STUDENT HANDBOOK FOR A.Y. 2024-25

I-B.TECH I &II SEM

DEPARTMENT OF

HUMANITIES & SCIENCES (ECE,CSE,CSM,CSD)

CMR ENGINEERING COLLEGE

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Vision of the Institute

To be recognized as a premier institution in offering the value based and futuristic quality technical education to meet the technological need of the society.

Mission of the the Institute

1. To impart value quality technical education through innovative teaching and learning methods.
2. To continuously produce employable technical graduates with advanced technical skills to meet the current and future technological need of the society.
3. To prepare the graduate for high learning with emphasis on academic and industrial research.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

- Excel in professional career or higher education by acquiring knowledge in mathematical, computing and engineering principles
- To provide intellectual environment for analyzing and designing computing systems for technical needs
- Exhibit professionalism, multidisciplinary teamwork and adapt to current trends by engaging in lifelong learning and practice their profession with legal, social and ethical responsibilities

Engineering Graduates will be able to satisfy these NBA graduate attributes:

Engineering knowledge: An ability to apply knowledge of computing, mathematics, science and engineering fundamentals appropriate to the discipline

Problem analysis: An ability to analyse a problem, and identify and formulate the computing requirements appropriate to its solution

Design/development of solutions: An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations

Conduct investigations of complex problems: An ability to design and conduct experiments, as well as to analyse and interpret data

Modern tool usage: An ability to use current techniques, skills, and modern tools necessary for computing practice

The engineer and society: An ability to analyze the local and global impact of computing on individuals, organizations, and society

Environment and sustainability: Knowledge of contemporary issues

Ethics: An understanding of professional, ethical, legal, security and social issues and responsibilities

Individual and team work: An ability to function effectively individually and on teams, including diverse and multidisciplinary, to accomplish a common goal

Communication: An ability to communicate effectively with a range of audiences

Project management and finance: An understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects

Life-long learning: Recognition of the need for and an ability to engage in continuing professional development

Quality Policy

Our quality policy is to continuously strive for over-all development of the department and the students. Our policy is to provide best inputs to the students and to develop them to imbibe the spirit of professionalism, dedication & commitment.

Dress Code

- We encourage our students to be formally dressed on and off campus. This nurtures the feeling of equality and belongings among the students fraternity.
- All students are required to carry Photo Identity card at all the time while in the campus.

POs:

1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES(PSO'S)

1. **Professional Skills and Foundations of Software development:** Ability to analyze, design and develop applications by adopting the dynamic nature of Software developments
2. **Applications of Computing and Research Ability:** Ability to use knowledge in cutting edge technologies in identifying research gaps and to render solutions with innovative ide

A Bird's Eye view about the Institution

CMR Engineering College, popularly known as CMREC is the brain child of the clairvoyant CH.Narasihma Reddy. CMR Engineering College is one of the best engineering Colleges for aspiring engineering students. It is one of the newly established Colleges by CMR Engineering Educational Society. CMR Engineering College was established in 2010 in 10 Acres and built up area of 4,785.78 Sq.m. with a single - minded aim to provide a perfect platform to students in the field of Engineering, Technology for their academic and overall personality development. The college has a very good academic activity which focuses for the campus placement.

The college is approved by the All India Council for Technical Education, New Delhi and is affiliated to JNT University Hyderabad. The CMREC is offering the three under graduate courses in ECE, CSE (AIML,CSD) and post graduate course in ECE and CSE.

Today, CMREC has grown in leaps and bounds and it is no wonder that CMREC has become cynosure of the eyes of many, hankering for the distinguished centre of technologicallearning.

Discipline, Character and Education are the three tenets for which CMREC stands, is certainly the haven where values blend seamlessly to churn out engineers for future.

- Collaborating with Institutions and Industries.
- Promoting research and development programme for the growth of economy.
- Disseminating technical knowledge in the region by continuing education programmes.
- Aiming at continual improvement of all round development of student

Department Profile

The humanities and sciences strongly acknowledge as the footing subject for all the other branches of engineering discipline. The humanities and sciences department aims at providing competitive quality of education and it supports the students to lay the basic profound foundation of information and knowledge to all the branches of engineering. The objective of the department is to make the students understand and aware of the importance of sciences and develop a natural elegance and interest towards engineering and technology, which in turn will enhance and mold the students into a competent professionals. It encourages the practical applications of concepts through the learning experience and active participation and sharpens the students' strength and capability to converse and think rationally, potentially, and innovatively in several ways and these are appropriate for their discipline.

The precept of the department is to cater the formidable education to the students with the assistance of well-qualified, dedicated and highly motivated faculty members. our faculty's research expertise in all frontier areas in English, physics, chemistry and mathematics will definitely aid the students to enrich their awareness in engineering studies. The faculty of humanities and sciences, impart the best teaching methodologies to the students, which results to mould the students to competent and true professionals, who are fit to apply their knowledge innovatively and independently and the outcome is they are recognized as ample engineers of the society.

Established: 2010 **EAMCET Code:** CMRN

Academic Regulations, Course Structure andDetailed Syllabus under Autonomous Status

BACHELOR OF TECHNOLOGY (B.TECH.)

(CMREC – R-22 Regulations)

(Applicable for the batch admitted from 2024-2025)

PRELIMINARY DEFINITIONS AND NOMENCLATURES

AICTE: Means All India Council for Technical Education, New Delhi.

Autonomous Institute: Means an institute designated as Autonomous by University Grants Commission (UGC), New Delhi in concurrence with affiliating University (Jawaharlal NehruTechnological University, Hyderabad) and State Government of Telangana.

Academic Autonomy: Means freedom to an institute in all aspects of conducting its academic programs, granted by UGC for Promoting Excellence.

Academic Council: The Academic Council is the highest academic body of the institute and is responsible for the maintenance of standards of instruction, education and examination within the institute. Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises two main semesters i.e., (one odd + one even) and supplementary semester.

Branch: Means specialization in a program like B.Tech. degree program in Electronics and communication Engineering, B.Tech degree program in Computer Science and Engineering, etc.

Board of Studies (BOS): BOS is an authority as defined in UGC regulations, constituted by Head of the Organization for each of the departments separately. They are responsible for curriculum design and updation in respect of all the programs offered by a department.

Backlog Course: A course is considered to be a backlog course, if the student has obtained a failure grade (F) in that course.

Basic Sciences: The courses offered in the areas of Mathematics, Physics, Chemistry etc., areconsidered to be foundational in nature.

Commission: Means University Grants Commission (UGC), New Delhi.

Choice Based Credit System: The credit based semester system is one which provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching along with provision of choice for the student in the course selection.

Compulsory course: Course required to be undertaken for the award of the degree as per the program.

Continuous Internal Examination: It is an examination conducted towards sessional assessment.

Core: The courses that are essential constituents of each engineering discipline are categorized as professional core courses for that discipline.

Course: A course is a subject offered by a department for learning in a particular semester.

Course Outcomes: The essential skills that need to be acquired by every student through a course.

Credit: A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture/tutorial/lab hour per week.

Credit point: It is the product of grade point and number of credits for a course.

Cumulative Grade Point Average (CGPA): It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all coursesin all the semesters. It is expressed up to two decimal places.

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

Department: An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff, and other resources in the processof study for a degree.

Dropping from Semester: Student who does not want to register for any semester can apply in writing in prescribed format before the commencement of that semester.

Elective Course: A course that can be chosen from a set of courses. An elective can be Professional Elective and or Open Elective.

Evaluation: Evaluation is the process of judging the academic performance of the student in her/his courses. It is done through a combination of continuous internal assessment and semester end examinations.

Grade: It is an index of the performance of the students in a said course. Grades are indicatedby alphabets.

Grade Point: It is a numerical weight allotted to each letter grade on a 10 - point scale.

Honors: An Honors degree typically refers to a higher level of academic achievement at anundergraduate level.

Institute: Means CMR Engineering, Hyderabad unless indicated otherwise by the context.

Massive Open Online Courses (MOOC): MOOC courses inculcate the habit of self-learning. MOOC courses would be additional choices in all the elective group courses.

Minor: Minor are coherent sequences of courses which may be taken in addition to thecourses required for the B.Tech. degree.

Pre-requisite: A specific course or subject, the knowledge of which is required to completebefore student register another course at the next grade level.

Professional Elective: It indicates a course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.

Program: Means, UG degree program: Bachelor of Technology (B.Tech.) and PG degree program: Master of Technology (M.Tech.).

Program Educational Objectives: The broad career, professional and personal goals that every student will achieve through a strategic and sequential action plan.

Project work: It is a design or research based work to be taken up by a student during his/herfinal year to achieve a particular aim. It is a credit based course and is to be planned carefully by the student.

Re-Appearing: A student can reappear only in the semester end examination for theory component of a course, subject to the regulations contained herein.

Registration: Process of enrolling into a set of courses in a semester of a program.

Regulations: The regulations, common to all B.Tech. programs offered by Institute, are designated as – CMREC Regulations – R-22 and are binding on all the stakeholders.

Semester: It is a period of study consisting of 15 to 18 weeks of academic work equivalent tonormally 90 working days. Odd semester commences usually in July and even semester in December of every year.

Semester End Examinations: It is an examination conducted for all courses offered in a semester at the end of the semester.

Student Outcomes: The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

University: Means Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, is an affiliating University.

Withdraw from a Course: Withdrawing from a course means that a student can drop from a course within the first two weeks of odd or even semester. However, he / she can choose a substitute course in place of it by exercising the option within 5 working days from the dateof withdrawal.

FOREWORD

The autonomy is conferred to **CMR Engineering College (CMREC),** Hyderabad by University Grants Commission (UGC), New Delhi based on its performance as well as future commitment and competency to impart quality education. It is a mark of its ability to functionindependently in accordance with the set norms of the monitoring bodies including JNT University Hyderabad (JNTUH), Hyderabad and AICTE, New Delhi. It reflects the confidence of the affiliating University in the autonomous institution to uphold and maintain standards it expects to deliver on its own behalf. Thus, an autonomous institution is given the freedom to have its own **examination system** and **monitoring mechanism**, independent of the affiliating University but under its observance.

CMREC is proud to win the credence of all the above bodies monitoring the quality in education and has gladly accepted the responsibility of sustaining, if not improving upon the standards and ethics for which it has been striving for more than a decade in reaching its present standing in the arena of contemporary technical education. As a follow up, statutory bodies such as Academic Council and Board of Studies (BOS) are constituted with the guidance of the Governing Body of the institute and recommendations of the JNTUH toframe the regulations, course structure, and syllabi under autonomous status.

The autonomous regulations, course structure, and syllabi have been prepared after prolongedand detailed interaction with several expertise solicited from academics, industry and research, in accordance with the vision and mission of the institute in order to produce a quality engineering graduate to the society.

All the faculty, parents, and students are requested to go through all the rules and regulations carefully. Any clarifications needed are to be sought at appropriate time and from the principal of the institute, without presumptions, to avoid unwanted subsequent inconveniences and embarrassments. The cooperation of all the stake holders is requested for the successful implementation of the autonomous system in the larger interests of the instituteand brighter prospects of engineering graduates.

PRINCIPAL

ACADEMIC REGULATIONS (R22) FOR B.TECH REGULAR STUDENTS WITH EFFECT FROM THE ACADEMIC YEAR 2024-25(CMREC-R22)

For pursuing four year under graduate Bachelor Degree Programme of study in Engineering (B.Tech.) offered by CMR Engineering College under Autonomous status is here in referred to as CMREC (An Autonomous Institution)

All the rules specified here in approved by the Academic Council will be in force and applicable to students admitted from the Academic Year 2024-25 onwards. Any reference to "Institute" or "College" in these rules and regulations shall stand for CMR Engineering College (An Autonomous Institution).

All the rules and regulations, specified hereafter shall be read as a whole for the purpose of interpretation as and when a doubt arises, the interpretation of the Chairman, Academic Council is final. As per the requirements of statutory bodies, the Principal, CMR Engineering College shall be the chairman Academic Council.

1.0 Under-Graduate Degree Programme in Engineering & Technology (UGP in E&T)

CMR Engineering College offers a 4-year (8 semesters) **Bachelor of Technology** (B.Tech.) degree programme, under Choice Based Credit System (CBCS) with effectfrom the academic year 2024-25

2.0 ADMISSION

2.1 Admission first year of four-year B. Tech. Degree Program of study in Engineering

Eligibility

A candidate seeking admission into the first year of four year B. Tech. Degree Program should have:

1. Passed either Intermediate Public Examination (I.P.E.) conducted by the Board of Intermediate Education, Telangana, with Mathematics, Physics and Chemistry as optional subjects or any equivalent examination recognized by Board of Intermediate Education, Telangana or a Diploma in Engineering in the relevant branch conducted by the Board of Technical Education, Telangana or equivalent Diploma recognized by Board of Technical Education for admission as per guidelines defined by the Regulatory bodies of Telangana State Council for Higher Education (TSCHE) and AICTE.
2. Secured a rank in the EAMCET examination conducted by the Telangana State Government or on the university or in the basis of any other order of merit approved by the

university, for allotment of a seat by the Convener, EAMCET.

Admission Procedure

Admissions are made into the first year of four year B. Tech. Degree Program as per thestipulations of the TSCHE.

(a) Category A seats are filled by the Convener, TSEAMCET (70%).
(b) Category B seats are filled by the Management (30%).

2.2 Admission into the second year of four year B. Tech. degree Program in Engineering

Eligibility

A candidate seeking admission under lateral entry into the II year I Semester B. Tech. degree Program should have passed the qualifying exam (B.Sc. Mathematics or Diploma in concerned course) and based on the rank secured by the candidate in Engineering Common Entrance Test ECET (FDH) in accordance with the instructions received from the Convener, ECET and Government of Telangana allotted the seats.

Admission Procedure

Admissions are made into the II year of four year B. Tech. Degree Program through Convener, ECET (FDH) against the sanctioned strength in each Program of study as lateral entry students.

3.0 B.Tech. Programme Structure

3.1 Programs Offered

CMR Engineering College, an autonomous institution affiliated to JNTUH, offers the following B. Tech. Programs of study leading to the award of B. Tech. degree under theautonomous scheme.

1) B.Tech. Computer Science and Engineering
2) B.Tech. Computer Science and Engineering (Artificial Intelligence &Machine Learning)
3) B.Tech. Computer Science and Engineering (Data Science)
4) B.Tech. Electronics and Communication Engineering

3.2 Duration of the Programs

A student after securing admission shall complete the B.Tech. programme in a minimum period of **four** academic years (8 semesters), and a maximum period of **eight** academic years (16 semesters) starting from the date of commencement of first year first semester, failing which student shall forfeit seat in B.Tech course. Each student shall secure 160 credits (with CGPA $\geq$ 5) required for the completion of the undergraduate programme and award of the B.Tech. degree.

3.3 UGC/ AICTE specified definitions/ descriptions are adopted appropriately for various terms and abbreviations used in these academic regulations/ norms, which are listed below.

3.3.1 Semester Scheme

Each undergraduate programme is of 4 academic years (8 semesters) with the academic year divided into two semesters of 22 weeks (□ 90 instructional days) each and in each semester - ‘Continuous Internal Evaluation (CIE)’ and ‘Semester End Examination (SEE)’

3.3.2 Credit Courses

All subjects/ courses are to be registered by the student in a semester to earn credits which shall be assigned to each subject/ course in an L: T: P: C (lecture periods: tutorial periods:practical periods: credits) structure based on the following general pattern.

- One credit for one hour/ week/ semester for Theory/ Lecture (L) courses or Tutorials.
- One credit for two hours/ week/ semester for Laboratory/ Practical (P) courses.

Courses like Environmental Science, Constitution of India, Intellectual Property Rights, and Gender Sensitization Lab are mandatory courses. These courses will not carry any credits.

3.3.3 Subject Course Classification

All subjects/ courses offered for the undergraduate programme in E&T (B.Tech. degree programmes) are broadly classified as follows.

S. No.	Broad Course Classification	Course Group/ Category	Course Description
1	Foundation Courses (FnC)	BS – Basic Sciences	Includes Mathematics, Physics and Chemistry subjects
2		ES - Engineering Sciences	Includes Fundamental Engineering Subjects
3		HS – Humanities and Social Sciences	Includes subjects related to Humanities, Social Sciences and Management

4	Core Courses (CoC)	PC – Professional Core	Includes core subjects related to the parent discipline/ department/ branch of Engineering.
5	Elective Courses (EℓC)	PE – Professional Electives	Includes elective subjects related to the parent discipline/ department/ branch of Engineering.
6		OE – Open Electives	Elective subjects which include inter-disciplinary subjects or subjects in an area outside the parent discipline/ department/ branch of Engineering.
7	Core Courses	Project Work	B.Tech. Project or UG Project or UG Major Project or Project Stage I & II
8		Industry Training/ Internship/ Industry Oriented Mini-project/ Mini- Project/ Skill Development Courses	Industry Training/ Internship/ Industry Oriented Mini-Project/ Mini-Project/ Skill Development Courses
9		Seminar	Seminar/ Colloquium based on core contents related to parent discipline/ department/ branch of Engineering.
10	Minor Courses	-	1 or 2 Credit Courses (subset of HS)
11	Mandatory Courses (MC)	-	Mandatory Courses (non-credit)

4.0 Course Registration

4.1 A 'faculty advisor or counselor' shall be assigned to a group of 20 students, who will advise the students about the undergraduate programme, its course structure and curriculum, choice/option for subjects/ courses, based on their competence, progress, pre- requisites and interest.

4.2 The academic section of the college invites 'registration forms' from students before the beginning of the semester through 'on-line registration', ensuring 'date and time stamping'. The on-line registration requests for any 'current semester' shall be **completed before the commencement of SEEs (Semester End Examinations) of the 'precedingsemester'**.

4.3 A student can apply for **on-line** registration, **only after** obtaining the '**written approval**' from faculty advisor/counselor, which should be submitted to the college academic section through the Head of the Department. A copy of it shall be retained with the Head of the Department, Faculty Advisor/ Counselor and the student.

4.4 A student may be permitted to register for all the subjects/ courses in a semester as specified in the course structure with maximum additional subject(s)/course(s) limited to 6 Credits (any 2 elective subjects), based on **progress** and SGPA/ CGPA, and completion of the '**pre-requisites'** as indicated for various subjects/ courses, in the department course structure and syllabus contents.

4.5 Choice for '**additional subjects/ courses**', not more than any 2 elective subjects in any Semester, must be clearly indicated, which needs the specific approval and signature of the Faculty Advisor/Mentor/HOD.

4.6 If the student submits ambiguous choices or multiple options or erroneous entries during **on-line** registration for the subject(s) / course(s) under a given/ specified course group/ category as listed in the course structure, only the first mentioned subject/ course in that category will be taken into consideration.

4.7 Subject/ course options exercised through **on-line** registration are final and **cannot** be changed or inter-changed; further, alternate choices also will not be considered. However,if the subject/ course that has already been listed for registration by the Head of the Department in a semester could not be offered due to any inevitable or unexpected reasons, then the student shall be allowed to have alternate choice either for a new subject(subject to offering of such a subject), or for another existing subject (subject to availability of seats). Such alternate arrangements will be made by the Head of the Department, with due notification and time-framed schedule, within **a week** after the commencement of class-work for that semester.

4.8 Dropping of subjects/ courses may be permitted, only after obtaining prior approval from the faculty advisor/ counselor 'within a period of 15 days' from the beginning of the current semester.

4.9 Open Electives: The students have to choose three Open Electives (OE-I, II & III) from the list of Open Electives given by other departments. However, the student can opt for an Open Elective subject offered by his own (parent) department, if the student has not registered and not studied that subject under any category (Professional Core, Professional Electives, Mandatory Courses etc.) offered by parent department in any semester. Open Elective subjects already studied should not repeat/should not match with any category (Professional Core, Professional Electives, Mandatory Courses etc.) of subjects even in the forthcoming semesters.

4.10 Professional Electives: The students have to choose six Professional Electives (PE-I to VI) from the list of professional electives given.

5.0 Subjects/ courses to be offered

5.1 A subject/ course may be offered to the students, **only if** a minimum of 15 students opt for it.

5.2 More than **one faculty member** may offer the **same subject** (lab/ practical may be included with the corresponding theory subject in the same semester) in any semester. However, selection of choice for students will be based on - '**first come first serve** basis and CGPA criterion' (i.e. the first focus shall be on early **on-line entry** from the student for registration in that semester, and the second focus, if needed, will be on CGPA of thestudent).

5.3 If more entries for registration of a subject come into picture, then the Head of the Department concerned shall decide, whether or not to offer such a subject/ course for **two (or multiple) sections**.

5.4 In case of options coming from students of other departments/ branches/ disciplines (not considering **open electives**), first **priority** shall be given to the student of the '**parent department**'.

6.0 Attendance requirements:

6.1 A student shall be eligible to appear for the semester end examinations, if the student acquires a minimum of 75% of attendance in aggregate of all the subjects/ courses (including attendance in mandatory courses like Environmental Science, Constitution of India, Intellectual Property Rights, and Gender Sensitization Lab) for that semester. **Two periods** of attendance for each theory subject shall be considered, if the student appears for the mid-term examination of that subject. **This attendance should also be included in the attendance uploaded every fortnight in the University Website.**

6.2 Shortage of attendance in aggregate upto 10% (65% and above, and below 75%) in each semester may be condoned by the college academic committee on genuine and valid grounds, based on the student's representation with supporting evidence.

6.3 A stipulated fee shall be payable for condoning of shortage of attendance.

6.4 Shortage of attendance below 65% in aggregate shall in **NO** case be condoned.

6.5 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examinations of that semester. They get detained and their registration for that semester shall stand cancelled, including all academic credentials (internal marks etc.) of that semester**. They will not be promoted to the next semester.** They may seek re-registration for all those subjects registered in that semester in which the student is detained, by seeking re-admission into that semester as and when offered; if there are any professional electives and/ or open electives, the same may also be re- registered if offered. However, if those electives are not offered in later semesters, then alternate electives may be chosen from the **same** set of elective subjects offered under that category.

6.6 A student fulfilling the attendance requirement in the present semester shall not be eligible for readmission into the same class.

7.0 Academic Requirements

The following academic requirements have to be satisfied, in addition to the attendancerequirements mentioned in Item No. **6**.

7.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course, if student secures not less than 35% (14 marks out of 40 marks including minimum 35% of average Mid-Term examinations for 25 marks) in the internal examinations, not less than 35% (21 marks out of 60 marks) in the semester end examination, and a minimum of 40% (40 marks out of 100 marks) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of letter grades, this implies securing **'C'** grade or above in that subject/ course.

7.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to Real-time Research Project (or) Field Based Research Project (or) Industry Oriented Mini Project (or) Internship (or) Seminar, if the student secures not less than 40% marks (i.e. 40 out of 100 allotted marks) in each of them. The student is deemed to have failed, if he (i) does not submit a report on Industry Oriented Mini Project/Internship, or (ii) not make a presentation of the same before the evaluation committee as per schedule, or (iii) secures less than 40% marks in Real-time Research Project (or) Field Based Research Project (or) Industry Oriented Mini Project (or) Internship evaluations.

A student may reappear once for each of the above evaluations, when they are scheduled again; if the student fails in such 'one reappearance' evaluation also, the student has toreappear for the same in the next subsequent semester, as and when it is scheduled.

7.3 Promotion Rules

S. No.	Promotion	Conditions to be fulfilled
1	**First year first semester to first year second semester**	**Regular course of study of first year first semester.**
2	**First year second semester to Second year first semester**	**(i) Regular course of study of first year second semester.** **(ii) Must have secured at least 20 credits out of 40 credits i.e., 50% credits up to first year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.**
3.	**Second year first semester to Second year second semester**	**Regular course of study of second year first semester.**
4	**Second year second semester to Third year first semester**	**(i) Regular course of study of second year second semester.** **(ii) Must have secured at least 48 credits out of 80 credits i.e., 60% credits up to second year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.**
5	**Third year first semester to Third year second semester**	**Regular course of study of third year first semester.**

6	**Third year second semester to Fourth year first semester**	**(i) Regular course of study of third year second semester.** **(ii) Must have secured at least 72 credits out of 120 credits i.e., 60% credits up to third year second**
		semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.
7	**Fourth year first semester to Fourth year second semester**	**Regular course of study of fourth year first semester.**

7.4 A student (i) shall register for all courses/subjects covering 160 credits as specified and listed in the course structure, (ii) fulfills all the attendance and academic requirements for 160 credits, (iii) earn all 160 credits by securing SGPA 5.0 (in each semester), and CGPA ≥ 5 (at the end of 8 semesters), (iv) **passes all the mandatory courses,** to successfully complete the undergraduate programme. The performance of the student in these 160 credits shall be considered for the calculation of the final CGPA **(at the end of undergraduate programme),** and shall be indicated in the grade card / marks memo of IV-year II semester.

7.5 If a student registers for '**extra subjects'** (in the parent department or other departments/branches of Engg.) other than those listed subjects totaling to 160 credits as specified in the course structure of his department, the performances in those '**extra subjects**' (although evaluated and graded using the same procedure as that of the required 160 credits) will not be considered while calculating the SGPA and CGPA. For such '**extra subjects'** registered, percentage of marks and letter grade alone will be indicated in the grade card / marks memo as a performance measure, subject to completion of the attendance and academic requirements as stated in regulations Items6 and 7.1 – 7.4 above.

7.6 A student eligible to appear in the semester end examination for any subject/ course, but absent from it or failed (thereby failing to secure **'C'** grade or above) may reappear for that subject/ course in the supplementary examination as and when conducted. In such cases, internal marks (CIE) assessed earlier for that subject/ course will be carried over, and added to the marks to be obtained in the SEE supplementary examination for evaluating performance in that subject.

7.7 A student **detained in a semester due to shortage of attendance may be re-admitted in the same semester in the next academic year for fulfillment of academic requirements**. The academic regulations under which a student has been re-admitted shall be applicable. Further, no grade allotments or SGPA/ CGPA calculations will be done for the entire semester in which the student has been detained.

7.8 A student detained **due to lack of credits, shall be promoted to the next academic year only after acquiring the required number of academic credits.** The academic regulations under which the student has been readmitted shall be applicable to him.

8.0 Evaluation - Distribution and Weightage of Marks

8.1 The performance of a student in every subject/course (including practicals and Project Stage – I & II) will be evaluated for 100 marks each, with 40 marks allotted for CIE (Continuous Internal Evaluation) and 60 marks for SEE (Semester End-Examination).

8.2 In CIE, for theory subjects, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of 2 hours as follows:

1. Mid_Term Examination for 30 marks:
   - ***a.*** Part - A : Objective/quiz paper for 10 marks. ***<u>(Five short answer 5*2=10 marks)</u>***
   - b. Part – B : Descriptive paper for 20 marks.

The objective/quiz paper is set with multiple choice, fill-in the blanks and match the following type of questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks. The **average of the two Mid Term Examinations** shall be taken as the final marks for Mid Term Examination (for 30 marks).
The remaining 10 marks of Continuous Internal Evaluation are distributed as:

2. Assignment for 5 marks. (**Average of 2 Assignments** each for 5 marks)
3. Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned subject for 5 marks.

While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

- Five (5) marks are allocated for assignments (as specified by the subject teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment (for 5 marks).

Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the subject concerned for 5 marks before II Mid-Term Examination.

 The Student, in each subject, shall have to earn 35% of marks (i.e. 14 marks out of 40 marks) in CIE, 35% of marks (i.e. 21 marks out of 60) in SEE and Overall 40% of marks (i.e. 40 marks out of 100 marks) both CIE and SEE marks put together.

- *The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥ 35% (14 marks) of 40 Continuous Internal Examination (CIE) marks.*
    - *In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 35% of CIE marks (14 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE.*
    - **There is NO Computer Based Test (CBT) for R22 regulations**.

- The details of the end semester question paper pattern are as follows:

.**8.2.1** The semester end examinations (SEE), for theory subjects, will be conducted for 60marks consisting of two parts viz. i) **Part- A** for 10 marks, ii) **Part - B** for 50 marks.

- Part-A is a compulsory question which consists of ten sub-questions from all units carrying equal marks.
- Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each. Each of these questions is from each unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.
- The duration of Semester End Examination is 3 hours.

8.3 For practical subjects there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks and 60 marks for semester end examination. Out of the 40 marks for internal evaluation:

1. A write-up on day-to-day experiment in the laboratory (in terms of aim, components/procedure, expected outcome) which shall be evaluated for 10 marks
2. **10 marks for viva-voce** (or) tutorial (or) case study (or) application (or) poster presentation of the course concerned.
3. Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for 10 marks.
4. The remaining 10 marks are for Laboratory Project, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the cluster / other colleges which will be decided by the examination branch of the University.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course

The Student, in each subject, shall have to earn 35% of marks (i.e. 14 marks out of 40 marks) in CIE, 35% of marks (i.e. 21 marks out of 60) in SEE and Overall 40% of marks (i.e. 40 marks out of 100 marks) both CIE and SEE marks put together.

The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥ 35% (14 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 35% of CIE marks (14 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE

8.4 The evaluation of courses having ONLY internal marks in I-Year I Semester and II- Year II Semester is as follows:

1. I Year I Semester course (*ex., Elements of CE/ME/EEE/ECE/CSE*): The internal evaluation is for 50 marks and it shall take place during I Mid-Term examination and II Mid-Term examination. The average marks of two Mid-Term examinations is the final for 50 marks. Student shall have to earn 40%, i.e 20 marks out of 50 marks from average of the two examinations. There shall be NO external evaluation. The student is deemed to have failed, if he (i) is absent as per schedule,or (ii) secures less than 40% marks in this course.
2. II Year II Semester *Real-Time (or) Field-based Research Project* course: The internal evaluation is for 50 marks and it shall take place during I Mid-Term examination and II Mid-Term examination. The average marks of two Mid-Term examinations is the final for 50 marks. Student shall have to earn 40%, i.e 20 marks out of 50 marks from average of the two examinations. There shall be NO external evaluation. The student is deemed to have failed, if he (i) does not submit a report on the Project, or (ii) does not make a presentation of the same before the internal committee as per schedule, or (ii) secures less than 40% marks in this course.

8.5 There shall be an Industry training (or) Internship (or) Industry oriented Mini-project (or) Skill Development Courses (or) Paper presentation in reputed journal (or) Industry Oriented Mini Project in collaboration with an industry of their specialization. Students shall register for this immediately after II-Year II Semester Examinations and pursue it during summer vacation/semester break & during III Year without effecting regular course work. Internship at reputed organization (or) Skill development courses (or) Paper presentation in reputed journal (or) Industry Oriented Mini Project shall be submitted in a report form and presented before the committee in III-year II semester before end semester examination. It shall be evaluated for 100 external marks. The committee consists of an External Examiner, Head of the Department, Supervisor of the Industry Oriented Mini Project (or) Internship etc, Internal Supervisor and a Senior Faculty Member of the Department. There shall be **NO internal marks** for Industry Training (or) Internship (or) Mini-Project (or) Skill Development Courses (or) Paper Presentation in reputed journal (or) Industry Oriented Mini Project.

8.6 The UG project shall be initiated at the end of the IV Year I Semester and the duration of the project work is one semester. The student must present Project Stage – I during IV Year I Semester before II Mid examinations, in consultation with his Supervisor, the title, objective and plan of action of his Project work to the departmental committee for approval before commencement of IV Year II Semester. Only after obtaining the approval of the departmental committee, the student can start his project work.

8.7 UG project work shall be carried out in two stages: Project Stage – I for approval of project before Mid-II examinations in IV Year I Semester and Project Stage – II during IV Year II Semester. Student has to submit project work report at the end of IV Year II Semester. The project shall be evaluated for 100 marks before commencement of SEETheory examinations.

8.8 For Project Stage – I, the departmental committee consisting of Head of the Department, project supervisor and a senior faculty member shall approve the project work to begin before II Mid-Term examination of IV Year I Semester. The student is deemed to be not eligible to register for the Project work, if he does not submit a report on Project Stage - I or does not make a presentation of the same before the evaluation committee as per schedule.

A student who has failed may reappear once for the above evaluation, when it is scheduled again; if he fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

8.9 For Project Stage – II, the external examiner shall evaluate the project work for 60 marks and the internal project commiittee shall evaluate it for 40 marks. Out of 40 internal marks, the departmental committee consisting of Head of the Department, Project Supervisor and a Senior Faculty Member shall evaluate the project work for 20 marks and Project Supervisor shall evaluate for 20 marks. The topics for Industry Oriented Mini Project/ Internship/SDC etc. and the main Project shall be different from the topic already taken. The student is deemed to have failed, if he (i) does not submit a report on the Project, or (ii) does not make a presentation of the same before the External Examiner as per schedule, or (iii) secures less than 40% marks in the sum totalof the CIE and SEE taken together.

For conducting viva-voce of project, University selects an external examiner from the list of experts in the relevant branch submitted by the Principal of the College.

A student who has failed, may reappear once for the above evaluation, when it is scheduled again; if student fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

8.10 A student shall be given one time chance to re-register for a maximum of two subjects:

- If the internal marks secured by a candidate in Mid examinations (average of two mid-term examinations consisting of Objective & descriptive parts) are less than 35% and failed in those subjects (or)

- failed in Assignment & Subject Viva-voce/ PPT/Poster Presentation/ Case Study on a topic in the concerned subject but fulfilled the attendance requirement. A student must re-register for the failed subject(s) for 40 marks within four weeks of commencement of the classwork in next academic year. Also, the student has to earn 35% of total internal marks (14 out of 40 marks including Mid-Term examinations, Assignment & Subject Viva-voce/PPT/ Poster presentation/ Case Study on a topic in the concerned subject).

In the event of the student taking this chance, his Continuous Internal Evaluation marks for 40 and Semester End Examination marks for 60 obtained in the previous attempt stand cancelled.

9.0 Grading Procedure

9.1 Grades will be awarded to indicate the performance of students in each Theory Subject, Laboratory/Practicals/ Industry-Oriented Mini Project/Internship/SDC and Project Stage. Based on the percentage of marks obtained (Continuous Internal Evaluation plus Semester End Examination, both taken together) as specified in item 8 above, a corresponding letter grade shall be given.

9.2 As a measure of the performance of a student, a 10-point absolute grading system using the following letter grades (as per UGC/AICTE guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured in a Subject/Course (Class Intervals)	Letter Grade (UGC Guidelines)	Grade Points
Greater than or equal to 90%	O (Outstanding)	10
80 and less than 90%	A^+ (Excellent)	9
70 and less than 80%	A (Very Good)	8
60 and less than 70%	B^+ (Good)	7
50 and less than 60%	B (Average)	6
40 and less than 50%	C (Pass)	5
Below 40%	F (FAIL)	0
Absent	Ab	0

9.3 A student who has obtained an '**F**' grade in any subject shall be deemed to have '**failed**' and is required to reappear as a 'supplementary student' in the semester end examination, as and when offered. In such cases, internal marks in those subjects will remain the same as those obtained earlier.

9.4 To a student who has not appeared for an examination in any subject, '**Ab**' grade will be allocated in that subject, and he is deemed to have '**Failed**'. A student will be required to reappear as a 'supplementary student' in the semester end examination, as and when offered next. In this case also, the internal marks in those subjects will remain the same as those obtained earlier.

9.5 A letter grade does not indicate any specific percentage of marks secured by the student, but it indicates only the range of percentage of marks.

9.6 A student earns Grade Point (GP) in each subject/ course, on the basis of the letter grade secured in that subject/ course. The corresponding 'Credit Points' (CP) are computed by multiplying the grade point with credits for that particular subject/ course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a course

9.7 A student passes the subject/ course only when **GP $\geq$ 5 ('C' grade or above)**

9.8 The Semester Grade Point Average (SGPA) is calculated by dividing the sum of credit points (□CP) secured from all subjects/ courses registered in a semester, by the total number of credits registered during that semester. SGPA is rounded off to **two** decimal places. SGPA is thus computed as

$$\textbf{SGPA} = \left\{ \sum_{i=1}^{N} C_i G_i \right\} / \left\{ \sum_{i=1}^{N} C_i \right\}$$ **…. For each semester**,

where 'i' is the subject indicator index (considering all subjects in a semester), 'N' is the no. of subjects '**registered'** for the semester (as specifically required and listed under the course structure of the parent department), C_i is the no. of credits allotted to the i^{th} subject, and G_i represents the grade points (GP) corresponding to the letter gradeawarded for that i^{th} subject.

9.9 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student in all semesters considered for registration. The CGPA is the ratio of the total credit points secured by a student in **all** registered courses (of 160) in **all** semesters, and the total number of credits registered in **all** the semesters. CGPA is rounded off to **two** decimal places. CGPA is thus computed from the I year II semester onwards at the end of each semester as per the formula

$$\textbf{CGPA} = \left\{ \sum_{j=1}^{M} C_j G_j \right\} / \left\{ \sum_{j=1}^{M} C_j \right\}$$ **… for all S semesters registered**

$j=1$

(i.e., up to and inclusive of S semesters, S ≥ 2),

where '**M'** is the **total** no. of subjects (as specifically required and listed under the course structure of the parent department) the student has '**registered'** i.e., from the 1st semester onwards up to and inclusive of the 8th semester, 'j' is the subject indicator index (takes into account all subjects from 1 to 8 semesters), C_j is the no. of credits allotted to the j^{th} subject, and G_j represents the grade points (GP) corresponding to the letter grade awarded for that j^{th} subject. After registration and completion of I year I semester, the SGPA of that semester itself may be taken as the CGPA, as there are no cumulative effects.

Illustration of calculation of SGPA:

Course/Subject	Credits	Letter Grade	Grade Points	Credit Points
Course 1	4	A	8	4 x 8 = 32
Course 2	4	O	10	4 x 10 = 40
Course 3	4	C	5	4 x 5 = 20
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	C	5	3 x 5 = 15
	21			152

SGPA = 152/21 = 7.24

Illustration of Calculation of CGPA up to 3rd Semester:

Semester	Course/ Subject Title	Credits Allotted	Letter Grade Secured	Corresponding Grade Point (GP)	Credit Points (CP)
I	Course 1	3	A	8	24
I	Course 2	3	O	10	30
I	Course 3	3	B	6	18
I	Course 4	4	A	8	32
I	Course 5	3	A+	9	27
I	Course 6	4	C	5	20
II	Course 7	4	B	6	24
II	Course 8	4	A	8	32
II	Course 9	3	C	5	15
II	Course 10	3	O	10	30
II	Course 11	3	B+	7	21
II	Course 12	4	B	6	24
II	Course 13	4	A	8	32
II	Course 14	3	O	10	30

III	Course 15	2	A	8	16
III	Course 16	1	C	5	5
III	Course 17	4	O	10	40
III	Course 18	3	B+	7	21
III	Course 19	4	B	6	24
III	Course 20	4	A	8	32
III	Course 21	3	B+	7	21
	Total Credits	**69**		**Total Credit Points**	**518**

CGPA = 518/69 = 7.51

The calculation process of CGPA illustrated above will be followed for each subsequent semester until 8th semester. The CGPA obtained at the end of 8th semester will becomethe final CGPA secured for entire B.Tech. programme.

9.10 For merit ranking or comparison purposes or any other listing, **only** the '**rounded off'** values of the CGPAs will be used.

9.11 SGPA and CGPA of a semester will be mentioned in the semester Memorandum of Grades if all subjects of that semester are passed in first attempt. Otherwise the SGPA and CGPA shall be mentioned only on the Memorandum of Grades in which sitting he passed his last exam in that semester. However, mandatory courses will not be taken into consideration.

10.0 Passing Standards

10.1 A student shall be declared successful or 'passed' in a semester, if he secures a GP ≥ 5 (**'C'** grade or above) in every subject/course in that semester (i.e. when the student gets an SGPA 5.0 at the end of that particular semester); and he shall be declared successful or 'passed' in the entire undergraduate programme, only when gets a CGPA
 5.00 (**'C'** grade or above) for the award of the degree as required.

10.2 After the completion of each semester, a grade card or grade sheet shall be issued to all the registered students of that semester, indicating the letter grades and credits earned. It will show the details of the courses registered (course code, title, no. of credits, grade earned, etc.) and credits earned. **There is NO exemption of credits in any case.**

11.0 Declaration of results

11.1 Computation of SGPA and CGPA are done using the procedure listed in 9.6 to 9.9.

11.2 For final percentage of marks equivalent to the computed final CGPA, the following formula may be used.

% of Marks = (final CGPA – 0.5) x 10

12.0 Award of Degree

12.1 A student who registers for all the specified subjects/ courses as listed in the course structure and secures the required number of 160 credits (with CGPA □ 5.0), within 8 academic years from the date of commencement of the first academic year, shall be declared to have '**qualified'** for the award of B.Tech. degree in the branch of Engineering selected at the time of admission.

12.2 A student who qualifies for the award of the degree as listed in item 12.1 shall be placed in the following classes.

12.3 A student with final CGPA (at the end of the undergraduate programme) > 8.00, and fulfilling the following conditions - shall be placed in '**First Class with Distinction'**.
However, he

(i) Should have passed all the subjects/courses in '**First Appearance'** within the first 4 academic years (or 8 sequential semesters) from the date of commencement of first year first semester.

(ii) Should not have been detained or prevented from writing the semester end examinations in any semester due to shortage of attendance or any other reason.

A student not fulfilling any of the above conditions with final CGPA > 8 shall be placed in **'First Class'.**

12.4 Students with final CGPA (at the end of the undergraduate programme) □ 7.0 but < 8.00 shall be placed in **'First Class'.**

12.5 Students with final CGPA (at the end of the undergraduate programme) □ 6.00 but < 7.00, shall be placed in '**Second Class'**.

12.6 All other students who qualify for the award of the degree (as per item 12.1), with final CGPA (at the end of the undergraduate programme) □ 5.00 but < 6, shall be placed in '**pass class**'.

12.7 A student with final CGPA (at the end of the undergraduate programme) < 5.00 will not be eligible for the award of the degree.

12.8 Students fulfilling the conditions listed under item 12.3 alone will be eligible for award of '**Gold Medal**'.

12.9 Award of 2-Year B.Tech. Diploma Certificate

1. A student is awarded 2-Year UG Diploma Certificate in the concerned engineering branch on completion of all the academic requirements and earned all the 80 credits (with in 4 years from the date of admission) upto B. Tech. – II Year – II Semester, if the student want to exit the 4-Year B. Tech. program. The student **once opted and awarded for 2-Year UG Diploma Certificate, the student will not be permitted to join** in B. Tech. III Year – I Semester and continue for completion of remaining years of study for 4-Year B. Tech. Degree.
2. A student may be permitted to take one year break after completion of II Year – II

Semester or B. Tech. – III Year – II Semester (with university permission through the principal of the college well in advance) and can re-enter the course in **next Academic Year in the same college** and complete the course on fulfilling all the academic credentials within a stipulated duration i.e. double the duration of the course (Ex. within 8 Years for 4-Year program).

13.0 Withholding of results

13.1 If the student has not paid the fees to the University at any stage, or has dues pending due to any reason whatsoever, or if any case of indiscipline is pending, the result of the student may be withheld, and the student will not be allowed to go into the next higher semester. The award or issue of the degree may also be withheld in such cases.

14.0 Transitory Regulations

A. For students detained due to shortage of attendance:

1. A Student who has been detained in I year of R18 Regulations due to lack of attendance, shall be permitted to join I year I Semester of R22 Regulations and he is required to complete the study of B.Tech./B. Pharmacy programme within the stipulated period of eight academic years from the date of first admission in I Year.
2. A student who has been detained in any semester of II, III and IV years of R18 regulations for want of attendance, shall be permitted to join the corresponding semester of R22 Regulations and is required to complete the study of B.Tech./B. Pharmacy within the stipulated period of eight academic years from the date of first admission in I Year. The R22 Academic Regulations under which a student has been readmitted shall be applicable to that student from that semester. See rule (C) for further Transitory Regulations.

B. For students detained due to shortage of credits:

A student of R18 Regulations who has been detained due to lack of credits, shall be promoted to the next semester of R22 Regulations only after acquiring the required number of credits as per the corresponding regulations of his/her first admission. The total credits required are 160 including both R18 & R22 regulations. The student is required to complete the study of B.Tech. within the stipulated period of eight academic years from the year of first admission. The R22 Academic Regulations are applicable to a student from the year of readmission. See rule (C) for further Transitory Regulations.

C. For readmitted students in R22 Regulations:

3. A student who has failed in any subject under any regulation has to pass those subjects in the same regulations.
4. The maximum credits that a student acquires for the award of degree, shall be the sum of the total number of credits secured in all the regulations of his/her study

including R22 Regulations. **There is NO exemption of credits in any case**.

5. If a student is readmitted to R22 Regulations and has any subject with 80% of syllabus common with his/her previous regulations, that particular subject in R22 Regulations will be substituted by another subject to be suggested by the University.

Note: If a student readmitted to R22 Regulations and has not studied any subjects/topicsin his/her earlier regulations of study which is prerequisite for further subjects in R22 Regulations, the College Principals concerned shall conduct remedial classes to cover those subjects/topics for the benefit of the students.

15.0 Student Transfers

15.1 There shall be no branch transfers after the completion of admission process.

15.2 There shall be no transfers from one college/stream to another within the constituent colleges and units of Jawaharlal Nehru Technological University Hyderabad.

15.3 The students seeking transfer to colleges affiliated to JNTUH from various other Universities/institutions have to pass the failed subjects which are equivalent to the subjects of JNTUH, and also pass the subjects of JNTUH which the students have not studied at the earlier institution. Further, though the students have passed some of the subjects at the earlier institutions, if the same subjects are prescribed in different semesters of JNTUH, the students have to study those subjects in JNTUH in spite of the fact that those subjects are repeated.

15.4 The transferred students from other Universities/Institutions to JNTUH affiliated colleges who are on rolls are to be provided one chance to write the CBT (for internal marks) in the **equivalent subject(s)** as per the clearance letter issued by the University.

15.5 The autonomous affiliated colleges have to provide one chance to write the internal examinations in the **equivalent subject(s)** to the students transferred from other universities/institutions to JNTUH autonomous affiliated colleges who are on rolls, asper the clearance (equivalence) letter issued by the University.

16.0 Scope

16.1 The academic regulations should be read as a whole, for the purpose of any interpretation.

16.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

16.3 The University may change or amend the academic regulations, course structure or syllabi at any time, and the changes or amendments made shall be applicable to all students with effect from the dates notified by the University authorities.

16.4 Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

ACADEMIC REGULATIONS FOR B.TECH (LATERAL ENTRY SCHEME) FROM THE AY 2025-26 (CMREC-R22)

1. Eligibility for the award of B.Tech Degree (LES)

The LES students after securing admission shall pursue a course of study for not less than three academic years and not more than six academic years.

2. The student shall register for 120 credits and secure 120 credits with CGPA ≥ 5 from II year to IV-year B.Tech. programme (LES) for the award of B.Tech. degree.

3. The students, who fail to fulfil the requirement for the award of the degree in six academic years from the year of admission, shall forfeit their seat in B.Tech.

4. The attendance requirements of B. Tech. (Regular) shall be applicable to B.Tech. (LES).

5. Promotion rule

S. No	Promotion	Conditions to be fulfilled
1	**Second year first semester to second year second semester**	**Regular course of study of second year first semester.**
2	**Second year second semester to third year first semester**	**(i) Regular course of study of second year second semester.** **(ii) Must have secured at least 24 credits out of 40 credits i.e., 60% credits up to second year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.**
3	**Third year first semester to third year second semester**	**Regular course of study of third year first semester.**
4	**Third year second semester to fourth year first semester**	**(i) Regular course of study of third year second semester.**

		(ii) Must have secured at least 48 credits out of 80 credits i.e., 60% credits up to third year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.
5	**Fourth year first semester to fourth year second semester**	**Regular course of study of fourth year first semester.**

6. All the other regulations as applicable to B. Tech. 4-year degree course (Regular)will hold good for B. Tech. (Lateral Entry Scheme).

7. LES students are not eligible for 2-Year B. Tech. Diploma Certificate.

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Malpractices Rules

Disciplinary Action For / Improper Conduct in Examinations

	Nature of Malpractices/Improper conduct	**Punishment**
	If the student:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which student is appearing but has not made use of (material shall include any marks on the body of the student which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the students involved. In case of an outsider, he will be handed over to the police and a case is registered against him.

2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The hall ticket of the student is to be cancelled and sent to the University.
3.	Impersonates any other student in connection with the examination.	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The
		student is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.

6.	Refuses to obey the orders of the chief superintendent/assistant – superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
	result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7.	Leaves the exam hall taking away answer script or intentionally tears off the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.

8.	Possesses any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeits the seat.
9.	If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject
		and all other subjects the student has already appeared for including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the student has appeared for including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award a suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the students as per the above guidelines.
2. Punishment for Institutions: (if the squad reports that the college is also involved in encouraging malpractices)
   a. A show-cause notice shall be issued to the college.
   b. Impose a suitable fine on the college.
   c. Shifting the examination center from one college to another college for a specificperiod of not less than one year.

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ACADEMIC CALENDAR

Date: 14-08-2024

B.Tech I Year - Academic Year 2024-2025

I-Semester

S.No.	Description	Period	Duration
1	Induction programme	19.08.2024 to 31.08.2024	2Weeks
2	Commencement of Class Work	02.09.2024	----
3	First Spell of Instructions (Including Dussehra Vacation)*	02.09.2024 to 02.11.2024	9 Weeks
4	***First Mid Examinations* (Theory & Practical)**	***04.11.2024 to 09.11.2024***	1Week
5	Second Spell of Instructions	11.11.2024 to 04.01.2025	8 Weeks
6	Submission of Mid-I Marks to Exam Branch	16.11.2024	---
7	Parent-Teacher Meeting	23.11.2024	---
8	***Second Mid Examinations* (Theory & Practical)**	***06.01.2025 to 11.01.2025***	1 Week
9	Preparations and Practical Examinations	13.01.2025 to 18.01.2025	1 Week
10	Submission of Mid-II Marks to Exam Branch	18.01.2025	---
11	***End Semester & Supplementary Examinations***	***20.01.2025 to 01.02.2025***	2 Weeks

II-Semester

S.No	Description	Period	Duration
1	Commencement of Class Work	03.02.2025	----
2	First Spell of Instructions	03.02.2025 to 29.03.2025	8 Weeks
3	***First Mid Examinations* (Theory & Practical)**	***31.03.2025 to 05.04.2025***	***1Week***
4	Second Spell of Instructions I	07.04.2025 to 10.05.2025	5Weeks
5	Submission of Mid-I Marks to Exam Branch	12.04.2025	
6	Parent-Teacher Meeting	19.04.2025	
7	***Summer vacation***	***12.05.2025 to 24.05.2025***	***2 Weeks***
8	Second Spell of Instructions II	26.05.2025 to14.06.2025	3Weeks
9	***Second Mid Examinations* (Theory & Practical)**	***16.06.2025 to 21.06.2025***	1Week
10	Submission of Mid-II Marks to Exam Branch	***28.06.2025***	---
11	Preparations and Practical examinations	23.06.2025 to 28.06.2025	1Week
12	***End Semester & Supplementary Examinations***	***30.06.2025 to 12.07.2025***	***2 Weeks***
13	Commencement of Class Work for the next A.Y 2025-2026	14.07.2025	---

***Dussehra Vacation Subject to declaration by JNTUH & TS Govt.**

Controller of Examinations **Principal**

ACADEMIC PLANNER (2024-25)

COURSE: IYEAR B. TECH

SUBJECT: Matrix Algebra and Differential Equations

CODE: MA101BS

YEAR: IYEARI SEM

ACADEMICPLANNER

SUBJECT: Matrix Algebra and Differential Equations

List of contents

1. Introduction
2. Prerequisites
3. Scope
4. Course Objective and out comes
5. Syllabus
6. List of subject experts
7. Journals
8. Session plan
9. Websites
10. Textbooks/Websites/Journals
11. Student's seminar topics
12. Final exam model papers
13. Question bank
14. PowerPointPresentations(PPTs)
15. Scheme of evaluation

1. Introduction

Engineersuseprinciplesofmathematicsandscienceintheirdailywork.Theworldcontains countless inefficienciesand problems.Engineers use their inquisitive minds to dig into theseproblems and come up with solutions. Throughout the process, an engineer will think on multiple levels. Forexample, an engineer may specify requirements to solve a problem, formulate it as a model. To solve this heneedstheconcepts of mathematics.

The main objective of Mathematics – I is to equip students with adequate knowledge of mathematics thatwillenable them informulating problems andsolving problems analytically.

At the end of the course the student will be in a position to use the concepts of mathematics – I likefinding solutions of linear equations, properties of matrices, whether a maxima or minima exists for afunction, finding solutions of differential equations of first and higher order, finding areas and volumes ofregionsusing multipleintegrals,applying LaplaceTransforms tosolve differentialequations.

2. PREREQUISITES

- Astudentshouldhavebasicknowledgeof calculus, differentiation&integration.
- Trigonometricratios,angles,identitiesetc.
- Matrices-order, addition, subtraction, multiplication of matrices, determinant, row & columntransformationsetc.
- Usageofcalculator
- Regularpracticeofproblemsandaboveall

3. SCOPE

The scope of mathematics is found in many of the engineering subjects of various branches. Some of the Computer science students make maximum use of matrices in coding and decoding.They use Boolean,Sparseand other matrices in many oftheircomputersubjects.

4. **Course Objectives**: To learn

- Determine the rank of the matrix and applying this concept to solving the system of linear equations.
- Concept of Eigen values and eigenvectorsand to reduce the quadratic form to canonical form.
- Geometrical approach to the mean value theorems and their application to the mathematical problems.
- Partial differentiation Finding maxima and minima of function of two and three variables.
- Methods of solving the differential equations of first orderand higher order.

Course Outcomes: After learning the contents of this subject the student must be able to

CO1: Solve the system of equations using matrices and interpret the rank of matrix using different methods.

CO2: Apply the concept of Eigen values, Eigen vectors in Cayley Hamilton theorem and Quadratic forms.

CO3: Examine the applications of Mean value theorems. Apply the concept of partial derivatives to findthe extreme values of functions.

CO4: Analyze the solutions of ODE of first order having first degree.

CO5: Solve higher order differential equations.

B.Tech I Year I Sem Syllabus (w.e.f. 2024-25)

MA101BS: MATRIX ALGEBRA AND DIFFERENTIAL EQUATIONS

Common for CSE, ECE, CSE (AI&ML), CSE(DS)

B. Tech. I Year I Sem **L T P C**

3 1 0 4

Course Objectives: To learn

- Determine the rank of the matrix and applying this concept to solving the system of linear equations.
- Concept of Eigen values and eigenvectorsand to reduce the quadratic form to canonical form.
- Geometrical approach to the mean value theorems and their application to the mathematical problems.
- Partial differentiation Finding maxima and minima of function of two and three variables.
- Methods of solving the differential equations of first orderand higher order.

Course Outcomes: After learning the contents of this subject the student must be able to

2. Solve the system of equations using matrices and interpret the rank of matrix using different methods.
3. Apply the concept of Eigen values, Eigen vectors in Cayley Hamilton theorem and Quadratic forms.
4. Examine the applications of Mean value theorems. Apply the concept of partial derivatives to findthe extreme values of functions.
5. Analyze the solutions of ODE of first order having first degree.
6. Solve higher order differential equations.

5. Syllabus

UNIT-I: Theory of Matrices (10 Hours)

Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss-Jordan method; System of linear equations; solving system of Homogeneous and Non-Homogeneous equations, Gauss elimination method, L-U decomposition method.

UNIT-II: Eigen values and Eigen vectors (10 Hours)

Eigen values and Eigen vectors and their properties (without proof); Diagonalization of a matrix; Cayley-Hamilton Theorem (without proof); finding inverse and power of a matrix by Cayley-Hamilton Theorem. Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

UNIT-III: Mean value theorems&Partial Differentiation and applications (10 Hours)

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem. Taylor's Series. (All theorems without proof). Jacobian; Functional dependence and independence, Maxima and minima of functions of two variables and three variables using method of Lagrange multipliers.

UNIT-IV: First Order ODE (8hours)

Exact differential equations, Equations reducible to exact differential equations, Linear and Bernoulli's equations;Applications: Newton's law of cooling, Law of natural growth and decay. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

UNIT-V: Higher Order ODE (10hours)

Second order linear differential equations with constant coefficients: non-Homogeneous terms of the type $e^{ax}, sinax, cosax$, polynomials in x, $e^{ax}V(x), x^{m}V(x)$; method of variation of parameters. Equations reducible to linear ODE with constant coefficients: Legendre's equation, Cauchy-Euler equation

TEXTBOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.

REFERENCES:

N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi

Publications, Reprint, 2008.

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002.

SYLLABUS-GATE

UNIT I

Algebraofmatrices,determinants,systemsoflinearequations

UNIT II

EigenvaluesandEigenvectors

UNIT III

Partialderivatives,Total derivatives,maxima& minima

UNIT IV

First order differential equations

UNIT V

Second and higher order differential equations

SYLLABUS-IES

UNITI

Algebraofmatrices,determinants,systemsoflinearequations

UNITII

EigenvaluesandEigenvectors

UNITIII

Partialderivatives,Total derivatives,maxima& minima

UNITIV

First order differential equations

UNITV

Second and higher order differential equations

6. List of subject expert details

EXPERTDETAILS

The Expert Details which have been mentioned below are only a few of the eminent ones knownInternationally,Nationally and Locally. Thereareafew others known as well.

INTERNATIONAL

1. AviM.Shapiro,ProfessorinApplied Mathematics,HarvardUniversity
2. DickeyEd,Professor, Universityof SouthCo1.

NATIONAL

1 Dr. K. Murugesan,Professor,Department of

Mathematics,NationalInstituteofTechnology,Tiru
chirappalli

2Dr.BalasubramanianRaman,Professor,IITRoorkee.

REGIONAL

1. Dr. Kasi Viswanatham K N S,Professor & Head,Maths Department,NIT, Warangal2. Dr.M ASrinivas,Professor &Head, MathsDepartment,JNTUH,Hyderabad.

7. JOURNALS

INTERNATIONAL

1. InternationalJournalof MathematicalEducationinScienceandTechnology
2. InternationalJournalofPureandAppliedMathematics
3. InternationalJournalofMathematicsResearch(IJMR)
4. InternationalJournalofScienceandMathematicsEducation
5. InternationalJournalofMathematicsandMathematicalSciences

NATIONAL

3. IndianJournalofMathematics(IJM)
4. IndianJournalofPureandAppliedMathematics(IJPAM)
5. AdvancedEngineeringMathematics,MichaelGreenberg,SecondEdition.Pearson

8. SessionPlan/LessonPlan

BRANCH:ECE,CSE,AI&ML,DS

SUB:MATRIX ALGEBRA AND DIFFERENTIAL EQUATIONS

TOPICS	SUB TOPICS	NO. OFPERIODS	SUGGESTED BOOKS	REMARKS	Teaching Methods
UNIT-I Matrices	Introduction 1.Typesofrealmatricesandcomplexmatrices 2.Rank a) Echelonform b) Normalform 3) InverseofNon-singularmatricesby a) Gauss-Jordan method 4) Systemoflinearequations a) solving system of HomogeneousequationsAX =0 b) solvingsystemofNon-HomogeneousequationsAX =B 5) Gausseliminationmethod 6) GaussSeidelIterationMethod.	L1 L2 L3 L4 L5 L6 L7 L8	T1,T2,R2	**UNIT-1** iscompleted byL8	M1,M2 M1,M2 M1,M2M1, M2 M1,M2,M1, M2 M1,M2
UNIT-II Eigenvaluesand Eigenvectors	1.Eigenvalues,Eigenvectors 2. propertiesDiagonalizationofamatrix 3. CayleyHamiltontheorem(withoutProof) a)Inverseandpowers ofamatrixusingCayleyHamiltontheorem 4) QuadraticForms a) RankandnatureoftheQuadraticforms b) Indexandsignature	L9 L10 L11, L12 L13 L14 L15 L16 L17 L18	T1,T2,R1, R2	**UNIT-2** iscompleted byL19	M1,M2 M1,M2 M1,M2 M1, M2 M1,M2 M1, M2

	7).ReductionofQuadraticformsintotheircanonicalform a)LinearTransformation b)OrthogonalTransformation	L19			M1,M2
UNIT–III **Mean value theorems&partial differentiation and applications**	1)Meanvaluetheorems a) Rolle'stheorem b)Lagrange'sMeanvaluetheoremwith their Geometrical Interpretation and applications,c) Cauchy's Mean value Theorem. 2)Taylor'sSeries. Jacobian; Functional dependence and independence Maxima and minima of functions of two variables Maxima and minima of functions of three variables using method of Lagrange multipliers.	L20 L21 L22 L23 L24 L25 L26, L27 L28 L29	T1,T2,R2	UNIT–3 Iscompleted byL29	M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2
UNIT-IV **FIRST ORDER ODE**	Exact differential equations Non-Exact differential equations reducible to exact	L30 L31, L32	T1,T2,R1		M1,M2 M1,M2

	Linear differential equations Non-linear differential equations reducible to linear (Bernoulli and Substitution Methods) Applications: Newton's law of cooling, Law of Natural growth and decay Equations solvable for p,y,x, Clairaut's type Revision	L34, L35 L36, L37 L38, L39 L40, L41 L42		UNIT–4 Iscompleted byL42 Iscompleted byL42	M1,M2
UNIT-V: Higher Order ODE	Homogenous linear higher order ode with constant coefficients Non-homogenous linear higher order ode with constant coefficients Method of variation of parameters Non-homogenous linear higher order ode with variable coefficients (Cauchy-Euler and Legendre ode's) Revision	L43, L44 L45, L46 L47 L48	T1,T2,R1	UNIT–5 Is completed byL48	M1,M2 M1,M2 M1,M2M1, M2

		48			

METHODSOFTEACHING:

M1:Greenboard	M3:Think-pair-share	M5:Mindmapping	M7:Assignment	M9:ProjectBased
M2:ICTMethods(PPT,E-Resources/Nptel)	M4:Grouplearning	M6:Mnemonics	M8:Industry Visit	M10:Charts/OHP/Others

9. Websites:

Websites/URLs/e-Resources :

1. http://www.engr.sjsu.edu/trhsu/Chapter%204%20Second%20order%20DEs.pdf
2. http://www.engr.sjsu.edu/trhsu/Chapter%203%20First%20order%20DEs.pdf
3. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
4. https://ocw.mit.edu/resources/res-18-006-calculus-revisited-single-variable-calculus-fall-2010/part-ii-differentiation/
5. http://nptel.ac.in/courses/111108081/
6. https://www.intmath.com/differential-equations/5-rl-circuits.php
7. https://www.youtube.com/watch?v=U-VAByа-XA0
8. https://www.slideshare.net/RajeshKumar670/electrical-circuits-in-concept-of-linear-algebra
9. http://personal.maths.surrey.ac.uk/st/S.Zelik/teach/calculus/max_min_2var.pdf

10. SUGGESTEDBOOKS

TEXTBOOKS:

1. B.S.Grewal,HigherEngineeringMathematics,KhannaPublishers,36thEdition,2010
2. Erwinkreyszig,AdvancedEngineeringMathematics,9thEdition,JohnWiley&Sons,2006.
3. G.B. ThomasandR.L. Finney,CalculusandAnalytic geometry,9thEdition,Pearson,Reprint,2002.

REFERENCES:

1. N.P.BaliandManishGoyal,A textbook ofEngineeringMathematics,LaxmiPublications,Reprint,2008.
2. RamanaB.V.,Higher EngineeringMathematics, TataMcGrawHillNew Delhi,11thReprint,2010.

11. SeminarTopics

- Echelonform
- **Normalform**
- Homogeneousequations
- **Non-Homogeneousequations.**
- **LU decomposition Method**
- Eigenvaluesandvectors
- **Quadraticforms**
- RolesTheoremgraphicalrepresentation
- **Lagrange'sgraphicalrepresentation**
- Cauchy'smeanvaluetheorem
- **Functionaldependence&independence**
- Maximaandminimaoffunctionsoftwoandthree variables
- Newton's law of cooling
- Law of natural growth or decay
- Linear differential equations
- First order and higher degree differential equations
- Higher order differential equations with constant coefficients
- Higher order differential equations with variable coefficients
- Method of variation of parameters

Code No.: MA101BS | R20 | H.T.No. | | | 8 | R | | | | | |

12.

CMR ENGINEERING COLLEGE: : HYDERABAD

UGC AUTONOMOUS

I–B.TECH–I–Semester End Examinations (Regular) - JULY- 2021

LINEAR ALGEBRA AND CALCULUS

(Common to CSE, CSM, CSD, CSC, IT, ECE and ME)

[Time: 3 Hours] [Max. Marks: 70]

1. *Answer Any **FIVE** Questions. Each Question Carries 14 Marks*
2. *Illustrate your answers with NEAT sketches wherever necessary.*

5 x 14M=70M

1. a) Find the rank of a Matrix $\begin{bmatrix} 1 & 2 & -1 & 3 \\ 4 & 1 & 2 & 1 \\ 3 & -1 & 1 & 2 \\ 1 & 2 & 0 & 1 \end{bmatrix}$ .using Echelon form

   b) Solve the system of equations $2x+3y+z=9$, $x+2y+3z=6$ and $3x+y+2z=8$.

2. Find the Eigen values and Eigen Vectors for $A=\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$

3. Verify Cayley Hamilton theorem for $A=\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ and hence find A^{-1} and A^4.

4. Reduce the quadratic form $2xy+2yz+2zx$ to canonical form and hence find the rank, index and nature of the quadratic form.

5. Test the convergence of the series $\sum_{n=1}^{\infty} \frac{2n!}{3.5.7...(2n+1)}$.

6. a) Verify Rolle's theorem for $f(x)=\log\left(\frac{x^2+ab}{x(a+b)}\right)$ on (a, b), a > 0 and b > 0.

   b) Evaluate $\int_0^{\infty} 2^{-3x^2}\,dx$ using gamma function.

7. Find the volume of the greatest rectangular parallelopiped that can be inscribed in the ellipsoid $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$.

8. a) Find volume of the object by revolving the semi-circle $x^2+y^2=a^2, a>0$ about its diameter.

   b) Verify $u=2x-y+3z$, $v=2x-y-z$ and $w=2x-y+z$ are functionally dependent and If so, find the relation between them.

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R18

Code No: 151AA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech I Year I Semester Examinations, December – 2019/January - 2020

MATHEMATICS-I

(Common to CE, EEE, ME, ECE, CSE, EIE, IT, MCT, MMT, AE, MIE, PTM, ITE)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Define Hermitian, Skew-Hermitian Matrices. [2]

b) State Cayley Hamilton theorem. [2]

c) State Ratio test. [2]

d) Define Beta and Gamma functions. [2]

e) Verify the continuity of $f(x,y)=\begin{cases}\dfrac{3xy}{x^2+y^2} & if \ \ (x,y)\neq(0,0)\\ 0 & if \ \ (x,y)=(0,0)\end{cases}$ at the origin. [2]

f) Define the rank of a matrix. [3]

g) Show that the determinant of a square matrix is equal to the product of the Eigen values for a 3×3 matrix. [3]

h) Test for the convergence of the series $\sum\left(\frac{n}{n+1}\right)^{n^2}$. [3]

i) Verify Rolle's mean value theorem for $f(x)=e^x(\sin x-\cos x)$ in $\left[\frac{\pi}{4},\frac{5\pi}{4}\right]$. [3]

j) If $z=f(x+ay)+g(x-ay)$ prove that $\frac{\partial^2 z}{\partial y^2}=a^2\frac{\partial^2 z}{\partial x^2}$. [3]

PART- B

(50 Marks)

2.a) Find the rank of $\begin{bmatrix}2 & 3 & -1 & -1\\ 1 & -1 & -2 & -4\\ 3 & 1 & 3 & -2\\ 6 & 3 & 0 & -7\end{bmatrix}$ by Normal form.

b) Find whether the following system of equations are consistant if so solve them $x-y+2z=5, 2x+y-z=1, 3x+y+z=8$. [5+5]

OR

3. Solve the following system of linear equations by using Gauss-Seidel method

$$20x+y-2z=17$$
$$3x+20y-z=-18$$
$$2x-3y+20z=25$$

[10]

4. Diagonalize the matrix $A=\begin{bmatrix}1 & 0 & -1\\ 1 & 2 & 1\\ 2 & 2 & 3\end{bmatrix}$. [10]

OR

5.a) Find the rank, index, signature of the quadratic form $x^2-2y^2+3z^2-4yz+6zx$.

b) Find the nature of the quadratic form $2x^2+2y^2+2z^2+2yz$. [5+5]

6.a) Test whether the series is conditionally convergent or absolutely convergent $\frac{1}{1.2}-\frac{1}{3.4}+\frac{1}{5.6}-\frac{1}{7.8}+....$

b) Examine the convergence of the series $\sum\frac{x^n}{n!}$. [5+5]

OR

7.a) Examine the absolute convergence of the series $\sum_{n=2}^{\infty}\frac{(-1)^n}{n(\log n)^2}$.

b) Test the convergence of the series $\frac{1}{2.3}+\frac{1}{3.4}+\frac{1}{4.5}+......$

[5+5]

8.a) Prove that $\frac{\pi}{6}+\frac{1}{5\sqrt{3}}<\sin^{-1}\left(\frac{3}{5}\right)<\frac{\pi}{6}+\frac{1}{8}$.

b) Verify Rolle's theorem for $f(x)=x(x+3)e^{-\frac{x}{2}}$ in $[-3,0]$. [5+5]

OR

9.a) Verify Cauchy's mean value theorem for x^2 and $\frac{1}{x^2}$ in (2, 4).

b) Prove that $\frac{\beta(p,q)}{p+q}=\frac{\beta(p,q+1)}{q}=\frac{\beta(p+1,q)}{p}$ $(p,q>0)$ [5+5]

10.a) Show that the function $f(x,y)=x^2-2xy+y^2+x^3-y^3+x^5$ has neither a maximum nor a minimum at $(0,0)$.

b) If $x=r\cos\theta$ and $y=r\sin\theta$, show that $\frac{\partial(r,\theta)}{\partial(x,y)}=\frac{1}{r}$. [5+5]

OR

11.a) If $u=f(r)$, where $r^2=x^2+y^2$, show that $\frac{\partial^2u}{\partial x^2}+\frac{\partial^2u}{\partial y^2}=f''(r)+\frac{1}{r}f'(r)$.

b) Find the area of a greatest rectangle that can be inscribed in an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$.

[5+5]

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Code No: 151AA **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech I Year I Semester Examinations, May/June - 2019
MATHEMATICS-I
(Common to CE, EEE, ME, ECE, CSE, EIE, IT MCT, MMT, AE, MIE, PTM)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) If A is orthogonal matrix, prove that A^T and A^{-1} are also orthogonal. [2]

b) Find the Eigen values of A^2, if $A=\begin{bmatrix} 1 & 2 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$. [2]

c) State Cauchy's integral test. [2]

d) State Rolle's theorem. [2]

e) State Euler's theorem for homogeneous function in x and y. [2]

f) State the conditions when the system of non homogenous equations AX=B will have i) unique solution ii) Infinite no of solutions iii) No solution. [3]

g) Prove that the Eigen values of a skew- Hermitian matrix are purely imaginary or zero. [3]

h) State Leibnitz test. [3]

i) Evaluate $\int_0^\infty e^{x^2} x^7 dx$. [3]

j) Find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$, if $u = x + y + z, v = x + y \text{ and } z = z$. [3]

PART- B

(50 Marks)

2. Using Gauss Seidel method solve 25x + 2y + 2z = 69, 2x + 10y + z = 63, x + y +z = 43. [10]

OR

3. Solve the system of equations x – y + 2z = 4, 3x + y + 4z = 6, x + y + z = 1 using Gauss elimination method. [10]

4. Find Eigen values and Eigen vectors of $\begin{bmatrix} 2 & 1 & -1 \\ 1 & 1 & -2 \\ -1 & -2 & 1 \end{bmatrix}$. [10]

OR

5. Find Eigen values and Eigen vectors of $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$. [10]

6.a) Test the convergence of the series $\sum_{n=0}^{\infty} \frac{n!(n+1)!}{(3n)!}$.

b) Find the radius of convergence of the series $\sum_{n=0}^{\infty} \frac{n^3 x^{3n}}{n^4+1}$. [5+5]

OR

7. Does the series $\sum_{n=0}^{\infty} \frac{(-1)^n}{\sqrt{n^2+1}}$ converge absolutely, conditionally or diverge? [10]

8.a) Expand $tan^{-1}x$ in powers of $(x-1)$ using Maclaurin's theorem.

b) Find the volume of the solid that results when the region enclosed by the curves xy = 1, x - axis and x = 1 rotated about x – axis. [5+5]

OR

9.a) Verify Cauchy mean value theorem for the functions e^x and e^{-x} in the interval (a,b).

b) Evaluate $\int_0^{\infty} x^4 e^{-x^2} dx$ Beta and Gamma. [5+5]

10.a) If $u = \log\left(\frac{x^2+y^2}{x+y}\right)$ prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 1$.

b) If x + y + z = u, y + z = uv, z = uvw, then evaluate $\frac{\partial(x,y,z)}{\partial(u,v,w)}$. [5+5]

OR

11.a) Show that U = $x^2e^{-y}\cosh z$, V = $x^2e^{-y}\sinh z$, w = $x^2+y^2+z^2-xy-yz-zx$ are functionally dependent. If dependent find the relationship between them.

b) Find the maximum of $x^2+y^2+z^2$ such that 2x+3y+z=14 using Lagrange's multiplier method. [5+5]

---ooOoo---

Code No: 131AA

R16

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech I Year I Semester Examinations, December - 2016
MATHEMATICS-I
(Common to all Branches)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Solve the following differential equation $n(2y - x^3)dx + x\,dy = 0$. [2]
b) Find the Particular Integral of the equation $(D^2 - 2D + 1)y = xe^x \sin x$ [3]
c) Examine whether the vectors are linearly dependent or not (3 1 1), (2 0 -1), (4 2 1).[2]
d) If $\alpha, \beta, and\ \gamma$ are the roots of the equation $x^3 + px + q = 0$ then the value of the determinant $\begin{vmatrix} \alpha & \beta & \gamma \\ \beta & \gamma & \alpha \\ \gamma & \alpha & \beta \end{vmatrix}$ is [3]
e) Compute the Eigen values and Eigen vectors of $\begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix}$. [2]
f) Find the Eigen values of the following system $\begin{matrix} 8x - 4y = \lambda x \\ 2x + 2y = \lambda y \end{matrix}$ [3]
g) Find the value of $\frac{\partial x}{\partial y} \cdot \frac{\partial y}{\partial z} \cdot \frac{\partial z}{\partial x}$ if f(x, y, z) = 0. [2]
h) Find $\frac{dy}{dx}$ if $x^y = y^x$. [3]
i) Form the partial differential equation by eliminating the arbitrary function $z = f(x^2 + y^2)$ [2]
j) Solve the following partial differential equation $y\,q - x\,p = z$. [3]

PART-B

(50 Marks)

2.a) Find the value of the constant d such that the parabolas $y = c_1 x^2 + d$ are the orthogonal trajectories of the family of ellipses $x^2 + 2y^2 - y = c_2$.
b) In a culture of yeast, the active ferment doubles itself in 3 hours. Determine the number of times it multiplies itself in 15 hours. [5+5]

OR

3.a) Solve $(D^2 + 5D + 6)y = e^x \cos 2x$.
b) Solve by the method of variation of parameters $y'' + y = \sec x$. [5+5]

4.a) Discuss the consistency of the system of equations $\begin{aligned} 2x + 3y + 4z &= 11 \\ x + 5y + 7z &= 15 \\ 3x + 11y + 13z &= 25 \end{aligned}$.

b) Find an LU decomposition of the Matrix A and solve the linear system AX=B

$$\begin{bmatrix} -3 & 12 & -6 \\ 1 & -2 & 2 \\ 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -33 \\ 7 \\ -1 \end{bmatrix}$$

[5+5]

OR

5.a) Solve the system of equations by the Gauss Seidel method

$$10x + y + z = 12$$
$$2x + 10y + z = 13$$
$$2x + 2y + 10z = 14$$

b) Convert the matrix into echelon form $\begin{bmatrix} 3 & 2 & 1 \\ 2 & 1 & 1 \\ 6 & 2 & 4 \end{bmatrix}$. [5+5]

6.a) Find A^{39} if $A = \begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$.

b) Compute the Modal matrix for $\begin{bmatrix} 5 & 4 \\ 12 & 7 \end{bmatrix}$. [5+5]

OR

7. Reduce the quadratic form $6x_1^2 + 3x_2^2 + 3x_3^2 - 4x_1x_2 - 2x_3x_2 + 4x_3x_1$ to the sum of squares and find the corresponding linear transformation. Find the index and signature. [10]

8.a) Determine the functional dependence and find the relation between $u = \frac{x-y}{x+y}$, $v = \frac{xy}{(x-y)^2}$.

b) If $u = x^2 + y^2 + z^2, v = xyz$ find $J\left(\frac{x, y}{u, v}\right)$. [5+5]

OR

9.a) Expand $x^2y + 3y - 2$ in powers of $x - 1$ using Taylor's theorem.

b) Find the maximum and minimum distances of the point (3, 4, 12) from the sphere $x^2 + y^2 + z^2 = 1$. [5+5]

10 Solve the partial differential equations:

a) $px(z - 2y^2) = (z - qy)(z - y^2 - 2x^3)$

b) $xp - yq + x^2 - y^2 = 0$. [5+5]

OR

11. Solve the partial differential equations:

a) $p(1 + q) = qz$

b) $z^2(p^2x^2 + q^2) = 1$. [5+5]

---ooOoo---

Code No: 121AB **R15**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech I Year Examinations, May/June - 2017
MATHEMATICS-I
(Common to CE, EEE, ME, ECE, CSE, EIE, IT, MCT, ETM, MMT, AE, AME, MIE, PTM, CEE, MSNT)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

Part- A (25 Marks)

1.a) Find the inverse of the matrix diag[a, b, c], a ≠ 0, b ≠ 0, c ≠ 0. [2]

b) Find the quadratic form corresponding to the symmetric matrix $\begin{bmatrix} 1 & -1 & 2 \\ -1 & 2 & -2 \\ 2 & -2 & 3 \end{bmatrix}$. [3]

c) Find C of the mean value theorem, if $f(x) = x(x-1)(x-2)$ and a = 0, b = 0.5. [2]

d) If $u = \frac{x+y}{1-xy}$, $v = \tan^{-1}x + \tan^{-1}y$ find $\frac{\partial(u,v)}{\partial(x,y)}$. [3]

e) Prove that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$. [2]

f) Evaluate $\int_{-1}^{1}\int_{-2}^{2}\int_{-3}^{3} dx\, dy\, dz$. [3]

g) Find the general solution of $(4D^2 + 4D + 1)y = 0$. [2]

h) Find $\frac{1}{D^2 - 1}e^x$. [3]

i) Find $L\left[te^{2t}\right]$. [2]

j) Find $L^{-1}\left\{\frac{s}{(s-1)(s-2)}\right\}$. [3]

Part-B (50 Marks)

2. Find for what values of λ the equations $x+y+z=1, x+2y+4z=\lambda, x+4y+10z=\lambda^2$ have a solution and solve them in each case. [10]

OR

3. If $A=\begin{bmatrix} 1 & 2 & -1 \\ 2 & 1 & -2 \\ 2 & -2 & 1 \end{bmatrix}$ verify Cayley-Hamilton theorem. Find A^{-1} using Cayley – Hamilton theorem. [10]

4.a) Verify Lagrange's mean value theorem for the function $f(x)=e^x$ in [0, 1].

b) Expand $\log\cos(x+h)$ in powers of h by Taylor's theorem. [5+5]

OR

5.a) If u and v are functions of x and y and $J=\dfrac{\partial(u,v)}{\partial(x,y)}$, $J'=\dfrac{\partial(x,y)}{\partial(u,v)}$ then prove that $JJ'=1$.

b) Find the minimum values of $x^2+y^2+z^2$ if $x+y+z=3a$. [5+5]

6. Show that $\int_0^{\pi/2} \sin^p\theta\cos^q\theta\, d\theta = \dfrac{\Gamma\left(\frac{p+1}{2}\right)\Gamma\left(\frac{q+1}{2}\right)}{2\Gamma\left(\frac{p+q+2}{2}\right)}$. [10]

OR

7. Change the order of integration and evaluate $\int_0^a \int_{x^2/a}^{\sqrt{x/a}} (x^2+y^2)\, dy\, dx$. [10]

8.a) Solve $x^3\sec^2 y\dfrac{dy}{dx}+3x^2\tan y=\cos x$.

b) If the surroundings are maintained at 30^{0}C and the temperature of body cools from 80^{0}C to 60^{0}C in 12 minutes, find the temperature of body after 24 minutes. [5+5]

OR

9.a) Solve $(D^2+3D+2)y=e^{-x}+\cos x$.

b) Solve $(D^3-7D^2+14D-8)y=e^x\cos 2x$. [5+5]

10.a) Find $L^{-1}\left\{\log\left(1+\dfrac{a^2}{s^2}\right)\right\}$

b) Find $L^{-1}\left\{\dfrac{s}{(s^2+4)^2}\right\}$ by convolution theorem. [5+5]

OR

11. Solve $\dfrac{d^2x}{dt^2}+2\dfrac{dx}{dt}+5x=e^{-t}\sin t, x(0)=0, x'(0)=1$ by Laplace transform. [10]

---ooOoo---

R13

Code No: 111AB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech I Year Examinations, October/November - 2016

MATHEMATICS-I

(Common to all Branches)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A **(25 Marks)**

1.a) Define Eigen vector of a matrix. [2]

b) Write the working procedure to solve the system of non-homogenous equations. [3]

c) Verify for $x = u,\ y = u\tan v,\ z = w,\ J\left(\frac{x, y, z}{u, v, w}\right) \times J'\left(\frac{u, v, w}{x, y, z}\right) = 1.$ [2]

d) Give an example of a function that is continuous on [-1, 1] and for which mean value theorem does not hold, explain. [3]

e) Show that $\beta(p,q) = \beta(p+1,q) + \beta(p,q+1)$. [2]

f) Evaluate $\int_0^1 \int_1^{2-x} xy\,dx\,dy$. [3]

g) Explain the method of solving Bernoulli equation. [2]

h) Solve $(D^4 + 2D^2n^2 + n^4)y = 0$. [3]

i) State and prove change of scale property of Laplace transforms. [2]

j) Prove that $L^{(-1)}\{F(s)\} = f(t)$ and $f(0) = 0$ then $L^{(-1)}\{sF(s)\} = \frac{df}{dt}$. [3]

PART-B **(50 Marks)**

2. Determine a non-singular matrix P such that P^TAP is a diagonal matrix, where

$$A = \begin{bmatrix} 0 & 1 & 2 \\ 1 & 0 & 3 \\ 2 & 3 & 0 \end{bmatrix}$$ [10]

OR

3.a) Show that the two matrices A, $C^{-1}AC$ have the same latent roots.

b) For a matrix $A = \begin{bmatrix} 1 & 2 & -3 \\ 0 & 3 & 2 \\ 0 & 0 & -2 \end{bmatrix}$ find the Eigen values of $3A^3 + 5A^2 - 6A + 2I$. [5+5]

4.a) Find the minimum and maximum values of $\sin x + \sin y + \sin(x+y)$.

b) If $u = \frac{1}{\sqrt{x^2+y^2+z^2}}$, $x^2+y^2+z^2 \neq 0$ then evaluate $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}$. [5+5]

OR

5.a) Prove that $\frac{\pi}{6}+\frac{1}{5\sqrt{3}}<\sin^{-1}\left(\frac{3}{5}\right)<\frac{\pi}{6}+\frac{1}{8}$.

b) Verify Lagrange's mean value theorem for $f(x)=\begin{cases} x\sin\frac{1}{x} & (x\neq 0) \\ 0 & (x=0) \end{cases}$ in [-1. 1]. [5+5]

6.a) Evaluate $\iiint_V x^{l-1}y^{m-1}z^{n-1}dxdydz$ where V is the region $x\geq 0, y\geq 0, z\geq 0$ and the plane $x+y+z<1$.

b) Express the integral $\int_0^\infty \frac{x^c}{c^x}dx\,(c>1)$ in terms of Gamma function. [5+5]

OR

7.a) By changing the order of integration and evaluate $\int_0^b\int_0^{\frac{a\sqrt{b^2-y^2}}{b}} xydydx$.

b) Find the area enclosed by the parabolas $x^2=y$ and $y^2=x$. [5+5]

8.a) The number N of bacteria in a culture grows at a rate proportional to N. The value of N was initially 100 and increased to 332 in one hour. What was the value of N after $1\frac{1}{2}$ hour?

b) Solve $(x-y)dx-dy=0, \quad y(0)=2.$ [5+5]

OR

9. Solve $(D^2-4D+4)y=x^2\sin x+e^{2x}+3.$ [10]

10.a) State and prove convolution theorem for Laplace transforms.

b) Find the Laplace transform of $f(t)=|t-1|+|t+1|, t\geq 0.$ [5+5]

OR

11.a) Solve the differential equation using Laplace transforms

$$\frac{d^2x}{dt^2}+3\frac{dx}{dt}+2x=e^{-t};\ x(0)=0, x'(0)=1.$$

b) Evaluate $L\left\{\int_0^t e^{-t}\cos t\,dt\right\}.$ [5+5]

--ooOoo—

13. MADEQUESTIONBANK

UNIT-I:MATRICES

Shortanswer questions

1. Find the valueofksuchthat the rankof$\begin{bmatrix}1 & 2 & 3\\ 2 & k & 7\\ 3 & 6 & 10\end{bmatrix}$is2.
2. Find thevalueofkif therank of matrix Ais 2 whereA= $\begin{bmatrix}0 & 1 & -3 & -1\\ 1 & 0 & 1 & 1\\ 3 & 1 & 0 & 2\\ 1 & 1 & k & 0\end{bmatrix}$.
3. Find the value ofk suchthattherankofA=$\begin{bmatrix}1 & 1 & -1 & 1\\ 1 & -1 & k & -1\\ 3 & 1 & 0 & 1\end{bmatrix}$is2.

Longanswerquestions

4. Definetherank of thematrixand find the rank ofthe followingmatrix $\begin{bmatrix}2 & 1 & 3 & 5\\ 4 & 2 & 1 & 3\\ 8 & 4 & 7 & 13\\ 8 & 4 & -3 & -1\end{bmatrix}$.

5. ReducethematrixtoEchelonform andhencefind itsrank.

A=$\begin{bmatrix}1 & 2 & 3 & 4\\ 1 & 2 & 3 & 1\\ -1 & -1 & 1 & 2\\ -1 & -1 & 1 & -1\end{bmatrix}$.

6. Findtherankof thematrixA=$\begin{bmatrix}2 & -2 & 0 & 6\\ 4 & 2 & 0 & 2\\ 1 & -1 & 0 & 3\\ 1 & -2 & 1 & 2\end{bmatrix}$byreducing ittocanonicalform.

7. Reducethe matrixto Ato normalform andhencefindits rank.

A=$\begin{bmatrix}2 & 1 & 3 & 4\\ 0 & 3 & 4 & 1\\ 2 & 3 & 7 & 5\\ 2 & 5 & 11 & 6\end{bmatrix}$.

8. Byreducingthematrix$\begin{bmatrix}2 & 3 & -1 & -1\\ 1 & -1 & -2 & -\\ 3 & 1 & 3 & -2\\ 6 & 3 & 0 & -7\end{bmatrix}$intonormalform,finditsrank.

9. Findtheinverseof thematrix A usingGauss-Jordan method.

A=$\begin{bmatrix}-1 & -3 & 3 & -1\\ 1 & 1 & -1 & 0\\ 2 & -5 & 2 & -3\end{bmatrix}$.

$-1 \quad 1 \quad 0 \quad 1$

10. Discussforwhatvalues of λ,μ thesimultaneous equations $x+y+z=6$, $x+2y+3z=10$, $x+2y+\lambda z=\mu$have(i)no solution(ii)a uniquesolution (iii)infinitesolutions.
11. Prove that the following set of equations are consistent and solve them.$3x+3y+2z=1$, $x+2y=4$, $10y+3z=-2$,$2x-3y-z=5$.
12. Find thevalues of p and q so that theequations $2x+3y+5z=9$, $7x+3y+2z=8$, $2x+3y+pz=q$have(i)nosolution (ii) a uniquesolution (iii) infinitesolutions.
13. Show that the only real number λ for which the system $x+2y+3z=\lambda x$, $3x+y+2z=\lambda y$,$2x+3y+z=\lambda z$has non-zero solution is 6 and solvethem, when $\lambda=6$.
14. Determine whether the following equations will have a non-trivial solution if so solvethem. $4x+2y+z+3w=0$, $6x+3y+4z+7w=0$, $2x+y+w=0$.
15. Express the following system of equations in matrix form and solve by Gauss Eliminationmethod. $2x_1+x_2+2x_3+x_4=6$; $6x_1-6x_2+6x_3+12x_4=36$; $4x_1+3x_2+3x_3-3x_4=-1$;$2x_1+2x_2-x_3+x_4=10$.
16. Use Gauss – Siedel Iteration method to solve the system. $10x+y+z=12$;$2x+10y+z=13$; $2x+2y+10z=14$.
17. Use Gauss – Siedel Iteration method to solve the system. $x+5y+2z=7$;$7x-y+z=2$; $x+2y+5z=9$.

UNIT-II:EIGENVALUESANDEIGENVECTORS

Shortanswer questions

1. Findtheeigenvalues andthe correspondingeigenvectorsof$\begin{bmatrix}5 & 4\\ 1 & 2\end{bmatrix}$.
2. Computethe eigen values and eigen vectors of$\begin{bmatrix}1 & 4\\ 3 & 2\end{bmatrix}$.
3. Findtheeigen values andeigen vectors of$\begin{bmatrix}2 & 1\\ 4 & 5\end{bmatrix}$
4. If2,3,5 aretheeigen values of amatrix A, thenfindthe eigen values of$2A^3+3A^2+5A+3I$.
5. FindtheeigenvaluesofA^{-1}, ifA = $\begin{bmatrix}2 & 3 & 4\\ 0 & 4 & 2\\ 0 & 0 & 3\end{bmatrix}$.
6. Forthe matrixA=$\begin{bmatrix}1 & 2 & 3\\ 0 & 3 & 2\\ 0 & 0 & -2\end{bmatrix}$find theeigenvaluesof $3A^3+5A^2-6A+2I$.
7. Using Cayley– Hamilton theorem, find A^8, if A=$\begin{bmatrix}1 & 2\\ 2 & -1\end{bmatrix}$.
8. Identifythenatureof the quadraticform $x_1^2+4x_2^2+x_3^2-4x_1x_2+2x_1x_3-4x_2x_3$.
9. Discuss thenatureof the quadraticform $x^2+4xy+6xz-y^2+2yz+4z^2$.

Long answer questions

10. Findthe eigen values andthe corresponding eigenvectors ofA=$\begin{bmatrix}-2 & 2 & 3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$.
11. Find thecharacteristic roots and the corresponding eigen vectorsof thematrix$\begin{bmatrix}6 & -2 & 2\\ -2 & 3 & -1\end{bmatrix}$.

2 −1 3

12. Find the eigen values and the corresponding eigenvectors of $A=\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$.

13. Find the eigen values and the corresponding eigenvectors of the matrix $A=\begin{bmatrix} 2 & 2 & 0 \\ 2 & 5 & 0 \\ 0 & 0 & 3 \end{bmatrix}$.

15. If $A=\begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 1 \\ -4 & 4 & 3 \end{bmatrix}$ find (i) A^8 (ii) A^4.

16. Using Cayley– Hamilton theorem, find the inverse and A^4 of the matrix $A=\begin{bmatrix} 7 & 2 & -2 \\ -6 & -1 & 2 \\ 6 & 2 & -1 \end{bmatrix}$.

17. Verify Cayley–Hamilton theorem for the matrix $A=\begin{bmatrix} 8 & -8 & 2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$.

18. Verify Cayley–Hamilton theorem for the matrix $A=\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$. Hence find A^{-1}.

19. Reduce the quadratic form $3x_1^2+5x_2^2+3x_3^2-2x_1x_2+2x_1x_3-2x_2x_3$ to canonical form and hence state nature, rank, index and signature of the quadratic form.

20. Reduce the quadratic form $3x_1^2+3x_2^2+3x_3^2+2x_1x_2+2x_1x_3-2x_2x_3$ into sum of squares form by an orthogonal transformation and give the matrix of transformation.

21. Reduce the quadratic form to canonical form by an orthogonal reduction and state the nature of the quadratic form $5x^2+26y^2+10z^2+4yz+14zx+6xy$.

UNIT-III: Mean value theorems & partial differentiation and applications

Short answer questions

– –

1. Verify Rolle's theorem for $f(x)=2x^3+x^2-4x-2$ in $[-\sqrt{3},\sqrt{3}]$.
2. Verify whether Rolle's theorem can be applied to the following functions in the intervals cited: (i) $f(x)=\tan x$ in $[0,\pi]$. (ii) $f(x)=\frac{1}{x^2}$ in $[-1,1]$. (iii) $f(x)=x^3$ in $[1,3]$.

3. Verify Rolle’s theorem for $f(x) = |x|$ in $[-1,1]$.
4. Verify Lagrange’s mean value theorem for $f(x)=x^3-x^2-5x+3$ in $[0,4]$.
5. Verify Lagrange’s mean value theorem for $f(x)=\log_e x$ in $[1,e]$.
6. Verify Lagrange’s mean value theorem for $f(x)=\cos x$ in $[0,\frac{\pi}{2}]$.

7. Show that for any $x>0$, $1+x<e^x<1+xe^x$.
8. Explain why Mean Value Theorem does not hold for $f(x)=x^{2/3}$ in $[-1,1]$.
9. Using Mean Value Theorem prove that $\tan x > x$ in $0<x<\frac{\pi}{2}$.
10. If $f(x) = \sqrt{x}$ and $g(x) = \frac{1}{\sqrt{x}}$ prove that ‘c’ of the Cauchy’s generalized mean value theorem is the geometric mean of ‘a’ and ‘b’ for any $a>0$, $b>0$.

Long answer questions

11. Verify Rolle’s theorem for the function $f(x) = e^{-x}\sin x$ in $[0,\pi]$.
12. Verify Rolle’s theorem for the function $f(x)=(x-a)^m(x-b)^n$ where m, n are positive integers in $[a,b]$.
13. Verify Rolle’s theorem for the function $f(x)=x^{\frac{2}{3}}-2x^{\frac{1}{3}}$ in $[0,8]$.

14. Verify Rolle’s theorem for the function $f(x) = x(x+3)e^{-\frac{x}{2}}$ in $[-3,0]$.
15. Verify Rolle’s theorem for the function $f(x)= e^x(\sin x-\cos x)$ in $[\frac{\pi}{4},\frac{5\pi}{4}]$.
16. Apply Rolle’s theorem for the function $f(x) = \sin x\sqrt{\cos 2x}$ in $[0,\frac{\pi}{4}]$.
17. If $a<b$, prove that $\frac{b-a}{(1+b^2)} < \tan^{-1}b-\tan^{-1}a < \frac{b-a}{(1+a^2)}$ using Lagrange’s mean value theorem deduce the following: (i) $\frac{\pi}{4}+\frac{3}{25} < \tan^{-1}\frac{4}{3} < \frac{\pi}{4}+\frac{1}{6}$ (ii) $\frac{5\pi+4}{20} < \tan^{-1}2 < \frac{\pi+2}{4}$

18. Using Lagrange’s mean value theorem prove $|\sin u-\sin v|\le|u-v|$.

Short answer questions

1. Find the points on the surface $z^2 = xy+1$ that are nearest to the origin.
2. Find the shortest distance from origin to the surface $xyz^2=2$.
3. Find the minimum value of $x^2+y^2+z^2$, given that $xyz = a^3$.
4. Find the minimum value of $x^2+y^2+z^2$ given $x+y+z=3a$.

5. Findthepointon theplane$3x+2y+z-12=0$,which isnearest tothe origin.
6. Findthemaximum valueofu=$x^2y^3z^4$if $2x+3y+4z=a$.
7. Findthepoints onthespherex$^2+y^2+z^2=4$ that areclosestand farthest from thepoint (3,1,-1).

Longanswerquestions

8..Findthemaximumand minimumvaluesoff=$3x^4-2x^3-6x^2+6x+1$.

9.Examineforminimum andmaximum values ofsin x+ sin y+sin (x+y).

10.Findthreepositivenumbers whosesum is 100and whoseproduct ismaximum.

11.Findthemaximum andminimumvalues of $f(x,y) =x^3y^2(1-x-y)$.

12.A rectangular box open at the top is to have volume of 32 cubic ft. Find the dimensions of the box requiringleastmaterial for its construction.

13. Divide 24 into three parts such that the continued product of the first, square of the second and cube of the thirdis maximum.

14.Findthemaximum valueofu=$x^2y^3z^4$if $2x+3y+4z=a$.

15.Given that $x+y+z=a$,find the maximum valueof$x^my^nz^p$.

8. powerPointPresentations(PPTs):

1.Unit-1

https://www.slideshare.net/vansi007/02-first-order-differential-equations

faculty.ksu.edu.sa/khawaja/.../02.5%20%20Exact%20Differential%20Eqaution.ppt

Unit-2

www.maths.unp.ac.za/coursework/Math132/lay_linalg5_01_01.pptwww.nplainfield.org/cms/.../Solving%20Systems%20of%20Linear%20Equations.ppt
zmarinco.weebly.com/uploads/5/4/0/1/54014121/systems_of_equations.ppt

Unit-3

www.ohio.edu/people/melkonia/math3200/slides/ch6.ppthttps://www.soest.hawaii.edu/GG/FACULTY/FRED/.../GG313_Lec_15_Eigen.ppthttps://www.slideshare.net/leingang/lesson-22-quadratic-forms

Unit-4
https://www.math.ubc.ca/~feldman/m105/maxmin.pdfhttps://www.sheltonstate.edu/Uploads/files/faculty/Lisa%20Nix/.../Section%209.2.ppt

Unit-5

www.powershow.com/.../First_Order_Partial_Differential_Equations_powerpoint_ppt..www.math.ucla.edu/~tat/MicroTeach/pde's.ppt

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ACADEMIC PLANNER

English for skill Enhancement

A.Y.2024-2025
(Common for CSE, ECE, CSM, CSD)

SUBJECT: English for skill Enhancement

COURSE CODE: EN104HS/EN204HS
YEAR: I Year I & II Semester

CONTENTS

1. INTRODUCTION

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training students to acquire language skills, the syllabus of “English for Skill Enhancement” has been designed to develop linguistic, communicative and critical thinking competencies of Engineering students. In English classes, the focus should be on the skills development in the areas of vocabulary, grammar, reading and writing.

2. PREREQUISITES

- Basic understanding of English, vocabulary.
- Ability to read and write.
- Basic knowledge of English grammar.
- Basic communication skills.

3. OBJECTIVES AND OUTCOMES

- ✓ Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
- ✓ Develop study skills and communication skills in various professional situations.
- ✓ Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

COURSE OUTCOMES: Students will be able to:

CO-1: Choose appropriate vocabulary and sentence structures for oral and written communication.
CO-2: Compare and **Contrast** the given text and respond appropriately.
CO-3: Demonstrate their understanding of the rules of functional grammar.
CO-4: Develop comprehension skills from the known and unknown passages.

4. SYLLABUS

UNIT-I

- Chapter entitled '***Toasted English***' **by R.K.Narayan** from ***"English:Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.
- **Vocabulary:** The Concept of Word Formation -The Use of Prefixes and Suffixes-Synonyms and Antonyms.
- **Grammar:** Identifying Common Errors in Writing with Reference to Articles and Prepositions.
- **Reading:** Reading and its Importance- Techniques for Effective Reading.
- **Writing:** Sentence Structures -Importance of Proper Punctuation- Paragraph writing – Types, Features of a Paragraph -Creating Coherence-Organizing Principles of Paragraphs in Documents.

<u>UNIT –II</u>

- Chapter entitled **'Appro JRD' by Sudha Murthy** from ***"English: Language, Context and Culture" published*** by Orient BlackSwan, Hyderabad.
- **Vocabulary:** Words Often Misspelt - Homophones, Homonyms and Homographs.
- **Grammar:** Identifying Common Errors in Writing with Reference to Noun-pronoun Agreement and Subject-verb Agreement.
- **Reading:** Sub-Skills of Reading – Skimming and Scanning.
- **Writing:** Defining-Describing People, Objects, Places and Events.

<u>UNIT –III</u>

- Chapter entitled **'Lessons from Online Learning' by F.Haider Alvi, Deborah Hurst et al** from "***English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.
- **Vocabulary**: Words Often Confused- Idioms and Phrases.
- **Grammar:** Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses.
- **Reading:** Sub-Skills of Reading -Intensive Reading and Extensive Reading.
- **Writing**: Writing Formal Letters E.g.., Letter of Complaint, Letter of Requisition, and Job Application with CV/Resume.

<u>UNIT –IV</u>

- Chapter entitled **'Art and Literature' by Abdul Kalam** from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.
- **Vocabulary**: Standard Abbreviations in English.
- **Grammar:** Redundancies in Oral and Written Communication.
- **Reading**: Survey, Question, Read, Recite and Review (SQ3R Method).
- **Writing:** Essay Writing and Précis Writing.

UNIT –V

- Chapter entitled **'Go, Kiss the World' by Subroto Bagchi** from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.
- **Vocabulary**: Technical Vocabulary and their usage
- **Grammar:** Error identification.
- **Reading:** Techniques for Reading Comprehension.
- **Writing:** Technical Reports- Characteristics of a Report - Structure of Reports (Manuscript Format) and Advertisement making.

5. LIST OF EXPERT DETAILS

INTERNATIONAL EXPERTS:

Scott Alkire

Lecturer, Department of Linguistics and Language Development

San José State University

USA

Dr. Steven J. Molinsky

Professor, Boston University Wheelock College

Education & Human Development.

Massachusetts

NATIONAL EXPERTS:

Prof. Paul Gunashekar

Dean, School of English Language Education

EFL-University-Hyderabad

REGIONAL EXPERTS:

Dr.V.Parvathi
Professor in English
JNTUH
PH NO: 9392535628

DR. J. SAVITHRI

M.A. [English], Ph.D, PGDELT, M.Sc [Psychology]-OU(CELT)

6. JOURNALS WITH MIN 5 REF PAPER FOR LITERATURE STUDY

https://ve-iitg.vlabs.ac.in/Common%20Error.html https://ve-iitg.vlabs.ac.in/Listening%20Skills.html

https://ve-iitg.vlabs.ac.in/Reading%20and%20Comprehension.html

https://ve-iitg.vlabs.ac.in/Vocabulary.html

https://ve-iitg.vlabs.ac.in/Technical%20Communication.html

7. LESSON PLAN

TOPICS	**SUB TOPICS**	**NO. OF PERIODS**	**SUGGESTED BOOKS**	**REMARKS**	**TEACHING METHODS**
UNIT-I Toasted English	**Introduction** ‘Chapter entitled ‘***Toasted English***’ **by R.K.Narayan**from ***“English:Language, Context andCulture”***publishedbyOrientBlackSwan ➢ **Vocabulary:** The Concept of Word Formation -The Use of Prefixes and Suffixes-Synonyms and Antonyms. ➢ **Grammar:** Identifying Common Errors in Writing with Reference to Articles and Prepositions. ➢ **Reading:** Reading and Its Importance- Strategies for Effective Reading- Sentence Structures-Phrases and Clauses in Sentences. ➢ **Writing:Punctuation-** Paragraph writing– Types, Features of Techniques for WritingPrecisely- Paragraph Writing.	L1 L2 L3 L4 L5 L6 L7 L8 L9 L10	T1	**UNIT-1** is completed by L10	M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M2 M1,M10

UNIT-II **Appro JRD**	➢ Chapter entitled ‘Appro JRD’ by Sudha Murthy from “English: Language, Context and Culture” published by Orient BlackSwan, ➢ **Vocabulary:** Words Often Misspelt - Homophones, Homonyms and Homographs. ➢ **Grammar:** Identifying Common Errors in Writing with Reference to Noun-pronoun Agreement and Subject-verb Agreement. ➢ **Reading:** Sub-Skills of Reading – Skimming and Scanning. ➢ **Writing:** Defining-Describing People, Objects, Places and Events.	L11 L12 L13 L14 L15 L16 L17	T1	**UNIT-2** is completed by L17	M1,M2, M1,M2 M1,M2,M7 M1,M2 M1,M2 M1,M2 M1,M2
	➢ Chapter entitled ‘Lessons from Online Learning’ by F.HaiderAlvi, Deborah Hurst et al from “English: Language, Context and Culture” published by Orient BlackSwan.	L18 L19 L20			M1,M2 M1,M2 M1,M2

UNIT – III **Lessons from Online Learning**	➢ **Vocabulary:** Words Often Confused- Idioms and Phrases. ➢ **Grammar:** Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses. ➢ **Reading:** Sub-Skills of Reading -Intensive Reading and Extensive Reading. ➢ **Writing**: Writing Formal Letters E.g.., Letter of Complaint, Letter of Requisition, and Job Application with CV/Resume.	L21 L22 L23 L24	T1	UNIT – 3 Is completed by L24	M1,M2 M1,M2 M1,M2 M1,M2
UNIT-IV Art and Literature	**Chapter entitled 'Art and Literature' by Abdul Kalam from "English: Language, Context and Culture" published by Orient BlackSwan** ➢ **Vocabulary:**Standard Abbreviations in English. ➢ **Grammar:**Redundancies in Oral and Written Communication. ➢ **Reading** Survey, Question, Read, Recite and Review (SQ3R Method). ➢ **Writing:** Essay Writing and Précis Writing.	L25 L26 L27 L28 L29	T1	UNIT – 4 Is completed by L29	M1,M2 M1,M2 M1,M2 M1,M2 M1,M2, M10

UNIT-V: Go, Kiss the World	Chapter entitled 'Go, Kiss the World' by SubrotoBagchi from "English: Language, Context and Culture" published by Orient BlackSwan ➢ **Vocabulary**: Technical Vocabulary and their Usage ➢ **Grammar:** Error identification. ➢ **Reading:** Techniques for Reading Comprehension. ➢ **Writing**: Technical Reports- Characteristics of a Report - Structure of Reports (Manuscript Format) and Advertisement making.	L30,L31 L32 L33 L34 L35 L36	T1	UNIT – 5 Is completed by L36	M1,M2 M1,M2,M7 M1,M2,M4 M1,M2 M1,M2,M7 M1,M2,M7
	Total Classes	**36**			

METHODS OF TEACHING:

M1:Green board	M3:Think-pair-share	M5:Mind mapping	M7:Assignment	M9:Project Based
M2:ICT Methods (PPT,E-Resources/Nptel)	M4:Group learning	M6:Mnemonics	M8:Industry Visit	M10:Charts/ OHP/Others

8. SUGGESTED BOOKS

"English: Language, Context and Culture" by Orient Black Swan Pvt. Ltd, Hyderabad. 2022. Print.

9. WEBSITES FOR SELF LEARNING RESOUREES LINK

https://www.literpretation.com/post/toasted-english-summary
http://www.svecw.edu.in/docs/2020/BS-Eng-Unit5-Summary.pdf
https://degmateng.wordpress.com/
https://scroll.in/article/1023118/
https://geekroll.wordpress.com/

10. MODEL PAPERS

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I.B.TECH- I-SEM MID-I EXAMINATIONS **Time: 10.00AM to 11:30AM**

SUBJECT: (EN105HS) ENGLISH **Marks: 30 M**

Note: This question paper contains two parts A and B.

Part-A is compulsory which carries 10 marks. Answer all questions in part-A.

Part-B consists of (21/2) units. Answer any one full question from each unit. Each question carries 5 marks and may have a,b,c sub questions.

Name:__________________________________

Hall Ticket No:

PART-A

(5x2=10) M

1. Provide prefixes to the following words
   i. Possible ii. Climax
2. Provide suffixes to the following words
   i. Suffocate ii. Capable
3. Fill in the blanks with articles
   i. My friend is going to ------------U.K for his MS.
   ii. If I get ---------- promotion, I will get higher salary.

4. Fill in the blanks with the right preposition
    i. The politician divided his property ------- his three daughters.
    ii. My teacher was angry ------- me because I was very late for his class.
5. Fill in the blanks with appropriate verbs or pronouns
    i. No matter how Ravi tried, ------ could not execute the program
    ii. Logistics ------ not my area of expertise.

Part-B 4X5=20

6. Discuss C.V.Raman discovery of scattering of light? CO1

(OR)

7. Why was Raman awarded the Noble Prize. CO1

8. Explain the significant advancements in the field of architecture during the reign of the Mauryan dynasty. CO2

(OR)

9. Draft a job application consisting of your resume and a cover letter for the position of a Trainee Engineer in BHEL, Hyderabad. CO-3

10. What are the steps in manufacturing the denim fabric? CO5

(OR)

11. Discuss the terms i. Carding ii. Sanforising iii. Washing CO-5

SUBJECT: ENGLISH **Branch: H&S**
Marks: 30 M

Note: Question paper contains two parts, Part - A and Part - B.

Part-A is compulsory which carries 10 marks. Answer all questions in part-A.

Part-B consists of (21/2) units. Answer any one full question from each unit. Each question carries 5marks and may have a, b, c sub questions.

PART-A

(5x2=10) M

1. Rewrite the following sentences by adding question tags to them.

a) Pavan has not kept his word

b) We work hard

c) Mani seldom writes letters

d) Shut the door

2. Solve the following Verbal Analogy.

a) Attack: defend:: timid: ___ a) quiet b) bold c) fight d) shy

b) Ocean: salty:: sharp: ___ a) blood b) knife c) cut d) bandage

c) Tomato: fruit ::sorghum: ___ a) wheat b) plant c) grain d) vegetable

d) Dove: peace:: lion: __ a) fierce b) cat c) courage d) symbol.

3. Identify the errors in these sentences and correct them.

a) We were going to market and bought fruits and vegetables.

b) MNTE is constructing this bridge since 2018 and it's not complete still.

c) Joseph is being a lecturer in an Engineering College.

d) When I was walking in the park, I was hearing a loud noise.

4. Find out the Abbreviation/Acronyms for the following words.

a) GIF b) LASER

c) TNT d) BBC

5. Write the theme of the "**Poem IF**"?

Part-B 4X5=20

6. Explain the sub skills of Reading with suitable examples. CO-1

(OR)

7. Describe your college Annual Day. CO-4

8. "Quality of food is more important than the quantity of food" explain with reference to what should you be eating? CO-2

(OR)

9. Write an Essay on the importance of "Women Education". CO-4

10. "MokshagundamVisweswarayya's contribution in nation building as an engineer is exemplary"- Elucidate. CO-1

(OR)

11. Write a report on "Covid-19". CO-4

11. TWO CASE STUDY PRESENTATIONS

- Literacy and the four skills of language acquisition
- Speaking and listening
- Writing
- Language learning for students *and* teachers
- Language learning for students *and* teachers
- Reading

12. ASSIGNMENT QUESTIONS/ INNOVATIVE ASSIGNMENTS

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ENGLISH FOR SKILL ENHANCEMENT
(A.Y 2024-2025) SEM-I
Assignment-I

BRANCH: ECE, AIML,CSD, CSE **SUBJECT: ENGLISH**

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1. 1. What qualities of Sir C.V. Raman are inspiring and worth emulating? Elucidate. [CO-1]
2. Why temples were the most important architectural achievements of various dynasties that ruled India? [CO-2]
3. Write a narrative paragraph on "India becoming a Republic" based on points given in Task 16, Page no: 21 from the textbook. [CO-2]
4. Create your own Resume and write a cover letter for the job advertisement given in task 18, page no: 70 from the textbook. [CO-1]
5. How were the Blue Jeans invented? Discuss its manufacturing process in detail. [CO-3]

INNOVATIVE ASSIGNMENT QUESTIONS:

1. Write a **paragraph** on' Covid 19 Pandemic"
2. Write a detail note about art and architecture in India.
3. List out the places known for ancient architectures in southern India?
4. Explain the **Reading techniques** for good comprehension.
5. Write a **letter** to a local bookseller enquiring if copies of the books prescribed in your syllabus are available with him/her. Find out about the mode of purchase available.
6. Create your own **Resume.** Write a C**over letter** for the job advertisement for a software developer.
7. What are the **Sub skills of Reading**? Or Explain **Skimming and Scanning** techniques of reading.
8. Explain **Intensive and Extensive** techniques of Reading.

9. Write an **essay** on Ethical Use of Digital Technology.
10. Write an **essay** about a memorable journey made to a historical place in your life?
11. Write a **report** on the Road Accident that took place in your area
12. Imagine you organize a sports day at your institute. Draft the highlights of the programme and prepare a report of the same. Assume relevant data.

13. LIST OF TOPICS FOR STUDENT SEMINARS

Seminar Topics:

- Raman discovery of Scattering of light.
- Reading techniques.
- Art and architecture in India.
- Healthy Eating Pyramid.
- Manufacturing processes of Blue Jeans.

14. STEP/ COURSE MATERIAL IN SOFT COPY

15. EXPERT LECTURES WITH TOPICS & SCHEDULES

S. NO	DATE	DETAILS
1	08/11/2024	Guest Lecture on Human Values & Ethics By Sri.Sudheer Sandra Garu, Psychologist & Motivational Speaker
2	19/12/2024	Guest Lecture on Personality Development By Sri.Mallesham Garu, Motivational Speaker
3	23/01/2025	Program By Dr.Yandamuri Virendranath in CMR Central Auditorium
4	04/02/2025	Mr.Chiranjeevi, Motivational speaker Talk

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ACADEMIC PLANNER

ENGLISH LANGUAGE COMMUNICATION SKILLS LAB

A.Y.2024-2025

(Common for CSE, ECE, CSM, CSD)

SUBJECT: ENGLISH LANGUAGE COMMUNICATION SKILLS LAB

COURSE CODE: EN108HS/EN208HS
YEAR: I Year I & II Semester

CONTENTS

1. INTRODUCTION

The **English Language and Communication Skills (ELCS) Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

2.PREREQUISITES

- Basic knowledge of English grammar
- Listening skills

- Basic understanding of English vocabulary
- Ability to write simple and good English
- Have interest to learn the language

3.OBJECTIVES AND OUTCOMES

- To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
- To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- To improve the fluency of students in spoken English and neutralize their mother tongue influence
- To train students to use language appropriately for public speaking and interviews

COURSE OUTCOMES: Students will be able to:

CO1: **Use** English with proper pronunciation.

CO2: **Describe** the persons, places, objects and events.

CO3: **Choose** appropriate vocabulary for oral and written communication.

CO4: **Develop** speaking skills with clarity and confidence.

4.SYLLABUS

Exercise-I

- **CALL Lab:** Listening Skill- Its importance-Types-Barriers-Effective Listening. Introduction to Phonetics – Speech Sounds- Vowels and Consonants -Minimal Pairs- Past Tense Marker and Plural Marker.
- **ICS Lab:** Ice-Breaking Activity and JAM Session.

Exercise-II

- **CALL Lab:** Structure of Syllables - Word Stress - Weak Forms and Strong Forms –Intonation.
- **ICS Lab:** Features of Good Conversation- Situational Dialogues – Role Play- Expressions in Various Situations –Telephone Etiquette.

Exercise-II

- **CALL Lab:** Structure of Syllables - Word Stress - Weak Forms and Strong Forms –Intonation.
- **ICS Lab:** Features of Good Conversation- Situational Dialogues – Role Play- Expressions in Various Situations –Telephone Etiquette.

Exercise-II

- **CALL Lab:** Structure of Syllables - Word Stress - Weak Forms and Strong Forms –Intonation.
- **ICS Lab:** Features of Good Conversation- Situational Dialogues – Role Play- Expressions in Various Situations –Telephone Etiquette., and Job Application with CV/Resume.

Exercise- V

- CALL Lab: Listening for Specific Details - Listening Comprehension.
- ICS Lab: Debate and Group Discussion.

5.LIST OF EXPERT DETAILS

Scott Alkire
Lecturer, Department of Linguistics and Language Development
San José State University
USA
Dr. Steven J. Molinsky
Professor, Boston University Wheelock College
Education & Human Development.
Massachusetts
National experts:
Prof. Paul Gunashekar
Dean, School of English Language Education

EFL-University-Hyderabad

Regional experts:
Dr.V.Parvathi
Professor in English
JNTUH

DR. J. SAVITHRI

M.A. [English], Ph.D, PGDELT, M.Sc [Psychology]-OU(CELT)

6.JOURNALS WITH MIN 5 REF PAPER FOR LITERATURE STUDY

https://ve-iitg.vlabs.ac.in/Common%20Error.html

https://ve-iitg.vlabs.ac.in/Listening%20Skills.html

https://ve-iitg.vlabs.ac.in/Reading%20and%20Comprehension.html

https://ve-iitg.vlabs.ac.in/Vocabulary.html

https://ve-iitg.vlabs.ac.in/Technical%20Communication.html

7.LESSON PLAN: Lab Schedule

	L LAB	**S LAB**	**SSIONS**
ERCISE-1	1.Phonetics	1.ice breaking activity	2
	2.Minimal pairs	2.Jam session	1
	3.Consonant clusters	3.Situational dialogs/r play	1
	4.Past tense markers		1

	5.Plural markers		1
EXERCISE-2	1.Syllables	1.Telephone etiquette	1
	2.word accent & stress shi		1
	3.Weak forms & str forms		1
	4.Intonation		1
EXERCISE-3	1.Common errors pronunciation	1.Describing objects	1
	2.Neutralization of mot tongue influence	2.Giving directions	1
EXERCISE-4	1.Listening skills	1.Extempore-public speaking	1
		2.Oral presentation ski	1
EXERCISE-5		1.Group discussions	1
		2.Interview skills	1
TOTAL SESSIONS			16

Each batch contains 32 students.

8.SUGGESTED BOOKS

- **ELCS Lab Manual:** A Workbook for CALL and ICS Lab Activities Orient BlackSwan

  References:

  Suresh Kumar, E. & Sreehari, P. 2009. A Handbook for English Language Laboratories. New Delhi: Foundation Speaking English Effectively 2nd Edition by Krishna Mohan and N. P. Singh, 2011. Macmillan Publishers India Ltd. Delhi.
- Sasi Kumar, V & Dhamija, P.V. How to Prepare for Group Discussion and Interviews. Tata McGraw Hill Hancock, M. 2009. English Pronunciation in Use. Intermediate. Cambridge: CUP Spoken English: A Manual of Speech and

Phonetics by R. K. Bansal & J. B. Harrison. 2013. Orient Blackswan. Hyderabad

- Hewings, M. 2009. English Pronunciation in Use. Advanced. Cambridge: CUP Marks, J. 2009. English Pronunciation in Use. Elementary. Cambridge: CUP Nambiar, K.C. 2011. Speaking Accurately. A Course in International Communication. New Delhi : Foundation Soundararaj, Francis. 2012. Basics of Communication in English. New Delhi: Macmillan Spoken English (CIEFL) in 3 volumes with 6 cassettes, OUP.
- English Pronouncing Dictionary Daniel Jones Current Edition with CD. A textbook of English Phonetics for Indian Students by T. Balasubramanian (Macmillan)

9.WEBSITES FOR SELF LEARNING RESOUREES LINK

- https://ve-iitg.vlabs.ac.in/Common%20Error.html
- https://ve-iitg.vlabs.ac.in/Listening%20Skills.html
- https://ve-iitg.vlabs.ac.in/Reading%20and%20Comprehension.html
- https://ve-iitg.vlabs.ac.in/Vocabulary.html
- https://ve-iitg.vlabs.ac.in/Technical%20Communication.html

10.MODEL PAPERS

Lab internal and external question papers with COS along with answer scripts

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ELCS LAB EXTERNAL QUESTION PAPER MARKS: 30

I. Answer any three of the following: (10 marks)

1. Define Phonetics? Write all the phonetics sounds with one example each? (CO1)
2. Define a syllable and types of syllables with one example each? (CO2)
3. What is role play? What are different types in role plays? Explain one of it.(CO2)

4. Define Intonation and types of Intonation with one example each? Explain falling tone? (CO3)

II. Day to day evaluation (15marks)

III. Viva (5marks)

ELCS LAB EXTERNAL EXAM

Answer any **FOUR** of the followings **Marks: 40 M**

ELCS LAB EXTERNAL PAPER MARKS: 70

ANSWER ANY FOUR OF THE FOLLOWING QUESTIONS: (40 MARKS)

1. Define phonetics? Write down all the consonant sounds with one example each? (CO1)
2. What you learned from ELCS lab? How come it is helpful for your future? (CO3)
3. What is role play? Write the difference between role play and situational dialogue? (CO2)
4. What are your short term goals and long term goals for your future? Explain them. (CO3)
5. Define presentation skills? Write the advantages of presentation skills? (CO1)

II. Day to day evaluation & activity (20 marks)

III. Viva (10 marks)

11.TWO CASE STUDY PRESENTATIONS

- Literacy and the four skills of language acquisition
- Speaking and listening
- Writing
- Language learning for students *and* teachers
- Language learning for students *and* teachers
- Reading

12. ASSIGNMENT QUESTIONS/ INNOVATIVE ASSIGNMENTS

13.INNOVATIVE ASSIGNMENT QUESTIONS:

13. Write a **paragraph** on' Covid 19 Pandemic"
14. Write a detail note about art and architecture in India.
15. List out the places known for ancient architectures in southern India?
16. Explain the **Reading techniques** for good comprehension.
17. Write a **letter** to a local bookseller enquiring if copies of the books prescribed in your syllabus are available with him/her. Find out about the mode of purchase available.
18. Create your own **Resume.** Write a C**over letter** for the job advertisement for a software developer.
19. What are the **Sub skills of Reading**? Or Explain **Skimming and Scanning** techniques of reading.
20. Explain **Intensive and Extensive** techniques of Reading.
21. Write an **essay** on Ethical Use of Digital Technology.
22. Write an **essay** about a memorable journey made to a historical place in your life?
23. Write a **report** on the Road Accident that took place in your area
24. Imagine you organize a sports day at your institute. Draft the highlights of the programme and prepare a report of the same. Assume relevant data.

14.LIST OF TOPICS FOR STUDENT SEMINARS

Seminar Topics:

- Raman discovery of Scattering of light.
- Reading techniques.
- Art and architecture in India.
- Healthy Eating Pyramid.
- Manufacturing processes of Blue Jeans.

15.STEP/ COURSE MATERIAL IN SOFT COPY

16. EXPERT LECTURES WITH TOPICS & SCHEDULES

S. NO	DATE	DETAILS
1	08/11/2024	Guest Lecture on Human Values & Ethics By Sri.Sudheer Sandra Garu, Psychologist & Motivational Speaker
2	19/12/2024	Guest Lecture on Personality Development By Sri.Mallesham Garu, Motivational Speaker
3	23/01/2025	Program By Dr.Yandamuri Virendranath in CMR Central Auditorium
4	04/02/2025	Mr.Chiranjeevi, Motivational speaker Talk

ACADEMIC PLAN FOR

THE ACADEMIC YEAR 2024-25

Regulation: R22

COURSE: I B.TECH I/II SEM

SUBJECT: APPLIED PHYSICS

CREDITS: 4

ACADEMIC PLANNER
Subject: APPLIED PHYSICS

S.NO	**CONTENT**
1	Introduction
2	Prerequisites
3	Scope
4	Course Objectives and Course outcomes
5	Syllabus
6	Expert details
7	Journals
8	Subject (lesson) Plan
9	Suggested books

-

10	Websites
11	Models
12	Student seminar Topics
13	Final exam Model papers
14	Assignment questions
15	Course material

(1) INTRODUCTION:

The Applied Physics is designed for students who have an interest in and an aptitude for both engineering and physics. The program provides students with a firm foundation in physics and mathematics, together with engineering design and problem-solving skills. This background prepares students to tackle complex problems in multidisciplinary areas that are at the forefront of 21st-century technology, such as solid state devices, quantum optics and photonics, materials science, nanotechnology, electromechanical systems, energy systems, and any engineering field that requires a very solid background in physics. Because the Applied physics emphasizes science, mathematics and engineering, students are well prepared to pursue graduate work in engineering, physics or applied physics.

(2) SCOPE:

- The study of Applied Physics emphasizes the application of basic scientific principles to the design of equipment, which includes electronic and electro-mechanical systems, for use in measurements and communications.
- The program is recommended for students interested in newly developing areas of physics, high technology, instrumentation and communications. Applied physics is fully accredited by the Canadian Engineering Accreditation Board so graduates will be eligible to be certified as a professional engineer. Graduates are also qualified for entry into graduate schools in Physics or other disciplines.

(3) PREREQUISITES:

A quantitative introduction to topics learned in elementary schooling and intermediate is required and basic mathematical knowledge is needed.

(4) COURSE OBJECTIVES AND COURSE OUTCOMES

OBJECTIVES: The course primarily aims at understanding the behaviour of matter in the condensed state and tries to explore the causes with reference to micro level mechanism of the solid matter.

- The objective of the first chapter is to study the micro level behaviour of the quantum particles of the matter and assess the draw backs of the free electron theory leading to the introduction of the Band Theory of Solids.
- The second chapter focuses on the working principles and applications of basic semiconductor devices.
- In the third chapter task to discuss dielectric, magnetic properties of the materials and applications.
- In the fourth chapter plan to discuss on fabrication of nanoparticles and their characterization techniques.
- In the fifth chapter, it is expected to understand the basic principles behind the coherent artificial light source (LASER) with reference to their construction, mechanism, operation and classification etc. In second part of this chapter aimed at to study an advanced communication system presently ruling the world throughout i.e. Fiber Optic communication system.

COURSE OUTCOMES: After learning the contents of this paper the student must be able to

CO1: Predict the behaviour of particle and wave and **solve** their wave functions.

CO2: Distinguish the different types of Semiconductor devices

CO3: Recall and **choose** different materials based on their properties.

CO4: Categorize Nano materials by fabrication methods.

CO5: Examine normal light and laser light and its **application** in communication.

(5) SYLLABUS:

UNIT - I: QUANTUM PHYSICS AND SOLIDS
10hrs

Quantum Mechanics: Introduction to quantum physics, blackbody radiation – Stefan-Boltzmann's law, Wein's and Rayleigh-Jean's law, Planck's radiation law - photoelectric effect –de-Broglie hypothesis- Davisson and Germer experiment –Heisenberg uncertainty principle - Born interpretation of the wave function – time independent Schrodinger wave equation - particle in one dimensional potential box.

Solids: Symmetry in solids, free electron theory (Drude & Lorentz) Variation of Fermi level-with temperature - Bloch's theorem -Kronig-Penney model – E-K diagram- effective mass of electron-origin of energy bands- classification of solids.

LAB:

- Determination of work function and Planck's constant using photoelectric effect.

UNIT - II: SEMICONDUCTORS AND DEVICES
10hrs

Intrinsic and extrinsic semiconductors – Hall effect - direct and indirect band gap semiconductors - construction, principle of operation and characteristics of P-N Junction diode, Zener diode and bipolar junction transistor (BJT) – structure, materials, working principle and characteristics: LED, PIN diode, avalanche photo diode (APD) and solar cells.

LAB:

- Determination of Hall co-efficient and carrier concentration of a given semiconductor.
- Characteristics of series and parallel LCR circuits.
- V-I characteristics of a p-n junction diode and Zener diode.
- Input and output characteristics of BJT
- V-I and L-I characteristics of light emitting diode (LED)
- V-I Characteristics of solar cell
- Determination of Energy gap of a semiconductor.
- Determination of the resistivity of semiconductor by two probe method

UNIT - III: DIELECTRIC, MAGNETIC AND ENERGY MATERIALS
10hrs

Dielectric Materials: Basic definitions- types of polarizations (qualitative) – piezoelectric, ferroelectric and pyroelectric materials – applications – liquid crystal displays (LCD).

Magnetic Materials: Basic definitions- Hysteresis - soft and hard magnetic materials - magnetostriction, magnetoresistance - applications - memory devices, magnetic field sensors and multiferroics.

Energy Materials: Conductivity of liquid and solid electrolytes- superionic conductors - materials and electrolytes for super capacitors - rechargeable ion batteries, solid fuel cells.

LAB:

- Study B-H curve of a magnetic material.
- Determination of time constant of RC Circuit

UNIT - IV: NANOTECHNOLOGY
10hrs

Introduction, Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods – top-down fabrication: ball milling - physical vapor deposition (PVD) - chemical vapor deposition (CVD) - characterization techniques - XRD, SEM &TEM - applications of nanomaterials.

UNIT - V: LASER AND FIBER OPTICS
10hrs

Lasers: Laser beam characteristics-three quantum processes-Einstein coefficients and their relations-lasing action - pumping methods- ruby laser, He-Ne laser , CO2 laser, semiconductor laser-applications of laser.

Fiber Optics: Introduction to optical fiber- advantages of optical Fibers - total internal reflection, construction of optical fiber - acceptance angle - numerical aperture- classification of optical fibers-losses in optical fiber- optical fiber for communication system – applications: medical, sensor and communication.

LAB:

- Determination of the beam divergence of the given LASER beam
- Determination of Acceptance Angle and Numerical Aperture of an optical fiber

GATE SYLLABUS:

- Particle in potential box
- Effective mass of electron
- Energy bands in silicon, intrinsic and extrinsic silicon.
- Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity.
- Generation and recombination of carriers in junction diode.
- Basics of LASERs and fiber optics

IES (INDIAN ENGINEERING SERVICES) SYLLABUS

- Conductors, Semiconductors and Insulators.
- Electrons and holes in semiconductors, Carrier Statistics.
- Mechanism of current flow in a semiconductor,
- Hall effect,
- Different types of diodes and their characteristics.
- Magnetic, Ferroelectric, Piezoelectric, Ceramic materials
- Optical and Super-conducting materials.

(6) SUBJECT EXPERTS DETAILS:

INTERNATIONAL:

1. **Serge Haroche, Professor at Collège de France (Holder of the chair in quantum physics). Phone : +33 (0)1 44 27 16 20**
2.
3. **David J. Wineland**, a lecturer in the University of Colorado Boulder physics department .
   Email: *david.wineland@colorado.edu*

NATIONAL:

1) **Dr. B.APPA RAO, Professor of Physics,** University College of Science, Osmania University, Hyderabad –500 007, CON: 9391060524
2) **Dr. S.P.Mallikarjun Rao, Professor of Physics,** University College of Science, Osmania University, Hyderabad –500 007
3) **Dr Katta Narasimha Reddy, Professor of Physics,** University College of Science, Osmania University, Hyderabad –500 007
4) **Dr. S. Chandralingam** is Professor of Physics at JNTUH College of Engineering, Hyderabad.
5) **Dr. G. Sathaiah,** Professor of Physics, Department of Physics ,Kakatiya University, Warangal

(7) JOURNALS

INTERNATIONAL

1. Journal of material science

2. Journal of Applied Physics

3. American Journal Of Physics

4. Physics of Solid State

5. Journal of Applied Crystallography

NATIONAL

1. Resonance (Indian Academy of Science, Bangalore)

2. Indian Journal of Pure and Applied Physics

3. Sadhana (Indian Academy Of science, Bangalore)

4. Pramana (Indian Academy Of science, Bangalore)

5. Journal of pure and applied Physics

6. Indian journal of Physics.

(8) SUBJECT (LESSON) PLAN

NAME OF THE TOPIC	NO.OF LECTURES REQUIRED	TENTATIVE DATE FOR COMPLETION OF TOPIC	TEACHING METHODS
UNIT 1 QUANTUM PHYSICS AND SOLIDS			
Introduction to quantum physics	**L1**	8/11/24	M1
Black body radiation-Stefans Boltzmann law,Weins law and Rayleigh-Jean's law	**L2**	11/11/24	M1
Plank's radiation law, photo electric effect	**L3**	11/11/24	M1,M2
Wave and particle, Matter Waves, de-Broglie Hypothesis	**L4**	12/11/24	M1
Characteristics of matter waves, Davisson and Germer's Experiment	**L5**	14/11/24	M1
Heisenberg's Uncertainty principle, Physical Significance of the Wave Function	**L6**	15/11/24	M1
Schrodinger's Time - Independent Wave Equation	**L7**	16/11/24	M1
Particle in One Dimensional Potential Box	**L8**	18/11/24	M1
Symmetry in solids, Classical Free Electron Theory-drude and Lorentz	**L9**	21/11/24	M1,M2
Variation of Fermi-level-with temperature, Bloch theorem	**L10**	25/11/24	M1
Kronig-Penny Model	**L11**	26/11/24	M1
E-k diagram, effective mass of an electron	**L12**	28/11/24	M1
Origin of Energy -Band Formation in Solids	**L13**	29/11/24	M1
Concept of Effective Mass of an Electron	**L14**	2/12/24	M1

UNIT-II: SEMICONDUCTOR PHYSICS AND DEVICES			
Intrinsic and extrinsic semicondutors	**L15**	3/12/24	M1
Hall effect and applications	**L16**	5/12/24	M1
Direct and Indirect Band gap Semiconductors	**L17**	6/12/24	M1
Construction,principle ,working and V-I characteristics of P-N junction diode	**L18**	9/12/24	M1,M2
Construction, principle ,working and V-I characteristics of Zener diode	**L19**	10/12/24	M1,M2
Construction, principle ,working and V-I characteristics ofBJT	**L20**	12/12/24	M1,M2
Structure ,materials, working principle and characteristic of LED	**L21**	13/12/24	M1,M2
Structure ,materials, working principle and characteristic of PIN diode	**L22**	16/12/24	M1,M2
Structure ,materials, working principle and characteristic of Avalanche photo diode(APD)	**L23**	17/12/24	M1,M2
Structure ,materials, working principle and characteristic of Photo Diode	**L24**	19/12/24	M1,M2
Structure ,materials, working principle and characteristic of Solar Cell	**L25**	20/12/24	M1,M2
UNIT-III: DIELECTRIC PROPERTIES, MAGNETIC PROPERTIES AND ENERGY MATERIALS			
Basic definitions	**L26**	24/12/24	M1
Electronic, Ionic and Orientation Polarizations	**L27**	26/12/24	M1
Piezo-electricity, Pyro- electricity and Ferro – electricity-applications	**L28**	27/12/24	M1
LCD	**L29**	30/12/24	M1
Basic definitions , Hysteresis	**L30**	31/12/24	M1

Soft and hard magnetic materials Magnetostriction, magneto resistance	**L31**	16/01/25	M1
Applicaions-memory devices, magnetic field sensors, multi ferroics	**L32**	17/01/25	M1,M2
Conductivity of liquid and solid electrolytes	**L33**	20/01/25	M1
Superionic conductors - materials and electrolytes for super capacitors	**L34**	21/01/25	M1
Rechargeable ion batteries, solid fuel cells	**L35**		M1
UNIT-IV NANOTECHNOLOGY			
Origin of Nanotechnology	**L36**	23/01/25	M1
Nano Scale, Surface to Volume Ratio	**L37**	24/01/25	
Quantum Confinement, Sol-Gel Method	**L38**	27/01/25	M1
Precipitation, combustion methods	**L39**	28/01/25	M1,M2
Top-down fabrication-Ball-milling	**L40**	30/01/25	M1,M2
Chemical Vapour Deposition	**L41**	31/01/25	M1,M2
Physical Vapor Deposition	**L42**	03/02/25	M1,M2
Characterization Techniques XRD	**L43**	04/02/25	M1,M2
SEM	**L44**	06/02/25	M1,M2
TEM	**L45**	07/02/25	M1,M2
Applications of Nanotechnology.	**L46**	10/02/25	M1,M2
UNIT-V LASERS AND FIBER OPTICS			
Characteristics of Lasers, Spontaneous and stimulated Emission of Radiation	**L47**	11/02/25	M1

Meta- Stable state, Population Inversion, Lasing Action	**L48**	13/02/25	M1
Einstein's Coefficients and Relation between them	**L49**	14/02/25	M1
Ruby Laser	**L50**	17/02/25	M1,M2
Helium- Neon Laser	**L51**	18/02/25	M1,M2
CO2 Laser	**L52**	20/02/25	M1,M2
Diode Laser and Applications of Lasers.	**L53**	21/02/25	M1,M2
Principle & construction (structure) of an Optical Fiber	**L54**	24/02/25	M1
Acceptance Angle , Numerical Aperture	**L55**	25/02/25	M1
Types of Optical Fibers	**L56**	27/02/25	M1
Losses in Optical Fibers	**L57**	28/02/25	M1
Applications of Optical Fibers in communication, medical sensor	**L58**	03/03/25	M1,M2
TOTAL NO OF CLASSES: 58			

M1: WHITE BOARD MARKER & TALK

M2: ICT TOOLS

(9) TEXT BOOKS:

1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy" A Text book of Engineering

Physics"- S. Chand Publications, 11th Edition 2019.

2. Engineering Physics by Shatendra Sharma and Jyotsna Sharma, Pearson Publication,2019

3. Semiconductor Physics and Devices- Basic Principle – Donald A, Neamen, Mc Graw Hill, 4

thEdition,2021.

4. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2ndEdition,2022.

5. Essentials of Nanoscience & Nanotechnology by Narasimha Reddy Katta, Typical Creatives

NANO DIGEST, 1st Edition, 2021.

REFERENCE BOOKS:

1. Quantum Physics, H.C. Verma, TBS Publication, 2nd Edition 2012.

2. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons,11th Edition,

2018.

3. Elementary Solid State Physics, S.L. Gupta and V. Kumar, Pragathi Prakashan, 2019.

4. A.K. Bhandhopadhya - Nano Materials, New Age International, 1stEdition, 2007.

5. Energy Materials a Short Introduction to Functional Materials for Energy Conversion and

Storage Aliaksandr S. Bandarenka, CRC Press Taylor & Francis Group.

6. Energy Materials, Taylor & Francis Group, 1st Edition, 2022.

(10) WEBSITES:

1) **http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/fibopt.html**
2) **http://www.bshgriet.in**
3) www.physics.org
4) **https://www.youtube.com/user/nptelhrd**
5) ***ebookbrowse.com/en/engineering-physics-unit-2***
6) **www.motionmountain.net/**
7) **https://www.youtube.com/watch?v=s1aE9idYX7g**
8) **https://www.youtube.com/watch?v=PXHczjOg06w**
9) **https://www.youtube.com/watch?v=-MI4JvebaFc**
10) **http://www.electronics-tutorials.ws/electromagnetism/magnetic-hysteresis.html**
11) **http://www.laserinternational.org/info/laserintroduction**

(11) WORKING MODELS

- Crystal structure
- Electromagnets
- Archimedes screw
- Iron in cereal
- Light tracking boats
- Gauss meter accelerator
- Electric motor

(12) STUDENT SEMINAR TOPICS

- Black body radiation
- I-D potential box
- Kronig-Penny model
- LED, APD and solar cell principle and working
- Applications of Piezo and Ferro electric materials
- Hysteresis behaviour of ferro magnets
- Synthesis of nano materials
- Lasers Principle and working
- Applications of Lasers
- Optical Fiber communication system.

(13) FINAL EXAM MODEL PAPER

Code No.: AP102BS

R20	H.T.No.			8	R						

CMR ENGINEERING COLLEGE: : HYDERABAD

UGC AUTONOMOUS

I-B.TECH-I-Semester End Examinations (Regular) - April- 2022

APPLIED PHYSICS

(Common to CSC, CSD, CSE, IT)

[Time: 3 Hours] **[Max. Marks: 70]**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 20 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART-A **(20 Marks)**

1\. a) Calculate the de Broglie wavelength, if an electron is accelerated from rest through a potential difference V=50V. [2M]

b) Will the effective mass of an electron be negative? Justify your answer. [2M]

c) Explain the formation of hole in a semiconductor. [2M]

d) What is meant by LED? Give its principle. [2M]

e) How does the function of a dielectric differ from an insulator? [2M]

f) Magnetic field intensity of a paramagnetic material is 10^4 Am^{-1} at room temperature its susceptibility is $3.7x10^3$. Calculate the magnetization in the material. [2M]

g) Define Einstein coefficients. [2M]

h) Calculate the refractive indices of the core and cladding material of a fiber [Given Numerical Aperture of an optical fiber =0.22 and relative refractive index differences 0.012]. [2M]

i) State the principle of transmission electron microscope (TEM). [2M]

j) What is bottom-up synthesis? Give examples of bottom-up approach in nanotechnology? [2M]

PART-B **(50 Marks)**

2\. Describe Davisson and Germer experiment to demonstrate the wave nature of particle. [10M]

OR

3\. Discuss qualitatively how band theory of solids leads to the classification of solids into conductors, semiconductors and insulators. [10M]

4\. Derive an expression for carrier concentration in an intrinsic semiconductor. [10M]

OR

5\. Explain the formation of PN junction Diode and V-I characteristics of the same. [10M]

6\. What is meant by local field? Derive the expression for internal filed in a dielectric material. [10M]

OR

7\. Explain the reason for the formation of domain structure in ferromagnetic material. How the hysteresis curve is explained on the basis of the domain theory. [10M]

8\. Draw a neat diagram of Helium-Neon laser and explain its construction and working principle. Discuss its important applications. [10M]

OR

9\. Describe the construction and working principle of optical fiber and discuss the detailed advantages of fiber optic cable over metallic cable. [10M]

10\. What is the origin of nanotechnology? Why do nano materials exhibit different properties explain in detail. [10M]

OR

11\. Describe the principle, construction and working of SEM (Scanning Electron Microscope) and give its limitations. [10M]

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I B.Tech II SEM I MID Examination

Time : 90mins
Marks:30

SUB: APPLIED PHYSICS **BRANCH: ECE, CSM ,CSE**

Note: This question paper contains two parts A and B.

Part-A is compulsory which carries 10 marks. Answer all questions in part-A.

Part-B consists of (21/2) units. Answer any one full question from each unit. Each question carries 5 marks.

PART A

5×2M=10M

1. Calculate the wavelength associated with an electron raised to a potential 1600V?(CO1)
2. Write the draw backs of free electron theory(CO1)
3. Define the intrinsic and extrinsic semiconductors(CO2)
4. Find the wavelength of LED which has energy gap 1.9 eV of GaAsP semiconductor (CO2).
5. Write short note on Piezo electricity.(CO3)

PART B

5×4M=20M

6. Explain about the Davisson and Germers's experiment with neat diagram(CO1)

Or

7. Explain Kronig – penny model, how it leads to band structure (CO1).
8. Derive the expression for carrier concentration of N-type semiconductors (CO2).

Or

9. What is LED?, Write the construction, working and applications of LED(CO2)
10. Derive the expression for the electronic polarizability.(CO3)

Or

11. Derive an expression for Local field or internal field in dielectric solids.(CO3)

(14) <u>ASSIGNMENT QUESTIONS</u>

UNIT-I

1. (a) Explain about the Davisson and Germer's experiment with neat diagram(CO1)
   (b) Derive the energy and wave function expressions of particle in 1D box(CO1)

2. (a) Explain Kronig – penny model, how it leads to band structure (CO1).
   (b) Explain the classification of materials into conductor, semiconductor and insulators (CO1).

UNIT-II

3. (a)Derive the expression for carrier concentration of p-type semiconductors (CO2).
   (b)Write the construction, working and applications of solar cell(CO2)

4. (a)What is LED?, Write the construction, working and applications of LED(CO2)
   (b)State the Hall effect, explain it with applications (CO2).

UNIT-III

5. (a)Derive the expression for the electronic polarizability.(CO3)
   (b)Derive an expression for internal field or Local field in solid.(CO3)

6. a) Classify and explain the properties of different types of magnetic materials.(CO3)
   b) Explain about origin of magnetic moment.(CO3)

UNIT-IV

7. a) What are Einstein's coefficients of radiation? Derive Einstein's relation of radiation.(CO4)
   b) Describe the construction and working principle of He-Ne laser.(CO4)

8. a) Derive an expression for acceptance angle and numerical aperture of optical fibre.(CO4)
   b) Write about step index and graded index fibers with neat light ray diagrams.(CO4)

UNIT-V

9. a) Explain the synthesis of nano particles by Sol-Gel method.(CO5)
   b) Explain in detail synthesis of nanoparticles by Chemical Vapour Deposition method.(CO5)
10. Describe the characterization of nanoparticles using Scanning Electron microscope.(CO5)

SCHEME OF MARKS (R22)

MID EXAM	ASSIGNMENT	SEMINOR	END EXAM	TOTAL
30M	5M	5M	60M	100M

INNOVATIVE ASSIGNMENT

Problem Statement

- Solve Schrödinger time independent wave equation for a one-dimensional potential box.
- How do you prove the existence of matter waves.
- Analyze the working principles of P-N junction diode, LED and Solar cell.
- Summarize different characterizing techniques of nano materials.
- Describe the working of bubble memory devices.

(15) COURSE MATERIAL

UNIT-I

QUANTUM MECHANICS

Introduction:

Advances in solid state physics are made by using the principles of Quantum mechanics. The energy of the electron in the solid, black body radiation, Spectra of solids, magnetism, superconductivity, etc., are all explained only by quantum mechanics.

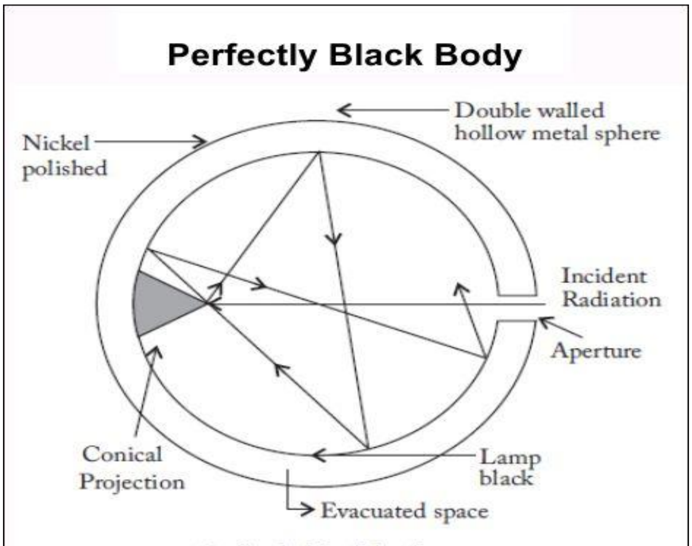
At the end of the 19th century, physicists had every reason to regard the Newtonian laws governing the motion of material bodies and man well less of electromagnetism, as fundamental laws of Physics. They believed that there should be some limitation on the validity of these laws which constitute "classical mechanics" to understand the submicroscopic world of the atom and its constitutes, it became necessary to introduce new ideas and concepts which led to the mathematical formulation of "Quantum mechanics" during 1925, that had no immediate and spectacular success in the explanation of the experimental observations. Quantum mechanics provided the key to the understanding of the behavior of very small objects like the atoms and it constitutes the failure of classical mechanics when applied to the submicroscopic world of the atom arose from the possibility the characterizing the instantaneous stale of the particle in motion by privies positions and velocities.

In this unit we will study the development of the Quantum mechanics, Blck body radiation, planck's law, photoelectric effect, compton effect, Broglie hypothesis, Heisenberg's uncertainly principle, Schrödinger's wave equation and its application.

Black body radiation:

A black body is a theoretical object that absorbs 100% of the radiation that hits it. Therefore it reflects no radiation and appears perfectly black.

Roughly we can say that the stars radiate like blackbody radiators. This is important because it means that we can use the theory for blackbody radiators to infer things about stars.



Perfectly black body

At a particular temperature the black body would emit the maximum amount of energy possible for that temperature. The radiation emitted by black body is known as black body radiation.
Blackbody radiation does not depend on the type of object emitting it. Entire spectrum of blackbody radiation depends on only one parameter, the temperature, T.

Fig. Illustration of black body

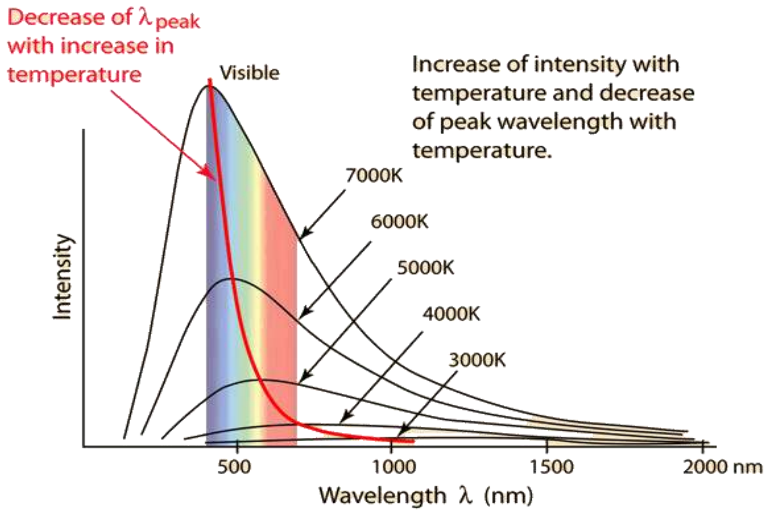


Fig. Energy density Vs wavelength at given temperature

1. At given temperature, the energy is not uniformly distributed in the radiation spectrum of the blackbody.

2. At a given temperature, the intensity of radiation increases with increase in wavelength and at a particular wavelength, its value is maximum. With further increase in wavelength, the intensity of radiation decreases.

3. With the increase in temperature, maximum wavelength (λ_m) decreases, when λ_m is the wavelength at which the maximum emission of energy takes place.

4. There is increase in energy emission with the increase in temperature corresponding to all the wavelengths.

5. The area under each curve the total energy emitted for the complete spectrum at a particular temperature. With the increase in temperature, this area increases.

Planck's law of black body radiation:

Max Plank, a German physicist derived an equation which successfully accounted for the spectrum of the blackbody radiation. He incorporated a new idea in his deduction of Plank eqn. that the probability of emission of radiation decreases as its frequency increases so that, the curve slopes down in the high frequency region. The oscillators in the blackbody can have only a discrete set of energy values. Such an assumption was radically different from the basic principles of physics.

The assumption in the derivation of Plank's law is that the wall of the experimental blackbody consists of a very large number of electrical oscillators, with each oscillator vibrating with a frequency of its own. Plank brought two special conditions in his theory. They are

(1) Only an integral multiple of energies $h\nu$ where 'h' is Plank's constant and 'ν' is frequency of vibration i e, the allowed energy values are $E = nh\nu$
where $n = 0, 1, 2, \ldots$

(2) An oscillator may lose or gain energy by emitting or absorbing radiation of frequency $\nu = (\Delta E / h)$,
where ΔE is the difference in the values of energies of the oscillator before and the emission or absorption had taken place.

Based on the above ideas, he derived the law governing the entire spectrum of the Blackbody radiation, given by

$$U_\lambda \, d\lambda = (8\Pi hc / \lambda^5)\,[1 / (e^{h\nu/kT} - 1)]\, d\lambda \quad (\text{since } \nu = c / \lambda)$$

This is called Plank's radiation law.

Black Body:

A blackbody allows all incident radiation to pass into it (no reflected energy) and internally absorbs all the incident radiation (no energy transmitted through the body). This is true for radiation of all wavelengths and for all angles of incidence. Hence the blackbody is a perfect absorber for all incident radiation. The theory of the energy distribution of blackbody radiation was developed by Planck and first appeared in 1901.

Planck's Radiation Formula:

Planck assumed the presence of number of resonators (harmonic oscillators) inside the cavity of the black-body and used the quantum by hypothesis to derive the formula. According to planck's quantum hypothesis , an oscillator can have only discrete energies given by

$$E_n = nh\nu = nE$$

$$\text{Where } n = 0,1,2\ldots..$$

ν is the frequency of the oscillator h is plank's constant n is an integer (including o) known as quantum number. Thus an oscillator can have energies o, $h\nu$, $2h\nu$,.... And the oscillator cannot emit or absorb energy continuously but in quanta of energy hv. We shall first calculate average energy of the oscillator of frequency v. if N is the total number of oscillators and E their total energy, then average energy per planck's oscillator is given by

$\overline{E}$ = E/N

Let N=N_0, N_1,……, N_r…..be the number of oscillators having o , hv, 2hv,…..rh$v$, respectively.

The relative probability that an oscillator will have the energy hv at temperature T is exp(-hv/kT) where k is Boltzmann constant. In other words, according to Maxwell's law of molecular motions if ε is a certain amount of energy, the probabilities that number of particles with energies o, ε, 2ε……rε are in the ratio

$1: e^{-\varepsilon/kT} : e^{-2\varepsilon/kT}: \ldots\ldots. e^{-r\,\varepsilon/kT}$

As said earlier if N_o is the number of resonators having energy zero, then the number of resonators N_1 having energy ε will be No $e^{-\varepsilon/kT}$, the number of resontors N_2 having energy ε will be $N_o^{-2\varepsilon/kT}$ and so on.

Thus, we have

$$Nr = N_o \exp[-rhv/kT]$$

And N= N_o +N_1+N_2+…….N_r+……

$$= N_o + No\exp\left[\frac{-hv}{kT}\right] + No\ \exp\ \left[\frac{-2hv}{kT}\right] + \ ......No\ \ \exp\ \ \left[\frac{-rhv}{kT}\right] + ...$$

$$\text{Put } exp\left[\frac{-hv}{kT}\right] = x$$

$$N= No\ (1+x+x^2+\ldots\ldots\ldots\ldots.x^r$$

$$N = No\ (1-x)^{-1}$$

As $(1-x)^{-1} = 1+x+x^2+\ldots\ldots x^r$

Now the total energy E is given by

E = No XO +hv No exp[-hv/kT] +2hvNo exp[-2hv/kT]+….rh$v$ No exp[-rh$v$/kT]+….

$$Nohv\ (1+2x+3x^2+4x^3\ldots\ldots\ldots\ (r+1)\ x^r$$

$$E = \frac{N_a hv}{(1-x)^2}$$

As $1+2x+3x^2+\ldots\ldots\ldots rx^{r-1}+\ldots. =1/(1-x)^2$

$$\overline{E} = N_o hv(1-x)^{-2}$$

Now the average energy of the oscillator is given by

$$\overline{E} = \frac{N_o h\nu}{(1-x)^{-2}} \Big/ \frac{N_0}{(1-x)}$$

$$= \frac{h\nu}{(1-x)}$$

$$= \frac{\mathrm{h\nu}}{1-\mathrm{e}^{-\mathrm{h\nu/kT}}} \qquad \text{with E = h}\nu$$

$$\overline{E} = \frac{h\nu}{\left\{\exp\left[\frac{h\nu}{kT}\right]-1\right\}}$$

Thus we see that the average energy of oscillator given by Eqn. is different form the energy KT of a classical oscillator.

If we assume that the number of oscillator given by Eqn. $\left[\frac{8\pi\upsilon^3}{c^3}\right]d\upsilon$, then we get the total energy per unit volume belonging dν or the energy density belonging to the range dν as

$$E\nu d\nu = \left[\frac{8\pi\nu^3}{c^3}\right]\left[\frac{h\nu}{\exp\left[\frac{h\nu}{kT}\right]-1}\right]d\nu$$

This is the famous Planck's radiation law

But ν = c/λ and $|d\nu| = -\frac{c}{\lambda^2}d\lambda$

$$\text{ie } E\lambda d\lambda = \frac{8\pi h}{c^3}\left[\frac{c^3}{\lambda^3}\right]\frac{1}{\left\{\exp\left[\frac{ch}{\lambda kT}\right]-1\right\}}\left[\frac{c}{\lambda^2}d\lambda\right]$$

therefore

$$E\lambda d\lambda = \left[\frac{8\pi hc}{\lambda^5}\right]\left[\frac{1}{\exp\left[\frac{ch}{\lambda kT}\right]-1}\right]d\lambda$$

This equation of Planck well agrees with the experimental value throughout the whole range of wavelength.

With the help of planck's radiation law, wien's displacement law and Rayleigh-Jeans law can be derived in the following way:

For small temperature , λT is small. Now $\exp(hc/\lambda kT) >> 1$ and 1 can be neglected in the denominator or Eqn.

$$E\lambda d\lambda = \frac{8\pi ch}{\lambda^5}\left\{\exp\left(\frac{-ch}{\lambda kT}\right)\right\}d\lambda$$

$$= C_1\lambda^{-5}\left\{exp\left(\frac{C_2}{\lambda T}\right)\right\}d\lambda \quad \text{where } C_1 = 8\pi ch,\ C_2 = \frac{ch}{k}$$

which is **Wein's law**

Rayleigh- Jeans law

For large temperatures λT is large.

$$\text{Now } \exp\left(\frac{ch}{\lambda kT}\right) = 1 + \left(\frac{ch}{\lambda kT}\right) + ½\left(\frac{ch}{\lambda kT}\right)^2 + \ldots\ldots\ldots\ldots$$

$$= 1 + \left(\frac{ch}{\lambda kT}\right)$$

$$E\lambda d\lambda = \frac{8\pi ch}{\lambda^5}\left[\frac{1}{1+\left(\frac{ch}{\lambda kT}\right)-1}\right]d\lambda$$

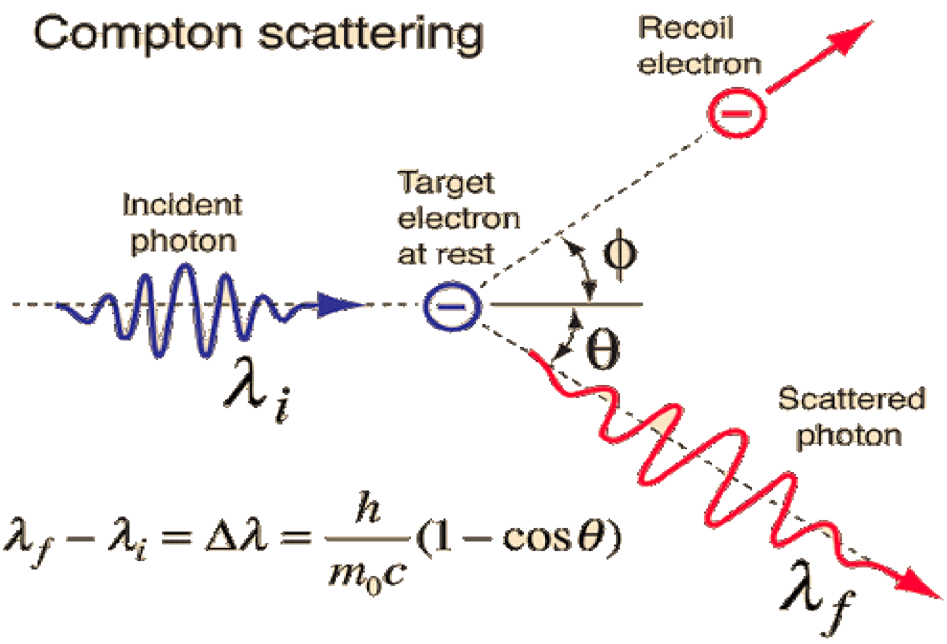
$$\text{i.e.} \quad E\lambda d\lambda = \frac{8\pi ch}{\lambda^5} \times \frac{\lambda kT}{Ch^5}d\lambda = \frac{8\pi KT}{\lambda^4}d\lambda$$

This is **Rayleigh- Jeans law**

where it should be clearly understood that the quantization of energy in the oscillators is not only confined to the atoms of black body but it is a general concept.

Compton Effect:

Compton effect is the phenomenon in which a collision between a photon and a particle results in an increase in the kinetic energy of the particle and a corresponding increase in the wavelength of the photon. Or An increase in wavelength of X-rays or gamma rays that occurs when they are scattered.



Where λ_i = wavelength of incident radiation

$\lambda_f = wavelength\ of\ scattered\ photon$

Θ =angle made by the recoiled electron

CASE 1) : When θ=0^0

$$\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_0 c}(1 - cos0^0)$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(1 - 1) \quad \text{since } cos0^0 = 1$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(\,0\,)$$

$$\lambda_f - \lambda_i = 0$$

This indicates no scattering along the direction of incidence

CASE 2) : When θ=90^0

$$\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_0 c}(1 - cos90^0)$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(1 - 0) \quad \text{since } cos90^0 = 0$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(\,1\,)$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c} = \frac{6.625*10^{-34}}{9.1*10^{-31}*3*10^8} = 0.02445A^0$$

This difference in wavelength is known as Compton wavelength

CASE 3) : When $\theta=180^0$

$$\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_0 c}(1 - cos180^0)$$

$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(1 - (-1)) \quad \text{since } cos180^0 = -1$$

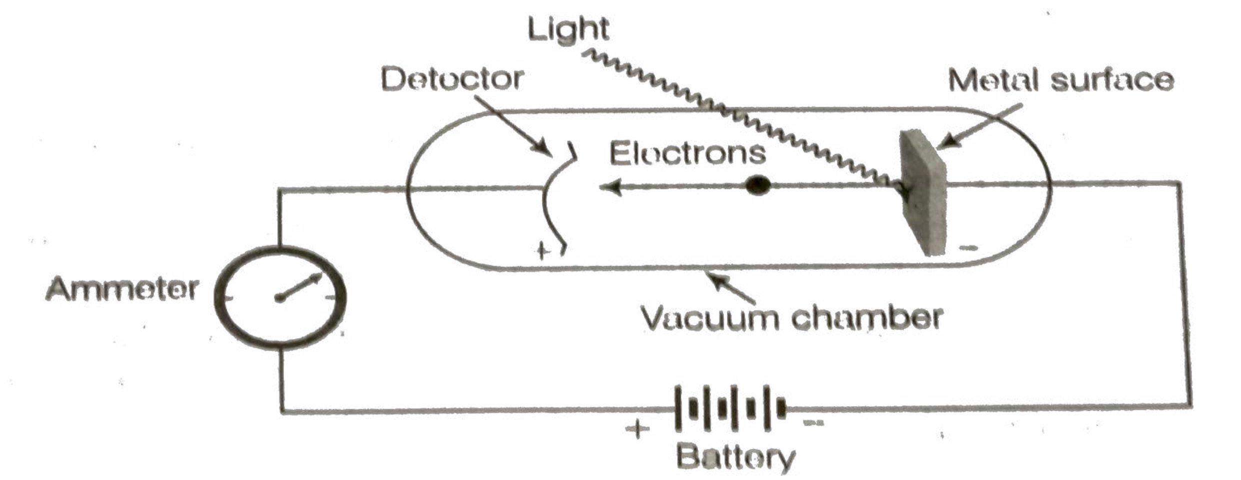
$$\lambda_f - \lambda_i = \frac{h}{m_0 c}(2)$$

$$\lambda_f - \lambda_i = \frac{2h}{m_0 c} = \frac{2*6.625*10^{-34}}{9.1*10^{-31}*3*10^8} = 0.4849A^0$$

Hence as θ varies from 0^0 to 180^0, the wavelength of the scattered radiation increases from λ to $\lambda + \frac{2h}{m_0 c}$

Photoelectric effect:

The photoelectric effect is the emission of electrons when electromagnetic radiation, such as light, hits a material. Electrons emitted in this manner are called photoelectrons.



The apparatus used to study photo electric effect is shown above.

It consists of an evaculated tube which contains two electrodes. One is connected to the negative terminal of the battery while other is connected to the positive terminal of the battery through ammeter.

In the absence of light there is no flow of current .

When monochromatic light is allowed to fall on the metal surface the electrons are ejected and travel towards the detector. This results a current flow in the circuit.

The no.of ejected electrons and their kinetic energy depends upon the following factors :

1) The potential difference between the two plates.

2) The intensity of incident radiation.

3) The frequency of incident radiation.

4) The photo metal used.

Laws of photoelectric effect:

(i) There is a definite cut off value of frequency below which electrons cannot be ejected by any substance.
(ii) Number of emitted electrons are directly proportional to the intensity of light incident.
(iii) Kinetic energy of emitted electrons depends on the frequency of incident light on substance.
(iv) There is no time logging between the incident of light and emission of electrons.

Waves and Particles:

De Broglie suggested that the radiation has dual nature i,e both particle as well as wave nature. The concept of particle is easy to grasp. It has mass, velocity, momentum and energy. The concept of wave is a bit more difficult than that of a particle. A wave is spread out over a relatively large region of space, it cannot be said to be located just here and there, and it is hard to think of mass being associated with a wave. A wave is specified by its frequency, wavelength, phase, amplitude, intensity.

Considering the above facts, it appears difficult to accept the conflicting ideas that radiation has dual nature. However this acceptance is essential because radiation sometimes behaves as a wave and at other times as a particle.

(1) Radiations behaves as waves in experiments based on interference, diffraction, polarization etc. this is due to the fact that these phenomena require the presence of two waves at the same position and at the same time. Thus we conclude that radiation behaves like wave.
(2) Plank's quantum theory was successful in explaining blackbody radiation, photoelectric effect, Compton Effect and had established that the radiant energy, in its interaction with the matter, behaves as though it consists of corpuscles. Here radiation interacts with matter in the form of photons or quanta. Thus radiation behaves like particle.

Hence radiation cannot exhibit both particle and wave nature simultaneously.

De Broglie hypothesis:

As electromagnetic waves behave like particles and Particles like electrons will behave like waves called **matter waves**. The matter waves thus conceived by de-Broglie are de-Broglie matter waves. He derived an expression for the wavelength of matter waves on the analogy of radiation

Based on the Planck's theory of radiation, the energy of a photon (Quanta) is given by

$$E = h\nu \qquad since\ \nu = \frac{C}{\lambda}$$

$$E = h\frac{C}{\lambda} \dots\dots\dots\dots\dots\dots (1)$$

C→ is velocity of light

λ is wavelength

According to Einstein mass-energy relation

From eqns (1) and (2)

$$\frac{hC}{\lambda} = mC^2$$

$$\lambda = \frac{h}{mC} = \frac{h}{P}$$

Where: $P = mC$ → is momentum of photon

λ → s de-Broglie wavelength associated with a photon.

De-Broglie proposed the concept of matter waves, according to which a material particle of mass 'm' moving with velocity 'v' should be associated with de-Broglie wavelength 'λ' given by

Wavelwngth for particle can be written as

$$\lambda = \frac{h}{mv} = \frac{h}{P}$$

Where: $P = mv$ →momentum associated with particle

De-Broglie suggested that this equation for wavelength is a perfectly general one, applying to, material particles as well as to photons.

If E is the kinetic energy of particle

$$E = \frac{1}{2}mv^2 = \frac{1}{2}\frac{m^2v^2}{m} = \frac{1}{2}\frac{P^2}{m}$$

$$P = \sqrt{2mE}$$

Hence de-Broglie's wave length is

$$\lambda = \frac{h}{\sqrt{2mE}}$$

de-Broglie's wave length of Electron

If m_0 is the rest mass of electron and it is accelerated with a potential V. if v is the velocity attained by electron due to acceleration.

Kinetic energy of electron

$$E = \frac{1}{2} m_0 v^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Energy of electron due to application of potential

$$E = eV \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .2$$

From 1 and 2

$$\frac{1}{2} m_0 v^2 = eV$$

$$\frac{1}{2} {m_0}^2 v^2 = m_0 eV$$

$${m_0}^2 v^2 = 2 m_0 eV$$

$$P^2 = 2 m_0 eV$$

From de-Broglie wave length

$$\lambda = \frac{h}{mc} = \frac{h}{P}$$

$$\lambda = \frac{h}{\sqrt{2 m_0 eV}}$$

$$\lambda = \frac{h}{\sqrt{2 * V * 9.1 * 10^{-31} * 1.63 * 10^{-19}}}$$

$$\lambda = \frac{12.26}{\sqrt{V}} A^0$$

The above expression is for non relativistic case since relative variation of mass with velocity is not considered. Thus accelerated electrons exhibit wave nature corresponding to wave length of x rays. This concept only helped Davisson & Germer to provide experimental evidence on matter waves when they conducted electron diffraction experiments.

Characteristics of Matter waves:

Since $\lambda = h / m v$

1. Lighter the particle, greater is the wavelength associated with it.
2. Lesser the velocity of the particle, longer the wavelength associated with it.
3. For v = 0, λ = ∞. This means that only with moving particle, matter waves is associated.

4. Whether the particle is changed or not, matter waves is associated with it.
5. It can be proved that matter waves travel faster than light.

   We know that $E = h\nu$ and $E = mc^2$

   $h\nu = mc^2$ or $\nu = mc^2 / h$

   Wave velocity (ω) is given by

$$\omega = \nu\lambda = mc^2\lambda / h = (mc^2 / h)(h / mv)$$

$$\Rightarrow \quad \omega = c^2 / v$$

As the particle velocity 'v' cannot exceed velocity of light, ω is greater than the velocity of light.

6. No single phenomena exhibit both particle nature and wave nature simultaneously.
7. The wave nature of matter introduces an uncertainty in the location of the particle & the momentum of the particle exists when both are determined simultaneously.

Davisson and Germer's experiment:

C. J. Davisson and L. H. Germer were studying scattering of electrons by a metal target and measuring the intensity of electrons scattered in different directions.

Experimental Arrangement:

An electron gun, which comprises of a tungsten filament is heated by a low tension battery B1, produces electrons. These electrons are accelerated to desired velocity by applying suitable potential from a high tension source B2. The accelerated electrons are collimated into a fine beam by allowing them to pass through a system of pin holes provided in the cylinder. The whole instrument is kept in an evacuated chamber.

The past moving beam of electrons is made to strike the Nickel target capable of rotating about an axis perpendicular to the plane. The electrons are now scattered in all directions by the atomic planes of crystals. The intensity of the electron beam scattered in a direction can be measured by the electron collector which can be rotated about the same axis as the target. The collector is connected to a galvanometer whose deflection is proportional to the intensity of the electron beam entering the collector.

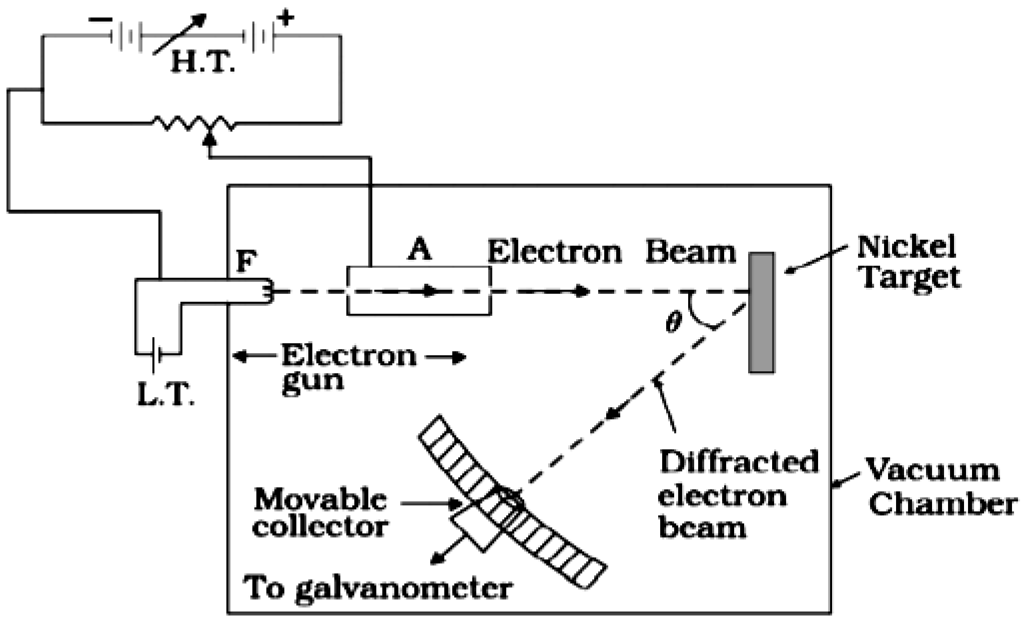


Fig. Davisson and Germer's Apparatus

The electron beam is accelerated by 54 V is made to strike the Nickel crystal and a sharp maximum is occurred at angle of 50° with the incident beam. The incident beam and the diffracted beam in this experiment make an angle of 65° with the family of Bragg's planes.

$$d = 0.091\text{nm} \quad \text{(for Ni crystals)}$$

According to Bragg's law for maxima in diffracted pattern,

$$2d \sin \theta = n \lambda$$

$$\text{For } n = 1, \quad \lambda = 2d \sin \theta$$

$$= 2 \times 0.91 \times 10^{-10} \times \sin 65^{o}$$

$$= 0.165 \text{ nm}$$

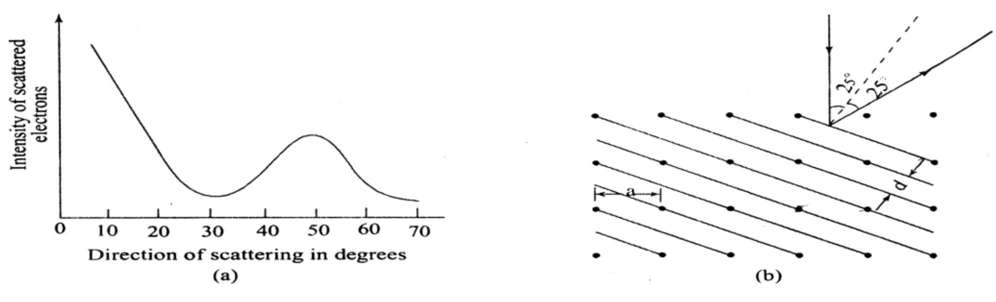


Figure : (a) The variation of the intensity of scatterd electrons with the direction of scattering and (b) nickel crystal acting as a grating

For a 54 V electron, the deBrogllie wavelength associated with the electron is given by

$$= 12.25 / \sqrt{V} = (12.25 / \sqrt{54})\ ^{o}A$$

$= 0.166$ nm.

This value is in agreement with the experimental value. This experiment provides a direct verification of deBroglie hypothesis of wave nature of moving particles.

Heisenberg Uncertainty Principle:

According to classical mechanics, a moving particle at any instant has a fixed position in space and a definite momentum which can be determined simultaneously with any desired accuracy. The classical point of view represents an approximation which is adequate for the objects of appreciable size, but not for the particles of atomic dimensions.

Since a moving particle has to be regarded as a de Broglie group, there is a limit to the accuracy with which we can measure the particle properties. The particle may be found anywhere within the wave group, moving with the group velocity. If the group is narrow, it is easy to locate its position but the uncertainty in calculating its velocity or momentum increases. On the other hand, if the group is wide, its momentum can be estimated satisfactorily, but the uncertainty in finding the location of the particle is great. Heisenberg stated that the simultaneous determination of exact position and momentum of a moving particle is impossible.

If Δx is Error in the measurement of position of the particle along X-axis

Δp is Error in the measurement of momentum

Then $\Delta x . \Delta p = h$ ---------- (1) where h is Plank's constant

The above relation represents the uncertainty involved in measurement of both the position and momentum of the particle.

To optimize the above error, lower limit is applied to the eqn. (1)

$$\text{Then } (\Delta x).(\Delta p) \geq \hbar / 2 \text{ where } \hbar = h / 2 \Pi$$

A particle can be exactly located ($\Delta x \to 0$) only at the expense of an infinite momentum ($\Delta p \to \infty$).

There are uncertainty relations between position and momentum, energy and time, and angular momentum and angle.

If the time during which a system occupies a certain state is not greater than Δt, then the energy of the state cannot be known within ΔE,

$$\text{i e } (\Delta E)(\Delta t) \geq \hbar / 2 .$$

Schrodinger's Time Independent Wave Equation:

Schrödinger, in 1926, developed wave equation for the moving particles. One of its forms can be derived by simply incorporating the de-Broglie wavelength expression into the classical wave eqn.

If a particle of mass moving with velocity ‘v’ is associated with a group of waves.

Let ψ be the wave function of the particle. Also let us consider a simple form of progressing wave like the one represented by the following equation,

$$\psi = \psi_0 \sin(\omega t - kx) \ldots\ldots\ldots\ldots (1)$$

Where $\psi = \psi(x, t)$ and ψ_0 is the amplitude.

Differentiating ψ partially w.r.to x,

$$\frac{\partial \psi}{\partial x} = \psi_0 \cos(\omega t - kx)(-k)$$

$$= -k\psi_0 \cos(\omega t - kx)$$

Once again differentiate w.r.to x

$$\frac{\partial^2 \psi}{\partial x^2} = -k\psi_0(-\sin(\omega t - kx))(-k)$$

$$= -k^2\psi_0 \sin(\omega t - kx)$$

$$\frac{\partial^2 \psi}{\partial x^2} = -k^2\psi \qquad from\ eq\ (1)$$

$$\frac{\partial^2 \psi}{\partial x^2} + k^2\psi = 0 \ldots\ldots\ldots\ldots\ldots (2)$$

Since $k = \frac{2\pi}{\lambda}$

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{4\pi^2}{\lambda^2}\psi = 0 \ldots\ldots\ldots\ldots (3)$$

From eqn. (2) or eqn. (3) is the differential form of the classical wave eqn. now we incorporate de-Broglie wavelength expression $\lambda = \frac{h}{mv}$

Thus we obtain

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{4\pi^2}{\left(\frac{h}{mv}\right)^2}\psi = 0$$

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{4\pi^2 m^2 v^2}{h^2}\psi = 0 \ldots\ldots\ldots\ldots (4)$$

The total energy E of the particle is the sum of its kinetic energy K and potential energy V

$$E = K.E. + P.E \dots\dots\dots (5)$$

$$E = \frac{1}{2}mv^2 + V$$

$$E - V = \frac{1}{2}mv^2 \dots\dots (6)$$

$$2(E - V) = mv^2$$

$$2m(E - V) = m^2v^2 \dots\dots\dots (7)$$

From (4) and (7)

$$\frac{\partial^2\psi}{\partial x^2} + \frac{8\pi^2 m(E - V)}{h^2}\psi = 0 \dots\dots\dots\dots\dots (8)$$

In quantum mechanics, the value $\frac{h}{2\pi}$ occurs more frequently.

Hence we denote, $\hbar = \frac{h}{2\pi}$

Using this notation, we have

$$\frac{\partial^2\psi}{\partial x^2} + \frac{2m(E - V)}{\hbar^2}\psi = 0 \dots\dots\dots\dots\dots (9)$$

For simplicity, we considered only one – dimensional wave. Extending eqn. (9) for a three – dimensional, we have

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{2m(E - V)}{\hbar^2}\psi = 0 \dots\dots\dots\dots\dots (10)$$

Where $\psi = \psi(x, y, z)$

Here, we have considered only stationary states of ψ after separating the time dependence of ψ.

Using the Laplacian operator,

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \dots\dots\dots\dots (11)$$

Eqn. (10) can be written as

$$\nabla^2\psi + \frac{2m(E - V)}{\hbar^2}\psi = 0 \dots\dots\dots\dots (12)$$

This is the Schrödinger Time Independent Wave Equation.

Physical Significance of Wave Function:

Max Born in 1926 gave a satisfactory interpretation of the wave function ψ associated with a moving particle. He postulated that the square of the magnitude of the wave function $|\psi|^2$(or $\psi\psi^*$), evaluated at a particular point represents the probability of finding the particle at the point. $|\psi|^2$ is called the probability density and ψ is the probability amplitude. Thus the probability of the particle within an element volume $d\tau$ is $|\psi|^2 \; d\tau$. Since the particle is certainly somewhere, the integral at $|\psi|^2 d\tau$ over all space must be unity i.e.

$$\int_{-\infty}^{\infty}|\psi|^2 \, .d\tau = 1$$

A wave function that obeys the above equations is said to be normalized. Energy acceptable wave function must be normalizable besides being normalizable; an acceptable wave function should fulfill the following requirements (limitations)

It must be finite everywhere.

It must be single valued.

It must be continuous and have a continuous first derivative everywhere.

Normalization of a wave function:

Since $|\psi(x, y, z)|^2.d\nu$ is the probability that the particle will be found in a volume element $d\nu$. Surrounding the point at position (x, y, z), the total probability that the particle will be somewhere in space must be equal to 1. Thus, we have

$$\int_{-\infty}^{\infty}|\psi(x, y, z)^2|.d\nu = 1$$

Where ψ is a function of the space coordinates (x, y, z) from this 'normalization condition' we can find the value of the complaint and its sign. A wave function which satisfies the above condition is said to be normalized (to unity).

The normalizing condition for the wave function for the motion of a particle in one dimension is

$$\int_{-\infty}^{\infty}|\psi(x)|^2 .dx = 1$$

From these equations, we see that for one – dimensional case, the dimension of $\psi(x)$ is $L^{-1/2}$ and for the three dimensional case the dimension of $\psi(x, y, z)$ is $L^{-3/2}$.

Particle in One Dimensional Potential Box:

Consider a particle of mass 'm' placed inside a one-dimensional box of infinite height and width L.

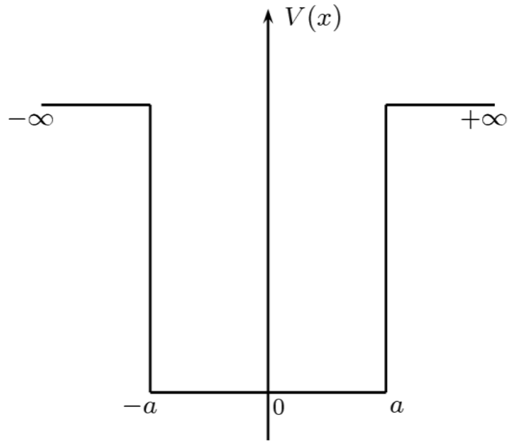


Fig. Particle in a potential well of infinite height.

Assume that the particle is freely moving inside the box. The motion of the particle is restricted by the walls of the box. The particle is bouncing back and forth between the walls of the box at x = 0 and x = a. For a freely moving particle at the bottom of the potential well, the potential energy is very low. Since the potential energy is very low, moving particle energy is assumed to be zero between x =0 and x = a.

The potential energy of the particle outside the walls is infinite due to the infinite P.E.

The particle cannot escape from the box

i.e. $V = 0$ for $0 < x < a$

$V = \infty$ for $0 \geq x \geq a$

Since the particle cannot be present outside the box, its wave function is zero

i e $|\psi| = 0$ for $0 > x > a$

$|\psi| = 0$ for $x = a$ & $x = 0$

The Schrödinger one – dimensional time independent eqn. is

$$\frac{\partial^2 \psi}{\partial x^2} + [2\, m\, (E - V) / \hbar^2]\, \psi = 0 \text{ ----------(1)}$$

For freely moving particle $V = 0$

$$\frac{\partial^2 \psi}{\partial x^2} + [\, 2\, m\, E / \hbar^2\,]\, \psi = 0 \text{ ----------(2)}$$

$$\text{Taking } 2\, m\, E / \hbar^2 = K^2 \text{ ------------ (3)}$$

$$\text{Eqn.(1) becomes } \partial^2 \psi / \partial x^2 + k^2\, \Psi = 0 \text{ -------------(4)}$$

Eqn. (1) is similar to eq. of harmonic motion and the solution of above eqn. is written as

$$\Psi = A \sin kx + B \cos kx \text{ -----------(5)}$$

where A, B and k are unknown quantities and to calculate them it is necessary to construct boundary conditions.

Hence boundary conditions are

When $x = 0$, $\Psi = 0$ => from (5) $0 = 0 + B$ => $B = 0$ -------- (6)

When $x = a$, $\Psi = 0$ => from (5) $0 = A \sin ka + B \cos ka$ ---------- (7)

But from (6) $B = 0$ therefore eqn. (7) may turn as

$$A \sin ka = 0$$

Since the electron is present in the box $a \neq 0$

$$\sin ka = 0$$

$$Ka = n\, \Pi$$

$$k = n\, \Pi / a \text{ -------------- (8)}$$

Substituting the value of k in eqn. (3)

$$2\, m\, E / \hbar^2 = (n\, \Pi / a)^2$$

$$E = (n\, \Pi / a)^2\, (\hbar^2 / 2\, m) = (n\, \Pi / a)^2\, (h^2 / 8\, m\, \Pi^2)$$

$$E = n^2\, h^2 / 8\, m\, a^2$$

$$E = n^2\, h^2 / 8\, m\, a^2$$

$$\text{In general } E_n = n^2\, h^2 / 8\, m\, a^2 \text{ ------------(9)}$$

The wave eqn. can be written as

$$\Psi = A \sin (n \Pi x / a) \text{ ---------- } (10)$$

Let us find the value of A, if an electron is definitely present inside the box, then

$$\Rightarrow \int_{-\infty}^{\infty} |\psi|^2 \, dx = 1$$

$$\Rightarrow \int_0^a A^2 \sin^2 (n \Pi x / a) \, dx = 1$$

$$\Rightarrow \int_0^a \sin^2 (n \Pi x / a) \, dx = 1 / A^2$$

$$\Rightarrow \int_0^a [1 - \cos (2 \Pi n (x / a)) / 2] \, dx = 1 / A^2$$

$$A = \sqrt{2 / a} \text{ ---------- } (11)$$

From eqn's. (10) & (11)

$$\Psi n = \sqrt{2 / a} \sin (n \Pi x / a) \text{ ----------} (12)$$

Eqn. (9) represents an energy level for each value of n. The wave function for this energy level is given in eqn. (12). Therefore the particle in the box can have discrete values of energies. These values are quantized. Not that the particle cannot have zero energy .The normalized wave functions $\Psi 1$, $\Psi 2$, $\Psi 3$ given by eqn (12) is plotted. The values corresponding to each E_n value is known as Eigen value and the corresponding wave function is known as Eigen function.

The wave function Ψ_1, has two nodes at x = 0 & x = a

The wave function Ψ_2, has three nodes at x = 0, x = a / 2 & x = a

The wave function Ψ_3, has three nodes at x = 0, x = a / 3, x = 2 a / 3 & at x = a

The wave function Ψ_n, has (n + 1) nodes

Substituting the value of E in (3), we get

For three dimensional potential box, the eigen functions are given by

Ψ_{n2} $\sin k_1 \times \sin k_2 \times \sin k_3$

Where $k_1 = \frac{n_1 \pi}{a}, k_2 = \frac{n_2 \pi}{a}, k_3 = \frac{n_2 \pi}{a},$

Eigen values are given by $E_n = \frac{n^2 h^2 \pi}{8ma^2}$

Eigen values are given by

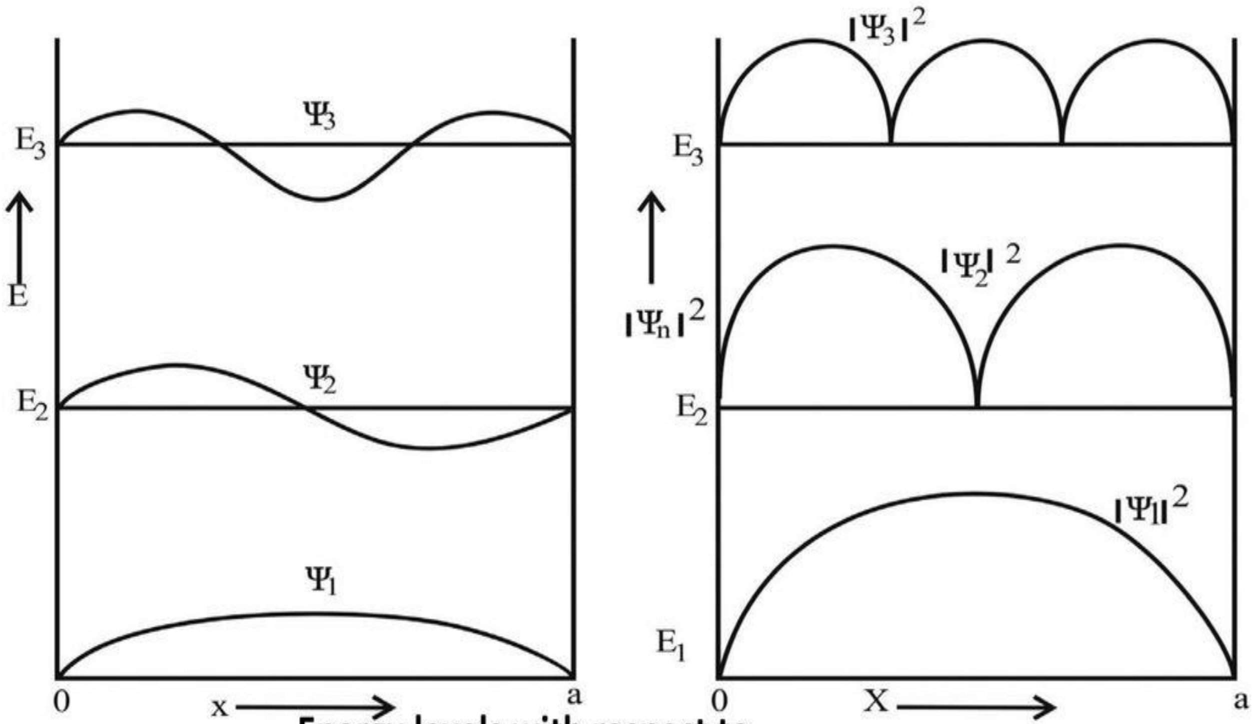
$(2\ m\ /\ \hbar^2)\ (\ p^2\ /\ 2\ m) = k^2$

Where n = $n = n_1^2 + n_2^2 + n_3^2$

$=> p^2\ /\ \hbar^2 = k^2$

k = p / ђ = p / (h / 2 Π) = 2 Π p / h

k = 2 Π / λ where k is known as wave vector.



Energy levels with respect to

(a) wave functions and (b) probability density

Therefore, the normalized wave function is given as,

$$\psi_n = \sqrt{\frac{2}{a}}\ sin\ \frac{n\pi}{a} x$$

1.	Equation for wavelength of a Photon is $\lambda = \frac{h}{mc}$	**6.**	Eigen energy level of a particle is given by $E_n = \frac{n^2h^2}{8mL^2}$
2.	De Broglie's wavelength for a particle associated with some velocity is $\lambda = \frac{h}{mv}$	**7.**	Equation for the particle in a one dimensional box is given by $\psi = (\sqrt{\frac{2}{L}})\sin\frac{n\pi x}{L}$
3.	De Broglie's wavelength for a particle with some energy is $\lambda = \frac{h}{\sqrt{2mE}}$	**8.**	Heisenberg's Uncertainty Principle for position & momentum is given by $\Delta x.\Delta p \geq \frac{h}{4\pi}$
4.	De Broglie's wavelength for a particle associated with T is $\lambda = \frac{h}{\sqrt{3kT}}$	**9.**	Schrodinger wave equation(time independent) is $\nabla^2\psi + \frac{2m}{\hbar^2}(E - v)\psi = 0$
5.	De Broglie's wavelength associated with an electron with potential is $\lambda = \frac{1.226}{\sqrt{v}}nm$	**10**	Compton shift $\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_0c}(1 - cos0^0)$

Short answer questions

1. What is a block body and explain its construction.
2. Explain about photoelectric effect.
3. Define Compton effect and Compton shift.
4. What are the postulates of Plank's hypothesis?
5. Distinguish between waves and particles.
6. What are matter wave? Explain their properties.
7. State and explain Heisenberg's uncertainty principle.
8. Explain Physical significance of wave function.

Essay questions

1. Derive expression for Plank's radiation law.

2. What is Compton effect? Derive Compton shift relation.
3. Describe experimental verification of matter waves using Davisson-Germer's experiment.
4. Derive time independent Schrodinger's wave equation for a free particle.
5. Derive an expression for energy and wave function of a particle bound to 1-D potential box.

UNIT-II

Semiconductor Physics and Devices

Contents

1. Introduction to semiconductors
2. Calculation of intrinsic carrier concentration and extrinsic carrier concentration
3. Dependence of Fermi level on carrier concentration and temperature
4. Carrier transport: diffusion and drift currents
5. Hall effect
6. p-n junction diode,Zener diode and their V-I Characteristics
7. Bipolar Junction transistor(BJT): construction and operation
8. Radiative and non radiative recombination mechanism
9. LED
10. Semiconductor laser
11. Photo diode
12. Solar cell
13. PIN Diode
14. Avalanche Diode

Semiconductor Physics

Introduction:

The materials which allow electricity partially to pass through them are known as semiconductors. From last two decades the use of solid state devises has become prominent. Most of these solid state devices use Semi conductor crystals. From the point of band theory of electrical conductivity, semiconductors differ from conductors and insulators. In metals addition of impurities and rise of temperature result in decrease in the electrical conductivity where as in semi conductors the electrical conductivity increases in contrary to conductors. Germanium and Silicon are most important semiconductors which are widely used in the manufacturing of diodes and transistors.

- **Types of Semi Conductors:**

Semiconductors are mainly classified into two types.

1. Intrinsic (or) Pure Semi conductor
2. Extrinsic (or) Impure semiconductor.

Intrinsic Semiconductor:

A semiconductor in its pure form is known as intrinsic semiconductor.

- The Silicon crystal which contains all of Si atoms is known as intrinsic semiconductor.
- In the Si (or) Ge the number of valence electrons is four. Each atom will complete '4' covalent bonds with four similar neighboring atoms.
- At the room temperature due to the thermal agitation some electrons in the valence band are shifted into the conduction band. Then electron vacancies created in the valence band. These are known as holes.
- The number of holes in the valence band and number of electrons in conduction band are equal.
- The average energy of holes and the electrons are represented by the Fermi energy level. It lies at the middle of forbidden gap.

Ex: - Ge, Si.

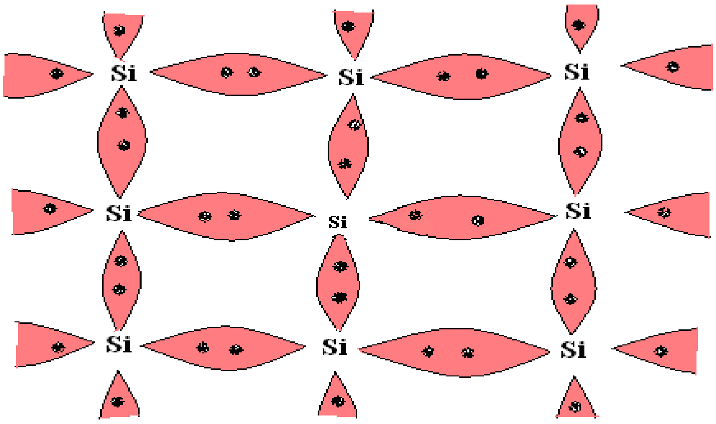


Fig: Pure Silicon

Extrinsic Semiconductor:

A doped semiconductor is called extrinsic semiconductor. The prices of adding impurities to a substance are called doping. On basis of doping Extrinsic semiconductors are again divided into two types.

1. N-type extrinsic semiconductor

2. P- type extrinsic semiconductor

1. N-type Extrinsic Semiconductor:

When we add the pentavalent impurity to a pure semiconductor then it is called N-type extrinsic semiconductor.

- This semiconductor is generated by doping pentavalent impurity to the intrinsic semiconductor.
- The phosphorous (p) atom is substituting in the place of 'Si' atom then it will complete four covalent bonds with four neighboring Si atoms. But one electron is left free without forming the band. This electron goes into the conduction band with out creating hole in the valence band.
- A small quantity of pentavalent impurity is added to the crystal then large number of electrons is produced in conduction band. Due to thermal agitation some electrons in the valence band are shifted into the conduction band by creating the holes in the valence band.
- The impurity atom is donating an electron to the conduction band. So this impurity is known as donor impurity.
- The majority charge carriers are electrons and the minority carriers are holes.
- The majority carriers are the negative charge carriers. So this semiconductor is known as N-type extrinsic semiconductor.

- The Fermi energy level is shifted towards the conduction band.

Ex: Pentavalent impurities are P, As, etc.

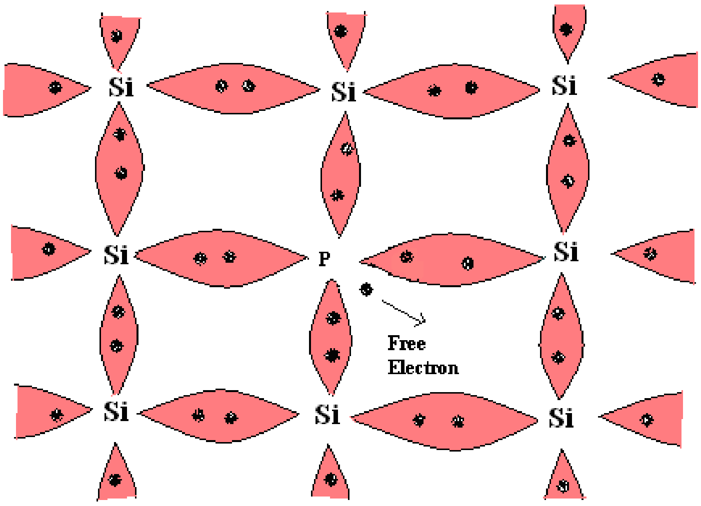


Fig: Pentavalent impurity (P) doped into intrinsic semiconductor (Si)

2. P-type Extrinsic Semiconductor:

When we add trivalent impurity to a pure semiconductor then it is called a P-type extrinsic semiconductor.

- This semiconductor is generated by doping trivalent impurity to the intrinsic semiconductor.
- If an 'Al' atom is substituted in place of 'Si' atom then it will complete three covalent bonds with three neighboring 'Si' atoms. But one more electron should be required to complete the fourth covalent bond. In the absence of fourth electron a hole is generated which lies in valence band. In this process no electron is shifted to the conduction bond.
- A small quantity trivalent impurity is added to the crystal then large number of holes in the valence band. Due to thermal agitation some more electrons in valence band are shifted to conduction band by creating the holes in valence band.
- The impurity atom is in a position to get an electron. So this impurity atom is known as acceptor impurity..
- In this semiconductor majority carriers are holes and minority carriers are electrons.
- The majority carriers have positive charge, so this semi conductor is known as P-type extrinsic semiconductor.
- The Fermi energy level shifted towards the valence band.

Ex: - B, Al, Ga, etc.

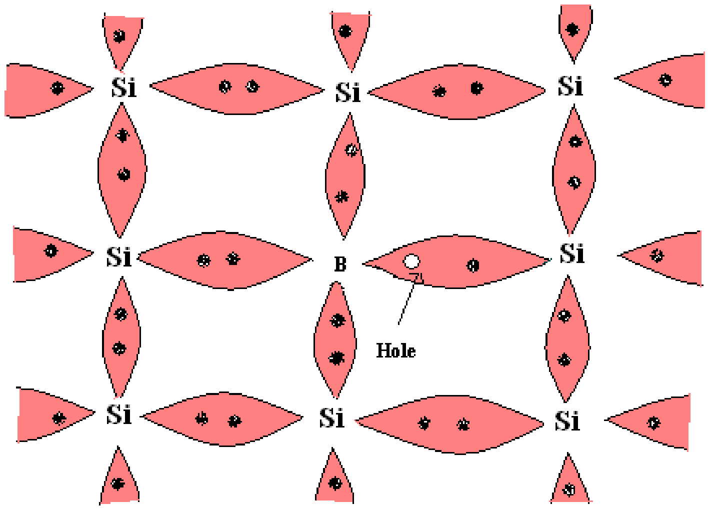


Fig: Trivalent impurity (B) doped into intrinsic semiconductor (Si)

Carrier Concentration in Semiconductors

The number of charge carriers per unit volume is defined as carrier concentration.

Units: Number of electrons/m^3.

Intrinsic Carrier Concentrations:

In intrinsic semi conductors, as the temperature is increased electron-hole passes will be generated. Hence the electron concentration, n_i, in the conduction band will be equal to the hole concentration p_i in the valence band.

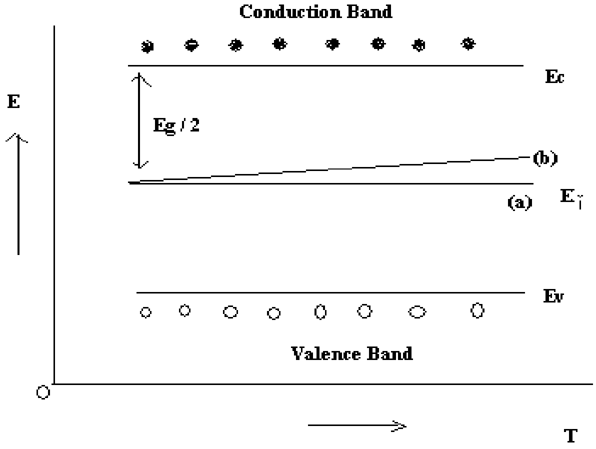


Fig: Fermi level at (a) T = 0 (b) As temperature increases $m_h^* > m_e^*$

Let E_i be the Fermi level of the intrinsic semiconductor in equilibrium, then the number of electrons per unit volume in the conduction band.

$$n_i = 2\left(\frac{2m_e\pi k_B T}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_i - E_c}{k_B T}\right)$$

And the number of holes per unit volume in the valence band

$$p_i = 2\left(\frac{2m_h\pi k_B T}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_v - E_i}{k_B T}\right)$$

But in intrinsic semiconductors $n_i = p_i$

$$\text{Hence, } 2\left(\frac{2m_e\pi k_B T}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_i - E_c}{k_B T}\right) = 2\left(\frac{2m_h\pi K_B T}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_v - E_i}{k_B T}\right)$$

$$m_e^{\frac{3}{2}} \exp\left(\frac{E_i - E_c}{k_B T}\right) = m_h^{\frac{3}{2}} \exp\left(\frac{E_v - E_i}{k_B T}\right)$$

$$\text{Exp}\left(\frac{E_i - E_c - E_v + E_i}{k_B T}\right) = \left(\frac{m_h}{m_e}\right)^{\frac{3}{2}}$$

$$2E_i - E_c - E_v = K_B T \ln\left(\frac{m_h}{m_e}\right) K_B T$$

$$E_i = \frac{1}{2}(E_c + E_v) + \frac{3}{4}\ln\left(\frac{m_h}{m_e}\right) k_B T.$$

If the effective masses $m_e = m_h$, then

$$E_i = \frac{E_c + E_v}{2}\left[\because \ln 1 = 0\right]$$

i.e. E_i lies mid way between E_c and E_v, which happens to be the centre of the bond gap at any temperature.

Combining n_i and p_i values,

$$n_i p_i = 4\left(\frac{2\pi m_e kT}{h^2}\right)^{\frac{3}{2}} \left[\frac{2\pi m_h k_B T}{h^2}\right]^{\frac{3}{2}} \exp\left(\frac{E_i - E_C}{KT}\right) \exp\left(\frac{E_v - E_i}{KT}\right)$$

$$n_i^2 = 4\left(\frac{2\pi k}{h^2}\right)^3 (m_e m_h)^{\frac{3}{2}} T^3 \exp\left(\frac{E_v - E_c}{KT}\right) (\because n_i = P_i)$$

$$n^2 = AT^3 \exp\left(\frac{-E_g}{KT}\right)$$

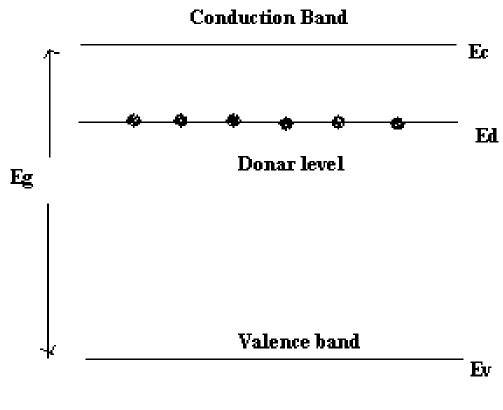
Where $A = 4\left(\frac{2\pi k}{h}\right)^3 (m_h m_e)^{\frac{3}{2}}$ a constant value of semiconductor and $E_g = E_c - E_v$ is energy gap of the semiconductor.

It is to be noted that A and E_g are constants for a given semiconductor and n_{i}- is called the intrinsic concentration which indicates thermally generated electrons and holes. It is a strong function of temperature 'T'.

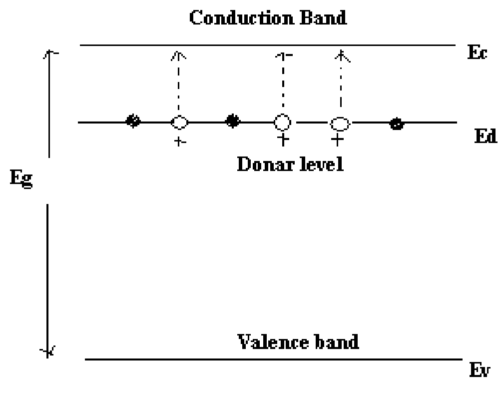
Electron Concentration in Extrinsic Semiconductor

1. **Carrier Concentration in N-Type Semiconductors**:

The energy level diagram of a N-type semiconductor shown in figure



At T = O K



At T > 0K

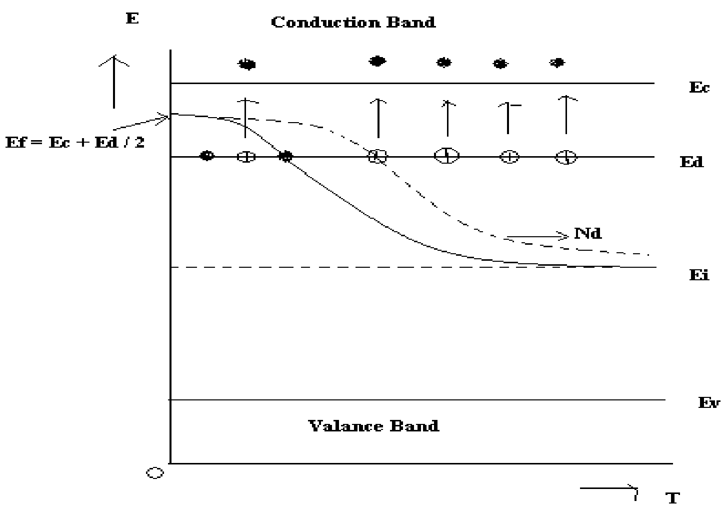


Fig: Variation of Fermi Level with Temperature

N_d is the donor concentration and E_d is the donor energy level. At very low temperatures all donor levels are filled with electrons. With increase of temperature more and more donor atoms get ionized and the density of electrons in the conduction band increases.

Density of electrons in conduction band is given by

$$n = 2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_F - E_C}{KT}\right) ----(1)$$

If we assume that E_F lies more than a few KT above the donor level then the density of ionized donors is given by

$$N_d\left[1 - F\left(E_d\right)\right] \approx N_d \quad \exp\left(\frac{E_d - E_F}{KT}\right)$$

At very low temperatures, when electron-hole pairs not generated due to breaking of covalent bonds. The number of electrons in the conduction band must be equal to the number of ionized donors.

$$\text{i.e.}\ 2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}} \quad \exp \quad \left(\frac{E_F - E_C}{KT}\right) = N_d \ \exp\left(\frac{E_d - E_F}{KT}\right)$$

Taking logarithm and rearranging we get

$$\left(\frac{E_F - E_C}{KT}\right) - \left(\frac{E_d - E_F}{KT}\right) = \log N_d - \log 2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}}$$

$$2E_F - \left(E_d + E_C\right) = KT \log \frac{N_d}{2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}}}$$

$$E_F = \left(\frac{E_d + E_c}{2}\right) + \frac{kT}{2} \log \frac{N_d}{2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{\frac{3}{2}}} ------(2)$$

$$\text{At O K. } E_F = \frac{E_d + E_c}{2}$$

i.e. at 0 k, Fermi level lies exactly at the middle of the donor level E_d and the bottom of the conduction band E_c

Density of Electrons in the Conduction Band:

The density of electrons in the conduction band is given by

$$n = 2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_F - E_C}{KT}\right) ----(3)$$

Substitute 'E_F' value in equation (2) in the above equation.

$$\exp\left(\frac{E_F - E_c}{KT}\right) = \exp\left\{\left(\frac{E_d - E_c}{2KT}\right) + \frac{1}{2}\log \frac{N_d}{2\left(\frac{2\pi m_e^* KT}{h^2}\right)}\right\}$$

$$\text{Exp } \left(\frac{E_F - E_C}{KT}\right) = \exp\left\{\left(\frac{E_d - E_c}{2KT}\right) + \log \frac{N_d^{\frac{1}{2}}}{\left[2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}}\right]^{\frac{1}{2}}}\right\} \left(\because \frac{1}{2} logx = \log x^{\frac{1}{2}}\right)$$

$$= \left[\exp\left(\frac{E_d - E_C}{2KT}\right)\right] \frac{N_d^{\frac{1}{2}}}{\left\{2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}}\right\}^{\frac{1}{2}}} \left[\because \exp\left(a+b\right) = e^a . e^b\right]$$

Hence

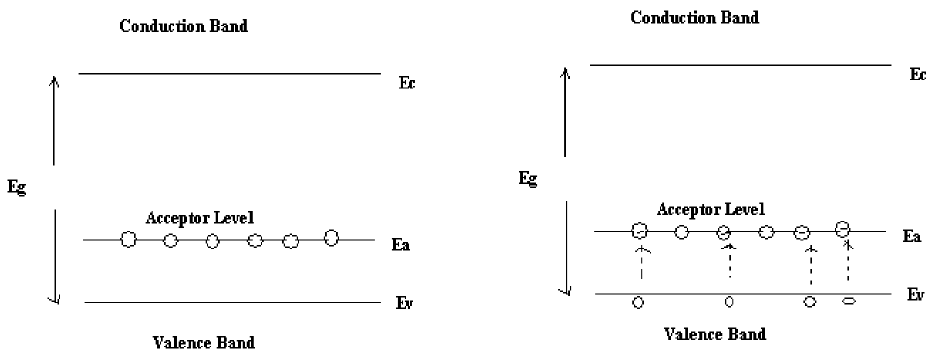
$$n = 2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}} \frac{N_d^{\frac{1}{2}}}{\left[2\left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{2}}\right]^{\frac{1}{2}}} \exp\left(\frac{E_d - E_C}{2KT}\right)$$

$$n = \left(2N_d\right)^{\frac{1}{2}} \left(\frac{2\pi m_e^* KT}{h^2}\right)^{\frac{3}{4}} \exp\left(\frac{E_d - E_C}{KT}\right)$$

Thus we find that the density of electrons in the conduction band is proportional to the square root of the donor concentration at moderately low temperatures.

2. Carrier Concentration in P-type Semiconductor:

The energy level diagram of a P-type semiconductor is as shown in figure below.



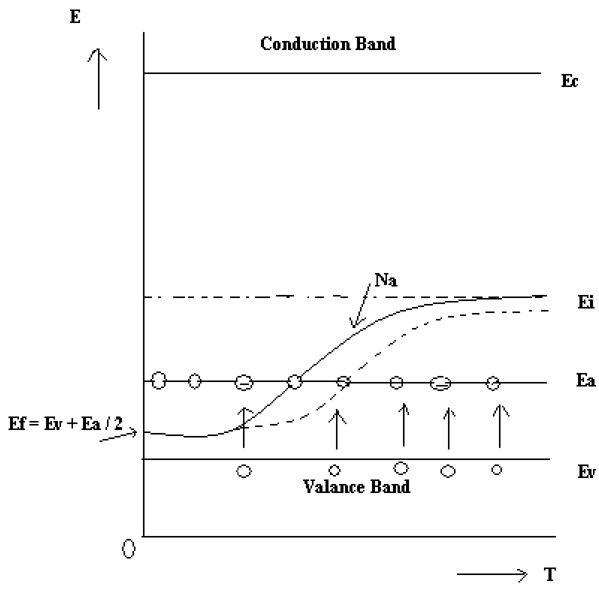


Fig: Variation of Fermi Level with Temperature

N_a is the acceptor concentration i.e. the number of acceptor atoms per unit volume of the material and E_a is the acceptor energy level.

At very low temperatures all the acceptor levels are empty. With increase of temperature acceptor atoms get ionized i.e. the electrons move from valence band and occupy the vacant sites in the acceptor energy level there by leaving holes in the valence band.

Density of holes in the valence band is given by

$$p = 2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_V - E_F}{KT}\right)$$

Since $E_F$lies below acceptor level, the density of ionized acceptor is given by

$$N_a F\left(E_a\right) = N_a \exp\left(\frac{E_F - E_a}{KT}\right)$$

Since the density of holes in the valence band is equal to the density of ionized acceptors

$$2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_V - E_F}{KT}\right) = N_a \exp\left(\frac{E_F - E_a}{KT}\right)$$

$$\text{i.e. } \exp\left(\frac{E_V + E_a - 2E_F}{KT}\right) = \frac{N_a}{2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}}}$$

Taking logarithm

$$\left(\frac{E_V + E_a - 2E_F}{KT}\right) = \log \frac{N_a}{2\left(\frac{2\pi n_h^* KT}{h^2}\right)^{\frac{3}{2}}}$$

$$\text{i.e. } E_F = \frac{E_V + E_a}{2} - \frac{KT}{2} \log \frac{N_a}{2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}}} ----(1)$$

$$\text{AT O K } E_F = \frac{E_V + E_d}{2}$$

At Ok, Fermi level lies exactly at the middle of the acceptor level and the top of the valence band as shown in above fig

Density of Holes in Valence Band:

The density of holes in the valence band is given by

$$p = 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_V - E_F}{KT}\right) ------ (2)$$

Substitute equation (1) value in equation (2)

$$\text{Exp}\left(\frac{E_V - E_F}{KT}\right) = \exp\left\{\frac{E_V}{KT} - \frac{E_V + E_d}{2KT} + \frac{1}{2}\log\frac{N_a}{2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}}}\right\}$$

$$= \exp\left\{\left(\frac{E_V - E_a}{2KT}\right) + \log\frac{N_a^{\frac{1}{2}}}{\left(2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}}\right)^{\frac{1}{2}}}\right\}$$

$$\text{Hence } p = 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{\frac{3}{2}} \left\{\exp\left(\frac{E_V - E_a}{2KT}\right)\right\} \frac{N_a^{\frac{1}{2}}}{\left[2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{\frac{3}{2}}\right]^{\frac{1}{2}}}$$

$$p = \left(2N_a\right)^{\frac{1}{2}} \left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{4}} \exp\left(\frac{E_V - E_a}{2KT}\right).$$

Thus we find that the density of holes in the valence band is proportional to the square root of the acceptor concentration at moderately low temperature.

Drift Current and Conductivity in Semiconductors

In the presence of electric field, the drift velocities V_{de} *and* V_{dh} carriers on the thermal velocities v_{te} and v_{th}. But the flow of charge carriers result in an electric current in the semiconductor crystal known as the drift currents. Let an electric field E be applied in the positive X-direction creating drift currents Jn_d and J_{pd} of electrons and holes respectively.

In the absence of electric field, the drift velocities reduce to zero. Thus current density will also be zero.Consider the free electrons in a semiconductor moving with a uniform velocity $v_{de.}$ In the negative X-direction due to the application of the electric field E in the positive X-direction. Suppose AB, a small rectangular box element of length v_{de} and unit sides of the square end faces A and B in the semiconductor shown in fig

{Total change in the box AB}**Q=** {Volume of the box AB} X {Density of Particles} X {Charge on each particle}

$$Q = \left(V_{de} \times 1 \times 1\right) \times n \times -q$$
$$\therefore Q = -qnV_{de} ---(1)$$

The current density J_{nd} due to the free electrons at the face B will be

$$J = \frac{charge}{time \times area} ----(2)$$

From (1) & (2) the current density of electrons J_{nd} = -qnv_{de} -------(3)

Similarly current density of holes, J_{pd} = qpV_{dh}-------(4)

But drift velocities in terms of mobilities are

$$V_{de} = -\mu_n E ----(5)$$

$$V_{dp} = \mu_p E -----(6)$$

Hence substituting equations (5) & (6) in (3) & (4)

$$J_{nd} = nq\mu_n E$$
$$J_{pd} = nq\mu_p E$$

Total current density due to both electrons and holes will be

$$J_d = J_{nd} + J_{pd}$$
$$J_d = (nq\mu_n + nq\mu_p)E$$

According to ohm's law, the current density

$$J_d = \sigma E$$
$$\sigma = nq\mu_n + nq\mu_p$$
$$\sigma = \sigma_n + \sigma_p$$

Where $\sigma_n = nq\mu_n \; and \sigma_p = nq\mu_p$ the electrical conductivities due to electrons and holes respectively.

Diffusion Currents: A directed movement of charge carriers constitutes an electric current diffusion takes place due to the existence of a non-uniform concentration of carriers. Fick's states that the diffusion flux F i.e. the particle current are proportional to and in a direction opposite to the gradient of the particles.

It can be written as

$$F \alpha \frac{-\partial N}{\partial x}.$$
$$F = \frac{-D\partial N}{\partial x}$$

Where 'D' is diffusion current.

If 'n' and 'p' are the electron and hole concentrations, then the flux densities of electrons and holes $J_e \; and \; J_P \; can be \; written \; as$

$$J_e = -D_n \frac{\partial n}{\partial x}$$
$$J_p = J_h = -D_p \frac{\partial p}{\partial x}$$

Where D_n and D_p are diffusion constants of the electrons and holes respectively.

Then diffusion current densities become.

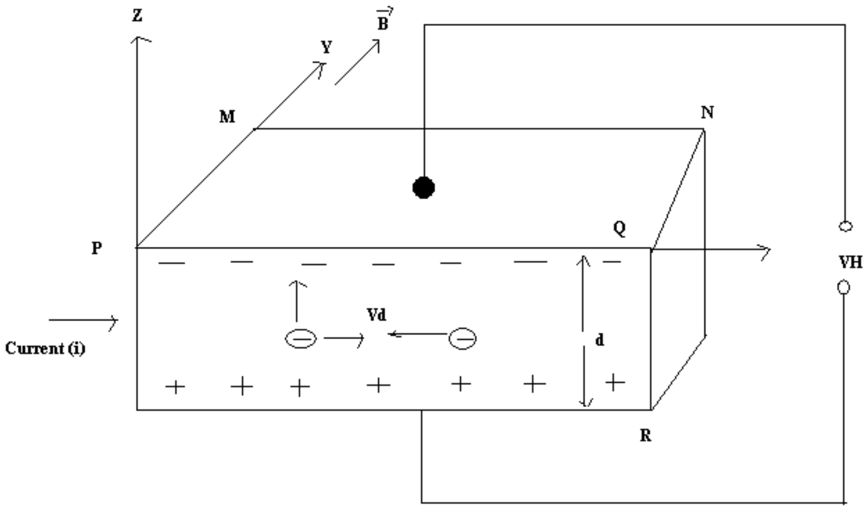
$$J_{ndiff} = qD_n . \frac{\partial n}{dx}.$$
$$J_{Pdiff} = -qD_p \frac{dp}{dx}$$

Where +q and –q are charges of the hole and electron respectively.

Hall Effect:

When a magnetic field is applied perpendicular to a current carrying conductor or semiconductor, a voltage is developed across the specimen in a direction perpendicular to both the current and the magnetic field. This phenomenon is called the Hall Effect and the voltage developed is called the Hall voltage.

Consider a uniform thick metal strip placed with its length parallel to x-axis. Let a current 'i' is passed in the conductor along x-Axis and magnetic field B is established along y-axis. Due to the magnetic field charge carriers experience a force F_D perpendicular to x-y plane. i.e. along z-axis. This force direction is given by Fleming left hand rule.



The nature of charge carriers can be found by determining the sign of Hall e.m f which can be measured by potentiometers. Experiments showed that the charge carriers in metal are electrons while the charge carriers in p-type semiconductors are holes.

Magnetic deflecting force $F_D = q(v_\alpha \times \beta)$------(1)

Hall electric deflecting force $F_H = qE_H$ --------------(2)

When equilibrium is reached, the magnetic deflecting forces on the charge carriers are balanced by the electric forces due to electric field.

Hence net farce on the charge carriers becomes zero.

From (1) & (2)

$$q(v_d \times B) + qE_H = 0$$
$$E_H = -(V_d \times B)$$

Interms of magnitude $E_H = V_d.B----(3)$

Where V_d is drift velocity of electrons.

The relation b/w current density and drift velocity is $J=V_dne$

$$V_d = \frac{J}{ne} = \frac{J}{nq} ------(4)$$

Where 'n' is the number of charge carriers per unit volume

Substitute Eq'n (4) in equation (3)

$$E_H = \left(\frac{J}{nq}\right)B----(5)$$

If V_{H}- be the Hall voltage in equilibrium.

$\therefore$ Hall electric field, $E_H = \left(\frac{{}^{V}H}{d}\right)------(6)\left(\because E = \frac{v}{d}\right)$

Where'd' is width of the metal strip.

By measuring the current in the slab, the current density J can be calculated. $\left(J = \frac{i}{A}\right)$

Where 'A' is the area of cross section of the slab.

The magnetic field 'B' can be measured by Gauss-meter.

On substituting E_H,J and B in Equation (5) the value of $\frac{1}{nq}$ can be calculated

$$\therefore Hall\ coefficient\ R_H = \frac{E_H}{JB}$$

$$\frac{E_H}{JB} = \frac{1}{nq}.\therefore R_H = \frac{1}{nq}$$

The Hall coefficient is negative when the charge carriers are electrons and positive when the charge carriers are holes.

Applications of Hall Effect:

1. The sign (electrons or holes) of charge carriers is determined.
2. The carrier concentration can be determined.
3. The mobility of charge carriers is measured directly.
4. Electrical conductivity of the material can be determined
5. It can be used to determine whether the given material is metal, insulator or semiconductor.
6. We can measure the unknown magnetic field by using the measured Hall voltage and the Hall coefficient for the slab.

PN JUNCTION DIODE

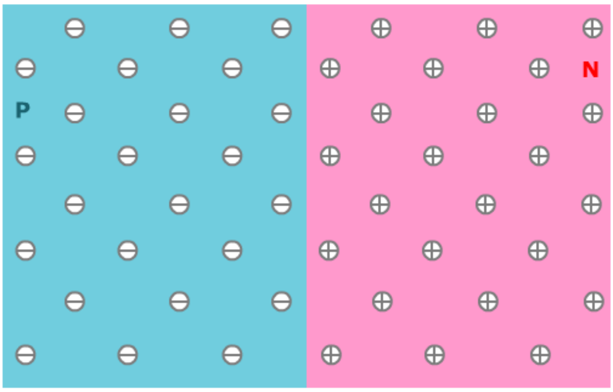


Fig: P- type material is joined with N-type material

Carrier Movement in Equilibrium:

A p-n junction with no external inputs represents equilibrium between carrier generation, recombination, diffusion and drift in the presence of the electric field in the depletion region. Despite the presence of the electric field, which creates an impediment to the diffusion of carriers across the electric field, some carriers still cross the junction by diffusion.

In the Figure below, most majority carriers which enter the **depletion region** move back towards the region from which they originated. However, statistically some carriers will have a high velocity and travel in a sufficient net direction such that they cross the junction. Once a majority carrier crosses the junction, it becomes a minority carrier. It will continue to diffuse away from the junction and can travel a distance on average equal to the diffusion length before it recombines.

The current caused by the diffusion of carriers across the junction is called diffusion current. In the figure below, watch the carriers in the depletion region and wait for carriers which cross the junction. Remember that in an actual p-n junction the number and velocity of the carriers is much greater and that the number of carriers crossing the junction is much larger.

Minority carriers which reach the edge of the diffusion region are swept across it by the electric field in the depletion region. This current is called the drift current. In equilibrium the drift current is limited by the number of minority carriers which are thermally generated within a diffusion length of the junction.

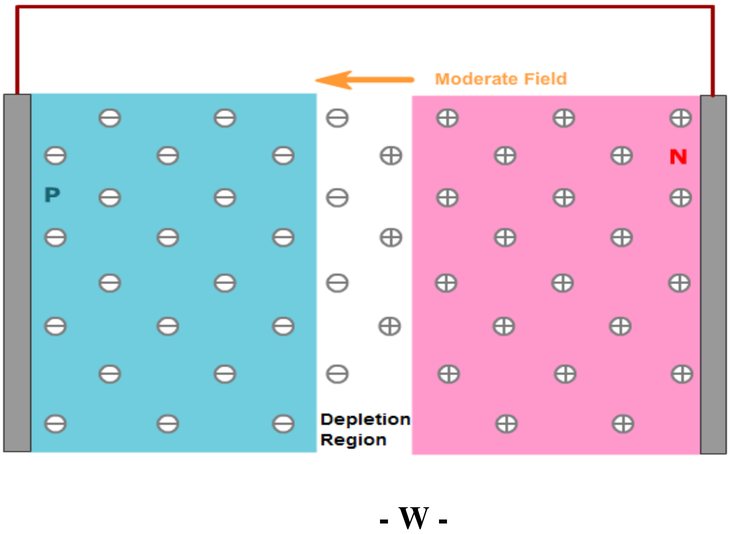
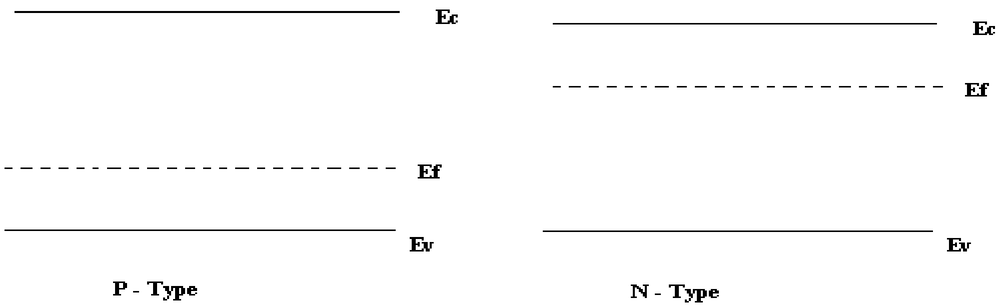


Fig: Formation of PN junction

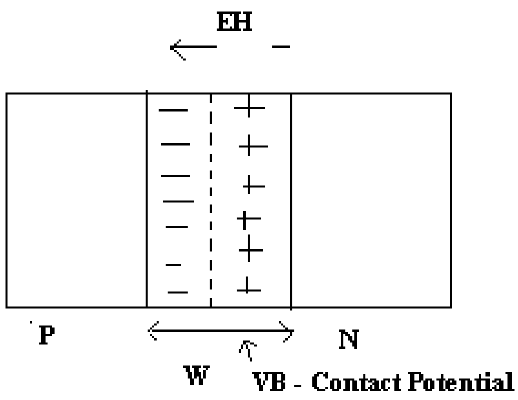
In equilibrium, the net current from the device is zero. The electron drift current and the electron diffusion current exactly balance out (if they did not there would be a net buildup of electrons on either one side or the other of the device). Similarly, the hole drift current and the hole diffusion current also balance each other out.

Energy Diagrams of PN Diode:

1. Before the formation of PN junction, the Fermi level lies to valence band in P type and near to conduction band in N type.

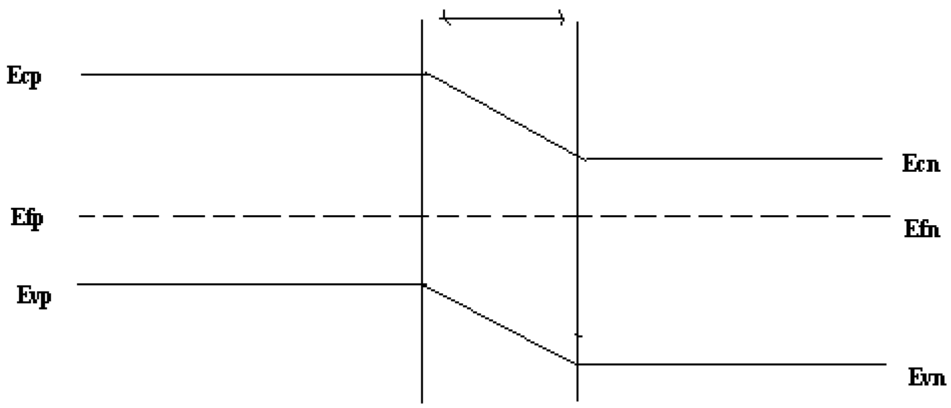


2. When a P type material is brought closer to N type material, a contact potential V_B is developed which is due to potentials of depletion regions on n- side p- side respectively.



3. The contact or barrier potential due to n- type is Vn and p-type is Vp. There fore at the junction $V_B = Vn - Vp$

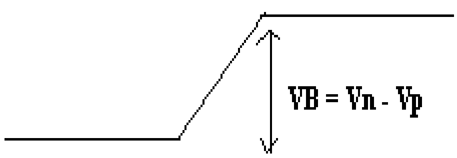
4. After the junction formation, the Fermi level becomes common for both types.



The electric field $E_B = E\ vp - E\ vn$

$= Ecp - Ecn$

$= eV_B$



There are three biasing conditions for the standard junction diodes. They are,

1. Zero Bias
2. Forward Bias
3. Reverse Bias

1. Zero Bias: When a diode is said to be zero biased, no external voltage is applied to the PN Junction.

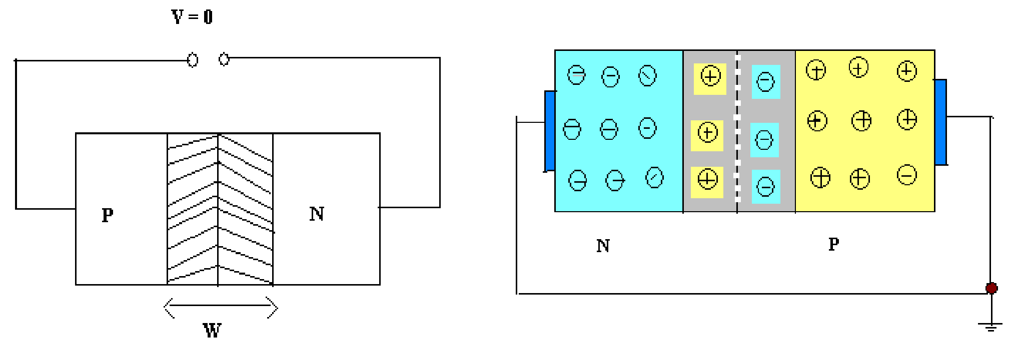


Fig: Zero biased PN junction

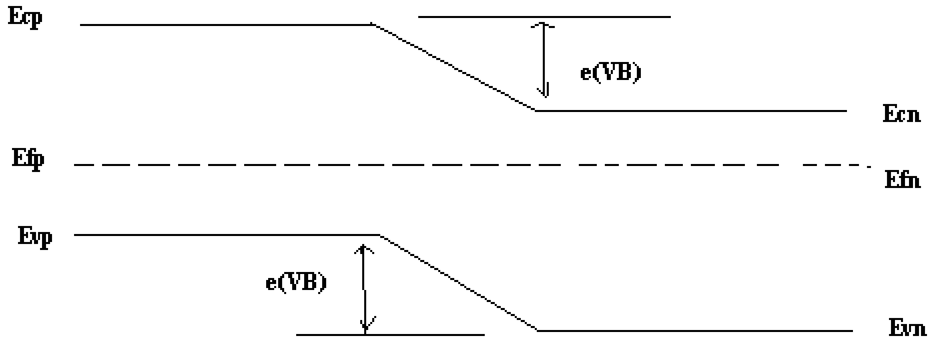


Fig: Energy level diagram

2. Forward Bias: When the positive terminal of the battery is connected to the P side and negative terminal to the N side, then the PN junction is known as Forward Biased.

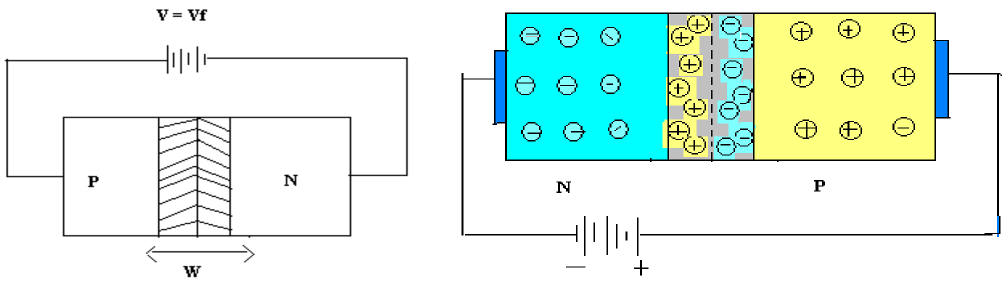


Fig: Forward biased PN junction

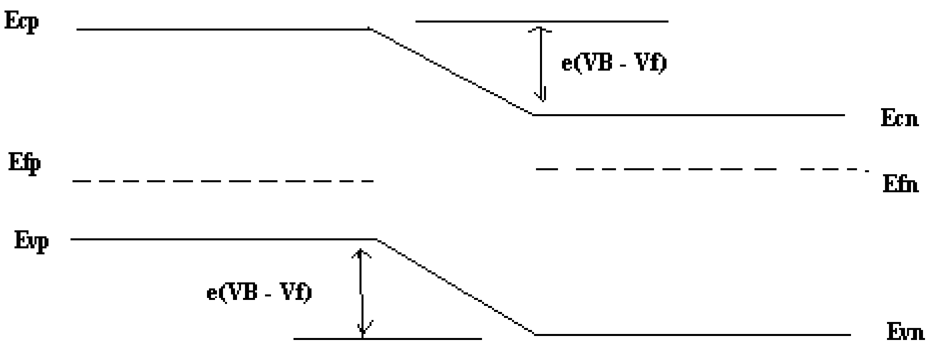


Fig: Energy level diagram

3. Reverse Bias: When the positive terminal of the battery is connected to the N side and negative terminal is to the P side then the PN junction is known as Reverse Biased.

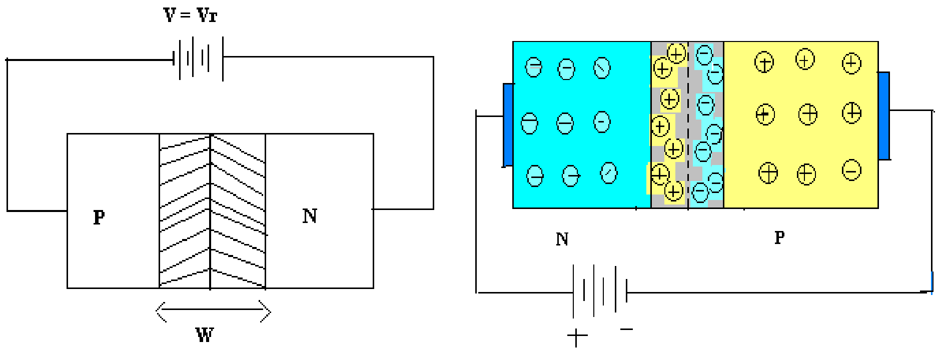


Fig: Reverse biased PN junction

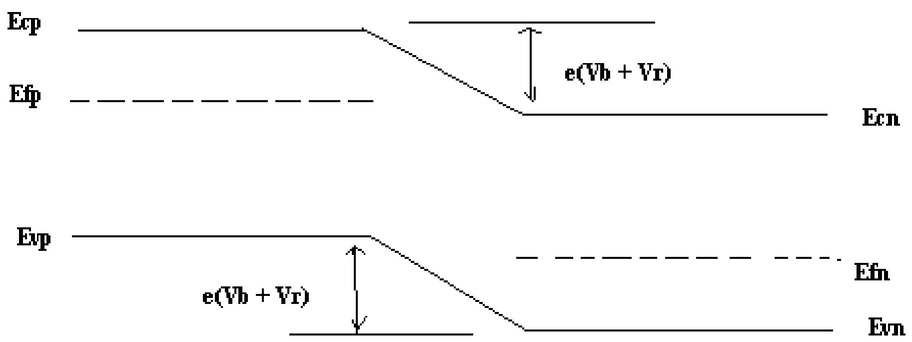


Fig: Energy level diagram

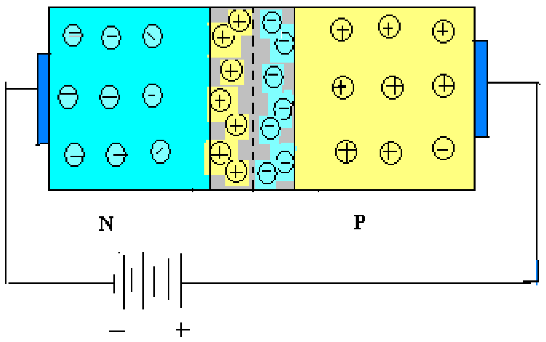
I-V Characteristics of PN Junction:

To understand how a diode responds when it is connected in an electrical circuit, its V – I characteristics should be studied.

It ca be understand simply by plotting a graph between the voltage applied across the terminals of the diode and the current that flows through the diode.

Forward Characteristics:

1. When a diode is connected in a forward bias condition the current through the diode is small for the low voltage. i.e. for first few tenths of volts.

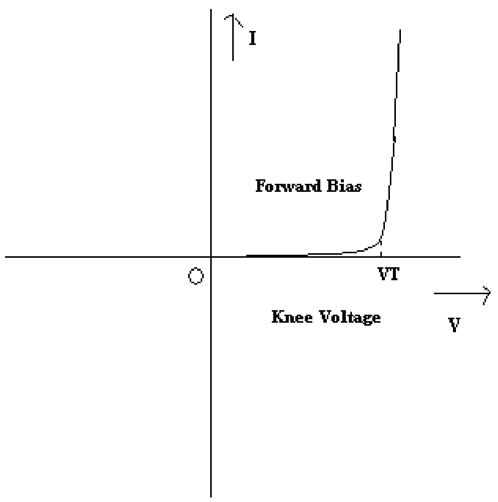


2. The external voltage applied reduces the barrier potential at the junction, but the diode does not conduct well until the applied external voltage overcomes the barrier potential.

3. When this happens, large number of electrons from n- side and holes from p-side start crossing the junction.

4. Now, even small increase in applied voltage produces a sharp increase in current.

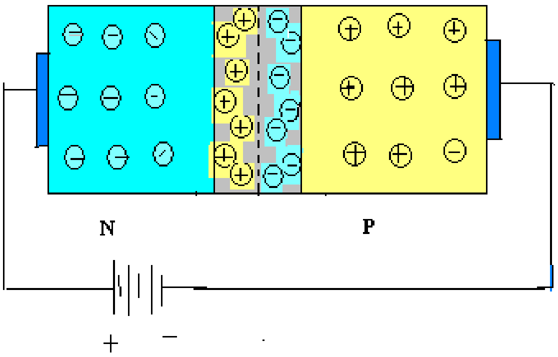
5. The voltage beyond which the current increases rapidly is called **Knee voltage or Threshold voltage.**



6. Since the diode can conduct infinite current above this knee point as if effectively becomes a short circuit, resistors are used in series with the device limit its current flow.

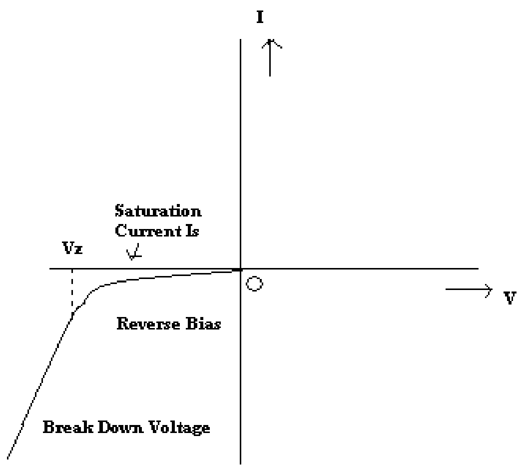
Reverse Characteristics:

1. Under Reverse bias condition, the conduction through the diode is almost negligible.



2. A very small current flows through the diode due to minority carriers crossing the junction.

3. This current remains constant for all voltages less than the break down voltage Vz. This current is called **reverse saturation current.**



4. When the applied reverse bias voltage becomes more than the break down voltage Vz, the current increases at a rapid rate.

5. An ordinary PN junction should not be operated in this voltage, because the diode becomes overheat and failed due to the “avalanche effect” around the junction.

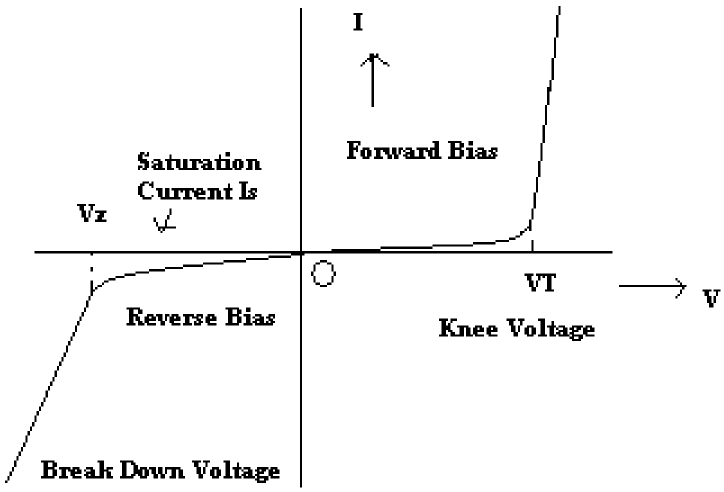
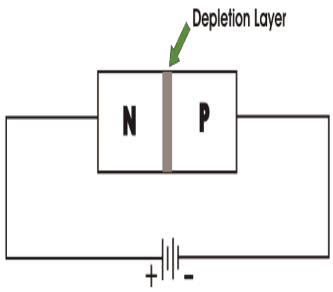


Fig: I – V Characteristics of PN junction diode

Zener diode:

A zener diode is a special type of device designed to operate in the zener breakdown region. Zener diodes acts like normal p-n junction diodes under forward biased condition. The breakdown voltage of a zener diode is carefully set by controlling the doping level during manufacture. Zener diodes are mainly used to protect electronic circuits from over voltage.

Zener diode is heavily doped than that of the normal p-n junction diode. Hence, it has very thin depletion region. Therefore, zener diodes allow more electric current than the normal p-n junction diodes. Zener diode allows electric current in forward direction like a normal diode but also allows electric current in the reverse direction if the applied reverse voltage is greater than the zener voltage. Zener diode is always connected in reverse direction because it is specifically designed to work in reverse direction.
The name zener diode was named after the American physicist Clarance Melvin Zener who discovered the zener effect. Zener diodes are the basic building blocks of electronic circuits. They are widely used in all kinds of electronic equipments.



Breakdown in zener diode

There are two types of reverse breakdown regions in a zener diode: avalanche breakdown and zener breakdown.

Avalanche breakdown: The avalanche breakdown occurs in both normal diodes and zener diodes at high reverse voltage. When high reverse voltage is applied to the p-n junction diode, the free electrons (minority carriers) gains large amount of energy and accelerated to greater velocities.

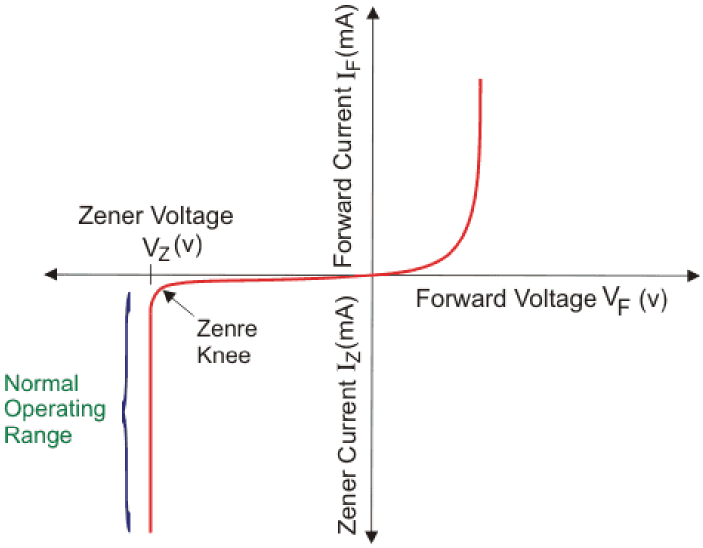
The free electrons moving at high speed will collides with the atoms and knock off more electrons. These electrons are again accelerated and collide with other atoms. Because of this continuous collision with the atoms, a large number of free electrons are generated. As a result, electric current in the diode increases rapidly. This sudden increase in electric current may permanently destroys the normal diode. However, avalanche diodes may not be destroyed because they are carefully designed to operate in avalanche breakdown region. Avalanche breakdown occurs in zener diodes with zener voltage (Vz) greater than 6V.

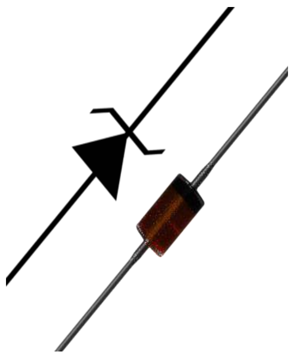
Zener breakdown: The zener breakdown occurs in heavily doped p-n junction diodes because of their narrow depletion region. When reverse biased voltage applied to the diode is increased, the narrow depletion region generates.

When reverse biased voltage applied to the diode reaches close to zener voltage, the electric field in the depletion region is strong enough to pull electrons from their valance band. The valence electrons which gains sufficient energy from the strong electric field of depletion region will breaks bonding with the parent atom will become free electrons. This free electrons carry electric current from one place to another place. At zener breakdown region, a small increase in voltage will rapidly increases the electric current.

• Zener breakdown occurs at low reverse voltage whereas avalanche breakdown occurs at high reverse voltage.
• Zener breakdown occurs in zener diodes because they have very thin depletion region.
• Breakdown region is the normal operating region for a zener diode.
• Zener breakdown occurs in zener voltage (Vz) less than 6V.Now, discussing about the diode circuits we should look through the graphical representation of the operation of the **zener diode**. Normally, it is called the V-I characteristics of a Zener diode.

V-I Characteristics of zener diode





The VI characteristics of a zener diode are shown in the above figure and its symbol. When forward biased voltage is applied to the zener diode, it works like a normal diode. However, when reverse biased voltage is applied to the zener diode, it works in different manner. When reverse biased voltage is applied to a zener diode, it allows only a small amount of leakage current until the voltage is less than zener voltage. When reverse biased voltage applied to the zener diode reaches zener voltage, it starts allowing large amount of electric current. At this point, a small increase in reverse voltage will rapidly increases the electric current. Because of this sudden rise in electric current, breakdown occurs called zener breakdown. However, zener diode exhibits a controlled breakdown that does damage the device. The zener breakdown voltae of the zener diode is depends on the amount of doping applied. If the diode is heavily doped, zener breakdown occurs low reverse voltages.

On the other hand, if the diode is lightly doped, the zener breakdown occurs at high reverse voltages.

Zener diodes are available with zener voltages in the range of 1.8V to 400V.

Advantages of zener diode:

• Power dissipation capacity is very high

• High accuracy

• Small size

• Low cost

Applications of zener diode:

• It is normally used as voltage reference

• Zener diodes are used in voltage stabilizers or shunt regulators.

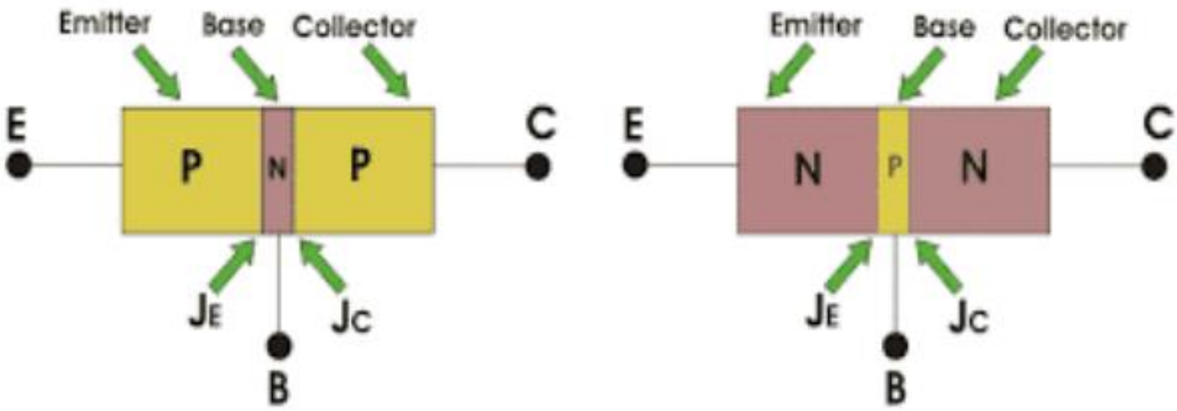
• Zener diodes are used in switching operations

• Zener dioes are used in clipping and clamping circuits.

• Zener dioes are used in various protection circuits.

Bipolar Junction Transistor (BJT) Construction:

A Bipolar Junction Transistor (BJT) has three terminals connected to three doped semiconductor regions. In an NPN transistor, a thin and lightly doped P-type base is sandwiched between a heavily doped N-type emitter and another N=type collector while in a PNP transistor, a thin and lightly doped N-type base is sandwiched between a heavily doped P-type emitter and another P-type collector. In the following we will only consider NPN BJTs.



1. Emitter: Emitter terminal is the heavily doped region as compared two base and collector. This is because the work of the emitter is to supply charge carrier to the collector via the base. The size of the emitter is more than base but less than the collector.

2. Base: The size of base region is extremely small, it is less than emitter as well as the collector. The size of the base is always kept small so that charge carriers coming from the emitter and entering base will not recombine in the base region and will be directed towards the collector region. The doping intensity of base is also less than emitter and collector for the same reason mentioned above.

3. Collector: The collector terminal is moderately doped, and the size of the collector region is slightly more than emitter region because all the charge carriers coming from the emitter recombine at base and heat is released in this process. Thus, it is necessary for the collector terminal to be large enough so that it can be dissipate the heat and the device may not burn out.

Principle of operation:

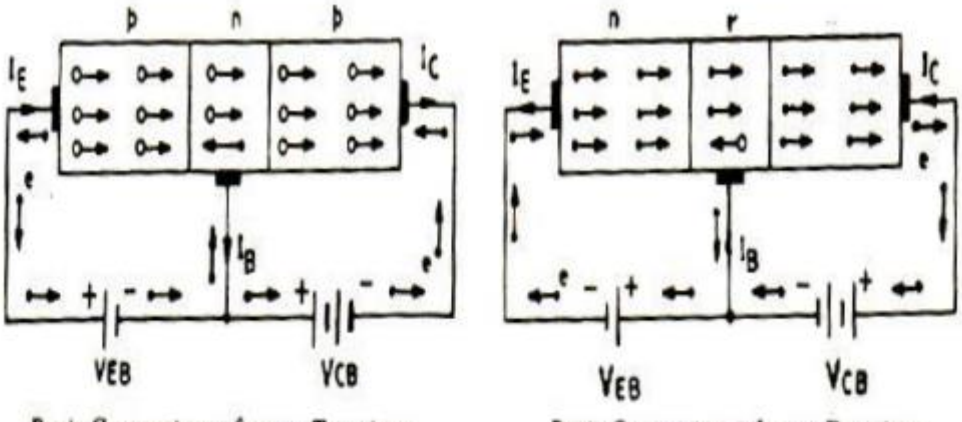
In many schematics of transistor circuits (especially when there exist a large number of transistors in the circuit), the circle in the symbol of a transistor is omitted. The figures below show the cross section of two NPN transistors. Note that although both the collector and emitter of a transistor are made of N-type semiconductor material, they have totally different geometry and therefore cannot be interchanged. All previously considered components (resistor, capacitor, inductor, and diode have two terminals (leads) and can therefore be characterized by the single relationship between the current going through and the voltage across the two leads. Differently, a transistor is a three-terminal component, which could be considered as a two-port network with an input-port and an output-port, each formed by two of the three terminals, and characterized by the relationships of both input and output currents and voltages. Depending on which of the three terminals is used as common terminal, there can be three possible

Configuration for the two-part network formed by a transistor:

• Common emitter (CE)

• Common base (CB)

• Common Collector (CC)



Basic Connections of p-n-p Transistor
(a)

Basic Connections of n-p-n Transistor
(b)

• Common-Base (CB) configuration

Two voltages VBE and VCB are applied respectively to the emitter E and collector C, with respect to the common base B, so that the BE junction forward biased while the CB junction is reversed biased. Note that the polarity of VBE and direction of IB associated with the PN-junction between E and B are the same as those associated with a diode, voltage polarity; positive on P, negative on N, current direction: from P to N, but VCB and the direction of IC associated with the PN-junction between the base and collector are defined oppositely.

The behaviour of the NPN-transistor is determined by its two PN-junctions:

• The forward biased base-emitter (BE) PN-junction allows the free electrons in emitter to go through the PN-junction to arrive at the base, forming the emitter current IE.

• As the P-type base is thin and lightly doped, only a small number of the electrons from the emitter are combined with the holes in base to form the base current IB.

• Most of the electrons coming from the emitter become minority carrier in the P-type base, and they go through the reverse biased collector-base PN junction to arrive at the collector.

• The percentage of those electrons that arrive at the collector out of the electrons from the emitter is defined as α (e.g. 99%, depending on the doping and geometry of the material). The total collector current IC is therefore IC= αIE. The current gain or current transfer ratio is defined as the ratio between the emitter (input) current IE and the collector (output) IC.

Formulas:

01	Fermi level in P-type semiconductor is $E_f = \frac{E_v + E_B}{2}$	5	Density of electrons in the conduction band is $n = (2N_d)^{1/2}\left(\frac{2\pi m_e^* KT}{h^2}\right)^{3/4} \exp\left(\frac{E_d - E_c}{2KT}\right)$
02	The diode equation is given by $I = I_0\left[\exp\left(\frac{eV}{\beta KT}\right) - 1\right]$	6	Fermi level in N-type semiconductor is $E_f = \frac{E_d + E_c}{2}$
03	Density of electrons in a semiconductors is given by $n = 2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_f - E_c}{KT}\right)$	7	**Fermi level in intrinsic semiconductor is** **$E_f = E_g/2$**
04	Density of holes in a semiconductor is given by $p = 2\left(\frac{2\pi m_h^* KT}{h^2}\right)^{\frac{3}{2}} \exp\left(\frac{E_v - E_f}{KT}\right)$	8	Intrinsic carrier concentration is given by $n_i = 2\left(\frac{2\pi Kt}{h^2}\right)^{\frac{3}{2}} (m_e^* m_h^*)^{3/4} \exp -\left(\frac{E_g}{2KT}\right)$

Short answer questions

1. What are intrinsic semiconductors? Give examples.
2. What are extrinsic semiconductors? Give examples.
3. Distinguish between intrinsic and extrinsic semiconductors.
4. Define Fermi level and mention its position in intrinsic and extrinsic semiconductors at 0K.
5. Explain about carrier generation and recombination mechanism.
6. Write the applications of Hall effect.
7. Write short note on Zener diode.
8. Explain V-I characteristics of p-n junction.

Essay questions

1. Derive an expression for concentration of electrons and holes in intrinsic semiconductor.
2. Derive an expression for carrier concentration in n-type and p-type semiconductor.
3. Explain drift and diffusion mechanism in semiconductors.
4. What is Hall effect? Derive expression for Hall coefficient.
5. Explain how a p-n junction is formed and explain with neat energy level diagram of p-n junction.
6. Explain construction and working of BJT.

Radiative and non-radiative recombination mechanism (or) Direct and Indirect Band Gap Semiconductors:

Semiconductors are available in elemental form (Ge,Si) and compound form (GaAs,Inp) Further they can further subdivided into direct band gap and indirect band gap semiconductors.

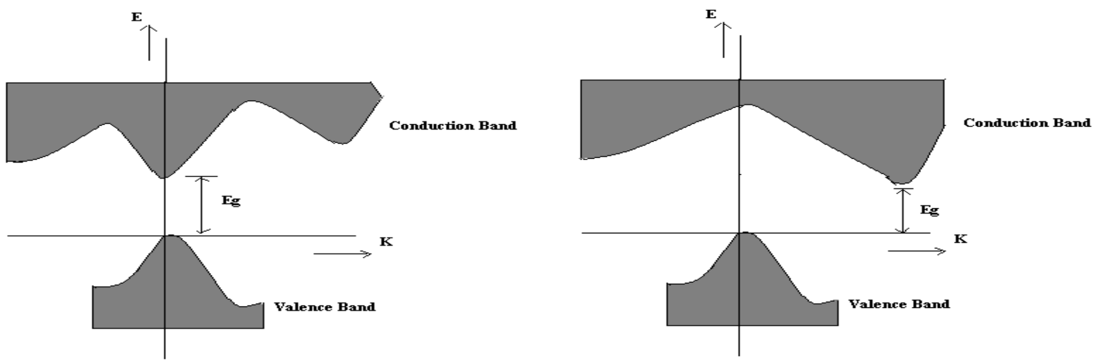
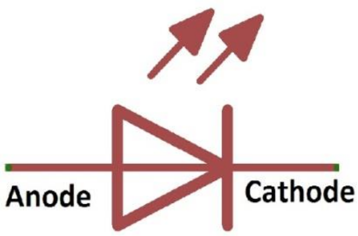


Fig: (a) Band diagram of direct band gap and indirect band gap semiconductors

Direct band gap Semiconductor	Indirect band gap Semiconductor
1. Fig(a) shows the energy band diagram drawn between energy ‘E’ and wave vector ‘k’ of a direct band gap semi conductor. 2. As shown in the band diagram, the minimum energy of conduction band and maximum energy of valence band are having the same value of wave vector. 3. An electron from the conduction band can recombine with a hole the valence band directly emitting a light photon of energy $h\upsilon$. 4. Life time (i.e. recombination time) of charge carriers is very less. 5. Due to emission of light photon during recombination of charge carriers, these are used to fabricate LEDS and laser diodes. 6. These are mostly from the compound semiconductors. 7. Ex: - In P, GaAs. 8. Band gap energy of InP =1.35eV And GaAs =1.42eV	1. Fig (b) shows the energy band diagram drawn between ‘E’ and wave vector ‘k’ of an indirect band gap semiconductor 2. In this band diagram the minimum energy of conduction band and maximum energy of valence band are having the different values of wave vector. 3. An electron from the conduction band can recombine with a hole in valence band indirectly through traps. Here there is no emission of light photon. 4. Life time of charge carriers is more 5. Due to longer life time of charge Carriers, these are used to amplify the signals, as in the case of diodes and transistors. 6. These are mostly from the elemental semiconductors 7. Ex: - Si, Ge. 8. Band gap energy of Si=0.7eV and Ge=1.12eV.

LIGHT EMITTING DIODE(LED):

The LED is a PN-junction diode which emits light when an electric current passes through it in the forward direction. In the LED, the recombination of charge carrier takes place. The electron from the N-side and the hole from the P-side are combined and gives the energy in the form of heat and light.



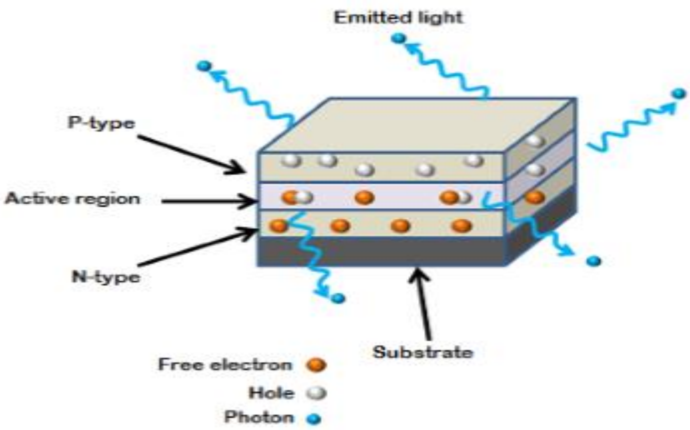
Construction of LED: The recombination of the charge carrier occurs in the P-type material, and hence P-material is the surface of the LED. For the maximum emission of light, the anode is deposited at the edge of the P-type material. The cathode is made of gold film, and it is usually placed at the bottom of the N-region. This gold layer of cathode helps in reflecting the light to the surface.

The gallium arsenide phosphide is used for the manufacturing of LED which emits red or yellow light for emission. The LED are also available in green, yellow amber and red in colour.

Working of LED:

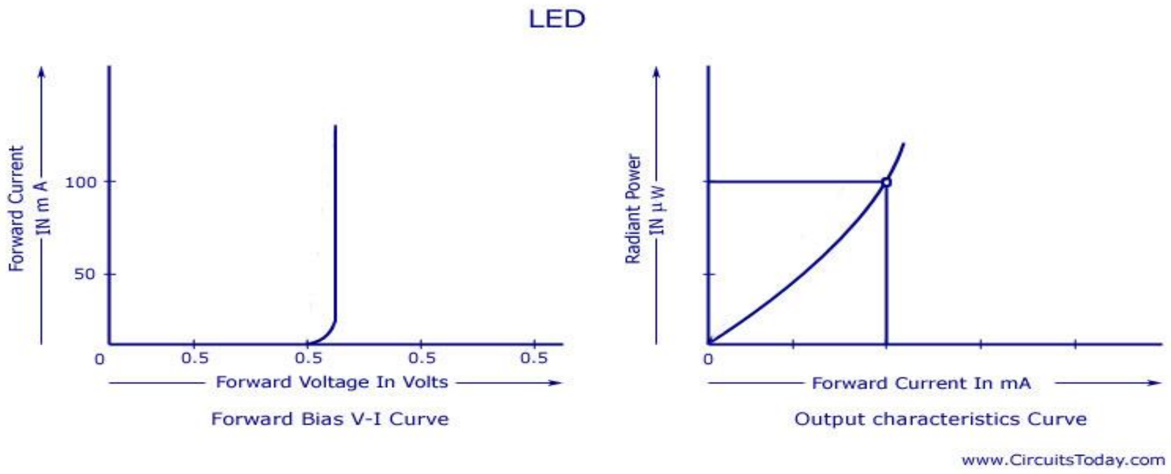
The working of the LED depends on the quantum theory. The quantum theory states that when the energy of electrons decreases from the higher level to lower level, it emits energy in the form of photons. The energy of the photons is equal to the gap between the higher and lower level.

The LED is connected in the forward biased, which allows the current to flows in the forward direction. The flow of current is because of the movement of electrons in the opposite direction. The recombination shows that the electrons move from the conduction band to valence band and they emits electromagnetic energy in the form of photons. The energy of photons is equal to the gap between the valence and the conduction band.



The gallium arsenide phosphide is used for the manufacturing of LED which emits red or yellow light for emission. The LED are also available in green, yellow amber and red in colour.

V –I Characteristics of LED:



The output characteristics curve shows that radiant power of LED is directly proportional the forward current in LED.

Applications of LEDs

- Electronic displays such as OLEDs, micro-LEDs, quantum dots etc.
- As an LED indicator.
- In remote controls.
- Lightings.
- Opto-isolators.

SEMICONDUCTOR LASER

A ***semiconductor diode laser*** is a specifically made p-n junction diode that emits coherent light under forward bias. R.N. Hall and his coworkers made the first semiconductor laser in 1962. P-N junction lasers are emits light almost anywhere in the spectrum from UV to IR.

The **laser diode** (light amplification by stimulated emission of radiation) produces a monochromatic (single Color) light. Laser diodes in conjunction with photodiodes are used to retrieve date from-compact discs.

Diode lasers are remarkably small in size (0.1 mm long). They have high efficiency of the order of 40%. In spite of their small size and low power requirements, they produce power outputs equivalent to that of He-Ne lasers. Diode lasers are useful in optical fibre communications, in CD players, CD-ROM drives, optical reading and high speed laser printing etc wide.

a) Semiconductor Materials

i) Semiconductors are two different groups, direct band gap semiconductors and indirect band gap semiconductors.

ii) Direct band gap semiconductors are formed by group III_V elements and group IV-VI elements. Most of the compound semiconductors belong to this group.

iii) Leasers are made using direct band gap semiconductors. Gallium Arsenide (GaAs) diode is an example of semiconductor diode laser.

iv) Direct band gap semiconductor is the one in which a conduction band electron can recombine directly with a hole in the valence band. The recombination process lead to emission of light.

b) Principle

i) The energy hand structure of a semiconductor consists of a valence band and a conduction band separated by an energy gap, E_g. The conduction band contains electrons and the valence band contains holes and electrons.

ii) When an electron from the conduction band jumps into a hole in the valence band, the excess energy E_g is given out in the form of a photon.

iii) Electron-hole recombination is the basic mechanism responsible for emission of light.

Iv) The wavelength of the light is given by the relation $\lambda = hc/E_g$.

v) Semiconductors having a suitable value of E_g emit light in the optical region.

c) Types of Semiconductor Diode Lasers

Broadly there are two types of semiconductor diode lasers. They are known as *homojunction semiconductor laser and heterojunction semiconductor lasers.*

i) Homojunction Semiconductor Laser

ii) Heetrojunction Semiconductor Laser

Homojunction Semiconductor Laser

A Simple diode laser which makes use of the same semiconductor material on both sides of the junction is known as a homojunction diode laser. Example: Gallium arsenide (GaAs) laser.

a) Construction: Fig. shows the schematic of a homojuncation diode laser. Starting with a heavily doped n-type GaAs material, a p-region is formed on its top by diffusing zinc atoms into it. A heavily zinc doped layer constitutes the heavily doped p-region.

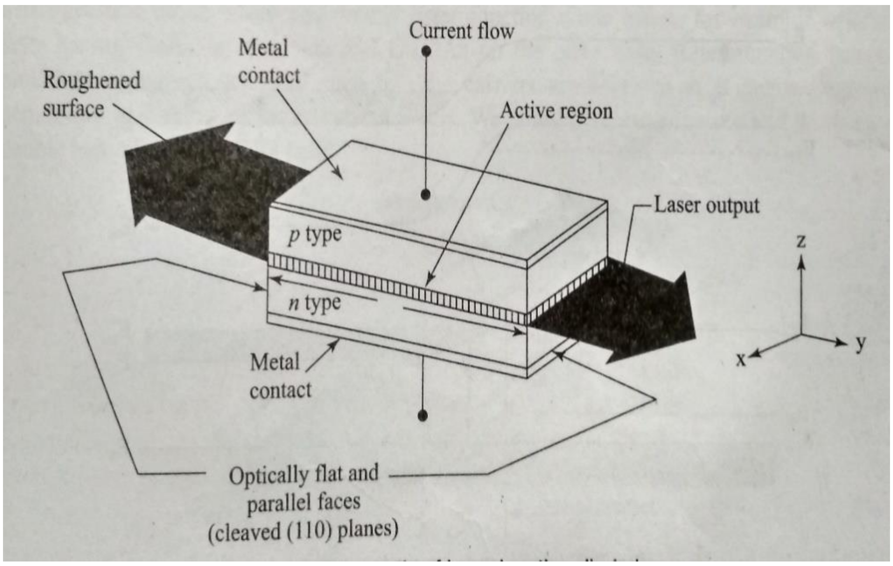


Fig: Homojunction diode laser

The diode is extremely small in size. Typical diode chips are 500 μm long and about 100 μm wide and thick. The top and bottom faces are metalized and metal contacts are provided to pass current through the diode. A pair of parallel planes cleaved at the two ends of the PN junction provides required reflection to from the cavity. The two remaining sides of the diode are roughened to remove lasing action in that direction. The entire structure is packaged in small case which looks like the metal case used for discrete transistors.

b) Working:

i) Heavily doped p- and n- regions are used. Because of very high doping on n-side, the donor levels are broadened and extend into the conduction band.

ii) The Fermi level is pushed into the conduction band and electrons occupy the levels lying below the Fermi level.

iii) Similarly, on the heavily doped p-side the Fermi level lies within the valence band and holes occupy the portion of the valence band that lies above the Fermi Level.

iv) At thermal equilibrium, the Fermi level is uniform across the junction.

Photo Detectors

A photo detector is an optoelectronic device which absorbs light and converts the optical energy into measurable electric current.

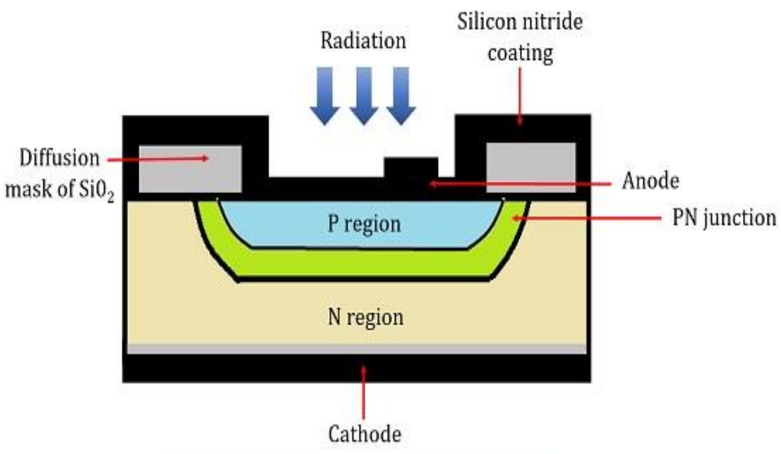
Photodiode: A photodiode is a p-n junction diode, used to convert the light into current or voltage by operating in reverse biased mode.

Working Principle:

The working principle of a photodiode is, when a photon of ample energy strikes the diode, it makes a couple of an electron-hole pairs. Therefore, holes in the region move toward the anode, and electrons move toward the cathode, and a photocurrent will be generated.

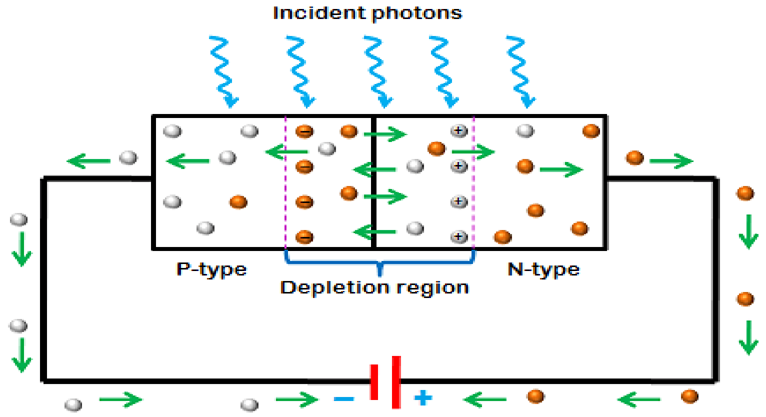
Construction: The photodiode is made up of two layers of P-type and N-type semiconductor. In this, the P-type material is formed from diffusion of the lightly doped P-type substrate. Thus, the layer of P+ ions is formed due to the diffusion process. And N-type epitaxial layer is grown on N-type substrate. The contacts are made up of metals to form two terminal cathode and anode. The front area of the diode is divided into two types that are active surface and non-active surface. The non-active surface is made up of SiO_2 (Silicon di Oxide) and the active surface is coated with anti-reflection material. The active surface is called so because the light rays are incident on it.

While on the non-active surface the light rays do not strike. The active layer is coated with anti-reflection material so that the light energy is not lost and the maximum of it can be converted into current.

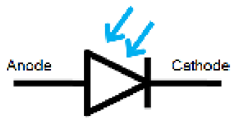


Structure of Photodiode

Working: When a light is made to illuminate the PN junction, the photon enters the depletion region of diode and hits the atom with high energy. This results electron - hole pairs. In general, an electron will have negative charge and holes will have a positive charge. The depletion energy will have built in electric filed. Due to that electric filed, electron hole pairs moves away from the junction. Hence, holes move to anode and electrons move to cathode to produce photo current.



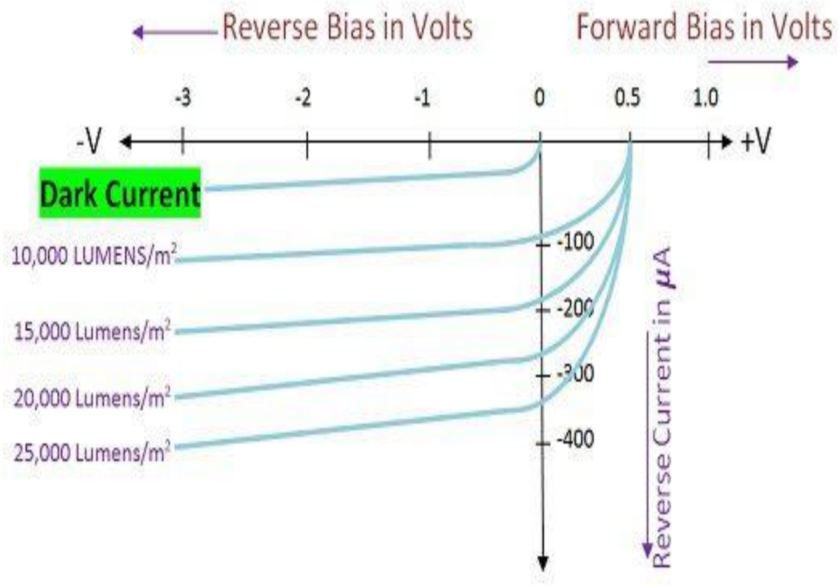
PN Junction photodiode



Photodiode symbol

V-I Characteristics of Photodiode

Photodiode operates in reverse bias condition. Reverse voltages are plotted along X axis in volts and reverse current are plotted along Y-axis in microampere. Reverse current does not depend on reverse voltage. When there is no light illumination, reverse current will be almost zero. The minimum amount of current present is called as **Dark Current**. Once when the light illumination increases, reverse current also increases linearly as shown in below figure.



Applications of photodiodes

Photodiodes are used in

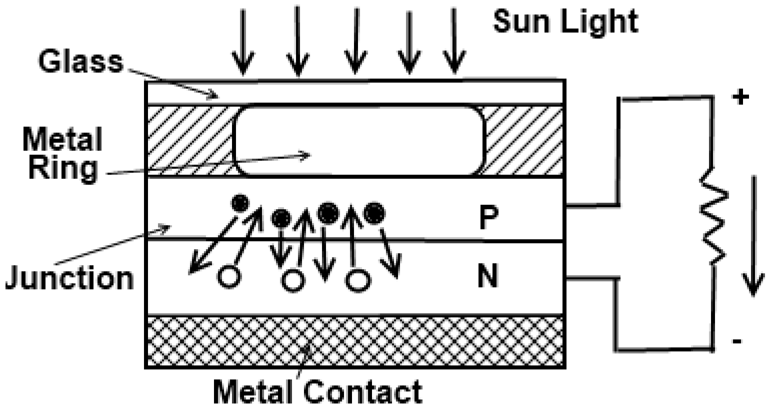
- Consumer electronics devices such as compact disc players,
- Smoke detectors,
- Medical devices
- Receivers for infrared remote control devices used to control equipment from televisions to air conditioners.

Solar Cell or Photovoltaic

A **solar cell** (also known as a photovoltaic cell or PV cell) is defined as an electrical device that converts light energy into electrical energy through the photovoltaic effect.

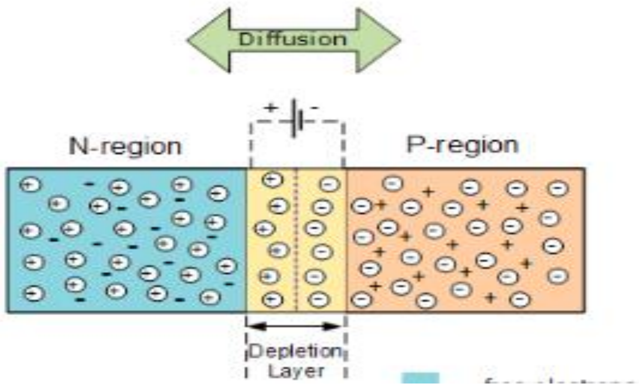
Construction: Consider the figure below shows the constructions of the silicon photovoltaic cell. The upper surface of the cell is made of the thin layer of the p-type material so that the light can easily enter into the material. The metal rings are placed around p-type and n-type material which acts as their positive and negative output terminals respectively.

Working Principle: When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs. The free electrons in the depletion region can quickly come to the n-type side of the junction. Similarly, the holes in the depletion can quickly come to the p-type side of the junction.



Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction. Similarly, the newly created holes once come to the p-type side cannot further cross the junction became of same barrier potential of the junction.

As the concentration of electrons becomes higher in one side, i.e. n-type side of the junction and concentration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it.



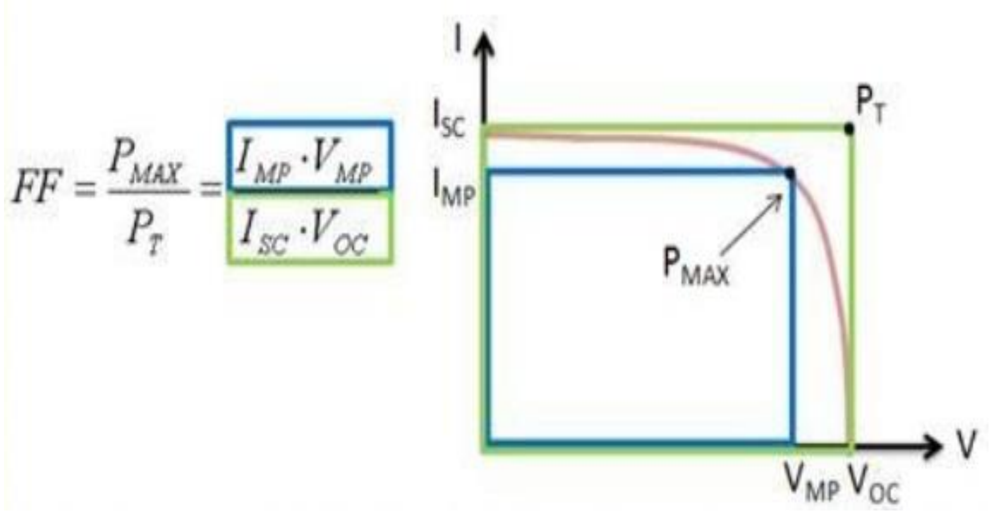
V-I Characteristics of a solar Cell:

The voltage - current characteristics of solar cell is shown in below figure.

From the graph it is clear that the maximum current occurs in the solar cell when the voltage is zero is known as **short circuit current I_{sc}**.

The maximum voltage that occurs in the solar cell when the current is zero is known as **open circuit voltage V_{oc}**.

The **fill factor** is the ratio of the actual maximum obtainable power to the product of the open circuit voltage and short circuit current.



The efficiency of a solar cell is determined as the fraction of incident power which is converted to electricity and is defined as:

$$P_{max} = V_{OC} I_{SC} FF$$

$$\eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

Materials Used in Solar Cell:

The materials which are used for this purpose must have band gap close to 1.5ev. Commonly used materials are-

1. Silicon.
2. GaAs.
3. CdTe.
4. $CuInSe_2$

Criteria for Materials to be Used in Solar Cell

1. Must have band gap from 1ev to 1.8ev.
2. It must have high optical absorption.
3. It must have high electrical conductivity.

4. The raw material must be available in abundance and the cost of the material must be low.

Advantages of Solar Cell

1. No pollution associated with it.
2. It must last for a long time.
3. No maintenance cost.

Disadvantages of Solar Cell

1. It has high cost of installation.
2. It has low efficiency.
3. During cloudy day, the energy cannot be produced and also at night we will not get solar energy.

Applications

1. It may be used to charge batteries.
2. Used in light meters.
3. It is used to power calculators and wrist watches.
4. It can be used in spacecraft to provide electrical energy.

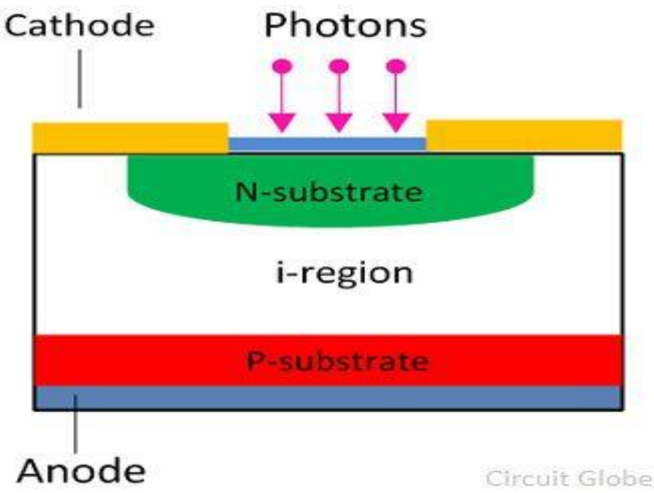
PIN Diode

The diode in which the intrinsic layer of high resistivity is sandwiched between the P and N-region of semiconductor material such type of diode is known as the PIN diode. The PIN diode is a type of photodetector used for converting the light energy into the electrical energy.

Construction: The diode consists the P-region and N-region which is separated by the intrinsic semiconductor material. The intrinsic region has no free charge carrier. It acts as an insulator between n and the p-type region. The i-region has the high resistance which obstructs the flow of electrons to pass through it.

PIN Diode

Working: The working of the PIN diode is similar to the ordinary diode. When the diode is unbiased, their charge carrier will diffuse. The process of diffusion occurs continue until the charges become equilibrium in the depletion region.



Let the N and I-layer make the depletion region. The diffusion of the hole and electron across the region generates the depletion layer across the NI-region. The thin depletion layer induces across n-region, and thick depletion region of opposite polarity induces across the I-region.

When the diode is kept forward biased, the charges are continuously injected into the I-region from the P and N-region. This reduces the forward resistance of the diode, and it behaves like a variable resistance.

When the reverse voltage is applied across the diode, the width of the depletion region increases. The thickness of the region increases until the entire mobile charge carrier of the I-region swept away from it. The reverse voltage requires for removing the complete charge carrier from the I-region is known as the **swept voltage**. In reverse bias, the diode behaves like a capacitor. The P and N region acts as the positive and negative plates of the capacitor, and the intrinsic region is the insulator between the plates.

Characteristics of PIN diode

- **Low Capacitance**: As we already discussed that a PIN diode offers a lower value of capacitance due to the larger distance between p and n region.
- **High breakdown voltage**: Due to the presence of intrinsic region, PIN diode exhibits a higher value of breakdown voltage.
- **High Sensitive to photodetection**: The depletion region is responsible for generating energy when radiation falls on its surface. The existence of an intrinsic region enhances the area for radiation absorption.
- **High Storage of carriers**: This is the important characteristic of PIN diode. The intrinsic region enhances the area for storage of carriers. The stored charge in the depletion region is responsible for the amount of current flowing through the circuit.

Applications of PIN diode

1. **As a Photodetector**: A PIN diode can change the absorbed light into electrical energy. The placement of intrinsic region between the p and n region increases the region for radiation absorption. With the increased radiation absorption region, the efficiency of the device to produce electrical energy also increases. Thus, it can be used as a photodiode.

2. **As a radio frequency switch**: The intrinsic region isolates the p and n region of the diode due to which capacitance decreases. The capacitance of the device should almost negligible in order to operate it as a switch.

3. **As a voltage rectifier**: PIN diode is able to bear high reverse voltage due to the intrinsic layer. This leads to an increase in the breakdown voltage of the diode. Hence, due to this, the device allows the rectification of high input voltage.

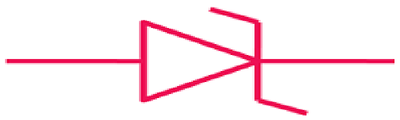
Avalanche Diode

An avalanche diode is a special type of semiconductor device designed to operate in reverse breakdown region.

Construction: Avalanche diodes are generally made from silicon or other semiconductor materials. The construction of avalanche diode is similar to zener diode but the doping level in avalanche diode differs from zener diode.

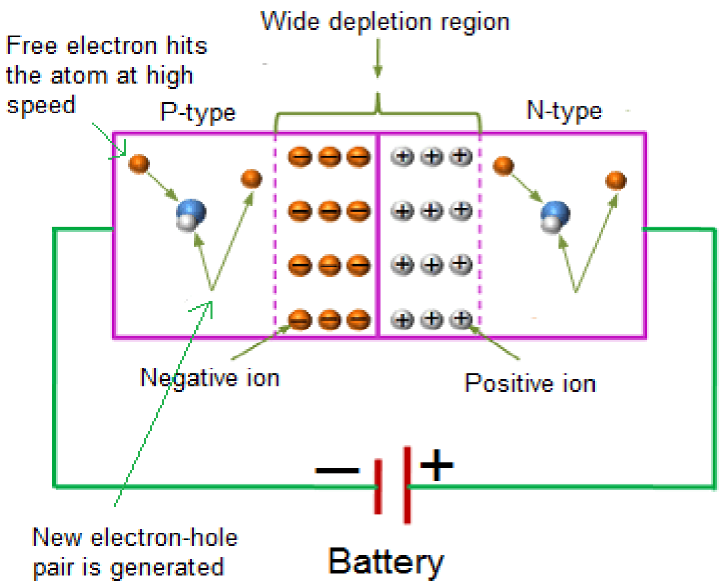
Zener diodes are heavily doped. Therefore, the width of depletion region in zener diode is very thin. Because of this thin depletion layer or region, reverse breakdown occurs at lower voltages in zener diode. On the other hand, avalanche diodes are lightly doped. Therefore, the width of depletion layer in avalanche diode is very wide compared to the zener diode. Because of this wide depletion region, reverse breakdown occurs at higher voltages in avalanche diode. The breakdown voltage of avalanche diode is carefully set by controlling the doping level during manufacture.

Avalanche diode symbol



The symbol of avalanche diode is similar to the normal diode but with the bend edges on the vertical bar.

Working: When reverse bias voltage is applied to the avalanche diode, the free electrons (majority carriers) in the n-type semiconductor and the holes (majority carriers) in the p-type semiconductor are moved away from the junction. As a result, the width of depletion region increases. Therefore, the majority carriers will not carry electric current. However, the minority carriers (free electrons in p-type and holes in n-type) experience a repulsive force from external voltage.

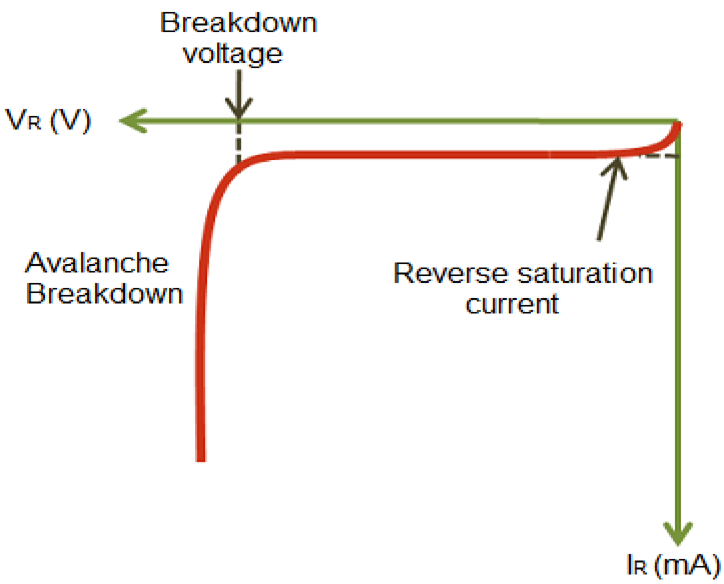


As a result, the minority carriers flow from p-type to n-type and n-type to p-type by carrying the electric current. However, electric current carried by minority carriers is very small. This small electric current carried by minority carriers is called reverse leakage current.

If the reverse bias voltage applied to the avalanche diode is further increased, the minority carriers (free electrons or holes) will gain large amount of energy and accelerated to greater velocities. The free electrons moving at high speed will collide with the atoms and transfer their energy to the valence electrons.

The valance electrons which gains enough energy from the high-speed electrons will be detached from the parent atom and become free electrons. These free electrons are again accelerated. When these free electrons again collide with other atoms, they knock off more electrons. Because of this continuous collision with the atoms, a large number of minority carriers (free electrons or holes) are generated. These large numbers of free electrons carry excess current in the diode.

When the reverse voltage applied to the avalanche diode continuously increases, at some point the junction breakdown or avalanche breakdown occurs. At this point, a small increase in voltage will suddenly increases the electric current. This sudden increase of electric current may permanently destroys the normal p-n junction diode. However, avalanche diodes may not be destroyed because they are carefully designed to operate in avalanche breakdown region.



The breakdown voltage of the avalanche diode depends on the doping density. Increasing the doping density will decreases the breakdown voltage of the avalanche diode.

Applications of avalanche diodes

- Avalanche diodes can be used as white noise generators.
- Avalanche diodes are used in protecting circuits.
- This makes the diode to start performing current without injuring itself, and switches the extreme power away from the electrical circuits to its ground terminal.

Questions

1. What are radiative and nonradiative recombinationmechanism?
2. Write short note on solar cell.
3. Explain construction and working of LED.
4. Write the applications of solar cell
5. Explain construction and working of semiconductor laser.
6. Explain PIN diode in detail.
7. Discuss avalanche photo diode in detail

UNIT-III

Dielectric and Magnetic Properties of Materials

Contents:

1. Introduction to dielectrics
2. Polarisation, Permittivity and Dielectric constant
3. classification of polarizabilities
4. calculation of polarizabilities: electronic polarizability, ionic polarizability
5. Internal fields in a solid
6. Clausius-Mossotti equation
7. Ferroelectrics and Piezoelectrics
8. applications of dielectric materials

   Magnetic Properties:

9. Magnetisation
10. permeability and susceptibility
11. Classification of magnetic materials
12. Ferromagnetism and ferromagnetic domains
13. Hysteresis
14. soft and hard magnetic materials
15. Applications of magnetic materials

Dielectrics

Introduction: Dielectrics are insulating materials so there are no free charge carriers in them.

Ex : Mica, plastic glass and wood.

The dielectrics are of two types they are,

1)**Non-polar dielectrics :**

In case of non–polar dielectrics the centre of gravity of positive charge is coincide with the center of gravity of negative charge.

They have symmetric in nature.

Their dipole moment is zero.

Ex: methane, benzene etc.

2)**Polar-dielectrics :**

In case of polar dielectrics the center of gravity of positive charge is not coincide with the center of gravity of negative charge.

They have asymmetric in nature.

Their dipole moment is not zero.

Ex: NH_3, Hcl, water etc.

Electric dipole: A system consisting of two equal and opposite charge separated by a small distance is called as electric dipole.

Length of dipole is denoted by 2l (or) d. q O-------------O -q

← 2l →

Electric dipole moment: The product of magnitude of charge and the distance between two charges is called as electric dipole moment It is denoted by P (or) μ

Dipole moment(μ) = charge × distance between them

$$(\mu) = q \times 2l$$

Units are coulomb-metre

Dielectric constant(or) relative permittivity (ϵ_r): Ratio between the permittivity of the medium to the permittivity of free space is called as relative permittivity.

That is (ϵ_r) = permittivity of medium / permittivity of free space

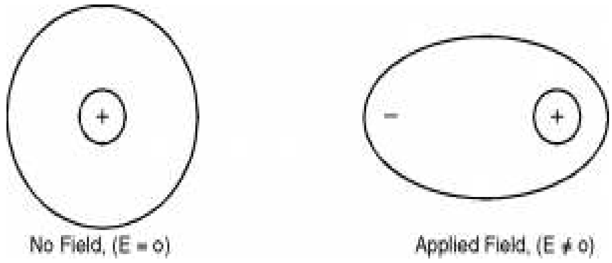
(ϵ_r) = ϵ / ϵ_o = capacitance of capacitor with dielectric / capacitance of capacitor without dielectric

$= c / c_o$

It has no units

<u>Electric polarization</u>:

The process of producing electric dipoles which are oriented along the field direction is called as polarization in dielectrics. It is denoted by P



<u>Polarizability(α):</u>

The induced dipole moment is directly proportional to the intensity of

the electric field.

That is μ proportional E

$\mu = \alpha E$ where α is called proportionality constant of polarizablity

Induced dipole moment per unit electric field is called as polarizability

i .e, $\alpha = \mu / E$

<u>Polarization vector ($\overline{P}$): </u> The dipole moment per unit volume of the dielectric material is called as polarization vector P.

$$\overline{P} = N \mu$$

Where μ = average dipole moment per molecule

N = no. of molecules per unit volume

<u>Electric flux density (or) Electric displacement (D):</u>

Electric displacement at a point in a material is given by $D = \epsilon E$

We know that $\epsilon = \epsilon_o \epsilon_r$

$$D = \epsilon_o \epsilon_r E$$

As the polarization measures the additional flux density rising from the presence of the material as compared to free space is given by

$$D = \epsilon_o E + P$$

We know that $D = \epsilon_o \epsilon_r E$

$$\epsilon_o \epsilon_r E = \epsilon_o E + P$$

$$P = \epsilon_o \epsilon_r E - \epsilon_o E$$

$$P = \epsilon_o (\epsilon_r - 1)E$$

Electric susceptibility(χ_e):

The polarization vector is proportional to the total electric flux density(E)

i.e., $P = \epsilon_o \chi_e E$

$$\chi_e = P/ \epsilon_o E$$

$$\chi_e = \epsilon_o (\epsilon_r - 1)E / \epsilon_o E$$

$$\chi_e = (\epsilon_r - 1)$$

Types of polarization:

They are

1) electronic polarization

2)ionic polarization

3)orientation polarization and

4) space charge polarization

Electronic polarization:

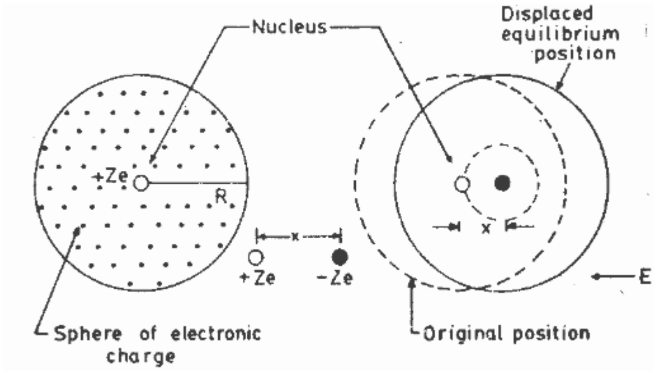
The displacement of the positively charged nucleus and the electrons of an atom in opposite directions, on application of an electric field, result in electronic polarization.

Induced dipole moment μ proportional E

$$\mu = \alpha_e E$$

where α_e is the electronic polarizability. It is independent of temperature.

Calculation of electronic polarizability:



A simplified classical modal of an atom is shown in above figure. Here the nucleus of charge Ze is surrounded by an electron cloud of charge –Ze distributed in a sphere of radius R. The charge density ρ is given by

$$\rho = \frac{-Ze}{4\pi R^3/3}$$

$$= -3Ze / 4\pi R^3$$

When an external field of intensity E is applied, the nucleus and the electrons experience Lorentz forces of magnitude ZeE in opposite directions. Hence the nucleus and electron cloud are pulled apart. When they are separated a coulomb force developed between them, which tends to opposite the displacement. When these forces namely Lorentz force and coulomb force are equal and opposite, equilibrium is reached and let x be the displacement under that condition.

Lorentz force = - ZeE

Coulomb force = Ze(charge enclosed in the sphere of radius x) / $4\pi\epsilon_o x^2$

The charge enclosed in the sphere = $4\pi x^3 \rho / 3$

$$= (4\pi x^3 / 3)(-3Ze / 4\pi R^3)$$

$$= -Zex^3 / R^3$$

Hence coulomb force $=(Ze / 4\pi\epsilon_o x^2)(-Zex^3 / R^3) = -Z^2 e^2 x / 4\pi\epsilon_o R^3$

In the equilibrium position, Lorentz force = coulomb force

$$-ZeE = -z^2 e^2 x / 4\pi\epsilon_o R^3$$

$$X = 4\pi\epsilon_o R^3 E / Ze$$

The two electric charges Ze and –Ze are separated by a distance x under the action of the applied field thus constituting induced electric dipoles.

Induced electric dipole moment $\mu_e = Zex$

$$= Ze4\pi\epsilon_o R^3 E / Ze$$

$$= 4\pi\epsilon_o R^3 E$$

i.e., $\mu_e = \alpha_e E$

Where $\alpha_e = 4\pi\epsilon_o R^3$ is called electronic polarizability.

The dipole moment per unit volume is called electronic polarization. It is independent of temperature.

P =N **μe** = N **αe** E where N is Number of atoms / m^3

$$\mathbf{P_e} = N(4\Pi\varepsilon_0 R^3 E) = 4\Pi\varepsilon_0 R^3 NE$$ where

R is radius of atom

<u>Ionic Polarization</u>: It is due to the displacement of cat ions and anions in opposite directions and occurs in an ionic solid .

Consider a NaCl molecule. Suppose an electric field is applied in the positive direction . The positive ion moves by x1 and the negative ion moves by x2

Let M is mass of positive ion

m is mass of negative ion

Total displacement x = x1 + x2 -------------- (1)

Lorentz force on positive ion = + e E ----------(2) Lorentz force on negative ion = - e E ----------(3) Restoring force on positive ion = -k1 x1 ----------(2 a)

Restoring force on negative ion = +k2 x2 ---------(3 a) where k1 , k2 Restoring force constants

At equilibrium, Lorentz force and restoring force are equal and opposite

For positive ion, e E = k1x1

$$X_1 = Ee / k_1$$

For negative ion, e E = k2 x_2

$$X_2 = Ee / k_2$$

Where $k_1 = M\omega_0^2$ & $k_2 = m\omega_0^2$ where ω_0 is angular velocity of ions

Therefore $x = x1 + x2 = (eE / \omega_0^2)$ [1/M + 1/m] -------(4)

From definition of dipole moment

μ = charge x distance of separation

$$\mu = e\,x = (e^2 E / \omega_0^2)\ [1/M + 1/m]$$

But $\mu \,\alpha\, E$ or $\mu = \alpha_i E$

Therefore $\alpha_i = (e^2 / \omega_0^2)$ [1/M + 1/m]---(5)

This is ionic polarization

Orientational Polarization:

In methane molecule, the centre of negative and positive charges coincides, so that there is no permanent dipole moment. On the other hand, in certain molecules such as Ch3Cl, the positive and negative charges do not coincide.Even in the absence of an electric field, this molecule carries a dipole moment, they tend to align themselves in the direction of applied field. The polarization due to such alignment is called orientation polarization. It is dependent on temperature. With increase of temperature the thermal energy tends to randomize the alignment.

Orientational polarization $Po = N\mu = N\mu^2 E / 3KT$

$$= N \alpha_0 E$$

Therefore Orientational polarizability$\alpha_0 = Po / NE$

$= \mu^2 / 3kT$

Thusorintational polarizability $\alpha_0$is proportional to absolute temperature material.

Space-charge polarization: Space-charge polarization occurs due to the accumulation of charge at the electrodes or at the interfaces in a multiphase material.

The total polarization of a material is the sum of the contribution from the various sources seen above.

$P_{total} = P_e + P_i + P_o + P_s$

Since the space-charge polarizability is very small when compared to other types of polarizabilities, the total polarizability of a gas can be written as

$$\alpha = \alpha_e + \alpha_i + \alpha_o$$

$$= 4\pi \epsilon_o R^3 + (e^2 / \omega_0^2)\ [1/M + 1/m] + \mu^2 / 3kT$$

Hence total polarization is given by

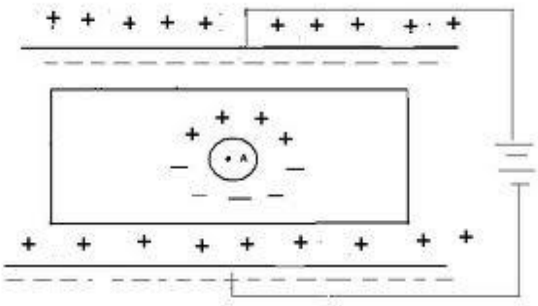
$$P = N\alpha E$$

$$P = NE\ \{4\pi\epsilon_o R^3 + (e^2 / \omega_0^2)\ [1/M\ +\ 1/m] + \mu^2\ / 3kT\ \}$$

This equation is known as Langevin-Debye equation

Internal fields in solids: (Lorentz method):

Let a dielectric be placed between the plates of a parallel plates capacitor and let there be an imaginary spherical cavity around the atom A inside the dielectric. It is also assumed that the radius of the cavity is large compared to the radius of the atom.



CALCLATION OF LOCAL FIELD

The internal fields at the atom site A can be considered to be made up of the following

four components namely E_1, E_2, E_3, and E_4.

$$E_{int} = E_1 + E_2 + E_3 + E_4 \qquad \text{---------------------------(1)}$$

E_1 is the field intensity at A due to the charge density on the plates. From the field theory

$$E_1 = D / \epsilon_o \qquad \text{we know that } D = P + \epsilon_o E$$

$$E_1 = P + \epsilon_o E / \epsilon_o = E + \frac{P}{\epsilon_o} \qquad \text{-------------------------------- (2)}$$

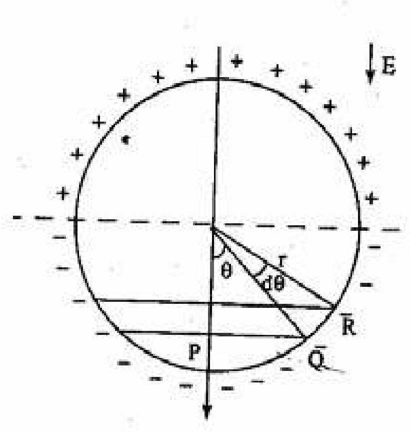
E_2 is the field intensity at A due to the charge density induced on the two sides of the dielectric.

Therefore $E_2 = - P / \epsilon_o$ ----------------------------------- (3)

E_3 is the field intensity at A due to other atoms contained in the cavity. We are assuming a cubic structure, because of symmetry

$E_3 = o$ ----------------------------------- (4)

Calculation of E_4:



If dA is the surface area of the sphere of radius r lying between θ and $\theta + d\theta$, where θ is the direction with reference to the direction of the applied force,

then $dA = 2\pi(PQ)\ (QR)$

but $\sin\theta = PQ / r$, $PQ = r \sin\theta$

and $d\theta = QR / r$, $QR = rd\theta$

Hence $dA = 2\pi r \sin\theta r d\theta = 2\pi r^2 \sin\theta d\theta$

The charge dq on the surface dA is equal to the normal component of the polarizarion multiplied by the surface area.

Therefore $dq = P \cos\theta dA = P\ (2\pi r^2 \sin\theta\cos\theta d\theta)$

The field due to this charge at A, denoted by dE_4 in the direction $\theta = o$ is

$$dE_4 = dq\cos\theta / 4\pi\epsilon_o r^2$$

$$= P\cos\theta 2\pi r^2 \sin\theta\cos\theta d\theta \ / \ 4\pi\epsilon_o r^2$$

$$= P \cos^2\theta \sin\theta d\theta / 2\epsilon_o$$

Thus the total field E_4 due to the charges on the surface of the entire cavity is obtained by integrating

$$E_4 = \int dE_4 = \frac{P}{2\epsilon_o} \int_0^{\Pi} \cos^2\theta \sin\theta\, d\theta$$

let $\cos\theta = x$

$\sin\theta\, d\theta = -dx$

limits are, when $\theta = 0^o$, $x = 1$ and $\theta = 180^o$, $x = -1$

$$E_4 = \underline{P} \int_{1}^{-1} x^2(-dx)$$

$2\epsilon_o$

$$E_4 = \frac{P}{2\epsilon_o} \int_{-1}^{1} x^2 \, dx$$

$$E_4 = \frac{P}{2\epsilon_o} \left[x^3/3 \right]_1^{-1}$$

$$E_4 = \frac{P}{2\epsilon_o} [1/3 - (-1/3)]$$

$$E_4 = \frac{P}{2\epsilon_o} (2/3)$$

$$E_4 = \frac{P}{3\epsilon_o} \text{ -------------- (5)}$$

Substituting the equations (2),(3),(4) and (5) in equation (1)

We get $E_{int} = E + \frac{P}{\epsilon_o} - \frac{P}{\epsilon_o} + \frac{P}{3\epsilon_o}$

$$E_{int} = E + \frac{P}{3\epsilon_o}$$ this is the equation for internal field

Clausius – Mosotti Relation:

Let us consider the elemental dielectric having cubic structure. Since there are no ions and fermanent dipoles in these materials, them ionic polarizability αi and orientational polarizability $\boldsymbol{\alpha 0}$ are zero.

i.e. $\alpha i = \alpha_0 = 0$

Hence polarization $P = N \alpha_e Ei$

$= N \alpha_e (E + P / 3\varepsilon_0)$

i.e. $P [1 - N \alpha_e / 3 \varepsilon_0] = N \alpha_e E$

$P = N \alpha_e E / [1 - N \alpha_e / 3 \varepsilon_0]$ ---(1)

We know that

$$D = P + \varepsilon_0 E$$

$$P = D - \varepsilon_0 E$$

Dividing on both sides by E

$$P / E = D / E - \varepsilon_0 = \varepsilon - \varepsilon_0 = \varepsilon_0 \varepsilon_r - \varepsilon_0$$

$$P = E \varepsilon_0 (\varepsilon_r - 1) \text{ --------(2)}$$

From eqn**1** and **2**, we get

$$P = E \varepsilon_0 (\varepsilon_r - 1) = N \alpha_e E / [1 - N \alpha_e / 3 \varepsilon_0]$$

$$[1 - N \alpha_e / 3 \varepsilon_0] = N \alpha_e / [\varepsilon_0 (\varepsilon_r - 1)]$$

$$1 = N \alpha e / 3 \varepsilon_0 + N \alpha_e / \varepsilon_0 (\varepsilon_r - 1)$$

$$1 = (N \alpha_e / 3 \varepsilon_0)(1 + 3 / (\varepsilon_r - 1))$$

$$1 = (N \alpha_e / 3 \varepsilon_0)[(\varepsilon_r - 1 + 3) / (\varepsilon_r - 1)]$$

$$1 = (N \alpha e / 3 \varepsilon_0)[(\varepsilon_r + 2) / (\varepsilon_r - 1)]$$

$$(\varepsilon_r + 2) / (\varepsilon_r - 1) = N \alpha e / 3 \varepsilon_0$$

Where N – no of molecules per unit volume

This is Clausius – Mosotti Relation.

Piezo – Electricity: These materials have the property of becoming electrically polarized when mechanical stress is applied. This property is known as Piezo – electric effect has an inverse

.According to inverse piezo electric effect, when an electric stress or voltage is applied, the material becomes strained. The strain is directly proportional to the applied field E.

When piezo electric crystals are subjected to compression or tension, opposite kinds of charges are developed at the opposite faces perpendicular to the direction of applied force. The charges produced are proportional to the applied force.

Piezo – Electric Materials and Their Applications: Single crystal of quartz is used for filter, resonator and delay line applications. Natural quartz is now being replaced by synthetic material.

Rochelle salt is used as transducer in gramophone pickups, ear phones,

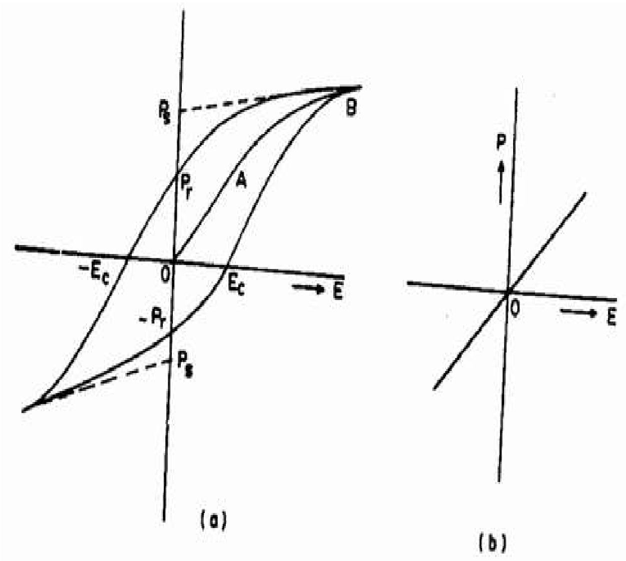
hearing aids, microphones etc. the commercial ceramic materials are based on barium titanate, lead zirconate and lead titanate. They are used for high voltage generation (gas lighters),

accelerometers, transducers etc.

Ferro electricity: Ferro electric materials are an important group not only because of intrinsic Ferro electric property, but because many possess useful piezo electric, birefringent and electro optical properties.

The intrinsic Ferro electric property is the possibility of reversal or change of orientation of the polarization direction by an electric field. This leads to hysteresis in the polarization P, electric field E relation , similar to magnetic hysteresis. Above a critical

temperature, the Curie point Tc , the spontaneous polarization is destroyed by thermal disorder. The permittivity shows a characteristic peak at Tc.



The basic aim in the study of the subject of magnetic materials is to understand the effect of an external magnetic field on a bulk material ,and also to account for its specific behaviour. A dipole is an object that a magnetic pole is on one end and a equal and opposite second magnetic dipole is on the other end.

A bar magnet can be considered as a dipole with a north pole at one end and South Pole at the other. If a magnet is cut into two, two magnets or dipoles are created out of one. This sectioning and creation of dipoles can continue to the atomic level. Therefore, the source of magnetism lies in the basic building block of all the matter i.e. the atom.

Consider electric current flowing through a conductor. When the electrons are flowing through the conductor, a magnetic field is forms around the conductor. A magnetic field is produced whenever an electric charge is in motion. The strength of the field is called the **magnetic moment.**

Magnetic materials are those which can be easily magnetized as they have permanent magnetic moment in the presence of applied magnetic field. Magnetism arises from the magnetic dipole moments. It is responsible for producing magnetic influence of attraction or repulsion.

Magnetic dipole :it is a system consisting of two equal and opposite magnetic poles separated by a small distance of '2l'metre.

Magnetic Moment (μm) ***:***It is defined as the product of the pole strength (m) and the distance between the two poles (2l) of the magnet.

i .e . . $\mu m = (2l)\, m$

Units: Ampere – metre^2

Magnetic Flux Density or Magnetic Induction (B): It is defined as the number of magnetic lines of force passing perpendicularly through unit area.

i .e . . **B** = magnetic flux / area = Φ / A Units: Weber / metre2 or Tesla.

Permeability:

Magnetic Field Intensity (H): The magnetic field intensity at any point in the magnetic field is the force experienced by a unit north pole placed at that point.

Units: Ampere / meter

The magnetic induction B due to magnetic field intensity H applied in vacuum is related by

B proportional

$$H\mathbf{B} = \mu 0\ \mathbf{H}$$

where $\mu 0$ is permeability of free space = 4 Π x 10-7 H / m

If the field is applied in a medium, the magnetic induction in the solid is given by

$$\mathbf{B} = \mu\ \mathbf{H}$$

where μ is permeability of the material in the medium

$$\mu = B / H$$

Hence magnetic Permeability μ of any material is the ratio of the magnetic induction to the applied magnetic field intensity. The ratio of $\mu / \mu 0$ is called the relative permeability (μ**r**).

$$\mu r = \mu / \mu 0$$

$$\text{Therefore} \qquad \mathbf{B} = \mu 0\, \mu r\, \mathbf{H}$$

Magnetization: It is the process of converting a non – magnetic material into a magnetic material. The intensity of magnetization (M) of a material is the magnetic moment per unit volume.

intensity of magnetization (M) = magnetic moment / volume

The intensity of magnetization is directly related to the applied field H through the susceptibility of the medium (χ) by

$$\chi = M / H \quad \text{------------} \ (1)$$

The magnetic susceptibility of a material is the ratio of the intensity of magnetization produced to the magnetic field intensity which produces the magnetization. It has no units.

We know

$$\mathbf{B = \mu\, H}$$

$$\mathbf{= \mu 0\, \mu r\, H}$$

$$\text{i.e} \quad \mathbf{B = \mu 0\, \mu r\, H + \mu 0\, H - \mu 0\, H}$$

$$\mathbf{= \mu 0\, H + \mu 0\, H\, (\, \mu r} - 1\,)$$

$$\mathbf{= \mu 0\, H + \mu 0\, M} \qquad \text{where M is magnetization} = \mathbf{H\, (\, \mu r} - 1\,)$$

$$\text{i.e} \quad \mathbf{B = \mu 0\, (\, H + M\,)} \ \text{----------}(2)$$

The first term on the right side of eqn (2) is due to external field. The second term is due to the magnetization.

$$\text{Hence } \mathbf{\mu 0 = B / H + M}$$

Relative Permeability ,

$$\mathbf{\mu r = \mu / \mu 0 = (\, B / H\,) \; / (\, B / H + M\,) = H + M / H = 1 + M / H}$$

$$\mathbf{\mu r = 1 + \chi \ \text{---------}(3)}$$

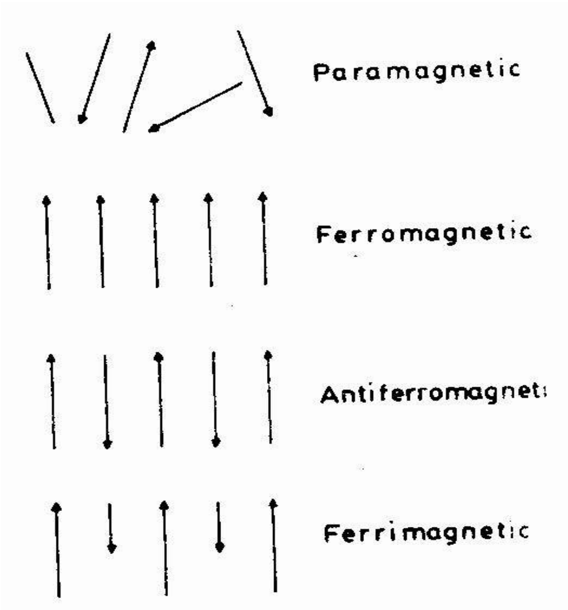
The magnetic properties of all substances are associated with the orbital and spin motions of the electrons in their atoms. Due to this motion, the electrons become elementary magnets of the substance. In few materials these elementary magnets are able to strengthen the applied magnetic field , while in few others , they orient themselves such that the applied magnetic field is weakened.

Classification Of Magnetic Materials : All matter respond in one way or the other when subjected to the influence of a magnetic field. The response could be strong or weak, but there is none with zero response ie, there is no matter which is non magnetic in the absolute sense. Depending upon the magnitude and sign of response to the applied field , and also on the basis of effect of temperature on the magnetic properties, all materials are classified broadly under 5 categories.

1. Diamagnetic materials 2. Paramagnetic materials, 3. Ferromagnetic materials

4.Antiferromagnetic materials and 5.Ferrimagnetic materials.

two more classes of materials have structure very close to ferromagnetic materials but possess quite different magnetic effects. They are i. Anti ferromagnetic materials and ii . Ferri magnetic materials



1. Diamagnetic materials: Diamagnetic materials are those which experience a repelling force when brought near the pole of a strong magnet. In a non uniform magnetic field they are repelled away from stronger parts of the field.

In the absence of an external magnetic field , the net magnetic dipole moment over each atom or molecule of a diamagnetic material is zero.

Ex: Cu, Bi , Pb .Zn and rare gases.

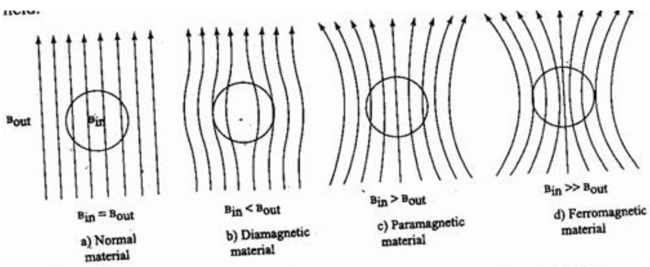


Fig. The behaviour of magnetic materials in the presence of magnetic field.

Paramagnetic materials: Paramagnetic materials are those which experience a feeble attractive force when brought near the pole of a magnet. They are attracted towards the stronger parts of magnetic field. Due to the spin and orbital motion of the electrons, the atoms of paramagnetic material posses a net intrinsic permanent moment.

Susceptibility χ is positive and small for these materials. The susceptibility is inversely proportional to the temperature T.

$\chi \alpha$ 1/T

$\chi = C/T$ where C is Curie's temperature.

Below superconducting transition temperatures, these materials exhibit the Para magnetism. Examples: Al, Mn, Pt, $CuCl_2$.

Ferromagnetic Materials: Ferromagnetic materials are those which experience a very

strong attractive force when brought near the pole of a magnet. These materials, apart from getting magnetized parallel to the direction of the applied field, will continue to retain the magnetic property even after the magnetizing field removed. The atoms of ferromagnetic materials also have a net intrinsic magnetic dipole moment which is due to the spin of the electrons.

Susceptibility is always positive and large and it depends upon temperature.

$\chi = C / (T- \theta)$ (only in paramagnetic region i.e., $T > \theta$)

θ is Curie's temperature.

When the temperature of the material is greater than its Curie temperature then it converts into paramagnetic material.

Examples: Fe, Ni, Co, MnO.

Antiferromagnetic matériels : These are the ferromagnetic materials in which equal no of opposite spins with same magnitude such that the orientation of neighbouring spins is in antiparallel manner are present.

Susceptibility is small and positive and it is inversely proportional to the temperature.

$\chi=C /(T+\theta)$

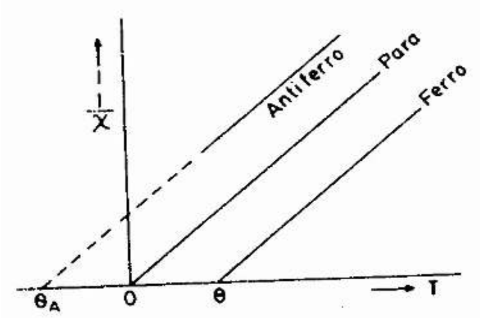
the temperature at which anti ferromagnetic material converts into paramagnetic material is known as Neel's temperature.

Examples: FeO, Cr_2O_3 .

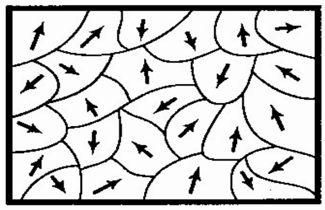
Ferrimagnetic materials: These are the ferromagnetic materials in which equal no of opposite spins with different magnitudes such that the orientation of neighbouring spins is in antiparallel manner are present.

Susceptibility positive and large, it is inversely proportional to temperature

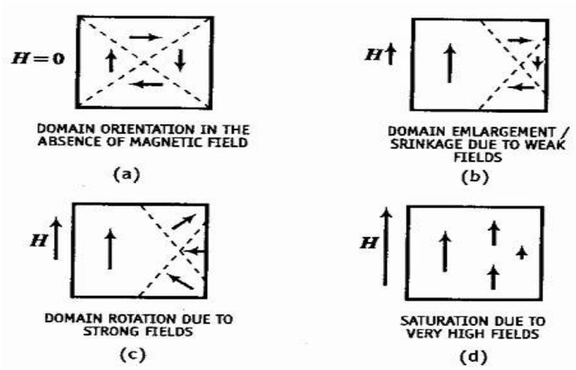
$\chi=C /(T \pm \theta)$ $T> T_N$ (Neel's temperature) Examples : $ZnFe_2O_4$, $CuFe_2O_4$



Domain theory of ferromagnetism: According to Weiss, a virgin specimen of ferromagnetic material consists of a no of regions or domains (≈ 10-6 m or larger) which are spontaneously magnetized. In each domain spontaneous magnetization is due to parallel alignment of all magnetic dipoles. The direction of spontaneous magnetization varies from domain to domain. The resultant magnetization may hence be zero or nearly zero. When an external field is applied there are two possible ways of alignment fo a random domain.



RANDOM ORIENTATION OF MAGNETIC MOMENTS OF THE DOMAINS

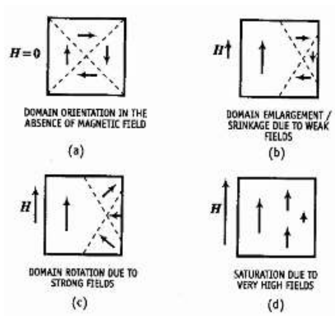


i). **By motion of domain walls:** The volume of the domains that are favourably oriented with respect to the magnetizing field increases at the cost of those that are unfavourably oriented

ii) **By rotation of domains**: When the applied magnetic field is strong, rotation of the direction of magnetization occurs in the direction of the field.

Hysteresis curve (study of B-H curve): The hysteresis of ferromagnetic materials refers to the lag of magnetization behind the magnetization field. when the temperature of the ferromagnetic substance is less than the ferromagnetic Curie temperature ,the substance exhibits hysteresis. The domain concept is well suited to explain the phenomenon of hysteresis. The increase in the value of the resultant magnetic moment of the specimen by the application of the applied field , it attributes to the 1. motion of the domain walls and 2. rotation of domains.

When a weak magnetic field is applied, the domains that are aligned parallel to the field and in the easy direction of magnetization, grow in size at the expense of less favorably oriented ones. These results in Bloch wall movement and when the weak field is removed, the domains reverse back to their original state. This reverse wall displacement is indicated by OA of the magnetization curve. When the field becomes stronger, the Bloch wall movement continues and it is mostly irreversible movement. This is indicated by the path AB of the graph. The phenomenon of hysteresis is due to this irreversibility.



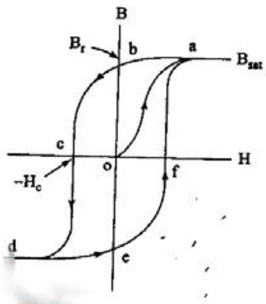


Fig. Schematic representation of the hysteresis loop for a ferromagnetic material.

At the point B all domains have got magnetized along their easy directions. Application of still higher fields rotates the domains into the field direction which may be away from the easy direction. Once the domain rotation is complete the specimen is saturated denoted by C. on removal of the field the specimen tends to attain the original configuration by the movement of Bloch walls. But this movement is hampered by the impurities, lattice imperfections etc, and so more energy must be supplied to overcome the opposing forces. This means that a coercive field is required to reduce the magnetization of the specimen to zero. The amount of energy spent in this regard is a loss. Hysteresis loss is the loss of energy in taking a ferromagnetic body through a complete cycle of magnetization and this loss is represented by the area enclosed by the hysteresis loop.

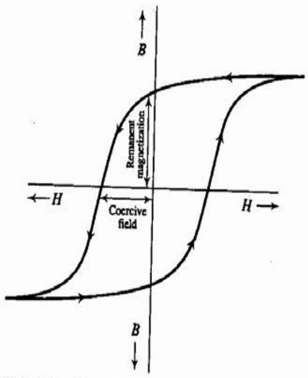
A hysteresis curve shows the relationship between the magnetic flux density B and applied magnetic field H. It is also referred to as the B-H curve(loop).

Hard and Soft Magnetic Materials:

Hysteresis loop of the ferromagnetic materials vary in size and shape. This variation in hysteresis loops leads to a broad classification of all the magnetic materials into hard type and soft type.

Hard Magnetic Materials:

Hard magnetic materials are those which are characterized by large hysteresis loop because of which they retain a considerable amount of their magnetic energy after the external magnetic field is switched off. These materials are subjected to a magnetic field of increasing intensity, the domain walls movements are impeded due to certain factors. The cause for such a nature is attributed to the presence of impurities or non-magnetic materials, or the lattice imperfections. Such defects attract the domain walls thereby reducing the wall energy. It results in a stable state for the domain walls and gives mechanical hardness to the material which increases the electrical resistivity. The increase in electrical resisitivity brings down the eddy current loss if used in a.c conditions. The hard magnetic materials can neither be easily magnetized nor easily demagnetized.



HYSTERESIS CURVE FOR HARD MAGNETIC MATERIAL

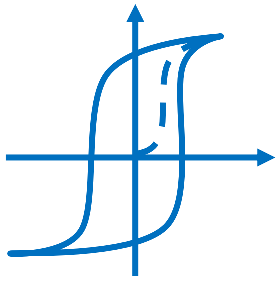
Properties:

1. High remanent magnetization
2. High coercivity
3. High saturation flux density
4. Low initial permeability
5. High hysteresis energy loss
6. High permeability
7. The eddy current loss is low for ceramic type and large for metallic type.

Examples of hard magnetic materials are, i) Iron- nickel- aluminum alloys with certain amount of cobalt called Alnico alloy. ii) Copper nickel iron alloys. iii) Platinum cobalt alloy.

Applications of hard magnetic materials: For production of permanent magnets, used in magnetic detectors, microphones, flux meters, voltage regulators, damping devices and magnetic separators.

SOFT MAGNETIC MATERIALS



- Soft Magnetic materials have low hysteresis loss

due to small hysteresis loop area.

- The curve is tall and thin.
- The coercivity and retentivity are small, hence these

materials can be easily magnetized and demagnetized.

- These materials have large values of permeability and susceptibility.
- **Ex: Iron silicon alloys, Ferrous nickel alloy, soft iron etc.,**
- These are used to make electromagnets and mainly used in electro-magnetic machinery and transformer cores and also used in switching circuits , microwave isolators and matrix storage of computers.

Short questions

1. Define the terms: dielectric constant, electricdisplacement, polarizability and electric susceptibility.
2. Deduce Clausius-Mositti relation.
3. Explain ferroelectricity.
4. Explain piezoelectricity.
5. Define the terms: magnetic field strength, magnetic flux density, magnetization and magnetic susceptibility.
6. Derive relation between χ_m and μ_r.
7. Why diamagnetic materials have negative susceptibility?
8. What are soft and hard magnetic materials?
9. What are the applications of ferrites?
10. Write about the hysteresis curve?

Essay type questions

1. Define current and current density and derive continuity equation.
2. What are Maxwell’s equations? Write Maxwell’s equations and explain their significance.
3. What is internal field of a dielectric and how it is calculated for a dielectric?
4. Classify and explain the properties of different types of magnetic materials.
5. What is domain? Explain ferromagnetic hysteresis on the basis of domains.
6. What are anti-ferro and ferri magnetic materials? Explain their properties.

UNIT-V

Lasers and Fibre Optics

Contents

Lasers

Introduction

Laser is a light source which amplifies intensity of light to produce highly directional, coherent and monochromatic beam of light. Lasers are now days used in different fields like medical, industrial, communication and military etc. The acronym (or) short form for LASER is “Light amplification by Stimulated Emission of Radiation” and laser is a specialized light source which is different from conventional light such as tube light (or) electric bulb.

Characteristics of Lasers:

Lasers when compared with conventional light, it possesses a few outstanding characteristics.

They are

(1) Laser is highly monochromatic

(2) Laser is highly directional

(3) Laser is highly coherent

(4) The intensity of laser is very high

Monochromaticity: The light emitted by a laser is more monochromatic than that of any conventional monochromatic source. The monochromaticity of a light source is measured by its degree of non-monochromaticity. For a good laser the degree of non-monochromaticity is of the order of 10^{-13} .where as the degree of non-monochromaticity for a conventional monochromatic light source is of the order 10^{-8} .Therefore by comparing these two values, it is clear that laser is highly monochromatic.

Directionality: Laser emits light in a single direction. The directionality of the laser beam is measured in terms of divergence, hence for getting high directionality there should be low divergence.

Coherence: The light rays emitting from the laser are in phase with each other, therefore the laser is highly coherent.

Intensity: Due to the concentration of energy over a small region laser beam becomes more intense. The intensity of a laser beam is measured in terms of number of photons emitted per unit area per sec.

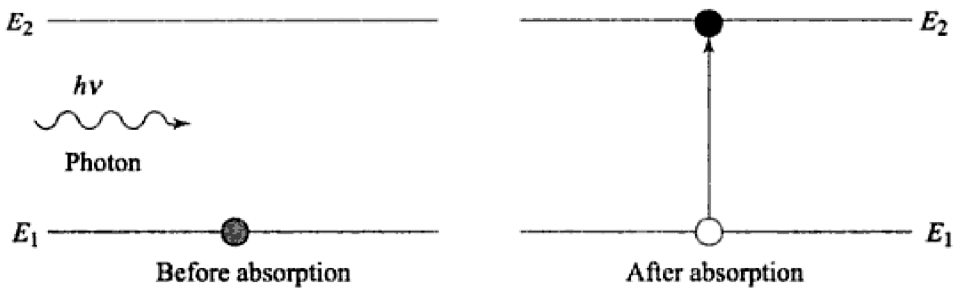
The number of photons emitted by a good laser is in the range of 10^{22} to 10^{34} photons per m^2-sec.But the no.of photons emitted by any other light source is in the range of 10^{16} photons/ m^2-sec.So by comparision it is clear that laser is highly intense.

Spontaneous Emission of Radiation:

Before knowing about spontaneous emission we need to know some fundamental concepts which are explained below:

Absorption:

The process of absorption of energy when a particle transfers from it's ground state to higher energy state is called as absorption.



Life time:

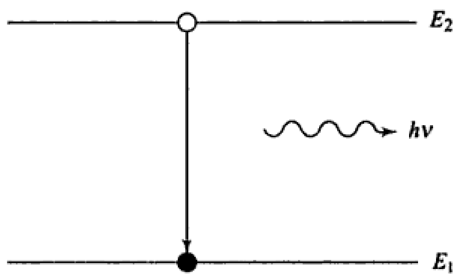
The duration of time spent by an atom in the excited state is known as life time of that energy state.

Spontaneous Emission:

The emission of light photon after the lifetime without any inducement during the transition of atoms from higher energy level to lower energy level is called as spontaneous emission.

Here frequency of emitted photon, $\upsilon = \frac{E_2 - E_1}{h}$

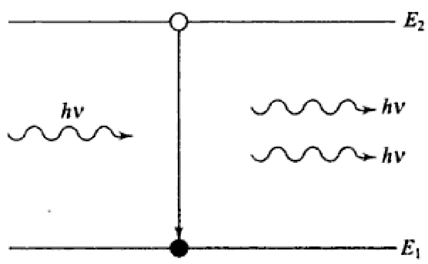
The photons in this case have various wavelengths and they are out of phase. Therefore the photons are incoherent.



Stimulated Emission:

Emission of light photon by the inducement of a photon having energy equal to the emitted photon's energy or the energy difference between the transmission energy levels is called as stimulated emission.

In stimulated emission, the two emitted photons will have same energy and phase. So therefore they are coherent and they have single wavelength.



Metastable State:

The excited state which has long lifetime is known as metastable state.

Einstein's Coefficients or Einstein's relation

Einstein coefficients explain about the transmissions of electrons among the energy levels in terms of probability.

Absorption:

If we consider a two level energy system, the rate of probability to occur absorption process from energy level 1to energy level 2 depends on properties of energy level 1 and 2 and is proportional to incident energy density U(v) of the radiation of frequency υ incident on the atom.

$$\therefore \qquad P_{12} \alpha U(v)$$

$$\Rightarrow \qquad P_{12} = B_{12} U(v) \text{ ---------------------- >(1)}$$

Where B_{12} is proportionality constant represents properties of energy levels known as Einstien's coefficient of absorption.

Spontaneous Emission:

The rate of probability to occur spontaneous emission process from energy level 2 to energy level 1 depends only on the properties of energy levels 1 and 2.This process is independent of energy density $U(v)$.

$$\therefore \qquad (P_{21})_{spontaneous} = A_{21} \text{ -------------------- >(2)}$$

Where A_{21} is proportionality constant, represents properties of energy levels known as Einstein's coefficient of spontaneous emission.

Stimulated emission:

The rate of probability to occur stimulated emission process from energy level 2 to energy level 1 depends on properties of energy levels 1 and 2 as well as proportional to stimulated energy density $U(v)$ of frequency ϑ incident on the atom.

$$\therefore \qquad (P_{21})_{stimulated} \propto U(v)$$

$$(P_{21})_{stimulated} = B_{12} U(v) \text{ ------------------- >(3)}$$

Where B_{12} is proportionality constant, represents properties of energy levels known as Einstien's coefficient of Stimulated emission.

The total transition probability of atoms from energy level 2 to energy level 1 can be written as

$$P_{21} = (P_{21})_{spontaneous} + (P_{21})_{stimulated}$$

$$P_{21} = A_{21} + B_{12}U(v) \text{ ---------------- >(4)}$$

Relation between Einstein Coefficients:

Let us consider N_1 and N_2 be populations in the energy level 1 and 2 respectively in a system of atoms, which is at thermal equilibrium at a temperature T.

The no. of atoms that take transitions per unit volume from energy level 1 to energy level 2 in unit time can be written as

$$N_1P_{12} = N_1B_{12}U(v) \text{ ----------------------- >(5)}$$

The no. of atoms that take transitions per unit volume from energy level 2 to energy level 1 in unit time can be written a

$$N_2P_{21} = N_2[A_{21} + B_{12}U(v)] \text{ -------------- >(6)}$$

At equilibrium, the no. of transitions from energy level 1 to energy level 2 will be equal to the no. of transitions from energy level 2 to energy level 1.

$$\therefore \quad N_1P_{12} = N_2P_{21} \text{ ------------------- >(7)}$$

From eq^{n}s (5) & (6)

We have,

$$N_1B_{12}U(v) = N_2[A_{21} + B_{12}U(v)]$$

$$\Rightarrow \quad N_1B_{12}U(v) - N_2\,B_{12}U(v) = N_2A_{21}$$

$$\Rightarrow [N_1B_{12} - N_2\,B_{12}]\,B_{12}U(v) = N_2A_{21}$$

$$\Rightarrow \quad U(v) = \frac{N_2A_{21}}{N_1B_{12} - N_2\,B_{12}}$$

$$\Rightarrow U(v) = \frac{N_2A_{21}}{B_{21}\left[\frac{N_1}{N_2}\left(\frac{B_{12}}{B_{21}}\right) - 1\right]}$$

$$\Rightarrow \quad U(v) = \frac{A_{21}}{B_{21}}\,.\frac{1}{\left[\frac{N_1}{N_2}\left(\frac{B_{12}}{B_{21}}\right) - 1\right]} \text{ -------------- >(8)}$$

But we know that, according to Boltzmann's distribution law

$$N_1 = N_0 exp\left[\frac{-E_1}{k_BT}\right] \text{ ---------------- >(10)}$$

Where N_0 **is population in the ground state and** k_B is Boltzmann's constant

$$\frac{N_1}{N_2} = exp\left[\frac{E_2 - E_1}{k_BT}\right]$$

$$\frac{N_1}{N_2} = exp\left[\frac{h\vartheta}{k_B T}\right] \quad (\because E_12 - E_11 = h\vartheta) \text{ ---------------- >(11)}$$

Substitute eq^n (11) in eq^n (8)

$$U(v) = \frac{A_{21}}{B_{21}} \frac{.1}{\left\{exp\left[\frac{h\vartheta}{k_B T}\right]\left(\frac{B_{12}}{B_{21}}\right) - 1\right\}} \text{ ------------------- >(12)}$$

But according to Planck's radiation law,

$$U(v) = \frac{8\pi h\vartheta^3}{C^3} \cdot \frac{1}{\left\{exp\left[\frac{h\vartheta}{k_B T}\right] - 1\right\}} \text{ --------------- >(13)}$$

By comparing eq^n.s (12) & (13)

$$\left.\begin{array}{ll} \frac{A_{21}}{B_{21}} = \frac{8\pi h\vartheta^3}{C^3} & \frac{B_{12}}{B_{21}} = 1 \\ \frac{A_{21}}{B_{21}} \propto \vartheta^3 \quad B_{12} = B_{21} & \end{array}\right\} \text{ --------------- >(14)}$$

Eq^n (14) shows the relations between Einstein's coefficients B_{12}, B_{21} and A_{21}.

The first relation shows that the ratio of Einstein's coefficients of A_{21} and B_{21} is proportional to cube of the frequency of incident photon. The second relation shows the rate of probability of induced emission and absorption are equal when the system is in equilibrium.

Population inversion:

The no of atoms per unit volume in an energy level is known as population of that energy level.

If N is the no of atoms per unit volume in an energy state E then the expression for population can be written as

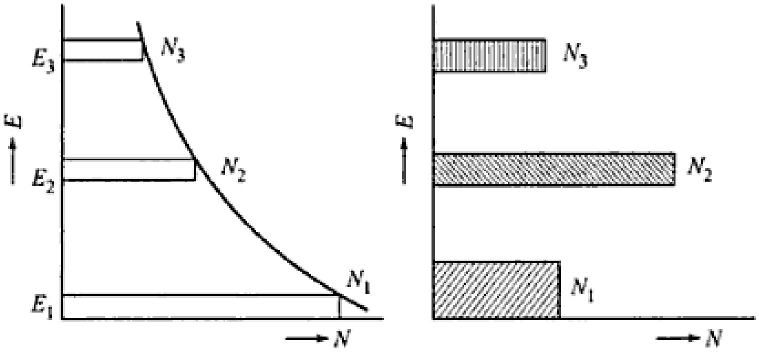
$$N = N_0 exp\left[\frac{E}{k_0 B}\right]$$

From the equation of population, population is maximum in the ground state and decreases exponentially as energy level increases.

So population inversion is a process in which the population of a particular higher energy state is made more populated than that of a lower energy state.

In order to understand the concept of population inversion consider three level system in which there are three energy levels E_1, E_2 and E_3 ,population in those energy levels are N_1, N_2 and N_3 respectively.In normal conditions $E_1 < E_2 < E_3$ and $N_1 > N_2 > N_3$.

We know that E_1 is the ground state and its lifetime is unlimited and E_3 is highest energy state and it is most unstable state and its lifetime is very less. Whereas E_2 is an excited state and has more lifetime compared to E_3 .Therefore here E_2 is metastable state.When some energy is supplied to the system, the atoms excite from ground state (E_1) to excited states (E_2 & $E_1$3) .Due to unstability, excited atoms will come back to ground state after the lifetime of the respective energy states E_2 and E_3 .If this process is continued then atoms will excite continuously to E_2 and E_3 .Because E_3 is the most unstable state,atoms will fall into E_2 immediately.At a particular point,the population in E_2 will become more than the population in ground state.



(a) Normal population of a system ($N_1 > N_2$)

(b) Inverted population of a system ($N_2 > N_1$)

Population of atoms

<u>Block Diagram of a Laser System</u>:

The block diagram of a laser system contains three components. They are

(1)Source of energy

(2)Active medium

(3)Optical cavity

Source of Energy:

It supplies energy to the active medium to achieve population inversion i.e., it performs pumping process.

Active medium:

It is a place where the metastable state is achieved. In metastable state only the population inversion takes place. It can be a liquid, solid, gas or PN-junction.

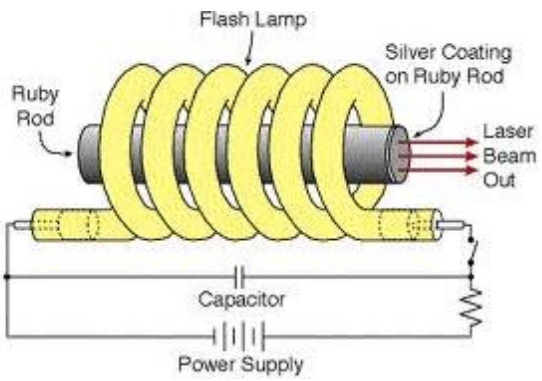
Optical Cavity:

It is an enclosure of active medium and consists of two mirrors. Here one mirror is fully reflective and the other one is partially transparent. Due to mirrors arrangement emitted laser takes back and forth reflections until it gains sufficient energy to come out. The output laser beam is emitted from partially transparent mirror.

<u>Ruby Laser</u>:

Ruby Laser is constructed by Maiman in 1960.It is a pulsed laser. The duration of each pulse is about 10 nanoseconds.

Construction: Ruby laser is made up of a cylindrical ruby crystal rod of composition Al_2O_3 which is doped with 0.05% of Cr_2O_3.The ends of the Ruby rod are silvered such that one end is fully reflecting and the other end is partially reflecting. A Xenon flash tube is arranged around the Ruby rod as shown in the below figure, which supplies flash light of wave length 5600 A^0 to the active medium to achieve population inversion.But here only a part of the flash light is used for pumping of chromium atoms while the rest heats up the apparatus. Therefore a cooling arrangement is provided to keep the experimental set up at normal temperature.



Therefore here,

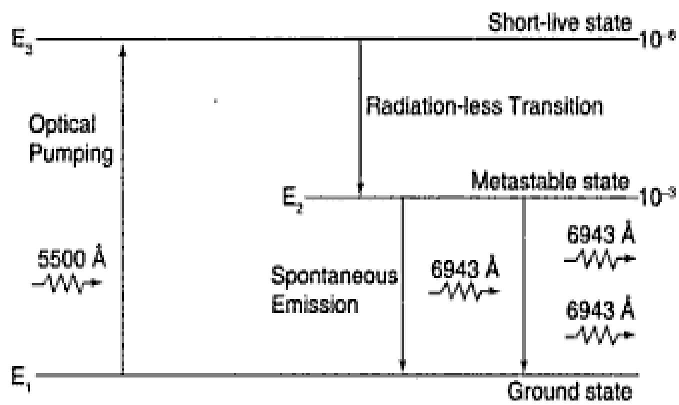
Source of Energy → Xenon flash light

Active medium → Ruby Crystal rod

Optical Cavity → Arrangement of Silver polished surfaces on either sides of Ruby rod

Working: In ruby crystal, chromium atoms are responsible for the population inversion. So here chromium atoms have three active energy levels, they are named as Ground state(G), Metastable state(M) and Higher energy state(H).Due to supply of Xenon flash light to Ruby rod, chromium atoms are excited to H energy state.

From higher energy state all of them do not return to the ground state , but some will return to state G and some will move to state M. Now here the transitions from level H to M are non-radiative i.e. the chromium atoms gives part of the energy to crystal lattice in the form of heat. The atoms which are present in this state M have a little chance to go to the ground energy state because it's lifetime is more. Due to continuous process of excitation of atoms



to the higher levels, the population in state M will become more, at this stage, the transition occurs from M to G level emitting out photons. Now stimulated emission starts and photons are emitted in different directions. But only those photons will come out of the laser which travel parallel to the axis of the tube while the photons that travel in other directions will pass out of the Ruby. Now this photon beam which is parallel to the axis of the crystal rod grows in strength and comes through the partial reflector and serves as output laser beam. The wavelength of this beam is 6943 A^0

Drawbacks:

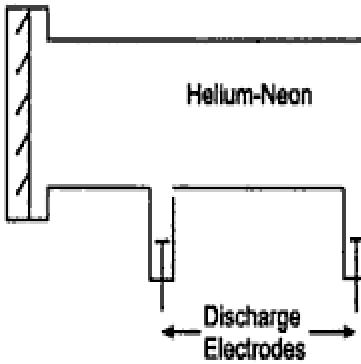
(1)Photons of 6943 A^0 are absorbed by the ground state atoms from the laser beam.

(2)The output laser beam is discontinuous.

<u>He-Ne Laser</u>:

It is a gas laser and is a four level laser system. Here electric discharge is used as an efficient method for producing population inversion.

Construction: This laser system consists of a gas discharge tube and it is filled with a mixture of Neon (Ne) and Helium (He).The ratio of He-Ne mixture is about 10:1.The gas mixture of Helium and Neon forms the lasing medium and this mixture is enclosed between a set of parallel mirrors forming an optical cavity. One of the mirrors is completely reflecting and the other is partially reflecting in order to amplify the output laser beam.



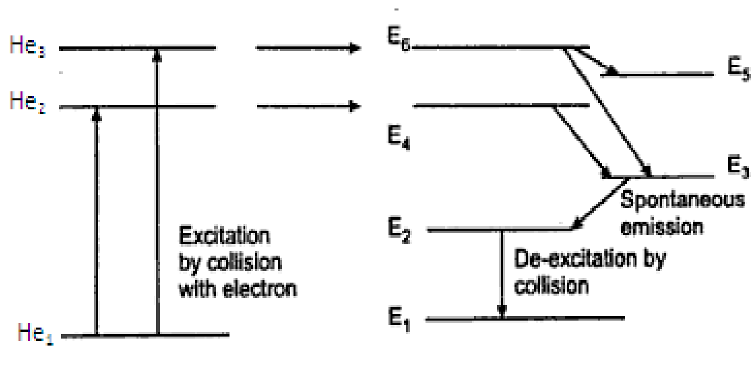
Therefore, here

Source of Energy → Discharge tube

Active medium → He-Ne gas mixture

Optical Cavity → arrangement of reflector

Working: In this laser, the lasing action is due to the Neon atoms. Here Helium atoms are used for pumping of Neon atoms to upper energy levels. When fast moving electrons collide with Helium atoms, then they are excited to the upper states.



Energy Level Diagram.

Here Helium atoms have three active energy levels He_1,He_2& He_3 and Neon atoms have six active energy levels Ne_1-------Ne_6.When He atoms collide with electrons they are excited to upper states He_2 and He_3.These are metastable states. So these atoms which are present in He_2 and He_3 states interact with neon atoms which are in the ground state. The interaction excite the neon atoms to their metastable states (Ne_4 and Ne_6).As the energy exchange continues, the population of neon atoms in the excited states increases more and more. So after reaching metastable state, stimulated emission starts emitting out photons and the excited neon atoms deexcite to the ground state in three different ways. They are

(1)Transition from Ne_6 level to Ne_5 level gives rise to radiation of wavelength 3.39 μm.

(2)Transition from Ne_6 level to Ne_3 level gives rise to visible radiation of wavelength 6328 A^0 this lies in red region.

(3)The transition from Ne_4 level to Ne_3 level gives rise to a wavelength of 1.15 μm ,this again lies in infrared region.

The atoms in Ne_5 and Ne_3 level undergo spontaneous transitions to Ne_2 level, finally Ne atoms comes to ground state through collisions with the walls of the tube. This transition is radiationless. The gas lasers are found to emit light which is more directional and monochromatic. Gas lasers are capable of operation continuously without need of cooling.

SEMICONDUCTOR LASER

A ***semiconductor diode laser*** is a specifically made p-n junction diode that emits coherent light under forward bias. R.N. Hall and his coworkers made the first semiconductor laser in 1962. P-N junction lasers are emits light almost anywhere in the spectrum from UV to IR.

The **laser diode** (light amplification by stimulated emission of radiation) produces a monochromatic (single Color) light. Laser diodes in conjunction with photodiodes are used to retrieve date from-compact discs.

Diode lasers are remarkably small in size (0.1 mm long). They have high efficiency of the order of 40%. In spite of their small size and low power requirements, they produce power outputs equivalent to that of He-Ne lasers. Diode lasers are useful in optical fibre communications, in CD players, CD-ROM drives, optical reading and high speed laser printing etc wide.

d) Semiconductor Materials

vi) Semiconductors are two different groups, direct band gap semiconductors and indirect band gap semiconductors.

vii) Direct band gap semiconductors are formed by group III_V elements and group IV-VI elements. Most of the compound semiconductors belong to this group.

viii) Leasers are made using direct band gap semiconductors. Gallium Arsenide (GaAs) diode is an example of semiconductor diode laser.

ix) Direct band gap semiconductor is the one in which a conduction band electron can recombine directly with a hole in the valence band. The recombination process lead to emission of light.

e) Principle

i) The energy hand structure of a semiconductor consists of a valence band and a conduction band separated by an energy gap, E_g. The conduction band contains electrons and the valence band contains holes and electrons.

ii) When an electron from the conduction band jumps into a hole in the valence band, the excess energy E_g is given out in the form of a photon.

iii) Electron-hole recombination is the basic mechanism responsible for emission of light.

Iv) The wavelength of the light is given by the relation $\lambda = hc/E_g$.

x) Semiconductors having a suitable value of E_g emit light in the optical region.

f) Types of Semiconductor Diode Lasers

Broadly there are two types of semiconductor diode lasers. They are known as *homojunction semiconductor laser and heterojunction semiconductor lasers.*

v) Homojunction Semiconductor Laser

vi) Heetrojunction Semiconductor Laser

Homojunction Semiconductor Laser

A Simple diode laser which makes use of the same semiconductor material on both sides of the junction is known as a homojunction diode laser. Example: Gallium arsenide (GaAs) laser.

a) Construction: Fig. shows the schematic of a homojuncation diode laser. Starting with a heavily doped n-type GaAs material, a p-region is formed on its top by diffusing zinc atoms into it. A heavily zinc doped layer constitutes the heavily doped p-region.

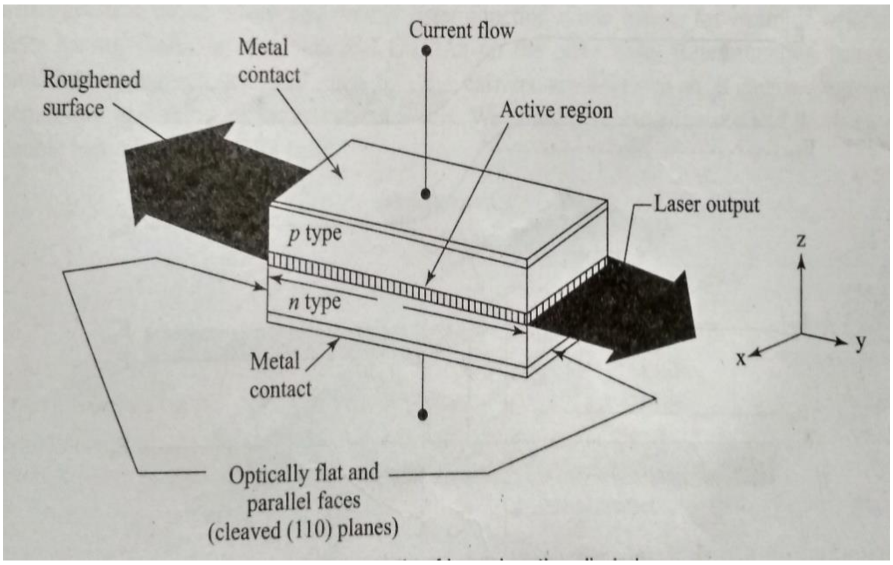


Fig: Homojunction diode laser

The diode is extremely small in size. Typical diode chips are 500 μm long and about 100 μm wide and thick. The top and bottom faces are metalized and metal contacts are provided to pass current through the diode. A pair of parallel planes cleaved at the two ends of the PN junction provides required reflection to from the cavity. The two remaining sides of the diode are roughened to remove lasing action in that direction. The entire structure is packaged in small case which looks like the metal case used for discrete transistors.

b) Working:

i) Heavily doped p- and n- regions are used. Because of very high doping on n-side, the donor levels are broadened and extend into the conduction band.

ii) The Fermi level is pushed into the conduction band and electrons occupy the levels lying below the Fermi level.

vii) Similarly, on the heavily doped p-side the Fermi level lies within the valence band and holes occupy the portion of the valence band that lies above the Fermi Level.

viii) At thermal equilibrium, the Fermi level is uniform across the junction.

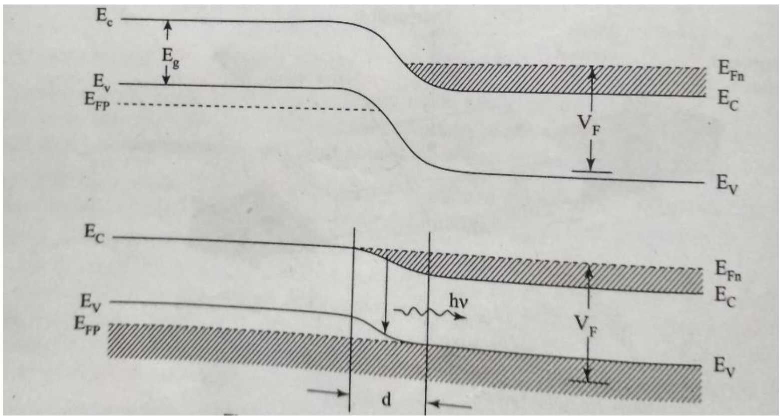


Fig. Laser diode under forward bias

c) Pumping Mechanism

i) When the junction is forward-biased, electrons and holes are injected into the junction region in high concentrations.

ii) When the diode current reaches a threshold value (see Fig.) , the carrier concentration in the junction region will rise to a very high value.

g) Population inversion

i) The region d as shown in Fig. contains a large concentration of electrons within the conduction band and simultaneously a large number of holes within the valence band.

ii) The upper energy levels in the narrow region are having a high electron population while the lower energy levels in the same region are vacant. It creates the condition of population inversion and is called an inversion region or active region.

h) Lasing action

i) Chance recombination leads to emission of spontaneous photons which stimulate the conduction electrons to jump into the vacant states of valence band.

ii) This stimulated electron-hole recombination produces coherent radiation.

iii) GaAs laser emits light at a wavelength of 9000 A in IR region.

i) Drawbacks of homojunction lasers

i) The active region is not well defined due to the diffusion length of the carriers.

ii) The semiconductor has nearly uniform refractive index throughout. Therefore, light can diffuse from active layer into the surrounding medium. As a result the cavity losses increase.

iii) High threshold currents are required and the laser cannot be operated continuously at room temperature.

Applications of Lasers:

Lasers are widely used in the fields of

(1)Communication

(2)Computers

(3)Industry

(4)Scientific Research

(5)Military Operation

(6)Medicine

Lasers in Communication:

(1)In case of optical fiber communication, semiconductor laser diodes are used as optical sources and it's band width is very high ($10^{14}\,Hz$) compared to the radio and microwave communications.

(2)Laser is highly directional and has less divergence, hence it has greater potential use in space crafts and submarines.

(3)Lasers are also used in other communication devices, including high speed photo copiers and printers.

Lasers in Computers:

(1)In local area network (LAN), data can be transferred or transmitted from the memory storage of one computer to other computer using laser for short time.

(2)Lasers are used in CD-Rom's during recording and reading the data.

Lasers in industry:

(1)Lasers can be used to make holes in diamonds and hard steel.

(2)Lasers are used to cut teeth saws, drill eyes in surgical needles, guide bulldozers and test the quality of a fabric.

(3)They are used as a source of intense heat.

(4)Lasers range finder is used to measure distance to make map by surveyors.

(5)Lasers can cut, drill, weld, remove metal from surfaces and perform these operations even at surfaces inaccessible by mechanical methods.

Lasers in Scientific Research:

(1)Scientists are working on separating isotopes of uranium using laser.

(2)Lasers are used in the field of 3D-photography called holography.

(3)Lasers are used to produce certain chemical reactions.

(4)Using lasers, the internal structure of microorganisms and cells are studied very accurately.

(5)The laser has been used in Michelson-Morle experiment, which showed that the velocity of light was constant and thus showed the way for Einstein's theory of relativity.

Lasers in Military Applications:

(1)High energy lasers are used to destroy enemy air crafts and missiles.

(2)Lasers can serve as a war weapon.

(3)Laser can be used for detection and ranging like RADAR. The only difference is it uses light instead of radio waves. Hence it is called as Light Detecting and Ranging(LIDAR).

Lasers in medicine:

(1)Doctors use the heating action of a laser beam to remove diseased body tissue.

(2)Laser beam is used to correct a condition called retinal detachment by eye-specialist.

(3)Lasers are used in opening blocked arteries, reconnecting several nerves, removing warts and treating bleeding ulcers.

(4)Argon and CO_2 lasers are used in treatment of liver and lungs.

(5)Lasers are used for elimination of moles and tumors which are developing in the skin tissue.

Fiber Optics

Introduction:

The optical fiber is a cylindrical wave-guide system through which optical signals can be transmitted over long distances. It is playing an important role in the field of communication to transmit voice, television and digital data signals from one place to another. Fiber optics is important because they have

(1)High information carrying capacity.

(2)Light in weight and small in size.

(3)No possibility of internal noise and cross talk generation.

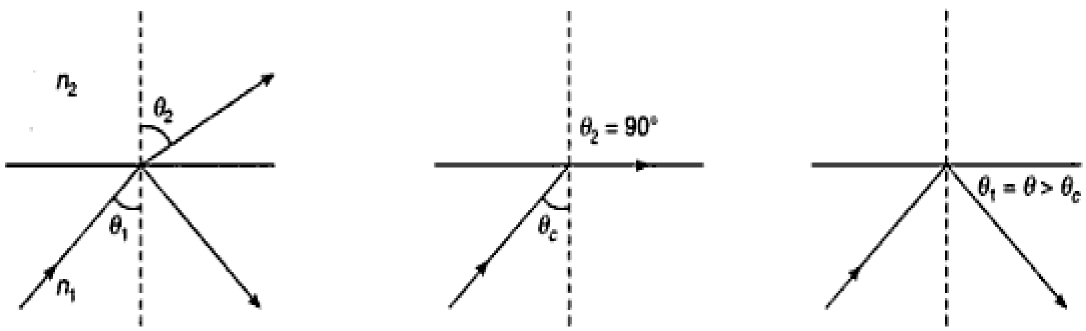
(4)No possibility of short circuits.

(5)Low cost of cables.

Principle of Optical Fiber:

Total Internal Reflection:

The transmission of light in an optical fiber is based on the phenomenon of total internal reflection. According to total internal reflection, when a ray of light travels from a denser medium into a rarer medium and if the angle of incidence is greater than the critical angle then the light gets totally reflected. That is if the light ray is incident at an angle greater than the critical angle for the two media, the ray is totally reflected back into the medium by obeying the laws of reflection. This phenomenon is known as total internal reflection.



(a) Some part of the incident beam is transmitted through n_2, when $\theta_1 < \theta_c$ (b) Refracted ray passes through the core-cladding interface, when $\theta_1 = \theta_c$ (c) Total internal reflection occurs when $\theta_1 > \theta_c$

So according to law of reflection,

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$\text{Here,} \quad \theta_1 = \theta_c \quad , \theta_c = 90^0$$

$$\therefore n_1 sin\theta_c = n_2 \sin 90^0$$

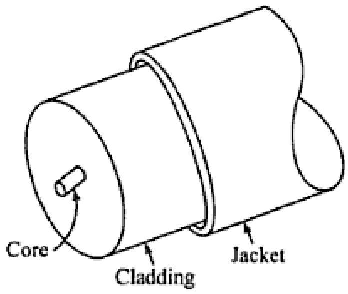
$$\Rightarrow \quad sin\theta_c = \frac{n_2}{n_1}$$

$$\Rightarrow \quad \theta_c = sin^{-1}\left(\frac{n_2}{n_1}\right) \text{ -------------- >(I)}$$

Here eq^n. (I) is the condition for total internal reflection.

<u>Construction of Optical Fiber</u>:

Optical fiber is a very thin and flexible medium having a cylindrical shape consisting of three sections. They are



(1)The core material

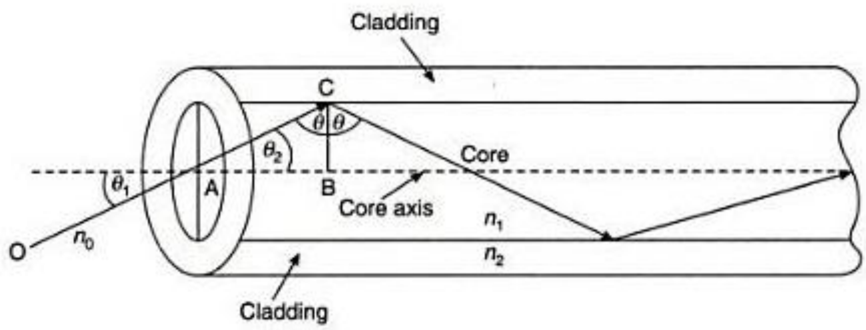
(2)The cladding material

(3)The outer protective jacket

The fiber has a core surrounded by a cladding material. The refractive index is slightly less than that of core material, to satisfy the condition of total internal reflection. To protect the fiber material and also to give mechanical support there is a protective cover called as outer jacket.

<u>Acceptance angle</u>:

Acceptance angle is defined as the angle at which we have to launch the light beam at one end of the fiber optic cable so that the entire light is propagated through the core.



Now in order to calculate an expression for the acceptance angle, consider the above figure which shows a cross section of a fiber with a light ray entering it. The light ray entered from a medium of refractive index n_o into core of refractive index n_1 .Here the ray (OA) enters with an angle of incidence α_i i.e,the incident ray makes an angle α_i with fiber axis.Let the refractive index of core be n_1 and the refractive index of cladding be n_2 .Here $n_1 > n_2$ and the light ray refracts at an angle α_r and strikes the core-cladding interface at angle θ .If the angle is greater than it's critical angle θ_c ,the light ray undergoes total internal reflection at the interface.

∴ According to Snell's Law, $n_o sin\alpha_i = n_1 sin\alpha_r$ ---------------- >(1)

From the right angled triangle ABC,

$$\alpha_r + \theta = 90^0$$

$$\Rightarrow \quad \alpha_r = 90^0 - \theta \quad \text{-------------- >(2)}$$

Substitute (2) in (1)

$$\Rightarrow \quad n_o sin\alpha_i = n_1 \sin(90^0 - \theta)$$

$$\Rightarrow \quad sin\alpha_i = \frac{n_1}{n_0} cos\theta \quad \text{-------------- >(3)}$$

When $\theta = \theta_c, \alpha_i = \alpha_m$ (maximum α value) i.e, maximum possible value of α_i for which $\theta = \theta_c$

$$\therefore \quad sin\alpha_m = \frac{n_1}{n_0} \cos\theta_c \quad \text{---------------- >(4)}$$

From eq^n of total internal reflection,

$$\Rightarrow \quad \sin\theta_c = \frac{n_2}{n_1}$$

$$\Rightarrow \quad \cos\theta_c = \sqrt{1 - sin^2\theta_c}$$

$$= \sqrt{1 - \left({}^{n_2}/{}_{n_1}\right)^2}$$

$$= \frac{\sqrt{{n_1}^2 - {n_2}^2}}{n_1} \quad \text{-------------------- >(5)}$$

From eq^{n}s. (4) & (5)

$$sin\alpha_m = \frac{\sqrt{{n_1}^2 - {n_2}^2}}{n_1} \cdot \frac{n_1}{n_0} = \frac{\sqrt{{n_1}^2 - {n_2}^2}}{n_0}$$

For air $\quad n_0 = 1$

$$\therefore \quad sin\alpha_m = \sqrt{{n_1}^2 - {n_2}^2}$$

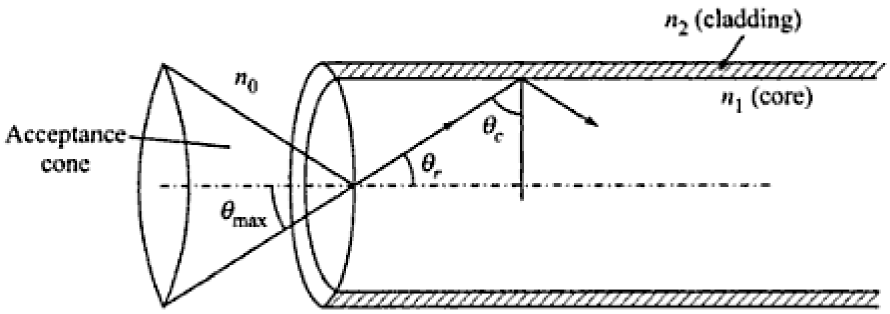
$$\Rightarrow \qquad \alpha_m = sin^{-1}\sqrt{n_1^2 - n_2^2} \text{ --------------------- >(6)}$$

Here the angle α_m is called the acceptance angle.

Acceptance Cone:

It is the cone of light incident at the entrance end of the fiber which will be guided through the fiber, provided the semi vertical angle of the cone is less than or equal to α_m .

Diagrammatically it is shown in the below figure:



Numerical Aperture:

It is defined as the light gathering capacity of an optical fiber and is proportional to acceptance angle. Numerically it is equal to sine of acceptance angle.

Numerical Aperture, NA= $sin\alpha_m = \dfrac{\sqrt{n_1^2 - n_2^2}}{n_0}$

If the medium is air, then $n_0 = 1$

$$\therefore \qquad NA = \sqrt{n_1^2 - n_2^2}$$

$$= \sqrt{(n_1 + n_2)(n_1 - n_2)}$$

$$= \sqrt{(n_1 + n_2)n_1\Delta}$$

Where $\Delta = \dfrac{(n_1 - n_2)}{n_1}$ called as fractional difference in refractive indices n_1 and n_2

For most of the fibers $n_1 \approx n_2$

So we can take $n_1 + n_2 = 2n_1$

$$\therefore \qquad NA = \sqrt{2n_1^2\Delta} = n_1\sqrt{2\Delta}$$

Therefore the numerical aperture is a measure of the amount of light that can be accepted by a fiber. It depends only on the refractive indices of core and cladding materials and is independent of fiber dimensions and generally this value ranges from 0.1 to 0.5.

Classification of fibers:

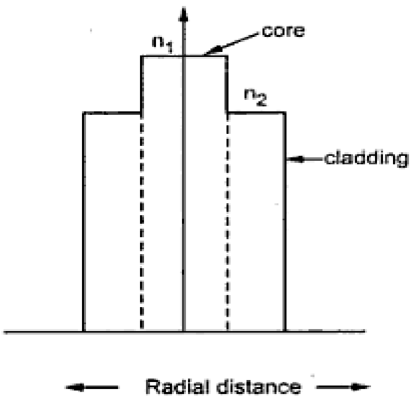
Depending upon the refractive index profile of the core, optical fibers are classified into two categories, they are

(1)Step-index fibers

(2)Graded-index fibers

Step-index fibers:

In step-index fibers, the refractive index of the core medium is uniform through out and undergoes a sudden change at the interface of core and cladding medium.



There are two types of step-index fibers, they are

(1)Single-mode step index fibers

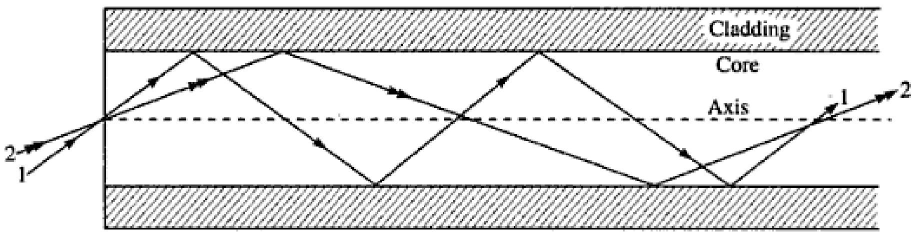
(2)Multi-mode step index fibers

The diameter of the core for a single mode step index fiber is very small of the order

10
μm, **and it propagates the light in only one mode, whereas** the diameter of the core for a multimode fiber is of the order 50-200 μm , and it propagates the light in multiple modes.

Transmission of signal in step-index fibers:

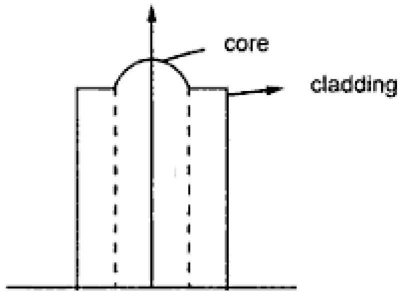
In digital communication systems, information is transmitted in the form of pulses. Light pulses transmitted through the fiber are to be decoded at the receiving end to receive the information.



Two rays entering a step-index fibre at different angles.

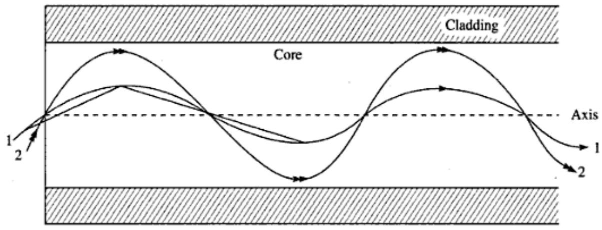
As shown in the above figure, there are three such pulses travelling through the fiber striking the core-cladding interface at different angles and they travel along the fiber by multiple reflections. They have different paths and reach the other end of the fiber at different points i.e., the three rays reach the received end at different times. The pulsed signal received at the other end will be broadened and this is called intermodal dispersion. This reduces the transmission rate and capacity. So smaller the pulse dispersion greater will be the information transmission capacity of the system.

Graded-index fibers: In graded-index fibers, the refractive index of the core medium is made to vary in a parabolic manner such that the maximum refractive index is present at the centre of the core. The diameter of the core is about 50 μm , therefore only multimode propagation is possible in graded index fibers.



Transmission of signal in Graded-index fiber:

In graded index fibers, optical signals travel through core medium in the form of skew rays or helical rays. As shown in the below figure, though different rays travel through the fiber but all come to focus at the same point i.e., all the rays arrive at the other end of the fiber at the same time. This is possible because the velocity is inversely proportional to refractive index.



Two rays entering a GRIN fibre at different angles.

<u>Attenuation in Optical fibers</u>:

Different mechanisms are responsible for the signal attenuation of the fiber and these mechanisms are influenced by material compositions, purification level, wave guide structure.

The attenuation of signal is measured in decibel/km. Signal attenuation is defined as the ratio of the input optical power P_i into the fiber to the output received optical power P_o from the fiber.then the attenuation coefficient of the signal per unit length is given as

$$\alpha = \frac{10}{L}\log\frac{P_i}{P_o}\ \frac{db}{km}$$

Where $L \rightarrow$ length of fiber

The mechanism of attenuation of signal may be classified broadly into two categories, they are

(1)Absorption losses

(2)Scattering losses

Absorption losses:

It is a material property i.e., it is a characteristic possessed by all the materials. Every material in the universe absorbs few suitable wavelengths as they incident on the material or passed through the material. In the same way core material of a fiber absorbs few wavelengths as the optical pulses or wavelengths pass though it.

Scattering losses:

The core medium of fibers is made of glass or Silica crystalline materials. Since there is no ideal crystal in the Universe, this medium possess few crystal defects. So in the passage of optical signals in the core medium if crystal defects are encountered, they deviate from the path and the total internal reflection is discontinued. Hence such signals will be destroyed by entering into the cladding.

Bending Losses:

The distortion of the fiber from the ideal straight line configuration may also result in losses in fibers. Tight bands cause some of the light to not to be internally reflected but to propagate into the cladding and be lost. The optical power scattered out of fiber at a major bends depends exponentially on the bend radius(R).The loss coefficient can be represented as

$$\alpha_B = C \; exp\left(-\frac{R}{R_C}\right)$$

Where 'C' is a constant and $R_C = \frac{a}{(NA)^2}$

Where 'a' is the radius of fiber.

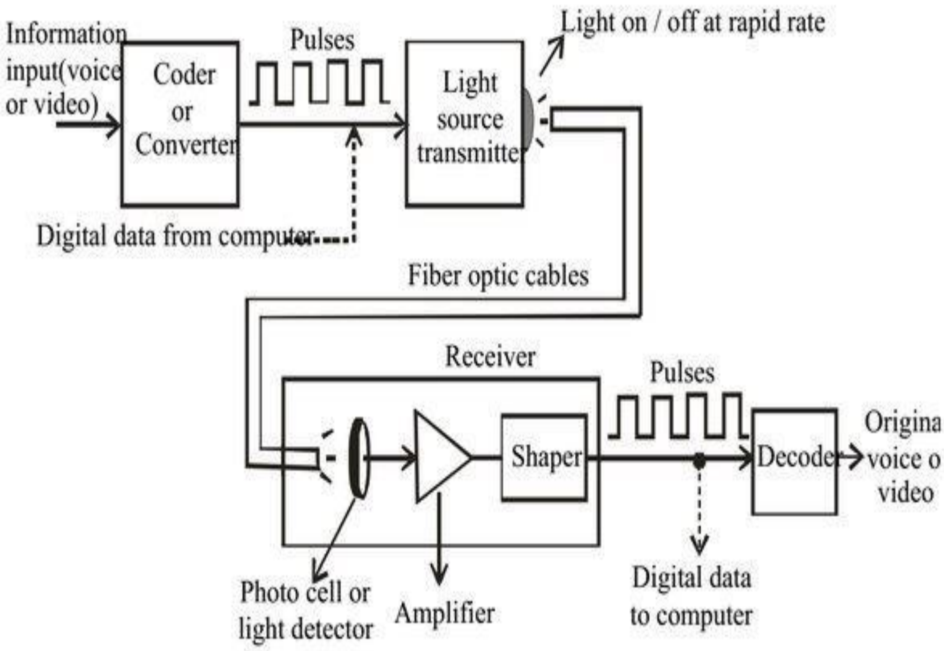
Micro bending and Waveguide losses:

In fiber optical cables a continuous succession of very small bends may cause a very significant rise in fiber attenuation. This effect is known as micro bending loss. Continuous small variation in core diameter or circularity which can easily arise during manufacture if sufficient care is not taken, gives rise to a similar scattering mechanism and cases losses which are called as wave guide losses.

By taking proper precaution all these losses can be minimized and they are largely wavelength independent.

Optical Fiber Communications

The communication system of fiber optics is well understood by studying the parts and sections of it. The major elements of an optical fiber communication system are shown in the following figure.



Itessentially consists of following parts.

1.Encoder 2.Transmitter 3.Waveguide 4.Receiver 5.Decoder

Encoder: It converts electric signal corresponding to analog information such as voice, figures, objects etc into a binary data This binary data comes out in the form of stream of electrical pulses.

Transmitter: It mainly consists of drive circuit and a light source Drive circuit supplies the

electric pulses to the light source from the encoder LED or diode laser is used as light source and it converts electrical signals are infected into optical signals These optical signals are injected into wave guide.

Wave Guide: It carries the information through the desired distance in the form of optical signal.

Receiver: It consists of photo detector, amplifier, signal restorer

Photo Detector: It converts optical signal into electrical signal This signal may become weak since it travels through very long distance

Amplifier: Such weak signal from photo detector is amplified This is allowed into signal restorer

Signal Restorer: The function of signal restorer is to put the signals In order which are received from wave guide subsequently from photo detector

Decoder: Finally, signals will be decoded and sent in the original form

Applications of Optical Fiber

Fiber optic cables find many uses in a wide variety of industries and applications. Some uses of fiber optic cables include:

- **Medical**

Used as light guides, imaging tools and also as lasers for surgeries

- **Defense/Government**

Used as hydrophones for seismic waves and SONAR , as wiring in aircraft, submarines and other vehicles and also for field networking

- **Data Storage**

Used for data transmission

- **Telecommunications**

Fiber is laid and used for transmitting and receiving purposes

- **Networking**

Used to connect users and servers in a variety of network settings and help increase the speed and accuracy of data transmission

- **Industrial/Commercial**

Used for imaging in hard to reach areas, as wiring where EMI is an issue, as sensory devices to make temperature, pressure and other measurements, and as wiring in automobiles and in industrial settings

- Broadcast/CATV

Broadcast/cable companies are using fiber optic cables for wiring CATV, HDTV, internet, video on-demand and other applications

Short Questions

1. What is LASER? Explain the characteristics of LASER's.
2. Explain the phenomenon of Absorption, Spontaneous emission and stimulated emission.
3. Explain different pumping mechanisms in laser.
4. Explain working principle of laser.
5. What are the main components of laser.
6. What is population and population inversion?
7. What is optical fiber? Explain the principle of optical fibres.
8. Explain construction of optical fibre.
9. What are step index and graded index optical fibres?
10. What are single mode and multi mode optical fibres?
11. Explain the Attenuation in Optical Fibers

12. What are radiative and nonradiative recombinationmechanism?
13. Write short note on solar cell.
14. Explain construction and working of LED.
15. Write the applications of solar cell

Essay type Questions

1. What are Einstein's coefficients of radiation? Give Einstein relation of radiation.
2. Describe the construction and working principle of ruby laser.
3. Describe the construction and working principle of He-Ne laser.
4. Describe the construction and working principle of CO2 laser.
5. Explain in detail acceptance angle, acceptance cone and numerical aperture of optical fibre.
6. Classify and explain different types of optical fibres with neat light ray diagrams.
7. Explain the applications of optical fibres.
8. Explain construction and working of semiconductor laser.
9. Explain PIN diode in detail.
10. Discuss avalanche photo diode in detail.

CMR GROUP OF INSTITUTIONS
EXPLORE TO INVENT

CMR ENGINEERING COLLEGE
Kandlakoya(V), Medchal Road, Hyderabad

Laboratory Improvement for Future Trends
LIFT
SUB: APPLIED PHYSICS
Department of Humanities & sciences

Laboratory Details (LIFT Planner, Lift Schedule)
CMR Engineering College
Kandlakoya(V), Medchal Road, Hyderabad
Department of Humanities & sciences

APPLIED PHYSICS LAB

1 OBJECTIVES AND RELEVANCE

The objectives of the engineering physics program are to:

Educate students to think and participate deeply, creatively, and analytically in emerging areas of engineering technology.

Educate students in the basics of instrumentation, design of laboratory techniques, measurement, data acquisition, interpretation, and analysis.

Educate students in the methodology of research.

Provide and facilitate teamwork and multidisciplinary experiences throughout the curriculum.

Foster the development of effective oral and written communication skills.

Expose students to environmental, ethical and contemporary issues.

Program Objective 1: Graduates of the Applied Physics program will apply their strong problem solving skills as physicists along with an understanding of the approach, methods, and requirements of engineering and engineering design for a successful career in advancing technology. Its engineering science and design components prepare students to work as professional engineers.

Program Objective 2: Graduates of the Applied Physics program will use their strong skills in problem solving, research experience and knowledge in physics and engineering as successful graduate students and researchers in highly ranked graduate programs.

2 SCOPE

The study of Applied Physics emphasizes the application of basic scientific principles to the design of equipment, which includes electronic and electro-mechanical systems, for use in measurements, communications, and data acquisition.

The program is recommended for students interested in newly developing areas of physics, high technology, instrumentation and communications. Our program is fully accredited by the Canadian Engineering Accreditation Board so graduates will be eligible to be certified as a professional engineer. Graduates are also qualified for entry into graduate schools in Physics or other disciplines.

3 PREREQUISITES

Lab experiments designed to illustrate the experimental basis of mechanics and to introduce students to the basic principles of experimental physics: Quantitative measurement in a framework of theoretical understanding, and the assessment of accuracy and uncertainty in measurements and experimental results.

4 SYLLABUS-J NTU

MAIN LINKAGE OF MACHINE TOOLS THEORY WITH LAB EXPERIMENTS:

UNIT-I
Two experiments suggested as per the JNTU sylllabus.
. **UNIT –II**
Five experiments suggested as per the JNTU sylllabus.
UNIT III:
Two experiments suggested as per the JNTU syllabus.
UNIT IV:
No experiments suggested as per the JNTU syllabus.
UNIT-V:
One experiments suggested as per the JNTU sylllabus.

List of Experiments:

Experiment 1: RC-CIRCUIT

Experiment 2: LCR RESONANCE CIRCUIT

Experiment 3: STUDY OF CHARACTERISTICS OF LED AND SOLARCELL

Experiment 4: NUMERICAL APERTURE AND ACCEPTANCE ANGLE OF OPTICAL FIBRE & DETERMINATION OF ANGLE OF DIVERGENCE OF LASER BEAM

Experiment 5: ENERGY GAP OF SEMI CONDUCTOR DIODE

Experiment 6: TORSIONAL PENDULAM

Experiment 7: CHARACTERISTICS OF PN JUNCTION DIODE AND ZENER DIODE

Experiment 8: HALL EFFECT

Experiment 9: PHOTO ELECTRIC EFFECT

Experiment 10: B-H CURVE

Experiment 11: CHRACTERISTICS OF BIPOLAR JUNCTION TRANSISTOR

Experiment 12: DETERMINATION OF RESISTIVITY OF SEMICONDUCTOR

Experiment 13: STUDY THE CHARACTERISTICS OF LASER DIODE

Experiment 14: NEWTON’S RINGS

Experiment 15: STEWART-GEE`S EXPERIMENT

Experiment 16: DETERMINATION OF WAVELENGTH OF LASER

Experiment 1: TORSIONAL PENDULUM

Objective: - To find the rigidity modules of a given material (wire) by using torsional pendulum

Prerequisites-:
Basic knowledge on modulii of elasticity, Time period ,screw guage and vernier calipers.

Description:
Introduction to experiment for 30 min
Determination of radius of the material wire
Determination of radius of the circular disc
Determination of the time period of the pendulum.
Obtaining the rigidity modulus of the wire.

Applications:-

1. Galvanometer is an example of making use of the torsional oscillations.

2. The balance wheel of a watch is also an example of angular harmonic motion.

Viva Questions:

1. Define Moment of inertia (I)
2. Define Torque (Γ)
3. Define time period and what are the factors influence time period
4. Define Rigidity Modulus and explain its Significance
5. State and Explain Hooks Law
6. Define stress
7. Define strain
8. Define young's Modulus and explain its Significance
9. Define Bulk Modulus and explain its Significance
10. Define time period.
11. Explain simple pendulum
12. What is the difference between young's Modulus and Rigidity Modulus
13. Difference between simple pendulum and torsion pendulum
14. What is second's pendulum?
15. What is restoring force?
16. State the relation between young's Modulus and Rigidity Modulus

Experiment 2: **ENERGY GAP OF SEMI CONDUCTOR DIODE**

Objective: - To determine the energy gap of semiconductor by using PN junction diode.

Prerequisites-:

Basic knowledge about semiconductors is needed. Knowledge on diode biasing, current flow through the semiconductors and effect of temperature on saturation of current with constant voltage.

Description:

Introduction to experiment for 30 min
Connections are made as per the circuit diagram.
To study the saturation of current in semiconductors with variation of temperature.
Determination of the energy gap of the semiconductor.

Applications:

1) **High power applications**

The high breakdown voltage of wide band gap semiconductors is a useful property in high power applications that require large electric fields.
Devices for high power and high temperature applications have been developed. Both gallium nitride and silicon carbide are robust materials well suited for such applications. Cubic boron nitride is used as well. Most of these are for specialist applications in space programmes and military systems. They have not begun to displace silicon from its leading place in the general power semiconductor market.

2) Light-emitting diodes

In the future, high brightness, long life white LEDs may replace incandescent bulbs in many situations. The next generation of DVD players (The Blu-ray and HD DVD formats) uses GaN based blue lasers.

3) Transducers

Large piezoelectric effects allow wide band gap materials to be used as transducers.

Viva Questions:

1. what is energy gap?
2. What is a semiconductor?
3. How many types of semiconductors are available?
4. What is intrinsic semi conductor? its examples?
5. What is P-type semi conductor?
6. What is N-type semi conductor?
7. What is doping?
8. How much energy gap value for Si and Ge is __?

9. Which biasing is used in this experiment
10. What happens to current when temp is increased.

Experiment 3: RC-CIRCUIT

Objective: - To determine the time constant of RC circuit of verify the theoretical and graphical value of RC circuit in charging and discharging modes.

Prerequisites-:

Basic knowledge on electrical and electronic components.
Knowledge on Kirchoff's law and Ohm's law

Description-:
Introduction to experiment for 30 min
Connections are made according to the circuit diagram
Studying the variation of voltage/ charge/ in the capacitor with time.
Obtaining the time constant of RC-circuit

Applications:

1. RC circuits can be used to filter a signal by blocking certain frequencies and passing others.
2. Capacitors are widely used in a wide range of electronic devices.
3. The photo flash capacitor is used in flash guns of photographic cameras.

Viva Questions:

1. What is meant by Charging time of Capacitor
2. What will happen if the resistance of low value is connected in the circuit
3. State the applications of Capacitor in filter circuits
4. State the factors affecting Capacitance
5. Write specifications of capacitor used in ceiling fans
6. Define Ohm's law
7. What are the units of resistance
8. What are the units of capacitance
9. If the resistor is replaced with a higher value what happens to time constant
10. Time constant depends on _____________

Experiment 4: **DIFFRACTION GRATING**

Objective: - To determine the wavelength of the given light source (Na Vapour lamp) by using spectrometer.

Prerequisites-: Basic Fundamentals on optics and knowledge on interference, diffraction etc.

Description:

Introduction to experiment for 30 minutes.

Determination of angle of minimum deviation

Studying the wavelength of sodium vapour lamp

Applications:

1. The spectrum of colours produced by diffraction grating can be observed

by a spectroscope. This technique has led to a wide variety of devices such as spectrograph, the spectrometer, the spectrophotometer and the colorimeter.

2 .The phenomenon of diffraction x-rays, diffraction of electrons and the diffraction of sound waves is well known.

3. The diffraction phenomenon is effectively used is explaining the structure of crystals.

Viva Questions:

1) Define Diffraction?
2) Mention the two types of diffraction?
3) What is the type of diffraction in the diffraction grating experiment?
4) What is grating?
5) What is the least count for the spectrometer?
6) What is meant by wave length of light?
7) If the wave length of Na line 5893A^0 then what is its frequency.
8) How many lines are present on the grating?
9) Which type of light we are using in this expt.
10) Define interference.

Experiment 5:WAVELENGTH OF LIGHT –DIFFRACTION GRATING USING LASER

Objective: - To determine the wavelength of the Laser source using diffraction grating

Prerequisites-:

Basic knowledge on Wave theory and Lasers.

Fundamentals of optics and knowledge on interference, diffraction etc.

Description:

Introduction to experiment for 30 minutes.

Determination of angle of diffraction in normal incidence method.

Studying the wavelength of the laser

Applications:

1. A high intense laser beam may be used to drill a small hole in a diamond.
2. Due to narrow band width lasers are used in microwave communication.

Viva Questions:

1) What is LASER?
2) What is the use of diffraction grating?
3) What are the characteristics of LASERS?
4) What does LASER stand for? What is the principle behind it?
5) What are the characteristics of LASER?
6) What is diffraction?
7) Explain about types of diffraction.
8) What happens to the pattern if the slit width is increased?
9) What is wavelength of the LASER?
10) How is a LASER different from normal light?

11) What is holography?
12) What are the applications of LASER?
13) What are the types of LASERs?

Experiment 6: MELDE`S EXPERIMENT

Objective: - To determine the frequency of given tuning fork by using Melde`s apparatus in transverse and longitudinal modes.

Prerequisites-:

Fundamentals on optical phenomena like dispersion, reflection, refraction and refractive index.

Description:

Introduction to experiment for 30 minutes.
Observe te formation of standing waves.
Determination the number of loops formed.
Vary the weight in the pan and get the loops when there is a resonance in the string.
Determine the frequency of the tuningfork.

Applications:

1. Vibrations of bars or rods, vibrations of metallic plates, vibrations of bells, Forced vibrations of a sound box in a gramophone or a loud speaker in a radio etc….

Viva Questions:

1. Explain the difference between the longitudinal and transverse waves
2. Define Nodes and Antinodes
3. Define Standing Wave
4. Define Resonance Condition
5. What happens to amplitude in resonance condition
6. What is the distance between two Successive modes.
7. What are stationary waves?
8. Define beats.
9. Examples of longitudinal waves
10. Examples of transverse waves

Experiment 7: NUMERICAL APERTURE

Objective: - To determine the numerical aperture of a given optical fiber cable.

Prerequisites-:

Fundamentals of wave properties like superposition, interference, path difference and phase difference.

Description-:

Introduction to experiment for 30 minutes.
Determination of diameter of the laser light emmited fom the optical fiber.
Change the distance of optical fiber cable from the jig.
Determine the NA.

Applications:

1. Fiber optic sensors play a major role in future industrial medical aerospace and consumer applications

2. for military applications like fiber optic hydro phones for submarine.

Viva Questions:

1. Define numerical aperture?
2. What is acceptance angle?
3. What is the principle of optical fibers?
4. What are the uses of optical fibers?
5. What are the conditions for TIR
6. Define Snell's law
7. What is denser medium
8. What is rarer medium
9. Explain about step index fiber.
10. Explain graded fiber.

Experiment 8: **LCR RESONANCE CIRCUITS**

Objective: - To draw the characteristics of a LCR series and parallel resonance and determine the resonance frequency, band width and quality factors.

Prerequisites-:

Basic knowledge on electrical and electronic components.

Description:

Introduction to experiment for 30 minutes.
Connect the circuit as per the circuit diagram
Determination of Resonant frequency in series and parallel connection.

Applications:

Electrical resonance plays an important role in modern living. The tuning of a T.V set or wireless set is an example for resonance.

Viva Questions:

1. Explain the importance of Band width
2. What is the physical Significance of LCR?
3. What is the role of inductance in LCR circuit and what are its units
4. Parallel resonance circuit is rejecter circuit and series resonant circuit is acceptor circuit, Explain
5. Why series circuit gives power maximum at resonance and parallel minimum.Define Ohm’s law
6. What are the units of resistance
7. What are the units of capacitance
8. What are the units of inductor

9. Explain about frequency.
10. What is bandwidth

Experiment 9: DISPERSIVE POWER OF PRISM MATERIAL

Objective: - To determine the dispersive power of a given prism material by using spectrometer.

Prerequisites-:

Fundamentals on optical phenomena like dispersion, reflection, refraction and refractive index.

Description:

Introduction to experiment for 30 minutes.
Determination of direct reading
Determination of angle of minimum deviation for different spectral lines.
Determination of refractive index of spectral lines.
Determination of Dispersive power of prism material.

Applications:

1. The brilliance of a diamond is due to its largest dispersion.
2. In recent years, synthetic crystal of titanium oxide and strontium titanate, with about eight times the dispersion of diamond has been produced.
3. The dispersion of light in optical fibers.

Viva Questions:

1. What Dispersive power
2. Distinguish between Prism Spectrum and Grating Spectrum
3. Units of Dispersive power
4. Which color will have more Refractive Index
5. If you replace Mercury light with Sodium light what color do you observe
6. Why should we keep prism in minimum Deviation position

7. What is the least count for the spectrometer?
8. What is meant by wave length of light?
9. How many lines are present on the grating?
10. Which type of light we are using in this expt.

Experiment 10: NEWTON'S RINGS

Objective: - To determine the radius of curvature of a given Plano convex lens ,by forming Newton's rings.

Prerequisites-:

Fundamentals of wave properties like superposition, interference, path difference and phase difference.

Description-:

Introduction to experiment for 30 minutes.
Determination of diameter of Bright or dark fringes.
Determination of radius of curvature of plano-convex lens.

Applications:

1. The interference of light can be used to determine the thickness of a thin film.
2. You can use Newton's rings to measure the refractive index
3. It is used to detect and measure small changes in radii of curvature and in the length of bodies
4. The refractive index of a liquid like water or oil can be determined.

Viva Questions:

1. What is the principle of Newton's Rings?
2. Why the rings are circular
3. Define interference phenomena

4. What is Constructive interference and Destructive interference
5. Define Monochromatic Radiation
6. What will happen if Plano convex lens replaced by glass plate
7. What is the least count for the travelling microscope?
8. What is meant by wave length of light?
9. If the wave length of Na line $5893A^0$ then what is its frequency.
10. Which type of light we are using in this expt.
11. Define interference.

Experiment 11: STEWART-GEE`S EXPERIMENT

Objective: - To study the magnetic field induction along the axis of current carrying the coil and verify the Biot-Savart`s law.

Prerequisties-:

Basic Concepts on Electricity and Magnetism, Electro-magnetism, Variation of magnetic field along the axis of a current carrying coil. Ampere's and Faraday's law.

Description-:

Introduction to experiment for 30 minutes.

Connect the circuit as per the circuit diagram

Studying the variation of magnetic filed with change in current.

Verifying the deflections in the magnetometer on moving either sides of the coil. Verifying the Magnetic field induction theoretically and experimentally.

Applications:

1. The Phenomenon of electromagnetic induction studies in this experiment is made use in a variety of applications like electric motors and electric generators.
2. Electromagnetic induction is general name given to a variety of phenomena to which we give different name depending on content in which we study them. Thus gamma rays, x rays, Ultra- violet rays, infrared rays and wireless (radio) waves are all of same nature and can be expressed in terms of continues inter change of magnetic and electric energy.
3. Electro magnetism is basic to operation of radio and T.V (or) ignition system, electric systems. Electric motors and generators, phones, electromagnetic cranes etc.
4. Electric traction motor – the motor, like dynamo, is an electromagnetic device. It's based on the fact that current carrying conductor experience a force on magnetic field.
5. In the construction of Helmholtz galvanometer.

6. They are used in a verity of applications like electric motors and electric generators

Viva Questions:

1. What is the use of cummutator and Rheostat
2. How the magnetic field is produced in the circular coil?
3. What is the principle acting in it?
4. What is magnetic induction?
5. How the earth's magnetic induction can act on the circular coil?
6. What are the 2 positions in tangent law?
7. What is the direction of magnetic field at the center of circular coil?
8. What is rehostate.
9. Current direction can be changed by using ____________
10. In which direction we should keep the Stewart and Gee`s apparatus

Experiment 12: CHARACTERISTICS OF LED AND LASER DIODE

Objective: - To study the Characteristics of LED and LASER Diode

Prerequisites-:

Basic knowledge about semiconductors is needed. Knowledge on diode biasing, current flow through the semiconductors and Basic knowledge on Lasers

Description-:

Introduction to experiment for 30 min

Connections are made according to the circuit diagram

Studying the variation of voltage/ current with intensities of the LED and LASER individually.

APPLICATIONS:

1. A high intense laser beam may be used to drill a small hole in a diamond.

2. Due to narrow band width lasers are used in microwave communication.

3. LED are used for display purpose.

Viva questions:

1. What does LASER stand for? What is the principle behind it?
2. What are the characteristics of LASER?
3. What is diffraction?
4. Explain about types of diffraction.
5. What happens to the pattern if the slit width is increased?
6. What is wavelength of the LASER?
7. How is a LASER different from normal light?
8. What is holography?
9. What are the applications of LASER?
10. What are the types of LASERs?

Experiment 13: CHARACTERISTICS OF SOLAR CELL

Objective: - To draw the I-V Characteristics of solar cell.

Prerequisites-:

Basic knowledge on diode, photo diode, photo electric effect.

Description:

Introduction to experiment for 30 minutes.
Connect the circuit as per the circuit diagram
Study the variation of current with voltage at different intensities of light.
Understanding I-V characteristics of solar cell.

Applications:

Although the cost of solar energy is still too expensive, yielding power ten times more costlier than that generated by oil, there are still applications for which solar power is economically feasible. It is particularly suited for remote applications where there is no direct tie-in to an electric utility feeder, or where the transportation of fuel to the generator site is impractical. In conjunction with an electrochemical storage battery and suitable charge control electronics, solar cell arrays can be designed to provide practically continuous power. Some examples of this type of application include:
1. electronic and optical beacons and warning devices such as channel buoys and shoreline barkers.

2. remote television and radio receiver stations.
3. radio transmitters and transponders, microwave repeater stations.
4. weather and earthquake monitoring stations.
5. electronic (galvanic) corrosion protection of metal structures such as bridges and towers.

Viva questions:

1. What is the principle used in solar cell
2. What is the difference between solar cell and photo diode
3. What is forward bias and reverse bias.
4. What is meant by threshold frequency
5. To increase current in the circuit we should vary_________
6. What is band energy gap
7. What is photo generation current (I_{PH})
8. What is meant by the fill factor and the efficiency?
9. What are the applications of solar cell?
10. What is a semiconductor.

LEAD EXPERIMENTS

1. Energies of the visible of spectra-To study the visible spectrum emitted from Mercury vapour lamp using student Diffraction Grating.
2. The spectrum of gases- To study the characteristics of common spectral line emitted from Sodium Vapour, Mercury vapour lamps.
3. Uncertainty Principle & its Explanation-Diffraction at a single slit
4. Diffraction at a double slit.
5. To find the thickness of material using wedge method.
6. To study the Divergence of Laser.
7. To study the I-V characteristics of p-n junction diode.
8. R-L Circuit
9. Demonstration of Half wave and Full wave Rectifiers with capacitor, L & π filters in CRO
10. Study of variation of magnetization with variation of current through a magnetic material.

Lead Experiment 1: Energies of the visible of spectra

Objective: - To study the visible spectrum emitted from Mercury vapour lamp using student Diffraction Grating.

Prerequisites-: Basic Fundamentals on optics and knowledge on interference, diffraction etc.

Description:

Introduction to experiment for 30 minutes.
Determination of angle of minimum deviation
Studying the wavelength, frequency, Energies of visible spectrum

Applications:

1. The spectrum of colours produced by diffraction grating can be observed by a spectroscope. This technique has led to a wide variety of devices such as spectrograph, the spectrometer, the spectrophotometer and the colorimeter.
2 .The phenomenon of diffraction x-rays, diffraction of electrons and the diffraction of sound waves is well known.
3. The diffraction phenomenon is effectively used is explaining the structure of crystals.

Lead Experiment 2 : The spectrum of gases

<u>Objective: -</u> To study the characteristics of common spectral line emitted from Sodium Vapour, Mercury vapour lamps.

Prerequisites-: Basic Fundamentals on optics and knowledge on interference, diffraction etc.

Description:
Introduction to experiment for 30 minutes.
Observation of common spectrum lines, Determination of their deviation angles.
Studying the wavelength, frequency, Energies of common spectrum lines from both the sources.

Applications:

1. The spectrum of colours produced by diffraction grating can be observed

by a spectroscope. This technique has led to a wide variety of devices such as spectrograph, the spectrometer, the spectrophotometer and the colorimeter.

2 .The phenomenon of diffraction x-rays, diffraction of electrons and the diffraction of sound waves is well known.

3. The diffraction phenomenon is effectively used is explaining the structure of crystals.

Lead Experiment 3 : Diffraction at a single slit

<u>Objective: -</u> To study the diffraction using single slit and to verify the Heisenberg's uncertainty principle.

Prerequisites-: Basic Fundamentals on Quantum physics, optics and knowledge on interference, diffraction etc.

Description:

Introduction to experiment for 30 minutes.

Observe the diffraction pattern produced by the single slit, gradually increase the slit width and observe the pattern.

Determine the slit width and verify the uncertainty principle.

Applications:

1.The phenomenon of diffraction x-rays, diffraction of electrons and the diffraction of sound waves is well known.

2.The diffraction phenomenon is effectively used is explaining the structure of crystals.

Lead Experiment 4 : To study the Divergence of Laser.

Objective: - It is used to determined the divergence angle of He-Ne laser

Prerequisites-:

Basic knowledge on Wave theory and Lasers.

Fundamentals of optics and knowledge on interference, diffraction etc.

Description:

Introduction to experiment for 30 minutes.

Obsering of variatin of diameter of laser beam with the diatance form screen.

Determation of divergence angle.

Applications:

1. A high intense laser beam may be used to drill a small hole in a diamond.

2. Due to narrow band width lasers are used in microwave communication

5. LAB SCHEDULE:

The lab schedule should be planned once in a week. The week wise scheduled experiment should be completed.

CYCLE 1 AND 2

Batch	wk 1	wk-2	wk-3	wk-4	wk-5	wk-6	wk-7	wk-8	wk-9	wk-10	wk-11	wk-12	wk-13	wk-14
B1	DEMO	Expt 1	Expt 2	Expt 3 activity	Expt 4	LEAD-1	Test	Expt 5	Expt 6	Expt 7	Expt8	Expt 9	Expt 10	LEAD-2
B2	DEMO	Expt 2	Expt 1	Expt 4	Expt3 activity		Test	Expt 6	Expt 5	Expt 8	Expt 7	Expt 10	Expt 9	

B_1 →Roll no 1-15 **B_2 →Roll no 16-30**

6. VIVA SCHEDULE:

The viva schedule should be planned prior starting to the lab experiment.

SG: Selected Group with a maximum of 4 students

ROUND - 1

Batch		Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk8	Wk9	Wk10	Wk11	Wk12	Wk13	Wk14
Batch 1	SG1	--	viva	viva	viva	viva	viva	TEST	viva	viva	viva	viva	viva	viva	viva
	SG2	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	viva	viva
	SG3	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	viva	Viva
	SG4	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	viva	Viva
Batch 2	SG5	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	viva	viva
	SG6	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	Viva	Viva
	SG7	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	Viva	Viva
	SG8	--	viva	viva	viva	viva	viva		viva	viva	viva	viva	viva	Viva	Viva

7. SUGGESTED BOOKS:

1. Laboratory Manual of Engineering Physics by Dr.Y.Aparna & Dr.K.Venkateswara Rao (V.G.S Publishers)
2. Practical Physics by Dr.T.Radhakrishna, Professor (Retd),JNTUK, Hyderabad and Dr.V.Rajeshwar Rao,
   Professor, KITS, Karimnagar
3. Engineering Physics Laboratory Manual by CV Madhusudhan Rao, Assoc.Professor, SVITS, Mahabubnagar

8. WEBSITES (USEFUL LINKS):

Expt. 1: TORSIONAL PENDULUM

https://www.youtube.com/watch?v=P-eJIXZimmQ

Expt. 2: ENERGY GAP OF SEMI CONDUCTOR DIODE https://www.youtube.com/watch?v=nZ0zQdmBbTM

Expt. 3: RC-CIRCUIT

https://www.youtube.com/watch?v=fbo3PLCzFGI

Expt. 4: DIFFRACTION GRATING

https://www.youtube.com/watch?v=DKDLF1ZI1wQ

Expt. 5: WAVELENGTH OF LIGHT –DIFFRACTION GRATING USING LASER

https://www.youtube.com/watch?v=0qIN2qHCvvs

Expt. 6: MELDE`S EXPERIMENT

https://www.youtube.com/watch?v=fqhek1wT5-s

Expt. 7: NUMERICAL APERTURE

https://www.youtube.com/watch?v=gNOVwOthKZI

Expt. 8: LCR RESONANCE CIRCUITS

https://www.youtube.com/watch?v=I_PlHnPGU94

Expt. 9:DISPERSIVE POWER OF PRISM MATERIAL

https://www.youtube.com/watch?v=_D8p_1p7FZ4

Expt. 10: NEWTON'S RINGS

https://www.youtube.com/watch?v=PU-SeNfIRcs

https://www.youtube.com/watch?v=ZqABNlA5d6I

Expt. 11: STEWART-GEE`S EXPERIMENT

https://www.youtube.com/watch?v=wIuAnP9xfxw

Expt. 12: DIFFRACTION AT A SINGLE AND DOUBLE SLIT (LASER)

https://www.youtube.com/watch?v=0qIN2qHCvvs

Expt. 13: CHARACTERISTICS OF SOLAR CELL

https://www.youtube.com/watch?v=ToKQY5eQQvM

9. EXPERTS DETAILS:

NATIONAL:

1. V. B. ASGEKAR,M.Sc. , Ph.D.Professor,Free Electron Lasers,Electron accelerators

2. Dr. Anjali Kshirsagar,M.Sc. Ph.D. (Physics)
3. Vidyasagar Pandit Bhalchandra, Professor and Head,Department of Physics,University of Pune,and Director, Board of College and University Development,University of Pune, Pune.

INTERNATIONAL:

1. *M. Zahid Hasan,Dept of Physics, Professor of Physics. Field: Quantum Condensed*

   Matter & Quantum Many-Body Physics

2. *Frank Calaprice, Frank Calaprice*

3. *Tony Rothman, Lecturer in Physics.*
4. Mark Newman,Paul Dirac Collegiate Professor of Physics, Department of Physics and Center for the Study of Complex Systems, University of Michigan

5. **Benjamin Schumacher**, Kenyon College, Ph.D., The University of Texas at Austin

10. MODEL MAKING / DEMONSTRATION

1. Construction of crystal systems
2. Drawing the Miller indices
3. Calculation of Packing Fraction of SC, FCC and BCC
4. Calculation of lattice parameters from powder XRD films.
5. Characteristics of different types of particle (Charts).
6. Distinguish between materials based on conductivity (Charts).
7. Classification of magnetic materials (Charts).
8. Effective resistance and capacitance in series circuit.
9. Application of Lasers in various fields (Charts).
10. Propagation of light in optical fiber.
11. Application of fiber optics in various fields (Charts).
12. Characteristics of light Emitting Diode.

(1) CONSTRUCTION OF THE CRYSTAL SYSTEMS

Apparatus: Thermocol balls, sticks, scale, Fevistick

The **seven crystal systems** are a method of classifying crystals according to their atomic lattice or structure. The atomic lattice is a three dimensional network of atoms that are arranged in a symmetrical pattern. The shape of the lattice determines not only which crystal system the stone belongs to, but all of its physical properties and appearance. In some crystal healing practices the axial symmetry of a crystal is believed to directly influence its metaphysical properties. For example crystals in the Cubic System are believed to be grounding, because the cube is a symbol of the element Earth.

There are seven crystal systems or groups, each of which has a distinct atomic lattice. Here we have outlined the basic atomic structure of the seven systems, along with some common examples of each system.

Cubic System

Also known as the isometric system. All three axes are of equal length and intersect at right angles. Based on a square inner structure.

Tetragonal System

Two axes are of equal length and are in the same plane, the main axis is either longer or shorter, and all three intersect at right angles.*Based on a rectangular inner structure.*

Hexagonal System

Three out of the four axes are in one plane, of the same length, and intersect each other at angles of 60 degrees. The fourth axis is of a different length and intersects the others at right angles. *Based on a hexagonal (6-sided) inner structure.*

Trigonal System(Rhombohedral System)

Axes and angles in this system are similar to the Hexagonal System, and the two systems are often combined as Hexagonal. In the cross-section of a Hexagonal crystal, there will be six sides. In the cross-section of a Trigonal crystal there will be three sides. *Based on a triangular inner structure.*

Orthorhombic System(Rhombic System)

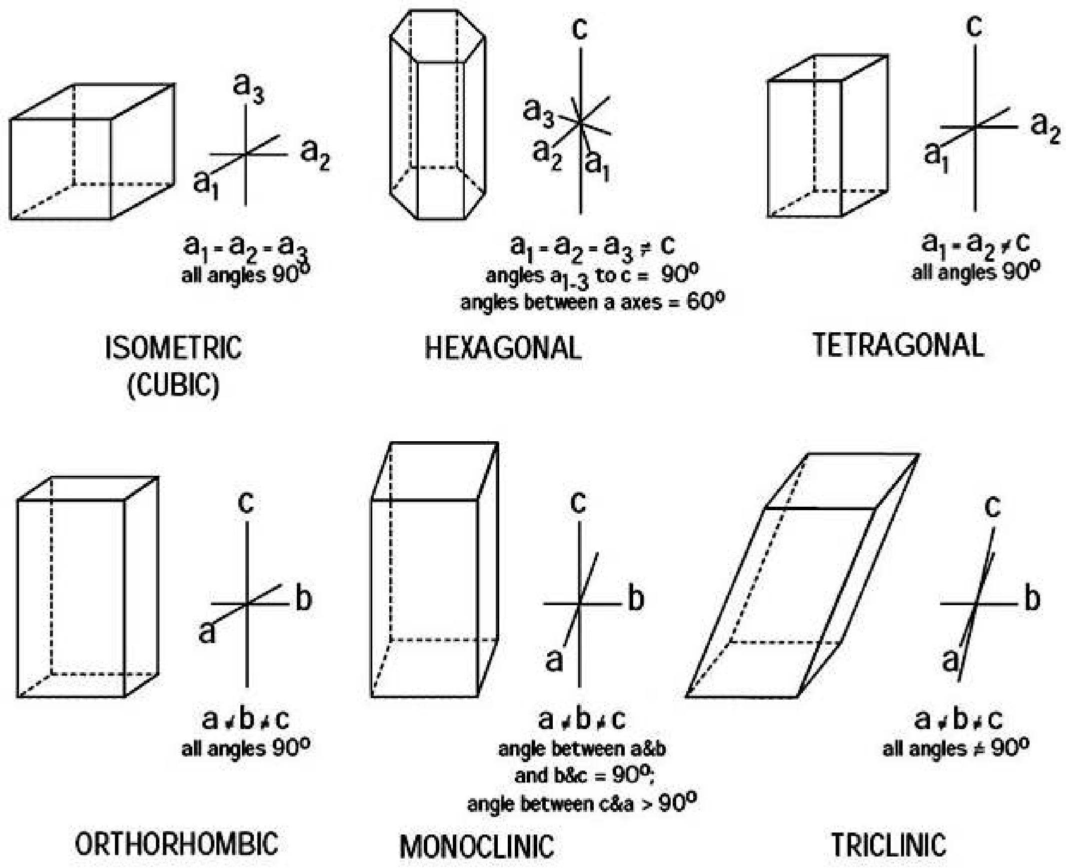
Three axes, all of different lengths, are at right angles to each other. *Based on a rhombic (diamond-shaped) inner structure.*

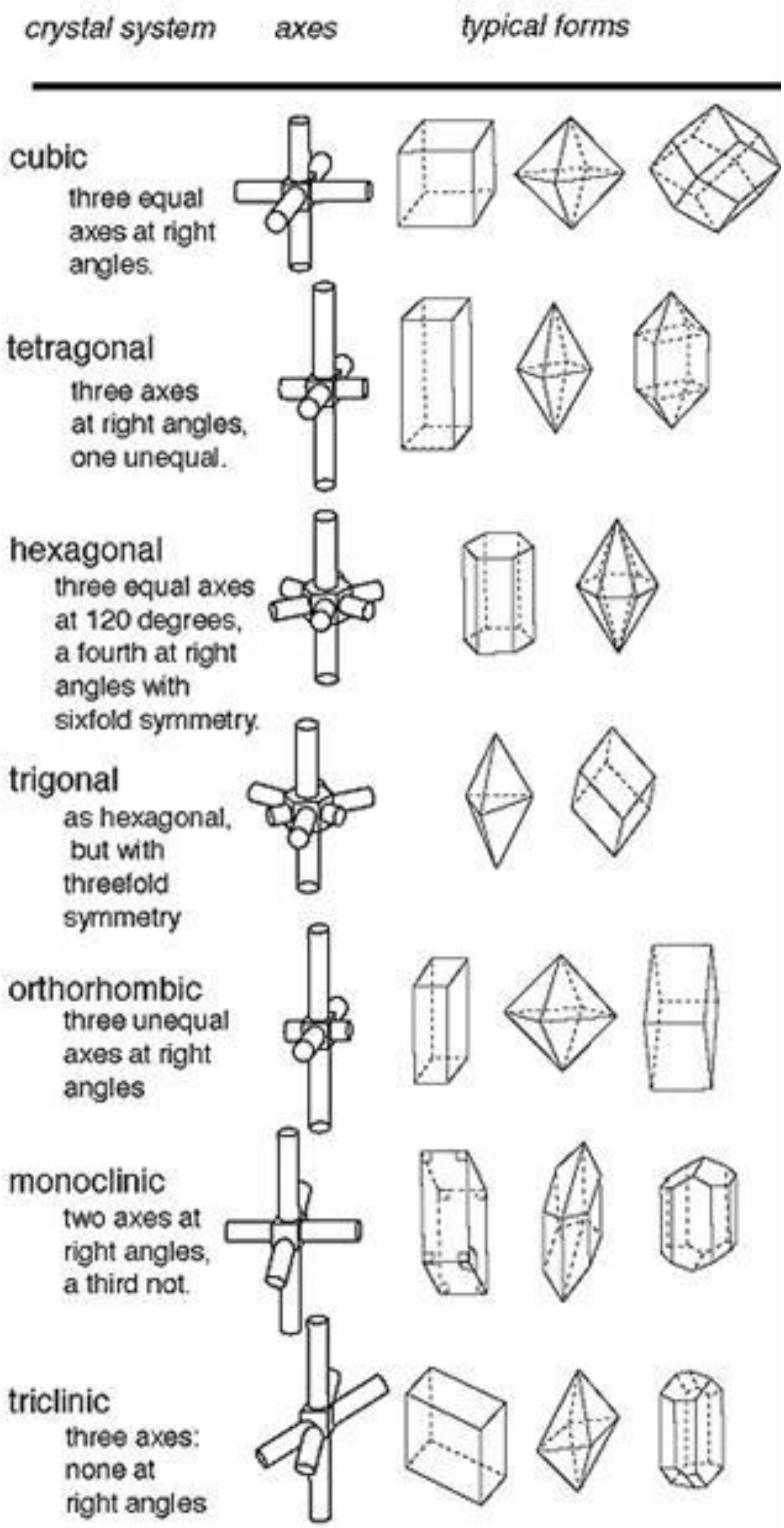
Monoclinic System

There are three axes, each of different lengths. Two are at right angles to each other and the third is inclined. *Based on a parallelogram inner structure.*

Triclinic System

All three axes are of different lengths and inclined towards each other. *Based on a 'triclinic' inner structure, meaning 'three inclined angles'.*


a3
a1
a2
a1 = a2 = a3
all angles 90°
ISOMETRIC
(CUBIC)
c
a3
a2
a1
a1 = a2 = a3 ≠ c
angles a1-3 to c = 90°
angles between a axes = 60°
HEXAGONAL
c
a1
a2
a1 = a2 ≠ c
all angles 90°
TETRAGONAL
c
a
b
a ≠ b ≠ c
all angles 90°
ORTHORHOMBIC
c
a
b
a ≠ b ≠ c
angle between a&b
and b&c = 90°;
angle between c&a > 90°
MONOCLINIC
c
a
b
a ≠ b ≠ c
all angles ≠ 90°
TRICLINIC


crystal system
axes
typical forms
cubic
three equal axes at right angles.
tetragonal
three axes at right angles, one unequal.
hexagonal
three equal axes at 120 degrees, a fourth at right angles with sixfold symmetry.
trigonal
as hexagonal, but with threefold symmetry
orthorhombic
three unequal axes at right angles
monoclinic
two axes at right angles, a third not.
triclinic
three axes: none at right angles

11. CALIBRATION, INSTALLATION, TESTING & INSPECTION:

Calibration: Aim of this concept is to check :

i.whether all the equipment is functioning correctly as per the standards

ii. To bring correctness in the errors of instrument or equipment.

iii. To rectify the errors if any

Installation: Aim of this concept is to make and maintain installation procedure for a New equipment or already existing equipment

Testing : Aim of this concept is to test the equipment after installation whether it Meets the existing standards.

The list of equipments (hardware/software) :

Necessity of tools for development and testing

Equipment to be calibrated

Installation of supporting equipment if any.

PROCEDURE FOR CALIBRATION:

Any Equipment or Instrument or Gauge or Machine can be calibrated as the standard guidelines mentioned under:

1.Identify the Equipment/Instrument/Gauge/Machine which is under defective or to be calibrated or correction for error

2.Identify the type of error and estimate its frequency of variation.

3. Check with Master Standards or equipment/instrument/machine which is working correctly and meeting our requirements.

4. Estimate the frequency of deviations from normal mode.

5. If the equipment is under warranty, then inform to concerned supplier or agency who will carry out calibration.

6. If the equipment is out of warranty then we can compare the deviations and set the error rectification.

7. Generally as per the procedure, the equipment or instruments can be calibrated by the agencies and issue calibration certificate which consists of date of calibration, calibration next due date and remarks as mentioned in the following format.

8. Record and keep all the calibration certificates in safe custody.

After calibration the details of equipment should be submitted in following format.

S.no	Type of equipment	Certificate number	Certificate issued by	Date of calibration	Date of calibration due	Remarks
1						
2						
3						
4						
5						

iv.Calibration,Testing and Installation details equipment wise are mentioned as follows:

Case 1: Calibration of Equipment ------------------------------------- if any

Case 2: Installation of Equipment ------------------------------------- if any

Case 3: Testing of Equipment -- if any

Calibration

<u>Calibration of DC Regulated power supply</u>

1. Take a DC Regulated power supply and set the desired voltage.
2. By using the multi meter verify the output voltage of the DC Regulated power supply.
3. If the multi meter shows the correct value, we can use the device for experiment purpose.

4. If it is not showing the correct value by using the adjust nob of DC Regulated power supply vary the voltage until we get the required voltage.
5. Once we get the correct value we can use for our experiment.

Calibration of voltmeter and ammeter

1. Voltmeters and ammeters of different circuit boards can be done.
2. Measure the voltage/current in the meters of respective circuit board
3. Remove the voltmeter and ammeter connectins and connect to a multi meter and measure the respective voltage and current.
4. If both the voltages and currents are not in coinsiding , by using the screw set to the correct values.

12. MAINTAINANCE OF THE EQUIPMENT:

Maintenance:

Maintenance and trouble shooting of each equipment in a laboratory must follow the following guidelines:

Maintenance Schedules:

(1) Preventive Maintenance Schedules of lab will be decided by lab in charge along with concerned HOD. The details of schedule should be recorded in the following template of format.

S.No.	Name of the Equipment	Date of Maintenance	Type of Activity	Remarks
1				
2				
3				
4				
5				

(2) Maintenance Reports duly signed by in charges as well as HODs and duly approved by Principal periodically.

	Daily	Weekly	Monthly	Annually
Dusting of equipments				
Update the daily consumables				
Labels of apparatus				
Checking of continuity in wires				
Cleaning telescopes and lences				
FIRST AID BOX				
Stock list Verification				
Repair of damaged apparatus				
Calibration of equipment (Service)				

13. TROUBLE SHOOTING SCHEDULES:

A proposal is to be made from each lab branchwise. The proposal should carry following details related to specific equipment in lab.

S.No., Equipment Name , Type of Problem (working of switches, Digital, Breakage of tools, discontinuity in wires etc.), Expected Reasons (improper connections and supplied voltage etc.)

Trouble shooting exercises should be properly recorded in a separate format as mentioned below:

S.No.	Date of recording activity	Equipment Name	Type of Trouble	Remedial Activity	Remarks

14. SCIENCE FAIR

1. To construct a parallel circuit.
2. To construct a simple motor.
3. To demonstrate how light rays interact with smooth surfaces to form reflections.
4. To Verify Ampere's law
5. To discover how secondary colors are derived from primary colors
6. To verify Ohm's law
7. To demonstrate how colliding particles from vibration bang into one another to produce

Sound.
8. To demonstrate how sound waves can penetrate various types of materials.
9. To prepare temporary magnet.
10. To demonstrate how water levels are affected by objects of various mass.
11. To demonstrate how different angles of incidence of solar rays impact the performance of a
Solar cell.
12. To demonstrate how solar cells are affected by their operating temperatures

NOTE: Science Fair will be conducted on National Science Day i.e. 28 February.

ACADEMIC PLANNER

COMPUTER AIDED ENGINEERING GRAPHICS

(2024-25)

COURSE: I YEAR B.TECH

"COMPUTER AIDED ENGINEERING GRAPHICS"

List of contents

S.NO	CONTENTS
1	PREAMBLE/INTRODUCTION
2	PRE REQUISITES
3	OBJECTIVES

PREAMBLE/INTRODUCTION

One of the best ways to communicate one's ideas is through some form of picture or drawing. This is especially true for the engineer. The purpose of this is to give you the basics of engineering sketching and drawing.

• "Sketching" and "Drawing": Sketching generally means freehand drawing. Without using any drawing instruments. Ex: Sketch the face of human being. Drawing usually means using drawing instruments. Ex: Draw the chair which is used to sit.

• Engineering Drawing is a document that communicates a precise description of a part. They are legal documents, so they must be formal and precise. They are drawn using from compasses to drafters to bring precision to the drawings. Ex: Draw the chair with dimensions so that they can manufacture.

• Computer Aided Engineering Drawing is a file that communicates a precise description of a part with all details. Wherein they can be easily edited as per requirements of individual (customized). They are drawn using Computer and CAD software as a tool. Computer-stored files generated by the variety of packages can also check for volume and mass property calculations, finite-element analysis, process planning, computer numerically controlled (CNC) machining or high-resolution displays, in a formal three-dimensional geometric modeling terms. Words are not the natural language of engineers. Drawings are their prose, mathematics their grammar and differential equations their poetry.

PREREQUISITES:

This Subject Requires Basic Drawing Practice And Basic Knowledge About Different Shapes Of Instruments.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

- Apply computer aided drafting tools to create 2D and 3D objects
- sketch conics and different types of solids
- Appreciate the need of Sectional views of solids and Development of surfaces of solids
- Read and interpret engineering drawings
- Conversion of orthographic projection into isometric view and vice versa manually and by using computer aided drafting

OBJECTIVES

- To develop the ability of visualization of different objects through technical drawings
- To acquire computer drafting skill for communication of concepts, ideas in thedesign of engineering products

SYLLABUS

UNIT – I:

Introduction to Engineering Graphics: Principles of Engineering Graphics and their Significance, Scales – Plain & Diagonal, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid, Introduction to Computer aided drafting – views, commands and conics

UNIT- II:

Orthographic Projections: Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures. Auxiliary Planes. Computer aided orthographic projections – points, lines and planes

UNIT – III:

Projections of Regular Solids – Auxiliary Views - Sections or Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views, Computer aided projections of solids – sectional views

UNIT – IV:

Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone, Development of surfaces using computer aided drafting

UNIT – V:

Isometric Projections: Principles of Isometric Projection – Isometric Scale – Isometric Views – Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa
–Conventions. Conversion of orthographic projection into isometric view using computer aided drafting.

LESSON PLAN / SESSION PLAN

Subject: COMPUTER AIDED ENGINEERING GRAPHICS

Course: I B.Tech

S.NO	Topic (JNTUH syllabus)	Sub-Topic	No. Of lectures required	Suggested Books	Remarks
UNIT – I					
1	INTRODUCTION TO ENGINEERING DRAWING	• Course objectives & course outcomes • Differences between Drawing & Engineering Graphics • Applications of Engineering Graphics	L1 to L2	T1,T2,R1	
2	INTRODUCTION TO COMPUTER AIDEDDRAFTING – VIEWS& COMMANDS	• Brief explanation about AUTOCAD Commands &Views • Usage of Commands &Views • Preparation of Template	L3 to L5	T1,T2,R1	
3	PRINCIPLES OF ENGINERING GRAPHICS	• Lettering & Dimensioning • Practice in AUTOCAD	L6 to L7	T1,T2,R1	
4	PRINCIPLES OF ENGINERING GRAPHICS	• Geometrical Constructions • Polygons • Practice in AUTOCAD	L8 to L10	T1,T2,R1	

5	CONIC SECTIONS GENERAL METHOD	Eccentricity Method • Ellipse • Parabola • Hyperbola • Rectangular Hyperbola • Practice in AUTOCAD	L11 to L14	T1,R2,R1	
6	CYCLOIDS	Construction of Cycloid • Different Type of Problems • Practice in AUTOCAD	L15 to L16	T1,T2,R1	
7	EPI CYCLOID HYPOCYCLOID	• Construction ofEpicycloid • Construction of Hypocycloid • Practice in AUTOCAD	L17to L19	T1,R1,R2	
8	PLAIN SCALES	Introduction to Scales • Representative Factor • Construction of Plain scale • Practice in AUTOCAD	L20 to L21	T1,R1,R2	
9	DIAGONAL SCALES	• Construction of Diagonal scale • Practice in AUTOCAD	L22to L24	T1,T2,R1	
UNIT – II					
10	PROJECTIONS OF POINTS	Principles of Orthographic projections & Conventions • Projection of points in all Quadrants • Practice in AUTOCAD	L25 to L26	T1,R1,R2	

11	PROJECTIONS OF LINES INTRODUCTION	Projection of Lines • Line Inclined to one plane • Its Traces	L27 to L29	T1,R1,R2	
12	PROJECTIONS OF LINES Inclined to both the planes	• Line Inclined to both the planes in the first quadrant • Traces • Finding True Length & true inclination • Practice in AUTOCAD	L29to L29	T1,T2,R2	
13	PROJECTIONS OF PLANES	• Plane parallel to one plane • Plane inclined to one plane • Practice in AUTOCAD	L30 to L31	T1,T2,R1	
14	PROJECTIONS OF PLANES	• Plane inclined to both the planes • Practice in AUTOCAD	L32to L34	T1,T2,R1	
UNIT – III					
15	PROJECTION OF SOLIDS Introduction	• Prism • Pyramid • Cylinder • Cone • Axis of the solid parallel to one plane &perpendicular to another plane	L35to L36	T1,T2,R1	
16	PROJECTION OF SOLIDS	• Axis of the solid Inclined to both planes • Practice in AUTOCAD	L37 to L39	T1,R1,R2	

UNIT – IV					
17	SECTIONS OF SOLIDS	Introduction to Sections of Solids • Section Plane parallel to one plane &perpendicular to another plane • Practice in AUTOCAD	L40to L41	T1,R1,R2	
18	SECTIONS OF SOLIDS	• Section Plane inclined to one plane & perpendicular to another plane • Practice in AUTOCAD	L42 to L44	T1,T2,R1	
19	DEVELOPMENT OF SURFACES	• Development of Prisms and cylinder • Practice in AUTOCAD	L45 to L46	T1,R1,R2	
20	DEVELOPMENT OF SURFACES	• Development of Pyramids and cone • Practice in AUTOCAD	L47 to L49	T1,T2,R1	
UNIT – V					
21	ISOMETRIC PROJECTIONS	Introduction to Isometric Projections • Conversion of Isometric views to Orthographic views • Creation of 2D Sketch by CAD package	L50 to L54	T1,T2,R1	

22	ORTHO GRAPHIC PROJECTIONS	• Conversion of Orthographic views to Isometric views • Creation of 3D Sketch by CAD package	L55 to L57	T1,T2,R1	

SUGGESTED BOOKS

TEXT BOOKS :

1.Engineering Drawing – Basant, Agrawal, TMH

2. Engineering Drawing, N.D. Bhatt

REFERENCES :

1. Engineering Graphics. P I Varghese Tata McGraw Hill Education Pvt. Ltd.

2. Engineering drawing – P.J. Shah .S.Chand Publishers.

3. Engineering Drawing- Johle/Tata Macgraw Hill Book Publishers.

4 .Engineering Drawing by K.Venu Gopal& V.Prabu Raja New Age Publications.

WEBSITES

- www.ehow.co.uk/facts_6869385_importance-technical-drawing.html
- www.ehow.com/about_6661392_importance-technical-drawing-architecture.html
- www.ideabuyer.com/news/the-importance-of-technical-drawings/
- www.ehow.com/about_5692099_importance-technical-drawing-engineer.html

QUESTION BANK

1. On a map the actual distance of 10meters is represented by a line of 50mm long. Calculate a Representative Factor and construct a diagonal scale long enough to measure upto 30 meters and mark a distance of 26.3 meters, 13.2 meters on it.
2. A fixed point is 80 mm from a fixed straight line. Draw the locus of a point p moving in such a way that its distance from the fixed straight line twice its distance from the fixed point. Name the curve. And draw a tangent and normal at any point on the curve.
3. The projectors of the ends of a line AB are 70mm apart. The end A is 10mm above the H.P. and 15mm in front of the V.P. The end B is 50mm above the H.P. and 40mm in front of the V.P. determine the true length of AB and its inclinations.
4. A regular pentagon of side 30 mm is resting on HP on one of its side with its surface 45^0 inclined to HP. Draw its projections when the side in HP makes 30^0 angle with VP.
5. Construct a diagonal scale to read kilometers, hectometers and decameters and long enough to measure up to 6 km. when a line of length 1cm on the map represents a distance of 0.5 km, calculate the R.F. and indicate a distance of 2.45 km on the scale.
6. Construct an Ellipse when a distance between Focus and Directrix is 50mm and eccentricity is 2/3. And also draw tangent and normal to the curve at a distance of 70mm from the Directrix.
7. The projectors of the ends of a line AB are 70mm apart. The end A is 10mm above the H.P. and 15mm in front of the V.P. The end B is 50mm above the H.P. and 40mm in front of the V.P. determine the true length of AB and its inclinations.
8. A Circle of diameter 50mm rolls on another circle of radius 90mm. Construct an Epicycloid. And draw a Tangent & Normal at any point on the curve.
9. Construct a diagonal scale to read kilometers, hectometers and decameters and long enough to measure up to 6 km. when a line of length 1cm on the map represents a distance of 0.5 km, calculate the R.F. and indicate a distance of 2.45 km on the scale.
10. A fixed point is 90 mm from a fixed straight line. Draw the locus of a point p moving in such a way that its distance from the fixed straight line twice its distance from the fixed point. Name the curve. And draw a tangent and normal at a distance of 70mm on the curve from the directrix.
11. A 70mm long line PQ has its end P 20mm above the HP. and 40mm in front of the VP.The line is inclined at45^0 to the H.P and 30^0 to V.P. Draw its projections and locate its traces.

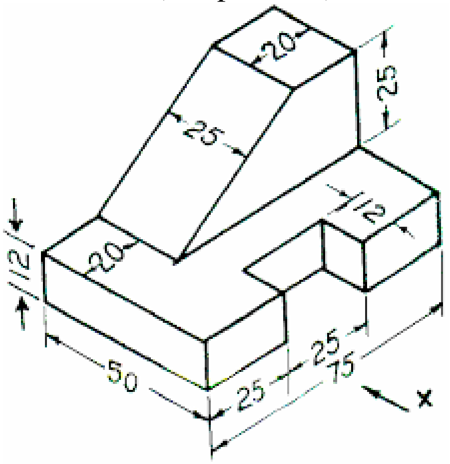
12. A hexagonal plane of side 30mm has an edge in the HP. The surface of the plane making an angle of 45^0 to the HP. And the side on which it rests is inclined at 30^0 to the VP. Draw the projections.

13. A square prism of base side 40mm and axis 65 mm rests on its base on the H.P. Draw its projections when the axis is inclined at 30° to the H.P. and the base side on which it is resting is inclined at 45^0 to VP, draw it projections.

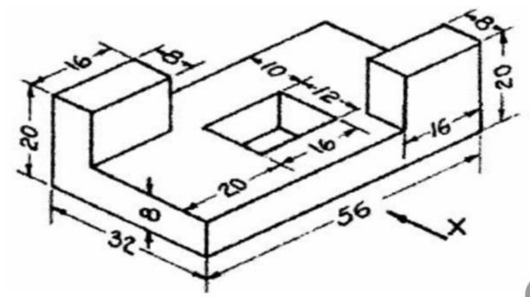
14. A Cone of base diameter 50 mm and axis 60 mm long is resting on its base on the H.P. It is cut by an A.I.P. bisecting the axis inclined at 45° to the H.P. Draw its sectional top view and true shape of the section.

15. Hexagonal pyramid of base side 25mm and axis 65mm is standing on HP with two of its base sides are parallel to VP. It is cut by a sectional plane inclined at 45^0 to HP, bisects the axis. Draw the development of its lateral surface.

16. Draw the following vies of the object given in figure below. All dimensions are in mm.
    a) Front view b) Top view c) Side view

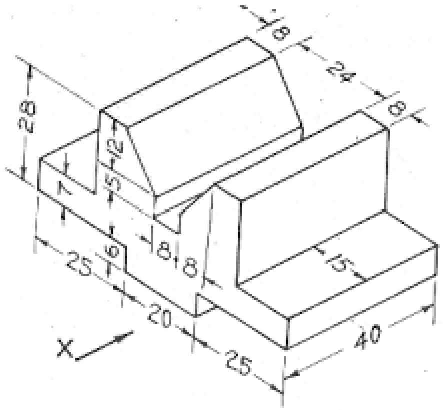


17. A square prism of base side 40mm and axis 65 mm rests on its base on the H.P. Draw its projections when the axis is inclined at 30° to the H.P. and the base side on which it is resting is inclined at 45^0 to VP, draw it projections.
18. A Cone of base diameter 50 mm and axis 60 mm long is resting on its base on the H.P. It is cut by an A.I.P. bisecting the axis inclined at 45° to the H.P. Draw its sectional top view and true shape of the section.
19. A Hexagonal pyramid of base side 25mm and axis 65mm is standing on HP with two of its base sides are parallel to VP. It is cut by a sectional plane inclined at 45^0 to HP, bisects the axis. Draw the development of its lateral surface.
20. Draw the following vies of the object given in figure below. All dimensions are in mm.
    a) Front view b) Top view c) Side view



21. A Line AB is 100mm long and is inclined at 40^0 to HP and 50^0 to VP. Its one end is 20mm above HP & 30mm infront of VP. Draw its projections.
22. A pentagonal prism of base side 30 mm and height 60 mm rests on one of its base side on the H.P. inclined at 30° to the V.P. Its axis is inclined at 45° to the H.P. Draw its projections.

23. A cone of base diameter 50 mm and axis 60 mm is resting on its base on the H.P. It is cut by an A.I.P. inclined at 45° to the H.P. and passing through a point on the axis, 20 mm above the base. Draw its sectional top view and obtain true shape of the section.
24. A hexagonal prism of base side 30 mm and height 70 mm, is resting on its base on the H.P. with a side of the base perpendicular to the V.P. The prism has a cylindrical hole of diameter 40 mm, drilled centrally such that the axis of hole is perpendicular to the V.P. Draw the development of the lateral surface of the prism.
25. Draw the following vies of the object given in figure below. All dimensions are in mm.
    a) Front view b) Top view c) Side view (CO5)



EXPERT LECTURES

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ACADEMIC PLANNER

Subject:Programming for Problem Solving

S.NO		CONTENT
(1)	-	**Preamble/Introduction**
(2)	-	**Prerequisites**
(3)	-	**Objectives and Outcomes**
(4)	-	**Syllabus** **1.Autonomous/R20-CMREC** **2.GATE** **3.IES**
(5)	-	**List of Expert Details** (Local/National/International with Contact details/Profile link/Blogs/their research Contribution towards the subject)
(6)	-	**Journals with min 5 ref paper for literature study**
(7)	-	**Subject -Lesson plan**
(8)	-	**Suggested Books** (prescribed and References)
(9)	-	**Websites for self learning Resources like**
(10)	-	**Question Banks** **1.JNTUH/Model papers** **2. GATE**
(11)	-	**Two case study presentations with Project / Product/Model/prototypes/ Industrial applications.**
(12)	-	**Assignment Question/Innovative Assignments sets.**
(13)	-	**Listof topics for students Seminars with Guidelines**
(14)	-	**STEP/Course material in softcopy**
(15)	-	**Expert Lectures with topics & Schedules (if any)**

1.Preamble/Introduction

C is a procedural programming language. It was initially developed by Dennis Ritchie in the year 1972.C has now become a widely used professional language for various reasons.

- Easy to learn
- Structured language
- It produces efficient programs.
- It can handle low-level activities.
- It can be compiled on a variety of computers.

It is said that ‘C’ is a god’s programming language. One can say, C is a base for the programming. If you know ‘C,’ you can easily grasp the knowledge of the other programming languages that uses the concept of ‘C’

2. Prerequisites

- Should be familiar with mathematical notations and terminology

3. Course objectives

- To learn the fundamentals of computers.
- To understand the various steps in program development.
- To learn the syntax and semantics of C programming language.
- To learn the usage of structured programming approach in solving problems.

Course outcomes

- To write algorithms and to draw flowcharts for solving problems.
- To convert the algorithms/flowcharts to C programs.
- To code and test a given logic in C programming language.
- To decompose a problem into functions and to develop modular reusable code
- To use arrays, pointers, strings and structures to write C programs.
- Searching and sorting problems.

4. 1 Syllabus CS103ES: PROGRAMMING FOR PROBLEM SOLVING

(Common to All Branches)

B. Tech I Year I SemL T P C

3 1 0 4

UNIT I

Introduction to Programming: Introduction to components of a computer system: disks, primary and secondary memory, Processor, operating system, compilers, creating, compiling and executing a program etc., Number systems. Introduction to Algorithms: steps to solve logical and numerical problems. Representation of Algorithm, Flowchart/Pseudo code with examples, Program design and structured Programming. Introduction to C Programming Language: variables (with data types and space Requirements) Syntax and Logical Errors in compilation, object and executable code, Operators, expressions and precedence, Expression evaluation, Storage classes (auto, extern, Static and register), type conversion, the main method and command line arguments. Bitwise operations: Bitwise AND, OR, XOR and NOT operators Conditional Branching and Loops: Writing and evaluation of conditionals and consequent Branching with if, if-else, switch-case, ternary operator, goto, Iteration with for, while, do while Loops. I/O: Simple input and output with scanf and printf, formatted I/O, Introduction to stdin, stdout and stderr, Command line arguments.

UNIT II

Arrays, Strings, Structures and Pointers:Arrays: one and two dimensional arrays, creating, accessing and manipulating elements of arrays. Strings: Introduction to strings, handling strings as array of characters, basic string functions available in C (strlen, strcat, strcpy, strstr etc.), arrays of strings Structures: Defining structures, initializing structures, unions, Array of structures Pointers: Idea of pointers, defining pointers, Pointers to Arrays and Structures, Use of Pointers in self-referential structures, usage of self referential structures in linked list (no Implementation), Enumeration data type.

UNIT III

Pre-processor and File handling in C: Pre-processor: Commonly used Pre-processor commands like include, define, undef, if, ifdef, ifndef. Files: Text and Binary files, Creating and Reading and writing text and binary files, appending data to existing files, Writing and reading structures using binary files, Random Access using fseek, ftell and rewind functions.

UNIT IV

Function and Dynamic Memory Allocation: Functions: Designing structured programs, declaring a function, Signature of a function, Parameters and return type of a function, passing parameters to functions, call by value, passing arrays to functions, passing pointers to functions, idea of call by reference, Some C Standard functions and libraries Recursion: Simple programs, such as Finding Factorial, Fibonacci series etc., Limitations of Recursive functions Dynamic Memory Allocation: Allocating and freeing memory, Allocating memory for arrays of different data types.

UNIT V

Introduction to Algorithms: Algorithms for finding roots of quadratic equations, finding minimum and maximum numbers of a given set, finding if a number is prime number, etc.

Basic searching in an array of elements (linear and binary search techniques),Basic algorithms to sort array of elements (Bubble, Insertion and Selection sort algorithms),Basic concept of order of complexity through the example programs

4.2GATE Syllabus:

- Programming in C
- Recursion, Arrays
- Searching, sorting

4.3 IES Syllabus:

- Not Applicable.

5. List of Expert Details

The Expert Details which have been mentioned below are only a few of the eminent ones known Internationally, Nationally and Locally. There are a few others known as well.

INTERNATIONAL:

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2. Prof. E Balagurusamy, Member, Union Public Service Commission.
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1. Mrs. Dr.P. Madhavi, HOD-IT, CMREC Medchal, Hyderabad.
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   Email: shamila.m@gmail.com

   Mobile: 9154246997

6. Journals with min 5 ref paper for literature study

- **International:**

1) **TITLE:** THE C PROGRAMMING LANGUAGE

   AUTHORS: Alia Ani

http://ijirt.org/master/publishedpaper/IJIRT142678_PAPER.pdf

2) **TITLE:**PROGRAMMING LANGUAGE /PROBLEM- SOLVING RESEARCH

   AUTHORS: David B. Palumbo

   https://www.jstor.org/stable/1170225

3) **TITLE**: Computational thinking development through creative programming in higher education

   AUTHORS: Margarida Romero

   https://educationaltechnologyjournal.springeropen.com/track/pdf/10.1186/s41239-017-0080-z.pdf

4) **TITLE**:Research and Development of C Language Programming Experiment Assistant Management Platform Based on Hybrid Architecture

AUTHORS: Ye Chena , Ren Zhikaoa ,Chen Chunpingb a

https://www.sciencedirect.com/science/article/pii/S1877705811020534

5) **TITLE:**Fundamentals of C programming language

   AUTHORS: Ritika Nain

   http://ijirt.org/master/publishedpaper/IJIRT142685_PAPER.pdf

7. Subject- Lesson Plan:

UNIT	CLASS	TOPIC	TEXT BOOK/REF. BOOK	Teaching Methods
UNIT-I (Introduction to programming)	**Introduction to components of computer system**			
	L1	Disks, primary and secondary memory,	T1&T2	M2
	L2	processor,operatingsystem,compilers,	T1&T2	M2
	L3	creating, compiling and executing a program	T1&T2	M2
	L4	Number systems introduction and types	T1&T2	M1
	Introduction to Algorithms:			
	L4	steps to solve logical and numerical problems Representation of Algorithm	T1,T2&R1	M1
	L5	Representation of Algorithm Flowchart/Pseudo code with examples	T1,T2&R3	M1
	L6	Program design and structured programming	T1,T2&R4	M1
	Introduction to C Programming Language:			
	L7	variables , Syntax and Logical Errors in compilation, object and executable code	T1,T2&R1	M1
	L8	Operators	T1,T2&R2	M1
	L9	expressions and precedence, Expression evaluation,	T1,T2&R3	M1
	L10	Expression evaluation, Storage classes	T1,T2&R4	M1
	L11	Type conversion, The main method and command line arguments	T1,T2&R5	M2
	L12	**Bitwise operations:**Bitwise AND, OR, XOR and NOT operators	T1&T2	M1
	Conditional Branching and Loops:			
	L13	conditionals and consequent branching with if, if-else, switch-case, ternary operator,	T1&T2	M1

		goto,		
	L14	Iteration with for, while, do-while loops	T1&T2	M1 M2
	Input and Output			
	L15	Simple input and output with scanf and printf, formatted I/O,	T1&T2	M1
	L15	Introduction to stdin, stdout and stderr. Command line arguments	T1&T2	M1
Total No.of classes for Unit-I:15				
UNIT-II (Arrays,strings,structures and pointers)	**Arrays**			
	L16	creating, accessing and manipulating elements of arrays -one Dimensional array	T1&T2	M2
	L16	creating, accessing and manipulating elements of arrays -Two Dimensional array	T1&T2	M1 M2
	Strings:			
	L17	Introduction to strings, handling strings as array of characters	T1,T2&R1	M1 M2
	L18	basic string functions available in C (strlen, strcat, strcpy, strstr etc.)	T1,T2&R2	M1 M2
	L19	arrays of strings	T1&T2	M2
	Structures:			
	L20,21	Defining structures, initializing structures&Accessing	T1&T2	M1
	L22	unions& Array of structures	T1&T2	M1
	Pointers:			
	L23	Idea of pointers, Defining pointers,	T1&T2	M1
	L24	Pointers to Arrays and Structures	T1&T2	M1
	L25,26	Use of Pointers in self-referential structures, usage of self referential structures in linked list	T1&T2	M1

	L27	Enumeration data type	T1&T2	M1
Total No.of classes for Unit-II: 12				
UNIT-III (preprocessor and file handling)	**Preprocessor:**			
	L28	Commonly used Preprocessor commands like include, define, undef, if, ifdef, ifndef	T1&T2	M1
	Files:			
	L29	Text and Binary files	T1&T2	M1,M3
	L30,L31,L32	Creating and Reading and writing text and binary files, Appending data to existing files	T1&T2	M1,M3
	L33	Writing and reading structures using binary files,	T1&T2	M1
	L34,L35	Random access using fseek, ftell and rewind functions.	T1&T2	M1
Total No. of classes for Unit-III: 8				
UNIT-IV (Function and Dynamic Memory Allocation)	**Functions:**			
	L36	Designing structured programs, Declaring a function	T1&T2	M1,M3
	L37,L38	Signature of a function, Parameters and return type of a function	T1&T2	M1,M2
	L39,L40	passing parameters to functions, call by value &call by reference,	T1&T2	M1,M3
	L41,L42	Passing arrays to functions, passing pointers to functions	T1&T2	M1
	Recursion:			
	L43,L44	Simple programs, such as Finding Factorial, Fibonacci series	T1&T2	M1
	Dynamic memory allocation			
	L45	Allocating and freeing memory, Allocating memory for arrays of different data types	T1&T2	M1,M2
Total No. of classes for Unit-IV:10				
	Introduction to Algorithms			
	L46	Algorithms for finding roots	T1&T2	M1,M4

UNIT-V (Introduction to Algorithms)		of a quadratic equations, finding minimum and maximum numbers of a given set		
	L47	Algorithm for finding if a number is prime number or not	T1,T2&R1	M1,M4
	L48	Basic searching in an array of elements -Linear Search	T1,T2&R2	M1,M3
	L49	Basic searching in an array of elements -binary Search	T1,T2&R3	M1
	L50	Basic algorithms to sort array of elements -Bubble sort	T1,T2&R4	M1,M3
	L51	Basic algorithms to sort array of elements -Insertion sort	T1,T2&R5	M1,M4
	L52	Basic algorithms to sort array of elements -Selection sort	T1,T2&R1	M1,M4
	L53,L54	Basic concept of order of complexity	T1,T2&R2	M1,M3,M4
Total No. of classes for Unit-V:9				

METHODS OF TEACHING:

M1 : White Board
M2 : ICT METHODS
M3 :Thinkpair/Share
M4 : Group Learning
M5 : Mind Mapping

8.SUGGESTED BOOKS:

TEXTBOOKS:

1. JeriR.HanlyandElliotB.Koffman,ProblemsolvingandProgramDesigninC7thEdition,Pearson
2. B.A.ForouzanandR.F.GilbergCProgrammingandDataStructures,CengageLearning,(3rdEdition)

REFERENCEBOOKS:

1. BrianW.KernighanandDennisM.Ritchie,TheCProgrammingLanguage,PrenticeHallofIndia
2. E.Balagurusamy,ComputerfundamentalsandC,2ndEdition,McGraw-Hill
3. YashavantKanetkar,LetUsC,18thEdition,BPB
4. R.G.Dromey,HowtosolveitbyComputer,Pearson(16thImpression)
5. Programmingin C,StephenG.Kochan,FourthEdition,PearsonEducation.
6. HerbertSchildt,C:The CompleteReference,McGrawHill,4thEdition
7. ByronGottfried,Schaum'sOutlineofProgrammingwithC,McGraw-Hill

9. Websites for self learning

https://onlinecourses.nptel.ac.in/noc19_cs42/preview

https://www.w3schools.in/c-tutorial/

https://fresh2refresh.com/c-programming/

https://www.tutorialspoint.com/cprogramming/index.html

http://www.cprogramming.com/tutorial.html

10. Model papers-JNTUH

jntu qon papers.rar

Important Questions sets on each unit

Unit1 : Introduction to computes

THEORY Questions:

Set-1:

1. Explain and specify the interactions between various components that support the basic functionality of a computer? (OR) Explain the architecture of a computer system.

2. Discuss in detail the program execution steps? (OR)Explain the concept of creating and running programs?

3. Explain the concept of Algorithm? What are the characteristics that any algorithm should satisfy? Use suitable example.

Set-2:

1. Explain the concept of Flowcharts? Use suitable example.

2. Explain the concept of software? Differentiate between application software and system software?

3. Explain the concept of computer languages. Differentiate between compiler and interpreter?

Set-3:

1. Briefly discuss various computing environments with neat diagrams?
2. What are the different types of errors one can encounter during the program execution?

Set-4:

1. Explain the concept of software development.

2. List the activities involved in each phase of waterfall system development life cycle model?

Intodroction to Flow chart and algorithms

Set-1:

1. Draw a flowchart for finding maximum of given three integers?
2. Draw a flowchart for finding the sum of 'n' numbers starting from 1?

3. Write an algorithm to read five integers and find out if the values are in ascending order.

Set-2:

1. Draw a flow chart to read ten integer values and print the sum of squares of the values.
2. Write an algorithm to find out if a given number is a prime.

3. Draw a flow chart to read ten positive integers and print how many are multiples of 7

Set-3:

1. Write an algorithm to find out all the factors of a given positive integer.
2. Draw a flow chart to read ten integers and print the sum of squares of all ten values.

Set-4:

1. Write an algorithm to read ten positive integers and find out how many are perfect squares (such as49, 81). You may assume that the input values read are in the range 1 to 10000.
2. Write an algorithm and draw a flowchart to find factorial of a given number.

Set-1:

1. List the basic data types, their sizes and range of values supported by 'C' language? Also describe the concept of variable and its declaration and initialization.

2. What is type casting? What is the implicit type conversion hierarchy that is applied while evaluating expressions? Use suitable examples. Also explain explicit type casting. Use suitable examples.

3. Explain different categories of C operators based on their functionality(purpose)? Give examples?

Set-2:

1. Explain the structure of a C program? Use suitable example.

2. Explain different types of coding constants in a C? (Explain Types of constants) Use suitable examples.

3. What is an identifier? What are the naming rules for identifiers in C? Use suitable examples.

Set-3:

1. What do you mean by operator precedence and associativity? How one can override the precedence defined by C language? Give illustrative examples?
2. Explain the concept of control structures? Use suitable examples.

Set-4:

1. Explain commonly used formatting input and formatting output functions in C? Use suitable examples.

(aboutprintf() and scanf() and their format specifiers such as %d, %f etc)

2. a)Explain the concept of keywords. List the keywords.
   b) Difference between
      i) while and do-while
      ii) else-if ladder and switch
   ii) if and switch
      iv) keyword and identifier
   c) What are modifiers that can be applied on basic data types?
   d) What are tokens? Use suitable examples.

Unit 2 : Arrays, Strings, Structures and Pointers:

THEORY Questions:

Set-1:

1. What is the need for user-defined functions. Explain the concept of functions? Use suitable examples.(about function , its prototype or declaration, definition, call)

2. a) Explain different categories of functions in C with simple illustrative examples?
   b) Explain the concept of Header files? Use suitable examples.
   c) Explain the concept of Library functions. Use suitable examples

.3 Explain the concept of arrays(1-D, 2-D, 3-D arrays (or) multidimensional arrays). Use suitable examples.

Set-2:

1.a) What are the different ways in which 1-dimensional arrays can be declared and initialized?

b) What are the different ways in which 2-dimensional arrays can be declared and initialized?

c) What are the different ways in which 3-dimensional arrays can be declared and initialized?

2. What are parameter passing techniques? Use suitable examples.
   (OR) Differentiate between call by value and call by reference with suitable examples?

3. What is recursion? Use suitable example.

Set-3:

1. Discuss with suitable examples the storage classes available in C?

2. Explain the concept of preprocessor directives in C. Use suitable examples. (OR) Explain the facilities provided by the C preprocessor with examples.

Set-4:

1. a)Explain the concept of macros in C. Use suitable examples.
   b) Explain the concept of function-like macros. Use suitable examples.
2. a)Explain how two dimensional arrays can be used to represent matrices.
   b) Explain how 1-dimensional arrays are passed to functions. Use suitable examples.
   c) Explain how 2-dimensional arrays are passed to functions. Use suitable examples.
   d) Explain how multi-dimensional arrays are passed to functions. Use suitable examples.
   e) Explain type qualifiers (OR) access modifiers.

Set-1:

1. Write a ‘C’ program using functions to check whether the given 3x3 matrix is symmetric or not

2. Write a C program using recursion for finding GCD (Greatest Common Divisor) of two given numbers?

Set-2:

1. a) Write a complete C program to find the factorial of the given number using recursion.

   b) Write a complete C program to find the factorial of the given number using iteration.

2.Write C code to perform matrix addition and matrix multiplication.

Set-3:

1. Write a C program that solves Towers of Hanoi problem.

2. Write a complete C program that reads a positive integer N, compute the first N Fibonacci numbers using recursion and print the results. Illustrate how the results are computed when the value of N is 4?

3. Write a complete C program to do the following: Read data to fill a two dimensional array *int table [4] [4]*. Then print the sum of each column and sum of each row.

Set-4:

1. Write a C program that finds transpose of a given matrix.
2. Write a C program to swap two integers using functions

Set-1:

1. What is a string? Explain how strings are declared and initialized in 'C'? Use suitable examples.

   (OR) Differentiate between a pointer and a variable? How a pointer is declared and initialized?

2. Explain the concept of pointers and its operators? Use suitable examples.

3. Explain the concept of dynamic memory allocation(about malloc(), calloc(),etc). Use suitable examples.

   (OR) Explain about memory allocation functions in C. Use suitable examples. (OR) Explain the concept of memory management in C. Use suitable examples.

Set-2:

1. a) What are the arithmetic operators that are permitted on pointers?

   (OR) Explain the concept of pointer expressions (or) pointer arithmetic.

   b) How to find address of array. Use suitable examples.

   (OR) Explain the use of arrays with pointers.

c) Derive the expressions for finding the address of any element of a 1-dimensional array, 2-D arrays?

2. Discuss briefly the following pointers.
   - i) Pointer pointing to a variable
   - ii) Pointer pointing to a constant
   - iii) Constant pointer pointing to a variable
   - iv) Constant pointer pointing to constant.
   - v) Pointer pointing to another pointer
   - vi) Array of pointers
   - vii) Compatibility of pointers
   - viii) pointer pointing to functions.
3. What are command line arguments? Illustrate their use with a simple C program.

Set-3:

1. Explain the string handling(string manipulation) functions and string/data conversion functions? Use suitable examples.
2. How functions are used as arguments in a function call. Use suitable examples.

Set-4:

1. Explain the library functions that are used to perform input and output of strings. Use suitable examples.
2. Explain array of strings. Use suitable examples.
   (OR) How 2-dimensional character array can be initialized. Use suitable examples.

Set-1:

1. Write a ‘C’ function to find reverse of given string that can be passed as an argument that cannot be altered?
2. Write a C program to find reverse of a given string.
3. Write a C function to find the length of a string that can be passed as an argument?

Set-2:

1. Write a C program to find the length of a given string.

2. Write a C program to concatenate two given strings into one string.

Write a C program to check whether one string is a substring of another string

(OR)

Write a complete C program that displays the position or index in the string S where the string T begins. The program displays -1 if S does not contain T. For example, if S is “information processing” and T is “process”, the value displayed is 12. The strings S and T are supplied by the user.

Set-3:

1. Write a C function to convert the string passed as an argument to its uppercase equivalent?

2. Write a C program that arranges the list of n given strings in an ascending order.(Use array of strings)

3. Write a complete C program that reads a string and prints if it is a palindrome or not. (OR) Write a C program that checks whether a given string is palindrome or not

Set-4:

1. Write the C function *int minpos (float x[], int n)* that returns the position of the first minimum value among the first *n* elements of the given array *x*.

2. Consider the function *maxpos* that has two parameters: *int maxpos(int arr[], int n) n* is greater than or equal to 1, but less than or equal to the size of the array *arr*. Code the function *maxpos* to return the position of the first maximum value among the first *n* elements of the array *arr*.

Derived data types

THEORY Questions:

Set-1:

1. Explain the concept of derived data types in C? Use suitable examples.

2. Briefly explain the type definition statement in ‘C’? Give any two examples where usage of type definition statement increases the readability of programs?
   (OR)Explain the use of typedef keyword. Use suitable examples.

3. Explain the concept of structures? Use suitable examples.

Set-2:

1. Explain the concept of unions? Use suitable examples.
2. What do you mean by bit fields? How bit fields are different from structures?
   (OR) Explain the concept of bit fields? Use suitable examples.

3. Explain the concept of structures with pointers? Use suitable examples. (OR) Explain the concept of pointers to structures? Use suitable examples.

Set-3:

1. How many possible ways one can access the members of a structure using a structure variable and a pointer to a structure variable? Illustrate with examples.

2. a) Differentiate between Arrays of structures and structures containing arrays with suitable examples?
   b)Differentiate between structures and unions?
   c) Differentiate between self referential and nested structures with suitable examples?

   d)Suppose or oppose the statement “In C a structure contains a union inside it”. Give suitable example?

3. What is an enumerated type? How it can be declared? What are the different ways one can initialize enumerations? (OR) Explain the concept of enumeration. Use suitable examples.

Set-4:

1. Explain the concept of array of structures. Use suitable examples.
2. Explain the following with suitable examples :
    a) Nested structures
    b) Self referential structures
3. How structures are passed to functions? Use suitable examples.

Unit3 :Input and Output (or) Files

THEORY Questions:

Set-1:

1. Explain the concept of file processing? Use suitable examples.
2. What is a file? How to open and close different types of files in ‘C’?
3. Explain the possible modes of opening files? In all these modes what happens when the file doesn’t exist and the file already exists?

Set-2:

1. List and explain the Streams functions (or) file functions for text files along with their prototypes.

   (OR) Explain library functions that can be used in file processing. Use suitable examples.

2. Explain commonly used library functions for reading and writing files. Use suitable examples.

Set-3:

1. Explain syntax with illustrative examples the functions support reading and writing formatted data to and from files?

   (OR) Explain library functions for formatting input and formatting output operations on files. Give examples.

2. Explain the concept of random access files? (OR) Explain the use of ftell() and fseek() functions. Use suitable examples.

Set-4:

1. Explain error handling functions in file I/O. (OR) What is the purpose of the ferror() and feof() functions?
2. What are the possible ways to set the file pointer to the beginning of the file?

Set-1:

1. Write a ‘C’ program to copy the contents of a file to another file?

Set-2:

2. Write a C program to count characters, lines and words in a given file? Assume that the words are separated by blanks or tabs.

Set-3:

3. Write a complete C program for the following: There are two input files named “first.dat” and “second.dat”. The files are to be merged. That is, copy the content of “first.dat” and then the content of “second.dat” to a new file named “result.dat”.

Set-4:

4. Write a complete C program to reverse the first n characters in a file. The file name and the value n are specified on the command line. Incorporate validation of arguments: that is, the program should check that the number of arguments passed and also the value of n are meaningful.

Unit - IV: Function and Dynamic Memory Allocation:
THEORY Questions:

Set-1:

1. What is the need for user-defined functions. Explain the concept of functions? Use suitable examples.

(about function , its prototype or declaration, definition, call)

Set-2:

2. a)Explain different categories of functions in C with simple illustrative examples?
   b) Explain the concept of Header files? Use suitable examples.
   c) Explain the concept of Library functions. Use suitable examples.

Set-3:

3. What is recursion? Use suitable example.
4. Discuss with suitable examples the storage classes available in C?

Set-4:

5. Explain the concept of preprocessor directives in C. Use suitable examples. (OR) Explain the facilities provided by the C preprocessor with examples.

Unit - V: Introduction to Algorithms:

Set-1:

1.What is the concept of binary search?
2.What is the time complexity of binary search?

Set-2:

3.What is the concept of sorting?

Set-3:

4.What is bubble sort?
5.What is the time complexity of bubble sort?

Set-4:

6.What is selection sort?

11.Two case study presentations with Project /Product/ Model /prototypes/ Industrial applications.

1) Student record System
2) Bank Management System
3) School Billing System
4) Library Management System
5) Hospital Management system

Case Study - Hospital Management system

Case study on Hospital Management system includes registration of patients, storing their details into the system, and also computerized billing in the pharmacy, and labs.

Our software has the facility to give a unique id for every patient and stores the details of every patient and the staff automatically. It also includes the purchase of items by the staff, the patient consultancy history and the laboratory test list.

User can search availability of a doctor and the details of a patient using the id.

The Hospital Management System can be entered using a username and Password. It is accessible either by an administrator or receptionist. Only they can add data into the database. The data can be retrieved easily. The interface is very user-friendly. The data is well protected for personal use and makes the data processing very fast.

Library Management System

The Library management System is related to the storage of information regarding the library. Library is the place with the huge collection of books. It is place from where the students and the faculties issue the books for their reference purpose. But the maintenance of keeping the records of issuing and borrowing is difficult if you use a normal book as a registry. To make this task easier, the library management system will be very useful. It helps in maintaining information regarding the issuing and borrowing the books by the students and faculties.

Arrays

Arrays are the simplest data structures that stores items of the same data type. A basicapplication of Arrays can be storing data in tabular format. For example, if we wish to store thecontacts on our phone, and if we want to store the songs then the software will simply place all our contacts in an array.

- **Customer Billing System C Project**

A real-time customer billing console application. It is a mini project developed especially to generate customer billing for the medical store, cafes, shops, super market, etc.

The entire program has been written with C - language only. The program is compiled in Turbo C++ using turbo c compiler.

```
#include<stdio.h>

#include<conio.h>

#include<dos.h>

//To avoid floting point error

voiddummy (float a)

{

float *p=&a;

}

structbill

{

charitem[40];

float qty, price;

}b[100];

intmain()

{

clrscr();

inti=0, c=1;

charch;

float amt, total=0;

do

{

flushall();

printf("Enter Product Name  :");

gets(b[i].item);
```

```
printf("Enter Qty and Price : ");
scanf("%f%f",&b[i].qty, &b[i].price);
flushall();
printf("Add More Items [y/n]");
scanf("%c",&ch);
if(ch=='y')
{i++;c++;};
}
while(ch=='y');
printf("=================================================================");
textcolor(RED);
textbackground(WHITE);
printf("\t\t\t\t\t\t\b\b\b");
cprintf("S U P E R  M A R K E T\n");
puts("\n=================================================================");
printf("%-10s%15s%17s%17s\n", "Item", "Qty", "Price", "Amount");
puts("-----------------------------------------------------------------");
for(i=0;i<c;i++)
{
amt=b[i].qty*b[i].price;
total=total+amt;
printf("%-9s %16.2f\t%10.2f\t%11.2f\n",b[i].item, b[i].qty,b[i].price, amt);
}
puts("-----------------------------------------------------------------");
structdate d;
getdate(&d);
printf("Total Amount :\t\t\t\t\%.3f\n",total);
printf("Billing Date :%d/%d/%d\n",d.da_day,d.da_mon,d.da_year);
puts("Happy Shopping\n");
```

```
puts("\t\t\tVisit ForGeeky.com");

getch();

}
```

```
Enter Product Name  :Oil
Enter Qty and Price : 2 39
Add More Items [y/n]y
Enter Product Name  :Soap
Enter Qty and Price : 5 56
Add More Items [y/n]y
Enter Product Name  :Sugar
Enter Qty and Price : 2 35
Add More Items [y/n]n
============================================================
                    S U P E R   M A R K E T

============================================================
Item                Qty          Price          Amount
------------------------------------------------------------
Oil                 2.00         39.00           78.00
Soap                5.00         56.00          280.00
Sugar               2.00         35.00           70.00
------------------------------------------------------------
Total Amount :                              428.000
Billing Date :24/10/2018
Happy Shopping

                        Visit ForGeeky.com
```

12. Assignment Question/Innovative Assignments sets.

11.Assignments/ Innovative Assignment

UNIT – 1

Introduction to Programming

THEORY Questions:

1. Explain and specify the interactions between various components that support the basic functionality of a computer? (OR) Explain the architecture of a computer system.

2. Discuss in detail the program execution steps? (OR) Explain the concept of creating and running programs?

3. Explain the concept of Algorithm? What are the characteristics that any algorithm should satisfy? Use suitable example.
4. Explain the concept of Flowcharts? Use suitable example.
5. Explain the concept of software? Differentiate between application software and system software?
6. Explain the concept of computer languages. Differentiate between compiler and interpreter?
7. Briefly discuss various computing environments with neat diagrams?
8. What are the different types of errors one can encounter during the program execution?
9. Explain the concept of software development.
10. List the activities involved in each phase of waterfall system development life cycle model?

Problems

1. Draw a flowchart for finding maximum of given three integers?

2. Draw a flowchart for finding the sum of ‘n’ numbers starting from 1?

3. Write an algorithm to read five integers and find out if the values are in ascending order.
4. Draw a flow chart to read ten integer values and print the sum of squares of the values.
5. Write an algorithm to find out if a given number is a prime.
6. Draw a flow chart to read ten positive integers and print how many are multiples of 7
7. Write an algorithm to find out all the factors of a given positive integer.
8. Draw a flow chart to read ten integers and print the sum of squares of all ten values.
9. Write an algorithm to read ten positive integers and find out how many are perfect squares (such as 49, 81). You may assume that the input values read are in the range 1 to 10000.
10. Write an algorithm and draw a flowchart to find factorial of a given number

Short Answer Questions

1. What is a computer?
2. What are the input devices?
3. What are the output devices?
4. Difference of Time sharing and Client-server environments?
5. What are high-level languages?
6. What are low-level languages?
7. What are middle-level languages?
8. What is personal computing environment?
9. What is distributed computing environment?
10. What are the steps to create and run the program?

Introduction to C Language

THEORY Questions:

1. List the basic data types, their sizes and range of values supported by ‘C’ language? Also describe the concept of variable and its declaration and initialization.
2. What is type casting? What is the implicit type conversion hierarchy that is applied while evaluating expressions? Use suitable examples. Also explain explicit type casting. Use suitable examples.
3. Explain different categories of C operators based on their functionality(purpose)? Give examples?
4. Explain the structure of a C program? Use suitable example.
5. Explain different types of coding constants in a C? (Explain Types of constants) Use suitable examples.
6. What is an identifier? What are the naming rules for identifiers in C? Use suitable examples.
7. What do you mean by operator precedence and associativity? How one can override the precedence defined by C language? Give illustrative examples?
8. Explain the concept of control structures? Use suitable examples.
9. Explain commonly used formatting input and formatting output functions in C? Use suitable examples.
   (aboutprintf() and scanf() and their format specifiers such as %d, %f etc)
10. a)Explain the concept of keywords. List the keywords.
    b) Difference between

i) while and do-while
ii) else-if ladder and switch
ii) if and switch
iv) keyword and identifier
c) What are modifiers that can be applied on basic data types?
d) What are tokens? Use suitable examples.

Short Answer Questions

1 What is water-fall model?

2. What is the structure of a C program?
3. What are input/output functions in C?
4. What are the operators in C?
5. What is precedence and associativity?
6. What are type conversions?
7. What is the syntax of for loop?
8. What is the syntax of While loop?
9. What is the syntax of simple if?
10. What is the syntax of continue and goto?

Unit - II: Arrays, Strings, Structures and Pointers:

Array Theory Questions:

1.Explain the concept of arrays(1-D, 2-D, 3-D arrays (or) multidimensional arrays). Use suitable examples.

2.a)What are the different ways in which 1-dimensional arrays can be declared and initialized?

b) What are the different ways in which 2-dimensional arrays can be declared and initialized?

c) What are the different ways in which 3-dimensional arrays can be declared and initialized?
3.a) Explain how two dimensional arrays can be used to represent matrices.
b) Explain how 1-dimensional arrays are passed to functions. Use suitable examples.
b) Explain how 2-dimensional arrays are passed to functions. Use suitable examples.
c) Explain how multi-dimensional arrays are passed to functions. Use suitable examples.

Problems

1. Write C code to perform matrix addition and matrix multiplication
2.Write a complete C program to do the following: Read data to fill a two dimensional array *int table[4][4]*. Then print the sum of each column and sum of each row.

3. Write a C program that finds transpose of a given matrix.

Short Answer Questions

1. What is an array?
2. List different types of arrays and mention their applications
3. What are the advantages of arrays
4. What is the concept of binary search?
5. What is the time complexity of binary search?
6. What is the concept of sorting?
7. What is bubble sort?

8. What is the time complexity of bubble sort?
9. What is selection sort?

String Theory Questions:

1. What is a string? Explain how strings are declared and initialized in ‘C’? Use suitable examples. (OR) Differentiate between a pointer and a variable? How a pointer is declared and initialized?
2. Explain the concept of pointers and its operators? Use suitable examples.
3. Explain the concept of dynamic memory allocation(about malloc(), calloc(),etc). Use suitable examples.

   (OR) Explain about memory allocation functions in C. Use suitable examples. (OR) Explain the concept of memory management in C. Use suitable examples.
4. a) What are the arithmetic operators that are permitted on pointers?
   (OR) Explain the concept of pointer expressions (or) pointer arithmetic.

   b) How to find address of array. Use suitable examples.

   (OR) Explain the use of arrays with pointers.

   c) Derive the expressions for finding the address of any element of a 1-dimensional array, 2-D arrays?
5. Discuss briefly the following pointers.
   i) Pointer pointing to a variable
   ii) Pointer pointing to a constant
   iii) Constant pointer pointing to a variable
   iv) Constant pointer pointing to constant.
   v) Pointer pointing to another pointer
   vi) Array of pointers
   vii) Compatibility of pointers
   viii) Pointer pointing to functions.
6. What are command line arguments? Illustrate their use with a simple C program.
7. Explain the string handling (string manipulation) functions and string/data conversion functions? Use suitable examples.
8. How functions are used as arguments in a function call. Use suitable examples.
9. Explain the library functions that are used to perform input and output of strings. Use suitable examples.
10. Explain array of strings. Use suitable examples.
    (OR) How 2-dimensional character array can be initialized. Use suitable examples.

Problems

1. Write a ‘C’ function to find reverse of given string that can be passed as an argument that cannot be altered?
2. Write a C program to find reverse of a given string.
3. Write a C function to find the length of a string that can be passed as an argument?
4. Write a C program to find the length of a given string.
5. Write a C program to concatenate two given strings into one string.
6. Write a C program to check whether one string is a substring of another string.

(OR) Write a complete C program that displays the position or index in the string S where the string T begins. The program displays -1 if S does not contain T. For example, if S is "information processing" and T is "process", the value displayed is 12. The strings S and T are supplied by the user.

7. Write a C function to convert the string passed as an argument to its uppercase equivalent?

8. Write a C program that arranges the list of n given strings in an ascending order.(Use array of strings)

9. Write a complete C program that reads a string and prints if it is a palindrome or not.
   (OR) Write a C program that checks whether a given string is palindrome or not

Pinters Short Answer Questions

1. Definition of a pointer?
2. What are the applications of pointers?
3. What is compatibility?
4. What are the memory allocation functions?
5. How to pass an array to a function?
6. Define the syntax of malloc?
7. What is the use of free function?
8. What is the use of calloc?
9. What is the use of realloc?
10. What is the concept of void pointers?
11. What is the definition of a string?
12. What are the string input/output functions?
13. What are operations of strings?
14. How to perform string copy?
15. What is string concatenation and how to perform it?
16. How to find the given two strings are identical?
17. How to find the length of a string?
18. How to check whether one string is a substring of another string?
19. How to convert lowercase of a string to uppercase?
20. How to convert string to data?

THEORY Questions:

1. Explain the concept of derived data types in C? Use suitable examples.
2. Briefly explain the type definition statement in 'C'? Give any two examples where usage of type definition statement increases the readability of programs?
   (OR)Explain the use of typedef keyword. Use suitable examples.

3. Explain the concept of structures? Use suitable examples.
4. Explain the concept of unions? Use suitable examples.

5. What do you mean by bit fields? How bit fields are different from structures?
   (OR) Explain the concept of bit fields? Use suitable examples.

6. Explain the concept of structures with pointers? Use suitable examples. (OR)
   Explain the concept of pointers to structures? Use suitable examples.
7. How many possible ways one can access the members of a structure using a structure variable and a pointer to a structure variable? Illustrate with examples.
8. a) Differentiate between Arrays of structures and structures containing arrays with suitable examples?

b) Differentiate between structures and unions?
c) Differentiate between self referential and nested structures with suitable examples?
d) Suppose or oppose the statement "In C a structure contains a union inside it". Give suitable example?

9. What is an enumerated type? How it can be declared? What are the different ways one can initialize enumerations? (OR) Explain the concept of enumeration. Use suitable examples.
10. Explain the concept of array of structures. Use suitable examples.
11. Explain the following with suitable examples :
    a) Nested structures
    b) Self referential structures
12. How structures are passed to functions? Use suitable examples.

Problems

1. Write a 'C' program to read, write, add, subtract, multiply and divide two complex numbers? (Represent complex number using structures).

2. Explain how complex numbers can be represented using structures. Write two C functions: one to return the sum of two complex numbers passed as parameters, and another to return the product of two complex numbers passed as parameters

Short Answer Questions

1. What is the syntax of typedef?
2. What is the syntax of structure?
3. What is the syntax of union?
4. How to pass an entire structure to a function?
5. How to access the members of structure with and without using pointers?
6. What is difference between structure and union?
7. What is self-referential structure?
8. What are command –line arguments?
9. What is enum with syntax?
10. What are bit-fields? How to use them?

Unit - III: Preprocessor and File handling in C:

THEORY Questions:

1. Explain the concept of file processing? Use suitable examples.
2. What is a file? How to open and close different types of files in 'C'?
3. Explain the possible modes of opening files? In all these modes what happens when the file doesn't exist and the file already exists?
4. List and explain the Streams functions (or) file functions for text files along with their prototypes. (OR) Explain library functions that can be used in file processing. Use suitable examples.

5. Explain commonly used library functions for reading and writing files. Use suitable examples.
6. Explain syntax with illustrative examples the functions support reading and writing formatted data to and from files?

   (OR) Explain library functions for formatting input and formatting output operations on files. Give examples.

7. Explain the concept of random access files? (OR) Explain the use of ftell() and fseek() functions. Use suitable examples.
8. Explain error handling functions in file I/O. (OR) What is the purpose of the ferror() and feof() functions?

9. What are the possible ways to set the file pointer to the beginning of the file?

Problems

1. Write a 'C' program to copy the contents of a file to another file?
2. Write a C program to count characters , lines and words in a given file? Assume that the words are separated by blanks or tabs.
3. Write a complete C program for the following: There are two input files named "first.dat" and "second.dat". The files are to be merged. That is, copy the content of "first.dat" and then the content of "second.dat" to a new file named "result.dat".
4. Write a complete C program to reverse the first n characters in a file. The file name and the value n are specified on the command line. Incorporate validation of arguments: that is, the program should check that the number of arguments passed and also the value of n are meaningful.

Short Answer Questions

1. What is the definition of a file?
2. What are the operations of files?
3. What are the modes in text files?
4. What are the modes in binary files?
5. How to open and close a file?
6. What are the file Input/output operations?
7. How to merge two files?
8. What are the error handlings functions in files?
9. What are random access files?
10. What is the use of fseek and ftell functions?

Unit - IV: Function and Dynamic Memory Allocation:

THEORY Questions:

6. What is the need for user-defined functions. Explain the concept of functions? Use suitable examples.

(about function , its prototype or declaration, definition, call)

7. a)Explain different categories of functions in C with simple illustrative examples?
   b) Explain the concept of Header files? Use suitable examples.
   c) Explain the concept of Library functions. Use suitable examples.
8. What is recursion? Use suitable example.
9. Discuss with suitable examples the storage classes available in C?
10. Explain the concept of preprocessor directives in C. Use suitable examples.
    (OR) Explain the facilities provided by the C preprocessor with examples.
11. a)Explain the concept of macros in C. Use suitable examples.

Explain the concept of function-like macros. Use suitable examples

Problems

1. Write a 'C' program using functions to check whether the given 3x3 matrix is symmetric or not
2. Write a C program using recursion for finding GCD (Greatest Common Divisor) of two given numbers?
3. a) Write a complete C program to find the factorial of the given number using recursion.

b) Write a complete C program to find the factorial of the given number using iteration

Short Answer Questions

1.What is a function?

2.List predefined functions

3.What is recursion?

4.What is preprocessor command? List some preprocessor commands?

5.What is storage class? What are the different storage classes available in C language6.Explain about math.h header file predefined functions

7.List the advantages of functions
8.What is call-by-value?
9.What is call-by-reference?
10.What is inter-function communication?
11.Write about scope rules
12.Explain about auto storage class
13.Explain about extern storage class
14.Explain about static storage class
15.How many types of functions available in C language

Unit - V: Introduction to Algorithms:

1 .What is the concept of binary search?
2. What is the time complexity of binary search?
3. What is the concept of sorting?
4 .What is bubble sort?
5. What is the time complexity of bubble sort?
6. What is selection sort?

INNOVATIVE QUESTIONS

Example 1:

What is the output of the following program?

```
 #include <stdio.h>

 void main()

 {

printf("%d", '-'-'-');

}
```

2. What is the output of the following program?

```
#include<stdio.h>

 void main()

{

printf("%d", '&'&&'&');

}
```

3. What is the output of the following program?

```
 #include<stdio.h>
```

```
void main()
{
printf("%d", sizeof "sizeof");
}
```

4. What is the output of the following program?

```
#include <stdio.h>
#include <string.h>
void main()
{char *str = "str";
printf("%d", strcmp("strcpy(str,str)","strlen(str)"));
}
```

13. List of topics for students Seminars with Guidelines

1. Components of Computer
2. Arrays and its Types
3. Self referential Structures
4. Dynamic memory Allocation Functions
5. Sorting Techniques
6. Searching Techniques

14. Step/Course material in softcopy

PPS.rar

pps (1).rar

15. Expert Lectures with topics & Schedules(if any)

ACADEMIC PLAN FOR THE ACADEMIC YEAR 2024-25

COURSE: I YEAR B.TECH

SUBJECT: ENGINEERING CHEMISTRY

ENGINEERING CHEMISTRY ACADEMIC PLANAR

List of contents

1. PRE AMBLE/INTRODUCTION

Chemistry is a basic science plays a vital role in preparing a strong foundation for engineering students and ensuring security by shaping a fruitful superstructure for their entire career.

A comprehensive knowledge of fundamental chemistry is essential for promising and sustainable future.

It plays a leading role in shaping the future of research and development with the integration of multidisciplinary fields which include life sciences, material science , medicine , engineering and technology.

2. PREREQUISITES:

The prerequisites of this subject are

- Basics of Physical, Inorganic and Organic chemistry.
- Basic knowledge of Mathematics.
- Basic knowledge of Physics.

3. OBJECTIVES AND COURSE OUTCOMES

Course Objectives

- ➢ To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
- ➢ To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it's control to protect the structures.
- ➢ To imbibe the basic concepts of petroleum and its products.
- ➢ To acquire required knowledge about engineering materials like polymers and Smart materials.

Course Outcomes

CO 1: Identify the different types of boiler troubles, **choose** appropriate method for softening and cleaning of water

CO 2 : Understanding on different types of fuels, their synthesis and analysis

CO 3 : **Explain** different types of electrode, electrode potential and **determine** EMF of a cell using Nernst equation

CO 4 : **Identify** the materials & methods that prevent corrosion in a particular environment

CO5 : **Compare** and **contrast** the chemical behavior & physical properties of polymers .

4. SYLLABUS

I.JNTUH/R 22-CMREC

<u>I: WATER AND ITS TREATMENT:</u>

- Sources of water, Impurities in water, Hardness of water,
- Temporary and permanent hardness, Units of hardness.
- Estimation of temporary and permanent hardness of water- EDTA method, Numerical problems.
- Potable water Treatment-Specifications, Steps involved in Treatment-Sedimentation, Coagulation, Filtration, Sterilization , Chlorination and Break point Chlorination, ozonization.
- Boiler Troubles-Scales and sludges, Caustic Embrittlement, Priming and foaming, Boiler corrosion.
- Internal conditioning methods - Phosphate, Carbonate, Calgon and Colloidal conditioning.
- External conditioning method- Ion exchange method.
- Desalination of Brackish Water- Reverse Osmosis and Electro dialysis.

UNIT-II : ENERGY SOURCES No.of classes required :10

- Introduction, Calorific value of fuel – HCV, LCV- Dulongs formula (Numerical problem).
- Classification- solid fuels: coal – analysis of coal – proximate and ultimate analysis and their significance.
- Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking. Knocking – octane and cetane rating, synthetic petrol - Fischer-Tropsch's process;
- Gaseous fuels – composition and uses of natural gas, LPG

  and CNG, Biodiesel – Trans esterification, advantages.

UNIT-III : ELECTROCHEMISTRY AND BATTERIES NO. OF CLASSES: 10

- Electrochemistry: Introduction, Electrode potential, Standard electrode

  potential , Electro chemical series and its applications.
- Electrochemical cell ,E.M.F of the cell, Nernst equation- derivation and applications- Determination of EMF, Determination of Equilibrium constant Numerical problems.
- Types of electrodes- Construction and working and determination of pH using Calomel electrode, Quinhydrone electrode and Glass electrode.

- Batteries: Construction and working of primary (Lithium cell), secondary (Lead acid storage battery and Lithium-ion battery)
- Fuel cells: Construction, working and application of H_2-O_2 and methanol-oxygen fuel cells
- Introduction to Solar cells and its applications.

UNIT – IV: CORROSION AND ITS CONTROL: No.of classes required : 10 hrs

- Introduction, Definition, Causes and effects of corrosion.
- Theories of chemical and electrochemical corrosion.
- Types of corrosion- Galvanic, Waterline and Pitting corrosion, Factors affecting rate of corrosion.
- Corrosion control methods- Cathodic protection-Sacrificial anode and impressed current cathodic methods.
- Surface coatings- Metallic coatings, hot dipping, galvanizing and tinning, Electroplating.

Unit –V: Material Chemistry No.of classes required : 10 hrs

- Polymers: Types of polymerizations (addition, condensation and copolymerization). Mechanism of Free radical Addition polymerization .
- Plastics: Thermoplastic and Thermosetting resins. Preparation , Properties and engineering applications of PVC, Bakelite, Teflon
- Fibre Reinforced Plastics (FRP) – applications.
- Rubbers: Natural rubber and its vulcanization.
- Bio-degradable polymers-preparation and applications of Polyvinyl acetate .
- Conducting polymers-Characteristics and Classification with examples-mechanism of conduction in trans polyacetylene and applications of conducting polymers.
- Smart materials- Introduction, classification and their engineering applications-Shape memory materials- Poly L- Lactic acid

II. GATE

NO APPLICABLE

III.IES

- ELECTROCHEMISTRY
- SURFACE PHENOMENON

5. **EXPERT DETAILS**(LOCAL /NATIONAL /INTERNATIONALWITH CONTACT DETAILS/PROFILE LINK/BLOGS/THEIRRESEARCH/CONTRIBUTIONTOWARDS THE SUBJECT)

INTERNATIONAL

1.Nicholas A.Peppas Chemical Engineering,

at the University of Texas at Austin.

2.Robert J. McMahonProfessor, chemistryUniversity of wisconsinExpert on physical-organic chemistrye.mail:mcmahon@chem.wisc.eduPh.608-262-0660

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IN HOUSE SUBJECT EXPERTS

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6.*JOURNALS*

INTERNATIONAL

1. Journal of Applied Electrochemistry Springer https://www.springer.com/journal/10800
2. International journal of Polymeric Materials and Polymeric Biomaterials. https://www.tandfonline.com/journals/gpom20?cookieSet=1
3. European Journal of Inorganic chemistry https://chemistry-europe.onlinelibrary.wiley.com/journal/10990682c
4. HTTPS://SCHOLAR.GOOGLE.CO.IN/SCHOLAR?Q=SYNTHESIS+OF+METAL+OXIDE+NANOPARTICLES+BY+MICRORGANISM+BY+Y+RAVINDRA+CMR+ENGINEERING+COLLEGE&HL=EN&AS_SDT=0&AS_VIS=1&OI=SCHOLART

NATIONAL

1. Indian Journal of Chemistry A CSIR HTTP://NOPR.NISCAIR.RES.IN/HANDLE/123456789/59
2. Indian Journal of Chemistry B CSIR http://op.niscair.res.in/index.php/IJCB
3. Journal of the Indian Chemical Society https://www.sciencedirect.com/journal/journal-of-the-indian-chemical-society

6. SUBJECT-LESSON PLAN

Unit 1 **Water and its treatment**	Lecture	Textbooks	Teaching Methods	**TENTATIVE DATE**
Introduction hardness of water – causes of hardness	L1	T1,T2	M1	
Types of hardness: temporary and permanent – expression and units of hardness	L2	T1		
Estimation of hardness of water by complexometric method	L3	T1	M2, M9	
Numerical problems.	L4	T1	M3	
Boiler troubles: Sludges, scales and.	L5	T1	M2	
Caustic Embrittlement, Priming and Foaming their causes and disadvantages	L6	T1	M1,M2	
Internal treatment(Calgon conditioning, Phosphate conditioning, carbonate conditioning, and Colloidal conditioning)	L7	T1,T2	M1, M2	
External Treatment- Softening of water by ion exchange processes	L8	T1,T2	M2, M9	
Potable water – specifications, steps involved in the treatment of potable water - Disinfection of potable water by chlorination and Ozonization	L9	T1	M2	
Desalination of water – Reverse osmosis, Electrodialysis	L10	T1	M1, M2	
UNIT 2 **Fuels and Combustions**				
Introduction, Calorific value of fuel – HCV, LCV- Dulongs formula	L11	T1,T4	M1, M2	
Classification- solid fuels: coal – analysis of coal – proximate and ultimate analysis and their significance	L12,L13	T1	M1,M2	
Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking.	L14,15	T1	M1, M2	

Knocking – octane and cetane rating, synthetic petrol - Fischer-Tropsch's process	L16,17	T1,T3	M1 M2	
Gaseous fuels – composition and uses of natural gas	L18,19	T1,T3	M1	
LPG and CNG, Biodiesel - Transesterification, advantages.	L20	T1,T3	M1	
UNIT 3 **Electrochemistry & Batteries**				
Electrochemical cells, Electrode potential Standarad Electrode potential, Daniel cell – cell notation, cell reaction and cell EMF	L21	T1,T3	M1	
– Numerical problems.Electrochemical series and its applications- Nernst equation	L22	T1,T2	M1, M3	
Construction and functioning of Standard hydrogen electrode, calomel electrode, Quinhydrone and glass electrode.	L23,L24	T1,T2	M2,M9	
Determination of pH of a solution by using Quinhydrone, glass electrode and calomel electrode	L25, L26	T1,T2	M2, M9	
Batteries: Primary (Lithium cell) and secondary batteries (Lead – acid storage battery and Lithium ion battery).	L27,L28	T2	M2,M7	
Fuel cells: Hydrogen–Oxygen fuel cell, Methanol-Oxygen fuel cell ,Advantages and Applications	L29	T2	M2,M7	
Introduction to Solar cells and its applications.	L30	T2	M2,M7	
Unit 4 Corrosion and its control				
Corrosion: Causes and effects of corrosion – theories of Chemical Corrosion, Mechanism of Oxidation corrosion	L31,L32	T1,T2	M1, M2	
electrochemical corrosion – mechanism of electrochemical corrosion	L33	T1, T2	M1, M2	
Types of wet corrosion: Galvanic, water-line and pitting corrosion	L34,L35	T1, T2	M1, M2	
Factors affecting rate of corrosion- nature of metal and nature of environment	L36	T1, T2	M1, M2	
Corrosion control methods – Cathodic protection (sacrificial anodic and impressed current)	L37	T1, T2	M1, M2	
Surface coatings: Metallic coatings & methods of application of metallic coatings - hot dipping (galvanization & tinning), metal cladding,)	L38,L39	T1 , T2	M1, M2	
Electroplating	L40	T1, T2	M1, M2	
UNIT 5 **Material Chemistry**				
Polymers: Introduction, classification and mechanism of polymerisation	L41	T1,T2	M1, M2	
Addition (Free radical polymerisation mechanism and Condensation polymerisation	L42	T1,T4	M1, M2	
Classification of polymers - Thermoplastics & Thermosetting resins. Types of Polymerization of polymers (i) Addition (ii) Condensation (iii) Co-	L43	T1,T4	M1, M2	

Polymerization.				
Preparation, properties and engineering application of PVC, Teflon and Bakelite. Fibers	L44,45	T1,T4	M1, M2	
characteristics of fibers – preparation, properties and uses of Nylon	L46	T1,T4	M1, M2	
Dacron – Fiber Reinforced Plastics (FRP) Glass Fibres – applications	L47	T1,T4	M1, M2	
Rubber – Natural rubber and its vulcanization. Synthetic Elastomers- Buna S, Butyl rubber and Thiokol Rubber	L48	T1,T4	M1, M2	
Conducting polymers: Introduction, classification and mechanism of conduction in Poly-acetylene, applications of conducting polymers	L49	T1,T4	M1, M2	
Biodegradable polymers: Introduction preparation, properties and applications of polylactic acid	L50	T1,T4	M1, M2	
TOTAL NO OF CLASSES	50			

M1: White Board	M3: Think Pair share	M5: Mind Mapping	M7: Assignment	M9: Project Based
M2: ICT (ppt, E-resources/NPTEL)	M4: Group Learning	M6: Mnemonics	M8: Industry Visit	M10: Charts/OHP/Others

SUGGESTED BOOKS

TEXT BOOKS:

1. Engineering Chemistry by P.C. Jain and M. Jain, Dhanpatrai Publishing Company, 2010.
2. Engineering Chemistry by Rama Devi and Rath, Cengage learning 2nd Edition 2022.
3. A text book of Engineering Chemistry by M. Thirumala Chary, E.Laxminarayana and K. Shashikala, Pearson Publications, 2021.
4. Textbook of Engineering Chemistry by Jaya Shree Anireddy, Wiley Publications.

REFERENCE BOOKS

1. Engineering Chemistry by Shikha Agarwal, Cambridge University Press, Delhi (2015).
2. Text book of Engineering Chemistry by S.S.Dara, S Chand Publications 2022.

7. WEB SITES FOR SELF LEARNING RESOURSES LIKE WWW.GEEKSFORGEEKS .ORG, WWW.SCHOOLS.COM,COURSEERA,EDX,UDEMY,KHAN ACADEMYNPTEL ETC ALONG REGISTRATION PROCEDURES)

Unit-1

https://ocw.mit.edu/courses/1-85-water-and-wastewater-treatment-engineering-spring-2006/pages/lecture-notes/

http://site.iugaza.edu.ps/frabah/files/2010/02/Water_Treatment_Lecture_1_1.pdf

Unit-2

https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004132159500424ranvijay_engg_Fuels.pdf

https://beeindia.gov.in/sites/default/files/2Ch1.pdf

https://stannescet.ac.in/cms/staff/qbank/CSE/Notes/CY8151-Engineering%20Chemistry-1908708516-unit_4.pdf

Unit-3

https://kshatriyacollegeofengineeringarmur.yolasite.com/resources/Engg_Chemistry.pdf

https://www.toppr.com/guides/chemistry/electrochemistry/

Unit-4

https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003251903229434ranvijay_Corrosion_Science.pdf

https://www.youtube.com/watch?v=5OxdXq91TV0

Unit-5

https://ncerthelp.com/cbse%20notes/class%2012/chemistry/Chemistry%20Notes%20for%20class%2012%20Chapter%2015%20Polymers%20.pdf

https://www.samareducation.com/2021/09/polymers-chemistry-class-12-notes.html

8. ENGINEERING CHEMISTRY PREVIOUS QUESTION PAPERS

- http://27.116.21.146/index.php/question-papers/2022
- https://www.manaresults.co.in/jntuh/download1.php?id=121AE052016.pdf&subcode=121AE
- https://www.manaresults.co.in/jntuh/download.php?subcode=111AE

9. QUESTION BANKS

a. JNTUH model papers

https://firstranker.com/frv2downloads.php/JNTUH/B-Tech/2018/1-1/Dec/R18/151AF-CHEMISTRY-2-R18

2.https://www.manaresults.co.in/jntuh/download1.php?id=152AN052019.pdf&subcode=152AN

3.https://www.manaresults.co.in/jntuh/download1.php?id=152AN082019.pdf&subcode=152AN

10. TWO CASE STUDY

1. Preparation of polymers

2.Ion exchange method

11. Assignment questions/innovative assignment sets

UNIT -1 WATER TECHNOLOGY

1. Discuss determination of hardness of water by EDTA method? CO1
2. Discuss Internal Treatment for softening of hard water CO1
3. Explain Ion exchange method for softening of hard water with neat diagram? CO1

Write short notes on scales, sludge and caustic embrittlement ?CO1

UNIT 2 ENERGY SOURCES

1.Explain Fixed bed –catalytic cracking with neat diagram? CO4

2.Discuss determination of calorific value of fuel by Orsat's apparatus? CO4

3. What are polymers? Discuss types of polymerization? CO5

UNIT ELECTROCHEMISTRY AND BATTERIES

1What is Glass electrode? Explain its construction and how to determine pH using Glass electrode? CO3

2.Discuss the construction and working of Pb-Acid battery? CO3

3. Explain construction and working of electrochemical cell ? CO3

10. Write the preparation and properties of Bakelite ? Define vulcanization of rubber ? CO5

UNIT – IV: CORROSION AND ITS CONTROL

1.Discuss the mechanism of Electrochemical corrosion ?CO5

2. types corrosion

3.Metallic coatings

4. metal cladding

5. Electroless plating

UNIT .5 ENGINEERING MATERIALS

1.What are polymers? Discuss types of polymerization? CO5

2. natural rubber preparation

3. conducting polymers

4. Preparation , properities and uses of PVC, NLON 6,6. BAKELLITE,

INNOVATIVE ASSIGNMENT QUESTIONS

Unit -1

WATER TRWATMENT

1. Explain scale and sludge formation in boilers
2. **Explain in detail desalination of boiler feed water**

UNIT 2. ENERGY SOURCES

1. Discuss proximate and ultimate analysis of coal sample
2. Write about the refining of petroleum
3. Define knocking

UNIT 3 ; UNIT ELECTROCHEMISTRY AND BATTERIES

1. Explain about electrochemical cell with a neat diagram
2. Differentiate between primary and secondary batteries
3. Explain in detail H_2– O_2 FUEL CELL

UNIT 4 CORROSION AND ITS CONTROL

1. write about cathodic protection
2. discuss in detail hot dipping method
3. Explain the electrochemical corrosion

UNIT 5. MATERIAL CHEMISTRY

1. Write the mechanism of free radical addition polymerisation reaction
2. DEFINE vulcanisation of natural rubber NATURAL RUBBER with proper chemical reactions
3. Explain preparation and applications of biodegradable polymers

12. LIST OF TOPICS FOR STUDENTS SEMINARS WITH GUIDELINES

1) EDTA method
2) fractional distillation
3) Secondary batteries
4) Electro chemical cell
5) Electroplating
6) Classification of plastics
7) Refining of crude oil

13. STEP /COURSEMATERIAL IN SOFTCOPY

https://cmrec.ac.in/hs-course-file/

14. EXPERT LECTURES WITH TOPICS AND SCHEDULE S (IF ANY)

Dr. B RamaDevi
Associate professor Chemistry
JNTUH College of Engineering Hyderabad (Autonomous)

1.ELECTROCHEMISTRY

SCHEME OF EVALUATION

MID Examination (Continuous Internal Evaluation)

S.No	No. of Division	No.of Questions	Allotted Marks for each question	Marks distribution
1	Part A (Attempt all questions)	5	2M	10M
2	Part B (Attempt only 3)	5	5M	15M
3	Assignment	5	1M	5M
4	Seminar/Project/Poster presentation/Viva-Voce	1	10M	10M
	Total Marks (CIE)			40M
SEE (Semester End Examination)				
1	Part A	10	1M	10M
2	Part B (Attempt only 5)	10	10M	50M
	Total Marks SEE			60M
Total Marks Including (CIE+SEE)				100M

ACADEMIC PLANNER(2024-25)

COURSE:IYEAR I B. TECH

SUBJECT: Vector Calculus and Transforms

CODE: MA201BS

YEAR: IYEARII SEM

SUBJECT: Vector Calculus and Transforms

List of contents

Introduction

Engineersuseprinciplesofmathematicsandscienceintheirdailywork.Theworldcontains countless inefficienciesand problems.Engineers use their inquisitive minds to dig into theseproblems and come up with solutions. Throughout the process, an engineer will think on multiple levels. Forexample, an engineer may specify requirements to solve a problem, formulate it as a model. To solve this heneedstheconcepts of mathematics.

The main objective of Mathematics – I is to equip students with adequate knowledge of mathematics thatwillenable them informulating problems andsolving problems analytically.

At the end of the course the student will be in a position to use the concepts of mathematics – I likefinding solutions of linear equations, properties of matrices, whether a maxima or minima exists for afunction, finding solutions of differential equations of first and higher order, finding areas and volumes ofregionsusing multipleintegrals,applying LaplaceTransforms tosolve differentialequations.

PREREQUISITES

- Astudentshouldhavebasicknowledgeof calculus, differentiation&integration.
- Trigonometricratios,angles,identitiesetc.
- Matrices-order, addition, subtraction, multiplication of matrices, determinant, row & columntransformationsetc.
- Usageofcalculator
- Regularpracticeofproblemsandaboveall

SCOPE

The scope of mathematics is found in many of the engineering subjects of various branches. Some of themareComputer science students make maximum use of matrices in coding and decoding.They use Boolean,Sparseand other matrices in many oftheircomputersubjects.

Course Objectives: To learn

- Concept, properties of Laplace transform and solving ordinary differential equations using Laplace transforms techniques.
- Evaluation of double integrals.Evaluation of improper integrals using Beta and Gamma functions.
- The physical quantities involved in engineering field related to vector valued functions.
- The basic properties of vector valued functions and their applications to line, surface and Volume integrals.

Course Outcomes: After learning the contents of this subject, the student must be able to

CO1: Find the Laplace transforms for given functions.

CO2: Applythe Laplace transforms techniques for solving ODEs.

CO3: Solve the double integrals and evaluate the improper integrals using Beta and Gamma functions.

CO4: Determine gradient, divergent and curl by using vector differentiation.

CO5: Evaluate the line, surface and volume integrals and converting them from one to another.

B.Tech I Year I Sem Syllabus (w.e.f. 2023-24)

Vector calculus and transforms

Common for ECE, CSE (AI&ML), CSE(DS)

B. Tech. I Year II Sem **L T P C**

3 1 0 4

10. Syllabus

UNIT-I: LAPLACE TRANSFORMS (8 hours)

Laplace Transforms; Laplace Transform of standard functions; first shifting theorem; Laplace transforms of functions when they are multiplied and divided by ‘t’. Laplace transforms of derivatives

and integrals of function; Evaluation of integrals by Laplace transforms; Laplace transforms of Special

functions; Laplace transform of periodic functions.

UNIT II: INVERSE LAPLACE TRANSFORMS (8 hours) Inverse Laplace transform by different methods, convolution theorem (without proof), solving ODEs by Laplace Transform method.

UNIT-III: Beta and Gamma Functions and Double integration (12 hours)

Beta and Gamma Functions, their properties, evaluation of improper integral using Beta and Gamma Functions. Evaluation of Double Integrals (Cartesian and polar coordinates); Change of order of integration (only Cartesian form); Change of variables.

UNIT-IV: Vector Differentiation **(10 hours)**

Vector point functions and scalar point functions. Gradient, Divergence and Curl. Directional derivatives, Tangent plane and normal line. Vector Identities. Scalar potential functions. Solenoidal and Irrotational vectors.

UNIT-V: Vector Integration **(10 hours)**

Line, Surface and Volume Integrals. Vector integral theorems: Green's, Gauss divergence and Stoke's (without proof) and their applications.

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition,2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
3. B.V.Ramana, A text Book of Engineering Mathematics, Tata Mc Graw Hill.

REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002.
2. S.R.K. Iyengar and R. K. Jain, Advanced Engineering Mathematics, Narosa Publication.

SYLLABUS-GATE

UNITI

LAPLACE TRANSFORMS

UNITII

INVERSE LAPLACE TRANSFORMS

UNITIII

BETA & GAMMA FUNCTIONS

I UNIT-IV

VECTOR DIFFERENTIATION

UNITV

VECTOR INTEGRATION

SYLLABUS-IES

UNITI

Laplace Transforms

UNITII

Inverse laplace transforms

UNITIII

Beta & Gamma functions

UNITIV

Vector differentiation

UNITV

Vector integration

11. List of subject expert details

EXPERTDETAILS

The Expert Details which have been mentioned below are only a few of the eminent ones knownInternationally,Nationally and Locally. Thereareafew others known as well.

INTERNATIONAL

6. AviM.Shapiro,ProfessorinApplied Mathematics,HarvardUniversity
7. DickeyEd,Professor, Universityof SouthCo1.

NATIONAL

3 Dr. K. Murugesan,Professor,Department of Mathematics,NationalInstituteofTechnology,Tiru

chirappalli

4Dr.BalasubramanianRaman,Professor,IITRoorkee.

REGIONAL

2. Dr. Kasi Viswanatham K N S,Professor & Head,Maths Department,NIT, Warangal2. Dr.M ASrinivas,Professor &Head, MathsDepartment,JNTUH,Hyderabad.

12. JOURNALS

INTERNATIONAL

6. InternationalJournalof MathematicalEducationinScienceandTechnology
7. InternationalJournalofPureandAppliedMathematics
8. InternationalJournalofMathematicsResearch(IJMR)
9. InternationalJournalofScienceandMathematicsEducation
10. InternationalJournalofMathematicsandMathematicalSciences

NATIONAL

8. IndianJournalofMathematics(IJM)
9. IndianJournalofPureandAppliedMathematics(IJPAM)
10. AdvancedEngineeringMathematics,MichaelGreenberg,SecondEdition.Pearson

13. SessionPlan/LessonPlan

BRANCH:ECE,CSE, AI&ML, DS

SUB: MATRIX ALGEBRA AND DIFFERENTIAL EQUATIONS

UNIT NO	UNIT NAME	SUB TOPICS	NO. Of Lectures Required	Suggested Books	Remarks	Teaching Methods
I	**LAPLACE TRANSFORMS**	Basic concepts, Laplace Transforms formulae and Exponential order Laplace Transform of standard Functions Firstshiftingtheorem Laplacetransforms of functions when they are multiplied by ‘t’, Laplacetransforms of functions when they are divided by ‘t’ Laplace transforms of integrals Laplace transforms of derivatives , Evaluation of integrals by Laplace transforms Laplace transforms of Special functions, Laplacetransformofperiodicfunctions	L1, L2 L3 L4, L5 L6,L7 L8 L9 L10, L11 L12,L13 L14,L15	T1, R1, R2	Unit-1 is completed by L15	M1,M2 M1,M2 M1,M2 M1,M2 M1,M2

II	**INVERSE LAPLACE TRANSFORMS**	Inverse Laplace transform by different methods Inverse Laplace transform by different methods, convolution theorem (without proof) solving ODEs by Laplace Transform method. Revision	L16 L17, L18 L19,L20 L21,L22 L23,L24 L25	T1,T2, R1, R2	Unit-2 is completed by L25	M1,M2 M1,M2

III	**Beta and Gamma Functions and Double integration**	Beta and Gamma Functions Beta and Gamma Functions, their properties evaluation of improper integral using Beta and Gamma Functions Evaluation of Double Integrals (Cartesian and polar coordinates) **Change of order of integration (only Cartesian form)** **Change of variables.**	L26,L27 L28,L29 L30,L31 L32,L33 L34, L35 L36 , L37 L38,L39 L40	T1, R1, R2	Unit-3 is complete d by L40	M1,M2 M1,M2 M1,M2 M1,M2
IV	**Vector Differentiation**	Introduction Gradient, Divergence, Curl and their properties Problems on Gradient Problems on Divergence Problems on curl Revision	L41 L42,L43 L44,L45 L46,L47 L48,L49 L50	T1,T2 , R1, R2	Unit-4 is complete d by L50	M1,M2 M1,M2 M1,M2
V	**Vector Integration**	Laplacian operator Line Integral – work done Surface Integral Volume Integral Green's ,Gauss's divergence and Stoke's theorem Revision	L51 L52 L53,L54 L55,L56 L57,L58 L59, L60	T2	Unit-5 is complete d by L60	M1,M2 M1,M2 M1,M2
		TOTAL NO. OF CLASSES	60			

METHODSOFTEACHING:

M1:Greenboard	M3:Think-pair-share	M5:Mindmapping	M7:Assignment	M9:ProjectBased
M2:ICTMethods(PPT,E-Resources/Nptel)	M4:Grouplearning	M6:Mnemonics	M8:IndustryVisit	M10:Charts/OHP/Others

14. Websites:

Websites/URLs/e-Resources :

14. http://www.engr.sjsu.edu/trhsu/Chapter%204%20Second%20order%20DEs.pdf
15. http://www.engr.sjsu.edu/trhsu/Chapter%203%20First%20order%20DEs.pdf
16. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
17. https://ocw.mit.edu/resources/res-18-006-calculus-revisited-single-variable-calculus-fall-2010/part-ii-differentiation/
18. http://nptel.ac.in/courses/111108081/
19. https://www.intmath.com/differential-equations/5-rl-circuits.php
20. https://www.youtube.com/watch?v=U-VAByа-XA0
21. https://www.slideshare.net/RajeshKumar670/electrical-circuits-in-concept-of-linear-algebra
22. http://personal.maths.surrey.ac.uk/st/S.Zelik/teach/calculus/max_min_2var.pdf

23. SUGGESTEDBOOKS

TEXTBOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition,2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9^{th} Edition, John Wiley & Sons,2006.
3. B.V.Ramana, A text Book of Engineering Mathematics, Tata Mc Graw Hill.

REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9^{th}Edition, Pearson, Reprint, 2002.
2. S.R.K. Iyengar and R. K. Jain, Advanced Engineering Mathematics, Narosa Publication.

24. SeminarTopics

- APPLICATIONS OF LAPLACE TRANSFORMS
- CONVOLUTION THEOREM
- UNIT STEP FUNCTION
- DIRAC'S DELTA FUNCTION
- PERIODIC FUNCTIONS
- SHIFTING THEOREMS
- APPLICATIONS OF BETA FUNCTION
- APPLICATIONS OF GAMMA FUNCTION
- APPLICATIONS OF DOUBLE INTEGRALS
- CHANGE OF ORDER OF INTEGRATIONIN
- DOUBLE INTEGRALS
- CHANGE VARIABLES IN DOUBLE INTEGRALS
- GRADIENT
- DIVERGENCE
- CURL
- DIRECTIONAL DERIVATIVE
- WORK DONE
- SCALR POTENTIAL
- SOLENOIDAL VECTORS
- IRROTATIONAL VECTORS
- GREEN'S THEOREM
- DIVERGENCE THEOREM
- STOKE'S THEORM

25. **JNTU/AUTONOMOUS QuestionPapers:**

26. VCT QUESTIONBANK

UNIT -I

LAPLACE TRANSFORMS

1. Prove that $L\{t^n] = \frac{n!}{s^{n+1}}$
2. Find the Laplace transform of $e^{3t} - 2e^{-2t} + sin2t + cos3t + sinh3t - 2cosh4t + 9$
3. Find the Laplace transforms of
   $(i)(\sqrt{t} + \frac{1}{\sqrt{t}})^3$ $(ii)\ sin(\omega t + \alpha)$ $(iii)3\ cos3t\ cos4t$
4. State and prove first shifting theorem, and change of scale property.
5. Find the Laplace transforms of
   $(i)f(t) = \begin{cases} sint, & 0 < t < \pi \\ 0, & t > \pi \end{cases}$ $(ii)\ f(t) = \begin{cases} cost, 0 < t < \pi \\ sint, \ t > \pi \end{cases}$
6. Find the Laplace transform of
   $(i)e^{-3t}(2cos5t - 3sin5t)$ $(ii)e^{3t}sin^2t$ $(iii)e^{-at}sinhbt$
7. Find the Laplace transforms of $g(t),\ where\ \ g(t) = \begin{cases} cos\left(t - \frac{\pi}{3}\right), t > \frac{\pi}{3} \\ 0\ , \ \ t < \frac{\pi}{3} \end{cases}$
8. If $L\{f(t)\} = \frac{9s^2-12s+15}{(s-1)^3}$ find $L\{f(3t)\}$ using change of scale property.
9. Prove that $L[f^{(n)}(t)] = s^n\bar{f}(s) - s^{n-1}f(0) - s^{n-2}f'(0) - \cdots f^{(n-1)}(0)$
10. Prove that if $L\{f(t)\} = \bar{f}(s)$then $L\left\{\int_0^t f(u)du\right\} = \frac{1}{s}\bar{f}(s)$
11. State and prove that Laplace Transforms of multiplication by ‘t’, and division by ‘t’
12. Find $L\left\{\int_0^t e^{-t}\cos t\, dt\right\}$
13. Find $(i)L[t\ sin3t\cos 2t]$ $(ii)L[te^{2t}sin3t]$ $(iii)L[te^{at}sinbt]$ $(iv)L[\int_0^t te^{-t}sin2t\ dt\ ]$
14. Find $(i)\ L\left[\frac{sin3t\cos t}{t}\right]$ $(ii)\ L\left[\frac{e^{-at}-e^{-bt}}{t}\right]$ $(iii)\ L\left[\frac{1-cost}{t^2}\right]$
15. Show that $\int_0^\infty t^2e^{-4t}sin2t\ dt = \frac{11}{500}$
16. Using Laplace transform, evaluate $\int_0^\infty te^{-t}sint\ dt$
17. Using Laplace transform, evaluate $\int_0^\infty \frac{e^{-t}-e^{-2t}}{t}\ dt$
18. Using Laplace transform, evaluate $\int_0^\infty \frac{e^{-at}sin^2t}{t}\ dt$
19. Using Laplace transform, evaluate $\int_0^\infty \frac{\cos at-\cos bt}{t}\ dt$
20. Find $L\{f(t)\}$ where $f(t)$ is given by $f(t) = t, 0 < t, b\ and\ f(t) = 2b - t, b < t < 2b$ being the period of $f(t)$
21. Find $L\{f(t)\}$ where $f(t)$ is given by $f(t) = \begin{cases} sin\omega t, & 0 < t < \pi/\omega \\ 0, & \pi/\omega < t < 2\pi/\omega \end{cases}$

22. Find $L\{f(t)\}$ where $f(t)$ is given by $f(t) = \begin{cases} k, & 0 < t < a \\ -k, & a < t < 2a \end{cases}$

UNIT -II

INVERSE LAPLACE TRANSFORMS:

1. Find $(i) L^{-1}\left\{\frac{3(s^2-2)^2}{2s^5}\right\}$ $(ii) L^{-1}\left\{\frac{s^2-3s+4}{s^3}\right\}$
2. Find the inverse Laplace transforms of $(i) \frac{s}{s^4+4a^4}$ $(ii) \frac{s+3}{s^2-10s+29}$ $(iii) \frac{1}{s^4+a^4}$
3. Evaluate $(i) L^{-1}\left\{\frac{1+e^{-\pi s}}{s^2+1}\right\}$ $(ii) L^{-1}\left\{\frac{e^{-\pi(s+2)}}{s+2}\right\}$ $(iii) L^{-1}\left\{\frac{e^{2s}}{s^2+4s+5}\right\}$
4. Find the inverse Laplace transforms of $(i) \log\left(\frac{s+a}{s-a}\right)$ $(ii) \log\left(\frac{s^2+a^2}{s^2+b^2}\right)$ $(iii) \log\left(1+\frac{16}{s^2}\right)$
5. Find $(i) L^{-1}\left\{\cot^{-1}\left(\frac{s+2}{3}\right)\right\}$ $(ii) L^{-1}\{\tan^{-1}(s+1)\}$
6. Find $L^{-1}\left\{\frac{s+1}{(s^2+2s+2)^2}\right\}$
7. Find the inverse Laplace transforms of $\frac{s+3}{(s^2+6s+13)^2}$
8. State the Convolution theorem.
9. Using convolution theorem find $(i) L^{-1}\left\{\frac{s}{(s^2+a^2)^2}\right\}$ $(ii) L^{-1}\left\{\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right\}$
$(iii) L^{-1}\left\{\frac{1}{(s^2+a^2)^2}\right\}$ $(iv) L^{-1}\left\{\frac{1}{(s^2+9)(s+1)^2}\right\}$
10. Using Laplace transform, solve $(D^2+4D+5)y = 5$, given that $y(0) = 0, y'(0) = 0$.
11. Solve the differential equation $\frac{d^2x}{dt^2} + 9x = sint$, using Laplace transform given $(i) x(0) = 1, x\left(\frac{\pi}{2}\right) = 1$ (ii) $x(0) = 1, x'(0) = 0$
12. Using Laplace transform, solve $(D^2+1)x = t\cos 2t$, given that $x = 0, \frac{dx}{dt} = 0$ at $t = 0$.
13. Using Laplace transform, solve $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 5x = e^{-t}sint, x = 0, \frac{dx}{dt} = 1$ at $t = 0$.
14. Using Laplace transform, solve $y'' = tcos2t,$ given that $y(0) = 0, y'(0) = 0$
15. Using Laplace transform, solve $y'' - 3y' + 2y = 4t + e^{3t}$ given that $y(0) = 1, y'(0) = 1$
16. Using Laplace transform, solve $\frac{d^2x}{dt^2} - 4\frac{dx}{dt} + 8x = e^{2t}$, given that $x(0) = 2, x'(0) = 2$
17. Using Laplace transform, solve $(D^2+1)y = 6\cos 2t$, given that $y(0) = 3, y'(0) = 1$
18. Using Laplace transform, solve $(D^2+n^2)x = a\sin(nt+2)$, $x(0) = 0, x'(0) = 0$

UNIT -III

BETA AND GAMMA FUNCTIONS AND DOUBLE INTEGRALS

BETA AND GAMMA FUNCTIONS:

1. Define beta function.
2. Prove that $B(m,n) = 2\int_0^{\frac{\pi}{2}} sin^{2m-1}\theta\ cos^{2n-1}\theta\ d\theta$
3. Prove that $B(m,n) = \int_0^{\infty} \frac{x^{m-1}}{(1+x)^{m+n}}dx$=$\int_0^{\infty} \frac{x^{n-1}}{(1+x)^{m+n}}dx$
4. Prove that $\frac{B(p,q+1)}{q} = \frac{B(p+1,q)}{p} = \frac{B(p,q)}{p+q}$ where P>0,q>0
5. Show that $\int_a^b (x-a)^m(b-x)^n dx = (b-a)^{m+n+1}B(m+1,n+1)$
6. Define Gamma function.
7. Write down the $B-\Gamma$relation and prove it. (or) Prove that $B(m,n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$ where m>0,n>0.
8. Prove that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$
9. Prove that $\int_0^{\infty} e^{-x^2}\,dx = \int_{-\infty}^{0} e^{-x^2}\,dx = \frac{\sqrt{\pi}}{2}$
10. Prove that $\Gamma(n) = \int_0^1 (log\frac{1}{x})^{n-1}dx,\ n > 0$
11. Evaluate $\int_0^{\frac{\pi}{2}} \sqrt{cot\theta}\ d\theta$
12. Evaluate $\int_0^1 x^4(log\frac{1}{x})^3 dx$
13. Prove that $\int_0^{\frac{\pi}{2}} sin^n\theta\ d\theta = \int_0^{\frac{\pi}{2}} cos^n\theta\ d\theta = \frac{\boldsymbol{\Gamma}\left(\frac{n+1}{2}\right)\sqrt{\pi}}{2\boldsymbol{\Gamma}(\frac{n+2}{2})}$
14. Evaluate $\int_0^{\infty} x^{-\frac{3}{2}}(1-e^{-x})dx$
15. Prove that $\int_0^{\infty} e^{-y^{\frac{1}{m}}}\,dy = m\Gamma(m)$
16. Prove that $\int_0^{\frac{\pi}{2}}[\sqrt{tan\theta} + \sqrt{sec\theta}]d\theta = \frac{1}{2}\Gamma\left(\frac{1}{4}\right)\left[\Gamma\left(\frac{3}{4}\right) + \frac{\sqrt{\pi}}{\Gamma\left(\frac{3}{4}\right)}\right]$
17. Evaluate $\int_0^{\infty} \frac{x}{(1+x^6)}dx$ using $B-\Gamma$ functions
18. Prove that $\int_0^1 x^m(logx)^n dx = \frac{(-1)^n n!}{(m+1)^{n+1}}$ where n is a positive integer and m>-1.
19. Evaluate $4\int_0^{\infty} \frac{x^2}{(1+x^4)}dx$ using $B-\Gamma$ functions
20. Prove that $\Gamma(m)\Gamma\left(m+\frac{1}{2}\right) = \frac{\sqrt{\pi}}{2^{2m-1}}\Gamma(2m)$
21. Evaluate $\int_0^1 \frac{x^2}{\sqrt{1-x^5}}dx$ in terms of Beta function.
22. Prove that $\int_0^{\frac{\pi}{2}} \frac{1}{\sqrt{sin\theta}}\ d\theta \times \int_0^{\frac{\pi}{2}} \sqrt{sin\theta}\ d\theta = \pi$

DOUBLE INTEGRALS:

1. Evaluate $\iint rsin\theta drd\theta$ over the cardioid $r = a(1-\cos\theta)$ above the initial line.
2. Show that $\iint r^2 sin\theta drd\theta\ = \frac{2a^2}{3}$, over the region in the semi-circle $r = 2a\cos\theta$above the initial line.

3. Evaluate $\iint y^2 dxdy$ where R is the region bounded by the parabolas $y^2=4ax$ and $x^2=4y$
4. Find the values of $\iint xy\,dxdy$ taken over the positive quadrant of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$
5. Evaluate $\int_0^{\pi}\int_0^{a(1+\cos\theta)} r^2\cos\theta\,drd\theta$
6. Evaluate $\iint r^3 drd\theta$ over the area included between the circles $r=2sin\theta$ and $r=4sin\theta$
7. Evaluate $\int_0^{a}\int_0^{\sqrt{a^2-y^2}}(x^2+y^2)dydx$ using change of variables.
8. Show that $\int_0^{4a}\int_{y^2/4a}^{y}\frac{(x^2-y^2)}{(x^2+y^2)}dxdy=8a^2\left(\frac{\pi}{2}-\frac{5}{3}\right)$
9. Change of order of integration in $\int_0^1\int_{x^2}^{2-x} xy\,dxdy$ and hence evaluate the double integral.
10. By Change of order of integration, evaluate $\int_0^1\int_0^{\sqrt{1-x^2}} y^2\,dxdy$.
11. By changing into polar coordinates $\iint\frac{(x^2y^2)}{(x^2+y^2)}dxdy$ over the region between the circles $x^2+y^2=a^2$ and $x^2+y^2=b^2 (b>a)$.
12. Evaluate $\iint(x^2+y^2)dxdy$ in the positive quadrant for which $x+y\leq 1$.

UNIT -IV

Vector Differentiation

1. Prove that $\nabla(r^n)= nr^{n-2}\bar{r}$
2. Find the directional derivative of $f = xy+yz+zx$ in the direction of vector $\bar{\imath}+2\bar{\jmath}+2\bar{k}$ at the point (1,2,0).
3. Find the directional derivative of the function $xy^2+yz^2+zx^2$ along the tangent to the curve $x=t, y=t^2, z=t^3$ at the point (1,1,1).
4. Find the directional derivative of the function $f=x^2-y^2+2z^2$ at the point P = (1,2,3) in the direction of the line $\overline{PQ}$ where Q = (5,0,4).
5. Find the directional derivative of xyz^2+xz at (1, 1 ,1) in a direction of the normal to the surface $3xy^2+y= z$ at (0,1,1).
6. Find the directional derivative of $\emptyset(x,y,z) = x^2yz+4xz^2$ at the point (1, -2, -1) in the direction of the normal to the surface $f(x,y,z) = x\log z-y^2\ at\ (-1,2,1)$.
7. Find the angle of intersection of the spheres $x^2+y^2+z^2 = 29$ and $x^2+y^2+z^2+4x-6y-8z-47 = 0$ at the point (4, -3,2).
8. Prove that $div\,\overline{f} = r^n\overline{r}$. Find 'n' if it is solenoidal?
9. Find $curl\,\bar{f}\ where\ \bar{f} = grad(x^3+y^3+z^3-3xyz)$
10. Prove that if $\bar{r}$ is the position vector of any point in space, then $\bar{r}r^n$ is Irrotational. (or) Show that $curl(\overline{r}r^n)=0$
11. Show that the vector $(x^2- yz)i+(y^2- zx)j+ (z^2- xy)\,k$ is irrotational and find its scalar potential.
12. Find constants $a, b\ and\ c$ if the $vector\ \bar{f} = (2x+ 3y+ az)i+ (bx+ 2y+ 3z)j+ (2x+ cy+ 3z)\,k$ is Irrotational.
13. Find constants a,b,c so that the

vector $\bar{A} = (x+2y+az)i+(bx-3y-z)j+(4x+cy+2z)k$ is Irrotational. Also find $\emptyset$ such that $\bar{A} = \nabla\emptyset$.

14. Prove that $div.(grad\, r^m) = m(m+1)r^{m-2}$ $(\boldsymbol{or})$ $\nabla^2(r^m) = m(m+1)r^{m-2}$
15. Prove that $grad\left(\bar{a}.\bar{b}\right) = \left(\bar{b}.\nabla\right)\bar{a} + (\bar{a}.\nabla)\bar{b} + \bar{b}\times curl\bar{a} + \bar{a}\times curl\bar{b}$
16. Prove that $div\left(\bar{a}\times\bar{b}\right) = \bar{b}.curl\bar{a} - \bar{a}.curl\bar{b}$
17. Prove that $curl\left(\bar{a}\times\bar{b}\right) = \bar{a}\, div\, \bar{b} - \bar{b}\, div\ \bar{a} + \left(\bar{b}.\nabla\right)\bar{a} - (\bar{a}.\nabla)\bar{b}$
18. Prove that $\nabla\times(\nabla\times\bar{a}) = \nabla(\nabla.\bar{a}) - \nabla^2\bar{a}$

UNIT -V

Vector Integration

1. Find the work done by the force $\bar{F} = zi + xj + y\,k$, when it moves a particle along the *arc* of the curve $\bar{r} = cost\, i + sint\, j\ - t\, k\ from\ t = 0\ to\ t = 2\pi.$
2. Using the line integral calculate the work done by the force $\bar{F} = (3x^2+6y)\, i - 14yz\, j\ + +20xz^2k$ along the lines from (0,0,0) to (1,0,0), then to (1,1,0) and then to (1,1,1).
3. Find the work done by the force $\bar{F} = (2y+3)\,i + (zx)j + (yz-x)k$ when it moves a particle from the point (0,0,0) to (2,1,1) along the curve $x = 2t^2, y = t, z = t^3$.
4. Evaluate $\int \bar{F}.n\, dS$ where $\bar{F} = zi + xj - 3y^2zk$ and S is the surface $x^2+y^2 = 16$ included in the first octant between $z = 0\ and\ z = 5.$
5. Find the work done in moving a particle in the force field a) $\bar{F} = 3x^2i + j + zk$, b) $\bar{F} = 3x^2i + (2xz-y)j + zk$ along the straight line from (0,0,0) to (2,1,3).
6. Find the work done in moving in a particle in the force field $\bar{F} = 3x^2i + (2xz-y)j + zk$ along the curve defined by $x^2 = 4y, 3x^3 = 8z$ from $x = 0\ to\ x = 2.$
7. If $\bar{F} = 2xz\, i - x\, j\ + y^2k$ evaluate $\int_v \bar{F}\, dv$ where V is the region bounded by the surfaces $x = 0, x = 2, y = 0, y = 6, z = x^2,\ z = 4.$
8. Verify divergence theorem for $2x^2y\, i\ - y^2\, j + 4xz^2\, k$ taken over the region of first octant of the cylinder $y^2+z^2 = 9\ and\ x = 2.$
9. Verify Gauss Divergence theorem for $\bar{F} = (x^3-yz)i - 2x^2y\, j + z\, k$ taken over the surface of the cube bounded by the planes $x = y = z = a$ and coordinate planes.
10. Use Divergence theorem to evaluate $\iint(x\, i + yj + z^2k).\bar{n}\, ds$ Where S is the surface bounded by the cone $x^2 + y^2 = z^2$in the plane $z = 4.$
11. Verify Gauss divergence theorem for $\bar{F} = x^3i + y^3\, j + z^3\, k$ taken over the cube bounded by $x = 0, x = a, y = 0, y = a, z = 0, z = a.$
12. Find $\int_S (4x\, i - 2y^2j + z^2k).\bar{n}\, ds$ Where S Is the region bounded by

    $x^2+y^2 = 4, z = 0\ and\ z = 3.$

13. Using Divergence theorem, evaluate $\iint_S (xdydz + y\, dzdx + zdxdy)$where

    $S: x^2+y^2+z^2 = a^2$

14. Evaluate by Green's theorem $\int_c (y - sinx)dx + cosxdy$ where C is the triangle enclosed by the lines $y = 0, x = \frac{\pi}{2}, \pi y = 2x.$

15. Evaluate by Green's theorem $\int_c (x^2 - coshy)dx + (y + sinx)dy$ where C is the rectangle with vertices $(0,0), (\pi, 0), (\pi, 1), (0,1)$.
16. Using Green's theorem evaluate $\int_c (2xy - x^2)dx + (x^2 + y^2)dy$ where C is the closed curve of the region bounded by $y = x^2\ and\ y^2 = x$
17. Verify Green's theorem for $\int_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$where c is the region bounded by $x = 0, y = 0\ and\ x + y = 1$.
18. Verify Green's theorem for $\int_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$where c is the region bounded by $y = x^2\ and\ y = \sqrt{x}$.
19. Apply Green's theorem to evaluate $\int_c (2x^2 - y^2)dx + (x^2 + y^2)dy$ where C is the boundary of the area enclosed by the X-axis and upper half of the circle $x^2 + y^2 = a^2$
20. Verify Green's theorem in the plane for $\int_c (x^2 - xy^3)dx + (y^2 - 2xy)dy$where C is square with vertices $(0,0), (2,0), (2,2), (0,2)$.
21. Verify Stokes theorem for $\bar{F} = -y^3 i + x^3 j$, where S is the circular disc

$$x^2 + y^2 \leq 1, z = 0$$

22. Verify Stokes theorem for $\bar{F} = (2x - y)i - yz^2 j\ - y^2 z\ k$, over the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ bounded by the projection of the xy-plane.
23. Verify Stokes theorem for the function$\bar{F} = x^2 i + xy\ j$ integrated round the square in the plan $z = 0$ whose sides are along the lines $x = 0, y = 0, x = a, y = a$.
24. Apply Stokes theorem, to evaluate $\int_c (ydx + zdy + xdz)$where C is the curve of intersection of the sphere $x^2 + y^2 + z^2 = a^2\ and\ x + z = a$.
25. Apply the Stokes theorem and show that $\iint_s\ curl\ \bar{F}\,.\bar{n}\ ds = 0$ where $\bar{F}$ is the vector and $S: x^2 + y^2 + z^2 = 1$
26. Verify Stokes theorem for $\bar{F} = (x^2 + y^2)i - 2xy\ j$ taken round the rectangle bounded by the lines $x = \pm a, y = 0, y = b$.
27. Verify Stoke's theorem for F=y²i+yj-zxk and S is the upper half of the sphere $x^2 + y^2 + z^2 = a^2$ and $z \geq 0$.
28. Using Stokes theorem evaluate the integral $\int_c \bar{F}\,.d\bar{r}$where $\bar{F} = 2y^2 i + 3x^2 j - (2x + z)k$ and C is the boundary of the triangle whose vertices are $(0,0,0), (2,0,0), (2,2,0)$.

PowerPointPresentations(PPTs):

1.Unit-1

https://www.slideshare.net/vansi007/02-first-order-differential-equations

faculty.ksu.edu.sa/khawaja/.../02.5%20%20Exact%20Differential%20Eqauation.ppt

Unit-2

www.maths.unp.ac.za/coursework/Math132/lay_linalg5_01_01.pptwww.nplainfield.org/cms/.../Solving%20Systems%20of%20Linear%20Equations.pptzmarinco.weebly.com/uploads/5/4/0/1/54014121/systems_of_equations.ppt

Unit-3

www.ohio.edu/people/melkonia/math3200/slides/ch6.ppthttps://www.soest.hawaii.edu/GG/FACULTY/FRED/.../GG313_Lec_15_Eigen.ppthttps://www.slideshare.net/leingang/lesson-22-quadratic-forms

Unit-4

https://www.math.ubc.ca/~feldman/m105/maxmin.pdfhttps://www.sheltonstate.edu/Uploads/files/faculty/Lisa%20Nix/.../Section%209.2.ppt

Unit-5

www.powershow.com/.../First_Order_Partial_Differential_Equations_powerpoint_ppt..www.math.ucla.edu/~tat/MicroTeach/pde's.ppt

ACADEMIC PLANNER

Subject:Basic Electrical Engineering

S.NO **CONTENT**

(1) - Preamble/Introduction
(2) - Prerequisites
(3) - Objectives and Outcomes
(4) - Syllabus
1.JNTU/R23-CMREC
2.GATE
3.IES
(5) - List of Expert Details(Local/National/International with Contact details/Profile link/Blogs/their research Contribution towards the subject)
(6) - Journals with min 5 ref paper for literature study
(7) - Subject -Lesson plan
(8) - Suggested Books (prescribed and References)
(9) - Websites for self learning Resources like *www.geeksforgeeks.org, www.schools.com, Coursera,edX, Udemy, Khan Academy*, NPTEL etc along Registration procedures*)*
(10) - Question Banks
1.JNTUH/Model papers
2.GATE
(11) - Two case study presentations with Project / Product/ Model /prototypes/ Industrial applications.
(12) - AssignmentQuestion/InnovativeAssignments sets.
(13) -List of topics for studentsSeminars with Guidelines
(14) - STEP/Course material in softcopy

(15) - Expert Lectures with topics &Schedules (if any)

Preamble/Introduction:

Electrical engineering is a professional engineering discipline that deals with the study and application of electricity and electromagnetism. The field first became an identifiable occupation in the late nineteenth century with the commercialization of the electric telegraph and electrical power supply. The field now covers a range of sub-disciplines including those that deal with power, optoelectronics, digital electronics, analog electronics, computer science, artificial intelligence, control systems, electronics, signal processing and telecommunications.

The term electrical engineering may or may not encompass electronic engineering. Where a distinction is made, electrical engineering is considered to deal with the problems associated with large-scale electrical systems such as power transmission and motor control, whereas electronic engineering deals with the study of small-scale electronic systems including computers and integrated circuits. Another way of looking at the distinction is that electrical engineers are usually concerned with using electricity to transmit energy, while electronics engineers are concerned with using electricity to transmit information.

PREREQUISITES

Before to start the subject one should have the knowledge of voltage, current, basic electrical components, relation between V and I with respect to electrical components, difference between ac and dc, Faraday's Laws, Lenz Law, Fleming's Hand Rules

OBJECTIVES AND OUTCOMES

COURSE OBJECTIVES:

- To introduce the concepts of electrical circuits and its components.
- To understand magnetic circuits, DC circuits and AC single phase and three phase circuits.
- To study and understand behaviour of transformers.
- To study and understand behaviour of DC machines.
- To study and understand behaviour of AC machines.

COURSE OUTCOMES:

CO1. Recall the basics of electric, magnetic and electromagnetic circuits**.**

CO2. Classify the types of machines and **explain** their working principles**.**

CO3. Explain the construction of DC and AC machines**.**

CO4. Analyze the characteristics of 1-Phase and 3-Phase machines**.**

CO5. **Interpret** different losses in the machines and determine their efficiency and regulation**.**

SYLLABUS

(CMREC Autonomous)

UNIT- I: D.C CIRCUITS

Electrical circuit elements (R,L,C), voltage and current sources, KVL & KCL, analysis of simple circuits with DC excitation. Superposition, Thevenin's and Norton's theorems.Time-domain analysis of first – order RL and RC circuits.

UNIT-II: A.C CIRCUITS

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, analysis of single-phase ac circuits consisting of R , L , C , RL , RC , RLC combinations (series and parallel), resonance in series R-L-C circuit. Three-phase balanced circuit, voltage and current relations in star and delta connections.

UNIT-III: TRANFORMERS

Ideal and practical transformers, equivalent circuits, losses in transformers, regulations and efficiency.Auto-transformer and three-phase transformer connections.

UNIT-IV: DC MACHINES

DC generators: Construction, working, emf equation and classification, DC motors: construction, working, back emf, torque equation, classification, characteristics, Loss components and efficiency.

UNIT-V: AC MACHINES

Generation of rotating magnetic fields , construction and working of a three-phase induction motor, significance of torque-slip characteristic, starting methods, Loss components and efficiency, construction and working of synchronous generators.

Syllabus

(GATE)

Electrical Circuits: Network elements: ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of dc and ac networks, resonance, balanced three phase circuits, star-delta transformation, complex power and power factor in ac circuits.

Electrical Machines: Single-phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, equivalent circuit, starting and speed control; Synchronous machines: cylindrical and salient pole machines, performance and characteristics; Types of losses and efficiency calculations of electric machines.

Syllabus

(IES)

Electrical circuits: Circuit elements, network graph, KCL, KVL, Node and Mesh analysis, ideal current and voltage sources, Thevenin's, Norton's and Superposition theorems , transient response of DC networks, Sinusoidal steady state analysis, three phase circuits, Magnetically coupled circuits.

Electrical machines: Single phase transformers, three phase transformers - connections, auto-transformer, energy conversion principles, DC machines - types, windings, generator characteristics, starting and speed control of motors, Induction motors - principles, types, performance characteristics, starting methods, Synchronous machines - performance, regulation, motor starting, characteristics and applications.

10. List of Expert Details

The Expert Details which have been mentioned below are only a few ofthe eminent ones known Internationally, Nationally and Locally. There are a few others known as well.

INTERNATIONAL

1. Dr. Steven W. BlumeProfessor of Electrical Engineering, Dept. of Electrical Engg. University of California, NewJersey.USA.
2. Mr. Joseph A. Edminister, Emeritus of Electrical Engineering's, Uni. of Akron, Akron,Ohio

NATIONAL

1. Prof G S Punekar, Dept of EEE,NITK.
2. Prof P S Sastry, Dept of Electrical Engineering, IIScBangalore.

REGIONAL

1. Prof. Shyam Mohan S Palli, HoDof Dept, EEE, SIR CRR College Of Engineering.
2. Dr. D M VinodKumar, Professor – Dept of EEE,NITW.

EXPERTSFROM DEPARTMENTAL / INSTITUTION / GROUP OF INSTITUTIONS: (TO BE INCLUDED)

1. Dr. A S Reddy, Principal, CMREC, Kandlakoya, T.S

11. Journals for literature study:

INTERNATIONAL

1. IEEE Transactions on Circuits andSystems.
2. IEEE Proceedings Circuits, Devices andSystems.
3. IEEE Transactions on ElectricalMachines.
4. SpringerPublications.

NATIONAL

11. ElectricalIndia
12. CircuitEngineering
13. Abhinav Journal
14. Sadhana

Note: 1. Any subject in a semester is supposed to be completed in 55 to 65 periods.

Each period of 50 minutes.

Each unit duration and completion should be mentioned in the remarks column.

List of suggested books can be marked with codes like T1, T2, R1, R2 etc.

12. Subject - Lesson Plan

S.NO	TOPIC	SUB-TOPIC	NO. OF LECTURES REQUIRED	Tentative Dates for the completion of topic	Unit wise Classes
UNIT-1 DC CIRCUITS					
1	**Electrical Components, sources**	Introduction to electrical engineering, definitions	**L1**	8/11/24	16
2		Ohm's Law with limitations and problems	**L2**	11/11/24	
3		Basic circuit elements	**L3**	11/11/24	
4		Energy Sources	**L4**	12/11/24	
5	**Network reduction techniques**	Network reduction techniques – series, parallel, series-parallel	**L5**	14/11/24	
6		Open circuit, Short circuit, Voltage division and current division	**L6**	15/11/24	
7		Kirchhoff's Laws	**L7**	16/11/24	
8		Source transformation	**L8**	18/11/24	
9		Star and Delta transformations	**L9**	21/11/24	

10		Mesh Analysis	**L10**	25/11/24	
11		Nodal Analysis	**L11**	26/11/24	
12	**Theorems**	Thevenin's theorem	**L12**	28/11/24	
13		Norton's theorem	**L13**	29/11/24	
14		Superposition theorem	**L14**	2/12/24	
15		Problems	**L15**	2/12/24	
16		Transient response of series RL and RC circuit	**L16**	3/12/24	
UNIT-2 AC CIRCUITS					
17	**Single Phase AC Circuit quantities**	R.M.S. and Average values, Form Factor	**L17**	5/12/24	
18		R.M.S. and Average values, Form Factor problems	**L18**	6/12/24	
19		Phasor representation	**L19**	9/12/24	
20	**Series and parallel circuits**	AC through pure resistance, inductance	**L20**	10/12/24	
21		AC through pure capacitance and problems	**L21**	12/12/24	
22		AC through series R-L circuit	**L22**	13/12/24	
23		AC through series R-C circuit	**L23**	16/12/24	12

24		AC through series R-L-C circuit	**L24**	17/12/24	
25		AC through parallel circuits	**L25**	19/12/24	
26	**Resonance**	Resonance in series R-L-C circuit	**L26**	20/12/24	
27	**Three phase circuits**	Introduction to three phase system and relationship between line and phase quantities of three phase system	**L27**	23/12/24	
28		Problems	**L28**	24/12/24	
UNIT-3 TRANSFORMERS					
29	**Transformer basics**	Introduction to transformers	**L29**	26/12/24	
30		Working principle of transformer	**L30**	27/12/24	
31		Construction of single phase transformer	**L31**	30/12/24	
32		EMF equation	**L32**	31/12/24	
33		Ideal transformer	**L33**	16/01/25	
34		Practical transformer on no load	**L34**	17/01/25	
35		Practical transformer on load	**L35**	20/01/25	
36		Equivalent circuit of transformer referring	**L36**	21/01/25	14

		primary and secondary sides			
37		Voltage regulation	**L37**	23/01/25	
38		Losses	**L38**	24/01/25	
39		Efficiency and condition for maximum efficiency of transformer	**L39**	27/01/25	
40	**Auto transformer**	Auto transformer	**L40**	28/01/25	
41		Copper saving	**L41**	30/01/25	
42		Three phase transformer connections	**L42**	31/01/25	
UNIT-4 DC MACHINES					
43	**DC Generators**	Working principle of DC generator	**L43**	03/02/25	
44		Construction of DC machine	**L44**	04/02/25	
45		EMF equation and problems	**L45**	06/02/25	
46		Classification of DC generators	**L46**	07/02/25	
47		Losses and efficiency	**L47**	10/02/25	
48		DC generator characteristics	**L48**	11/02/25	
49	**DC Motors**	DC motor Working principle	**L49**	13/02/25	

50		Classification of DC Motors	**L50**	14/02/25	10
51		Torque equation	**L51**	17/02/25	
52		Characteristics of DC motors	**L52**	18/02/25	
UNIT V-AC MACHINES					
53	**Three phase Induction motor**	Induction motor construction	**L53**	20/02/25	08
54		working principle of Induction motor	**L54**	21/02/25	
55		Production of RMF	**L55**	24/02/25	
56		Effect of Rotor parameters	**L56**	25/02/25	
57		Torque Equation	**L57**	27/02/25	
58		Torque-Slip characteristics	**L58**	28/02/25	
59		Power stages of induction motor	**L59**	03/03/25	
60	**Alternator**	Alternator construction and working principle	**L60**	04/03/25	

13.

NOTE: **1.**Any Subject in a Semester is supposed to be completed in 55 to 65 periods.
2. Each Period is of 50 minutes.
3. Each unit duration & completion should be mentioned in the Remarks column.
4. List of Suggested books can be marked with Codes like T1, T2, R1, R2 etc.

14. Suggested books (Prescribed and references)

Basic Electrical Engineering - D.P. Kothari and I.J. Nagrath, 3rd edition 2010, Tata McGraw Hill.

D.C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill,2009.

REFERENCE-BOOKS:

e) L.S. Bobrow, Fundamentals of Electrical Engineering”, Oxford University Press,2011

f) Electrical and Electronics Technology, E. Hughes, 10th Edition, Pearson,2010

g) Electrical Engineering Fundamentals, Vincent Deltoro, Second Edition, Prentice Hall India.

15. Websites for self learning

Do not confine yourself to the list of websites mentioned here alone. Be cognizant and keep yourself abreast of the others too. The given list is not exhaustive.

1. www.mit.edu
2. www.iitk.ac.in
3. www.iitd.ernet.in
4. www.iitb.ac.in
5. www.iitm.ac.in
6. www.iitr.ac.in
7. www.iitg.ernet.in
8. www.bits-pilani.ac.in
9. www.iisc.ernet.in
10. www.circuit-magic.com
11. www.ece.rice.edu

12. www.**electrical**4u.com

10. Question banks: (Attached separately)

1. **JNTUH Model Papers**
2. **GATE**

11. Case study:

1. **Electrical circuits – a Case Study**

Abstract:

Redevelopment of engineering course from traditional to blended model is a challenging prospect. Some general guidelines are given at first, then Electric Circuit Theory (ECT) case study is discussed. Over the last six years the ECT course, at the Silesian University of Technology (SUT), has been gradually converted into blended e-course, for both the Learning Content and Assessment Program. Some details of this conversion, which is continuously updated, as well as students' feedback and the lessons learned are presented.

2. **Electrical Machines- a case study**

Abstract:

The increase in machines lab all over Indian Engineering college's energy consumption has been more apparent than such increases in the industrial and transportation sectors. The main objective of this project is to analysis the energy consumption of the machine's lab in VIT. On an periodical monitoring of these energy meter daily at a particular time for one month we can able to find the power factor, active, reactive and apparent powers of that particular lab.Thus, we can able to give solutions on what basis the load can be decreased. What amount of capacitor should be placed in order to maintain the power factor and reactive power. Thus, by plotting the graph and comparing all the outputs of the above-mentioned

monitoring process the total amount is calculated according to TNEB norms can also be calculated. And after placing the capacitor the amount in reduction of cost can also be calculated.

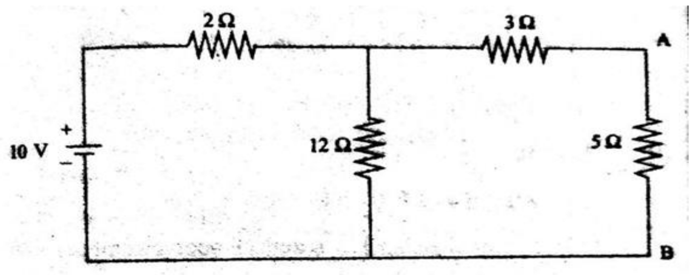
12. Assignment Questions:

UNIT-1 (DC CIRCUITS)

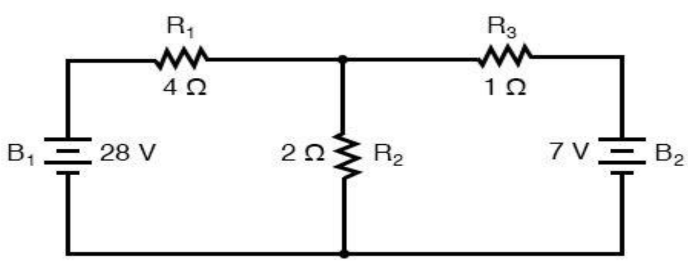
1. Explainabout(i) typesofsources, (ii) passive elements and (iii) source transformation techniques.
2. Determinethecurrent through5Ωresisterbyusing

   a. Thevenin’stheorem

   b. Norton’s theorem



3. State and explain superposition theorem and Kirchhoff’s laws.
4. Explainthetransientresponseofseries RL and RC circuit using DC excitation.
5. Find the current through each resistor using mesh and nodal techniques.



NOTE:

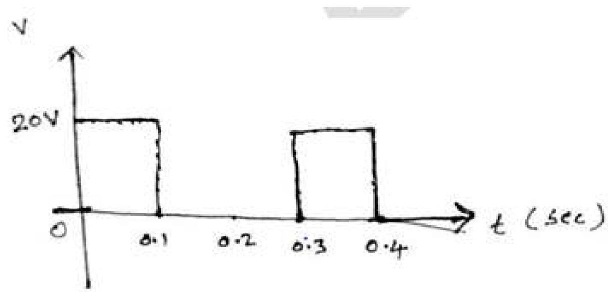
11. ProblemsbasedonKVL,KCL,meshanalysis,nodalanalysis**(practicedifferentcircuitsfromreferencebooks).**

12. Problemsbasedonthevenins,nortonsandsuperpositiontheorems.**(Practicedifferentcircuitsfromreferencebooks)**

UNIT-2 (AC CIRCUITS)

iii) (a) DerivetheexpressionforRMS and averagevalueofalternatingcurrent$I=I_m Sin\omega t$.

(b) Computetheform factorofsquarewaveformshown inbelowfigure



iv) Derivetherelationbetweenphaseandlinevoltagesandcurrentsinabalancedthreephasestar and delta connections.
v) Derive resonance frequency of series RLC circuit in terms of half power frequencies.
vi) Describe the phasor representation of series RLC circuit.
vii) Define the following terms: (i) Frequency, (ii) Peak factor, (iii) Form factor, (iv) Average value of alternating quantity.

NOTE:

1. CalculationofRMSvalue,averagevalue,formfactorandpeakfactorfordifferentwaveforms.

2. ProblemsbasedonseriesandparallelRL,RCandRLCcircuits(calculationofimpedance,admittanceandpowersetc.) ___**(practicefromreferencebooks)**

3. Problems on series resonance i.e calculation of bandwidth, quality factor, resonancefrequencyetc.**(practicefromreferencebooks)**

UNIT-3 (TRANSFORMERS)

1. Whatistransformer? Explain the working principle of transformer.
2. (a) Deriveanexpressionforemfinducedinatransformer.
   (b) Drawandderivetheequivalentcircuitparametersofsinglephasetransformer referring primary and secondary windings.
3. (a) Explain the various losses in a single phase transformer.
   4. Derive the condition for maximum efficiency in a single phase transformer.
4. Describe the principle of operation of auto transformer, what is the saving of copper in this transformerwhencomparedwithtwowindingtransformer.
5. Discussthevariousthreephasetransformerconnectionsandtheirsignificance?

NOTE:

1. Problemsbasedonemfequationandcalculationequivalentcircuitparameters.
2. Problemsoncalculationofefficiencyandregulationoftransformer.

UNIT-4 (DC MACHINES)

1. Explain the construction of DC machines.
2. (a) Explain the working principle and derive the emf equation in DC generator.
   (b) Explain the working principle and derive the torque equation in DC motor.
3. (a) Explain the losses taking place in DC machines. With the help of these losses draw power stages for a DC machines.(Motor and Generator)
   (b) Derive the condition for maximum efficiency of DC generator.
4. Explain the characteristics of DC generators. (self and separately excitation)
5. Explain the classification of DC motors.

NOTE:

1. Practice numerical Problems on DC machines.

UNIT-5(AC MACHINES)

1. Describehowtherotatingmagneticfieldisproducedin3-PhasewindingofInductionmotor. (φ_T=1.5φ_m).

2. (a) SketchandDiscussthetorque–slipcharacteristicsof3-phaseinductionmotor.

   (b) Derive the relation between rotor input (P_2), rotor cu loss (P_C) and rotor output (P_m). (1:S:1-S)

3. (a) Explain the construction and working principle of three phase induction motor.

   (b) Explain the starting methods of induction motors. (5 methods)

4. (a) Derivetheconditionmaximumtorqueunder runningconditionof3phaseinductionmotor.

   (b) Whatarethevarious lossesoccursinthethreephaseinductionmotorintheiroperation.

5. *(a)A3-phase, 60Hzinductionmotorhas2poles. Iftheslopis2%atacertainload, Determine

(i)Thesynchronousspeed.

(ii) The speedoftherotor.

(iii) Thefrequencyofinducedemfintherotor.

(b) Explain the construction and working principle of three phase alternator.

NOTE:

1. Practice the problems on three phase induction motor.

13. List of student seminars:

b Smart Dust
c Solar refrigerator
d Solar mobile charger
e Floating Power Plant
f HVDC
g Wave energy
h Power generation through Footstep
i Power generation through speed breaker
j Underwater windmills
k Electrical power Transmission and Distribution
l Rain power- Energy harvesting from the sky
m Electrical AC and DC drives
n Hybrid electric vehicles
o Applications of fuel cells
p Irrigation control system

q Power factor improvement methods
r Power system operation and control
s Renewable energy and environment protection
t Electric traction system
u Wireless power transfer through coils

14. Course File
(Attached Separately)

15. Expert Lecture:

S.NO	SUBJECT	TOPIC	YEAR	RESOURCE PERSON	DATE
1	BEE	ELECTRICAL CIRCUITS	I-I/II	Dr.D.Kishan	30/12/2024
2	BEE	ELECTRICAL MACHINES	I-I/II	Dr.D.Kishan	15/02/2025

CMR Engineering College Kandlakoya(V), Medchal Road, Hyderabad

Department of Humanities & sciences

Laboratory Improvement for Future Trends

(LIFT) **2023 - 24**

ENGINEERING CHEMISTRY LAB 1. Objectives and Relevance

2. Scope
3. Prerequisites 4. Syllabus
5. Lab Schedule
6. Viva and practical oriented quiz 7. Suggested Books
8. URL links
9. Experts' Details
10. Model making / demonstration
11. Calibration, Testing and Inspection 12. Maintenance of equipment
13. Troubleshooting 14. Science fair

1. Objectives and Relevance:

- The main objective of engineering chemistry lab is to develop the analytical ability of the students
- To make the engineering students acquainted with the modern instrumental techniques like conductometry, and potentiometry.
- To develop skills in analysis and estimation of a given sample by chemical methods.

2. Scope:

The scope of engineering chemistry lab is to introduce the engineering students with theoretical and experimental approach to the Instrumental methods of analysis as they have become popular in industrial and research laboratories due to their rapidity, accuracy, precision, convenience and computerization.

3. Prerequisites:

Basic knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. Basic knowledge of molarity, normality and volumetric analysis. In addition Laboratory skills, accuracy and precision is also required.

ENGINEERING CHEMISTRY LAB

LIST OF EXPERIMENTS:

VOLUMETRC ANALYSIS

1. Determination of Total hardness of water by complexometric method using EDTA **CONDUCTOMETRY:**
   2. Determination of concentration of strong acid by Conductometric titrations 3.Determination of concentration of weak acid by Conductometric titrations

POTENTIOMETRY:

4.Estimation of amount of Fe^{+2} by potentiometric titrations

5. Estimation of strong acid by Potentiometric titration using NaOH **PH METRY:**

6. Estimation of strong acid by pHmetry using NaOH

PREPARATIONS:

7.Preparation of Bakelite

8.Preparation of Nylon -6

9. Determination of viscosity of lubricant by using Ostwald's Viscometer 10. Preparation of Hand Sanitizer

VIRTUAL LAB EXPERIMENTS

1. Construction of fuel cell and its working
2. Smart materials for biomedical applications 3. Batteries for electrical vehicles
4. Functioning of solar cell and its applications

EXPERIMENT NO. 1

ESTIMATION OF HARDNESS OF WATER BY EDTA METHOD

OBJECTIVE

To estimate the amount of total hardness (Ca & Mg) present as ($CaCO_3$) in the given water sample by titrating against EDTA and using metal indicator.

PREREQUISITES

Hardness of water, concept regarding total, temporary and permanent hardness. Basic knowledge of Unit of hardness and its conversion.

DESCRIPTION

a. Introduction to experiment -30 min b. Experimental construction
c. Titration of solutions
d. Determining the end point

APPLICATIONS

1.The determination of water hardness is a useful test that provides a measure of quality of water for households and industrial uses.
2. Estimation of hardness of water is important to fish culture and is a commonly reported aspect of water quality.

EXPERIMENT NO.2

DETERMINATION OF CONCENTRATION OF STRONG ACID BY CONDUCTOMETRIC TITRATIONS

OBJECTIVE

Determination of strength and equivalence point of a titration based upon the measurement of the conductance.

PREREQUISITES

Concept of Electrochemistry, Conductance, Resistance, cell constant, units. **DESCRIPTION**

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications c. Experimental determination of conductance

d. Graphical determination of values obtained **APPLICATIONS**

1.Solubility of sparingly soluble salts 2.Ionic product of water.

3.Basicity of organic acid. 4.Salinity of sea water

5.Chemical equilibrium in ionic reactions. reported aspect of water quality.

EXPERIMENT NO.3

DETERMINATION OF CONCENTRATION OF WEAK ACID BY CONDUCTOMETRIC TITRATIONS

OBJECTIVE

Determination of strength and equivalence point of a titration based upon the measurement of the conductance.

PREREQUISITES

Concept of Electrochemistry, Conductance, Resistance, cell constant, units. **DESCRIPTION**

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications c. Experimental determination of conductance

d. Graphical determination of values obtained **APPLICATIONS**

1.Solubility of sparingly soluble salts 2.Ionic product of water.

3.Basicity of organic acid. 4.Salinity of sea water

5.Chemical equilibrium in ionic reactions. reported aspect of water quality.

EXPERIMENT NO.4

ESTIMATION OF THE AMOUNT OF Fe^{+2} BY POTENTIOMETRY

Estimation of amount of Fe^{+2} by measuring its potential using potentiometer. **PREREQUISITES**
Basic knowledge of electro chemistry potential measurements, concepts of molarity E.M.F. concepts
DESCRIPTION
a. Introduction to experiment -30 min
b. Connection of experiment and its verifications c. Experimental determination of potentials
d. Graphical determination of values obtained **APPLICATIONS**
□1.The determination of equivalence point by this method depends upon a series of independent observations rather than on one judgement. The method thus, gives very reliable results.
□2.Mono segemented flow potentiometric titration for the determination of chloride in milk and wine
□3.Extremely dilute solutions may also be titrated by this method.
□4.The method is of particular use in the titration of highly coloured solutions where indicators cannot be used.

EXPERIMENT NO. 5

ESTIMATION OF AMOUNT OF STRONG ACID BY POTENTIOMETRY

OBJECTIVES

Estimation of amount of strong acid by measuring its potential using potentiometer. **PREREQUISITES**

Basic knowledge of electro chemistry potential measurements, concepts of molarity E.M.F. concepts

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications c. Experimental determination of potentials

d. Graphical determination of values obtained **APPLICATIONS**

□1.The determination of equivalence point by this method depends upon a series of independent observations rather than on one judgement. The method thus, gives very reliable results.

□2.Mono segemented flow potentiometric titration for the determination of chloride in milk and wine

□3.Extremely dilute solutions may also be titrated by this method.

□4.The method is of particular use in the titration of highly coloured solutions where indicators cannot be used.

EXPERIMENT NO. 6

DETERMINATION OF STRONG ACID CONCENTRATION BY pH METER

OBJECTIVE

Determination of strength of a given solution by measuring pH values using pHmeter.

PREREQUISITES

Basic knowledge of electro chemistry, concepts of normality ,Nernst equation , basic knowledge of pH values

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications c. Experimental determination of pH values

d. Graphical determination of values obtained **APPLICATIONS**

1.The determination of equivalence point by this method depends upon a series of independent observations rather than on one judgement. The method thus, gives very reliable results.

2.Extremely dilute solutions may also be titrated by this method.

3.The method is of particular use in the titration of highly coloured solutions where indicators cannot be used.

EXPERIMENT NO. 7

PREPARATION OF BAKELITE OBJECTIVE

Objective of this experiment is to give the practical experience of synthesis of phenol resins

PREREQUISITES

Basic knowledge of Polymer chemistry and resins .Knowledge of use of reactants like

DESCRIPTION

a. Introduction to experiment -30 min
b. mixing of reactants in measured quantities c. obtaining the product by filtration
d. determining the weight of final product

APPLICATIONS

They are used for making moulded articles such as radio and TV parts, combs, fountain pen barrels, phonograph records etc. They are used for making decorative laminates, wall coverings etc. They are used for making electrical goods such as switches, plugs etc. They are used for impregnating fabrics wood and paper.

EXPERIMENT NO. 8

PREPARATION OF NYLON - 6

OBJECTIVE

Objective of this experiment is to give the practical experience of synthesis ofsynthetic fibres.

PREREQUISITES

Basic knowledge of Polymer chemistry andsynthetic fibres

DESCRIPTION

a. Introduction to experiment -30 min

b. mixing of reactants in measured quantities c. obtaining the product by filtration

d. determining the weight of final product

AP

it's often used in gears, brushings, and plastic bearings due to its durable, and low-friction properties.

marine applications for towing and docking

9. DETERMINATION OF VISCOSITY OF LUBRICANT BY USING OSTWALD'S VISCOMETER

OBJECTIVE
To determine the internal resistance of a liquid to flow by use of Viscometer.

PREREQUISITES
Concept and different properties of Viscosity. Effect of Temp and other factors on viscosity.

DESCRIPTION
a. Introduction to experiment -30 min b. introducing lubricants
in Viscometer
c. Recording and Tabulating the Time flow (secs) d. calculation of Viscosity

APPLICATIONS
1.This method can be employed to find the viscosity of lubricants and different liquids.
2.Determination of Molecular weight by Viscometric method.

10. Preparation of Hand Sanitizer **OBJECTIVE**
Objective of this experiment is to give the practical experience of synthesis of HAND SANITIZER

PREREQUISITES
Basic knowledge of anti bacterial activity of solutions

DESCRIPTION
a. Introduction to experiment -30 min
b. mixing of reactants in measured quantities c. obtaining the product by mixing
d. determining the volume of final liquid

A

Hand sanitiser kills pathogens present on our hands and diminishes transmission of germ also from one person to another.

Sanitisers have ethyl alcohol, isopropyl alcohol, and the antibacterial substance triclosan. The use of hand sanitiser can help us fight against the

Coronavirus effectively.

VIRTUAL EXPERIMENTS

1. CONSTRUCTION OF FULE CELL AND ITS WORKING **OBJECTIVE**

Objective of this experiment is the Construction of fuel cell and its working **PREREQUISITES**
Basic knowledge of batteries and combustion **DESCRIPTION**
a. Introduction to experiment -30 min

A

Fuel cell electric vehicles, or FCEVs, use clean fuels and are therefore more eco-friendly than internal combustion engine-based vehicles.

They have been used to power many space expeditions including the Appolo space program.

Generally, the byproducts produced from these cells are heat and water. The portability of some fuel cells is extremely useful in some military applications.

These electrochemical cells can also be used to power several electronic devices.

Fuel cells are also used as primary or backup sources of electricity in many remote areas.

2. SMART MATERRIALS FOR BIOMEDICAL APPLICATIONS

Smart materials are having ability to change its shape according to the external stimulus like temperature, pressure, electric field, magnetic field, etc. These materials
includes piezoelectric materials, magnetorheostatic materials, electrorheostatic materials, and shape memory alloy.

Remote Monitoring and Automated Healthcare SystemsRemote monitoring of patients' healthcare is a growing trend that goes beyond traditional healthcare and into mainstream culture. Smart watches and fitness trackers have become standard for many peaople, monitoring health factors like heart rate, blood oxygen, irregular heartbeat monitoring, and more.

For example, connected inhalers are a smart technology in healthcare that saves lives by helping patients track usage and by reminding them when to take a dosage to maintain a healthy schedule.

66% of asthma deaths could have been prevented with smart technology monitoring like connected inhalers

There are a number of different wearable items or devices patients can keep on their person to help improve overall healthcare, including:

Biosensors
Smart thermometers Connected
inhalers Smart watches
Fitness trackers (FitBits)

ECG monitors

Blood pressure monitors

3.Batteries for electrical vehicles

The following energy storage systems are used in all-electric vehicles, PHEVs, and HEVs.

Lithium-Ion Batteries

Lithium-ion batteries are currently used in most portable consumer electronics such as cell phones and laptops because of their high energy per unit mass relative to other electrical energy storage systems. They also have a high power -to-weight ratio, high energy efficiency, good high-temperature performance, and low self-discharge. Most components of lithium-ion batteries can be recycled, but the cost of material recovery remains a challenge for the industry. The U.S. Department of Energy is also supporting the Lithium-Ion Battery Recycling Prize to develop and demonstrate profitable solutions for collecting, sorting, storing, and transporting spent and discarded lithium-ion batteries for eventual recycling and materials recovery. Most of today's all-electric vehicles and PHEVs use lithium -ion batteries, though the exact chemistry often varies from that of consumer electronics batteries. Research and development are ongoing to reduce their relatively high cost, extend their useful life, and address safety concerns in regard to overheating.

Nickel-Metal Hydride Batteries

Nickel-metal hydride batteries, used routinely in computer and medical equipment, offer reasonable specific energy and specific power capabilities. Nickel-metal hydride batteries have a much longer life cycle than lead-acid **batteries** and are safe and abuse tolerant. These batteries have been widely used in HEVs. The main challenges with nickel-metal hydride batteries are their high cost, high self-discharge and heat generation at high temperatures, and the need to control hydrogen loss.

Lead-Acid Batteries

Lead-acid batteries can be designed to be high power and are inexpensive, safe, and reliable. However, low specific energy, poor cold-temperature performance, and short calendar and lifecycle impede their use. Advanced high-power lead-acid batteries are being developed, but these batteries are only used in commercially available electric-drive vehicles for ancillary loads.

4.FUNCTIONING OF SOLAR CELL AND ITS APPLICATIONS **Solar Cell**

Solar Cell is an energy conversion device which are used to convert sunlight to electricity by the use of the photovoltaic effect.

This is also known as **photovoltaic cell** (**PV Cell**).

The term **Solar Cell** designates to capture energy from sunlight, where **PV** cell is referred to an unspecified light source.

The first practical solar cell was produced in 1954 using **Selenium** (Se). This solar cell could convert only **1%** solar energy into electricity. Present day solar cells have efficiency as high as **25%.**

Now a days, Solar cells are usually produced from **semiconductors**, such as Silicon and Gallium. A single Solar cell produces very small current at a small potential difference.

So, for practical use, a large number of such solar cells are connected together. A combination of a large number of solar cells is called a **solar cell panel.** **Albert Einstein** is known as the father of solar cells.

Solar Cell Definition

A device which converts the sunlight directly into electricity is called a **solar cell.**

Solar Cells are often coated with transparent thin film of silicon monoxide (**SiO**) to minimise the reflective losses from the surface.

Solar cells panel

A **solar cell panel** can provide stronger currents under high potential difference. They use for producing electricity for use in space stations and artificial satellites.

5. LAB SCHEDULE: The week wise schedule:

B1□1 TO 30 B2□31 TO 60

Every batch will contain **6Groups** which comprises of **5Students**

6.VIVA/QUIZ

Viva Questions:
Marks allotted – 5 marks
Group of people : 30 students are allotted in a session 6 groups of 4 people each in a session
2 groups of 3 people each in a session

Quiz Plan:

• Written exam • Oral
• Quiz on ppt •
Practical test

VIVA SCHEDULE:

<table>
<tr><th>Batch</th><th>wk 1</th><th>wk-2</th><th>wk-3</th><th>wk-4</th><th>wk-5</th><th>wk-6</th><th>wk-7</th><th>wk-8</th><th>Wk-9</th><th>wk-10</th><th>wk-11</th><th>wk-12</th><th>wk-13</th><th>wk-14</th></tr>
<tr><td>B1</td><td></td><td></td><td>VIVA</td><td></td><td></td><td rowspan="2">INTERNAL 1</td><td>VIVA</td><td rowspan="2"></td><td>VIVA</td><td></td><td></td><td>VIVA</td><td></td><td rowspan="2">INTERNAL-2</td></tr>
<tr><td>B2</td><td></td><td></td><td></td><td>VIVA</td><td>VIVA</td><td></td><td></td><td>VIVA</td><td>VIVA</td><td></td><td>VIVA</td></tr>
</table>

LAB INTERNAL

SCHEME OF EVALUATION OF LABS ACADEMIC YEAR 2023 -24

LAB INTERNAL:							
Day to Day Evalution- 20					**Internal Exam-20**		
Uniform	**Observation & Record**	**Performance Of the Experiment**	**Result**	**Viva**	**Write up**	**Execution & Results**	**Viva**
Marks-3	**Marks-3**	**Marks-4**	**Marks-5**	**Marks-5**	**Marks-10**	**Marks-8**	**Marks-2**
Total Marks- 40							

7. SUGGESTED BOOKS

REFERENCE BOOKS:

1.Lab manual for Engineering chemistry by B.Ramadevi and P.Aparna , S.Chand publications New Delhi (2022)
2. Vogel’s text book of practical organic chemistry 5th edition
3. inorganic quantitative analysis bya.i.vogel , ELBS publications 4. College practical chemistry by V.K. Ahluwalia , Narosa Publications Ltd. New Delhi (2007)

URL LINKS

1. DETERMINING TOTAL HARDNESS IN WATER

2. Conductometric Titrations, Potentiometric titrations, Hardness of water, colorimetry**………Video demonstrations**
https://www.youtube.com/watch?v=amFOhvc6p74
3.Determination of concentration of weak acid by Conductometric titrations
https://www.tau.ac.il/~chemlaba/Files/conductometry-titrations.pdf
https://www.youtube.com/watch?v=Dc4aUdADqY8
http://www.coaleducation.org/lessons/sec/properties/coalmoi.htm 4.Estimation of amount of Fe+2 by potentiometric titrations https://www.youtube.com/watch?v=xQ5U6McQ0XU
http://www.tau.ac.il/~advanal/PotentiometricTitrations.htm..... **Procedures 5.** Estimation of strong acid by Potentiometric titration using NaOH
https://www.youtube.com/watch?v=6CC9byzWszk

http://ion.chem.usu.edu/~sbialkow/Classes/361/mixed/titration

https://www.aakash.ac.in/important-concepts/chemistry/bakelite 8.Preparation of Nylon -6

.9.Determination of viscosity of lubricant by using Ostwald's Viscometer
https://www.youtube.com/watch?v=YslaWEpTDWk

https://www.youtube.com/watch?v=LTjWwF-1_Mg
VIRTUAL EXPERIMENTS
1. Construction of fuel cell and its working :https://www.youtube.com/watch?v=Tv8ANj-_L6c 2. Smart materials for biomedical applications : https://www.youtube.com/watch?v=qjo21rIp2aA 3. Batteries for electrical vehicles: https://www.youtube.com/watch?v=2ZZqYv8ubP8
4. Functioning of solar cell and its application :s https://www.youtube.com/watch?v=X0OZ6tpZ3Mc

9. Experts' Details

The expert details which have been mentioned below are only a few of the eminent ones known Internationally, Nationally and Locally.

International

Jonathan Paul Clayden (1968–),Professor of organic chemistry . University of Manchester.

National

Prof. S.S DARA
Professor chemistry Department
Nagpur University Email.drar.s.s@yahoo.com

Regional

Dr. CH. VENKATA RAMANA REDDY
Professor of Chemistry & *Director*, University Industry Interaction Centre
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
Kukatpally, HYDERABAD-500 085, Telangana, INDIA
Email: vrr9@jntuh.ac.in, vrr9@yahoo.com, Phone: +91-98858 27579

Dr. T. PARTHASARATHY, Principal & Professor
University College of Science Saifabad, Osmania University,
Hyderabad – 500 004.
Fax: +91 48 23386136 ,
Ph.no :040-23393530

In house experts;

•Dr. K.V.Reddy
Prof. in Chemistry(HOD H&S Dept) CMR Engg. College
Kandlakoya Medchal Ph No; 9248727228

•Dr. S.P. SINGH Prof. in Chemistry
CMR Engg. College
Kandlakoya Medchal Ph No; 8008715058

10. Model Making/ Demonstration:

a. Differentiating hard water and Soft water.

b.

Demonstration of nylon preparation. d. Determine whether Sulfuric acid or Sodium

Sulfate is a stronger electrolyte in electrolysis (which one causes Hydrogen gas to be produced more)

e. Test Different Kinds of Water for pH, Dissolved Oxygen, Nitrate, Phosphates, Coliform Bacteria, Iron and Hardness

11.Calibration Testing and Inspection: 1.Calibration of conductometer.
2.Calibration of thermometer.

Calibration of conductivity meter
This conductivity meter calibration procedure can be used to calibrate any standard electrical conductivity meter instruments.
Things required:
Conductivity meter to be calibrated. a
plastic cup
Sodium chloride (NaCl) standard solution.
Distilled water
Conductivity meter calibration instructions
Take the standard Sodium Chloride solution in the plastic cup.Immerse the electrodes of conductivity meter in to the solution.Turn on the instrument and let it settle in the standard solution for few minutes.Press the calibrate button on the instrument and keep adjusting the conductivity values till it matches with the conductivity reading of the standard solution used. It usually is 2.76mS/cm.Once calibration is completed, Turn off the conductivity meter and wash the electrodes with distilled water.
Now the calibration is complete, you can use the calibrated conductivity probe to calculate the conductivity of solutions. Calibrate the conductivity probe regularly for accurate results.

THERMOMETER CALIBRATION

The accuracy of your melting-point determinations can be no better than the accuracy of your thermometer. Often one simply assumes that the thermometer has been accurately calibrated. Although frequently this is the case, it is not always true. Thermometers can give high or low temperature readings of one or two degrees or more. A thermometer can be calibrated with a series of compounds that are readily available in the pure state and whose melting points are easy to reproduce. A useful series of such compounds is given in the Table below.In addition to these standards, measure the melting point of ice by simply measuring the temperature of a beaker of ice water. Record the temperature deviation of your thermometer at a number of these points. Plot observed temperature against temperature correction and interpolate to correct the future determinations. Usually these plots are linear.

Compound Melting Point, °C

Water* 100 (bp) Benzoic Acid

122

*Measure temperature of boiling water Procedure:

1. Examine thermometer to be sure that its range is appropriate and that there are no breaks in the fluid.
2. Use a mortar and pestle to crush the crystalline solid into a fine powder.
3. Introduce the powdered, dry solid sample into a capillary tube that is sealed at one end. 4. Place the capillary tube in the melting-point apparatus.
5. Adjust the rate of heating so that the temperature rises at a moderate rate. This can be a faster rate if, for example, the melting point is 170°C rather than 70°C.
6. When a temperature 15°-20° below the expected melting pint is reached, decrease the rate of heating so that the temperature rises only one to two degrees per minute. Note: There is a time lag on electrically heated devices before the rate of heating changes. 7. If the temperature is rising more than one to two degrees per minute at the time of melting, retake the melting point, using a new sample.
8. Record the melting range as the range of temperatures that begins with the onset of melting and ends with the temperature at which only liquid remains in the tube.

12. MAINTENANCE OF EQUIPMENT, GLASSWARE & CHEMICALS

- **Dusting of equipments** must be done regularly.

  Glass electrodes must be dipped in water / solvents always.

- uld be repaired immediately, if not repaired should be informed to the higher

authorities.

- **Labels** of chemicals, reagents, must be monitored regularly.

- Glass apparatus must be **washed** with chromic acid and **dried** with out fail.

MAINTENANCE OF EQUIPMENT, GLASSWARE & CHEMICALS:

13. Troubleshooting:

•Glass Apparatus must be washed thoroughly with chromic acid. •Glass Apparatus must be dry.
•Fresh H SO must be used in aspirin preparation if reaction do not occur. •Normality of the solutions need to be standardised if values are not satisfactory •Cuvettes must be rinsed thoroughly with deionised water.

14. Science Fair:

1. PREPARATIONS: Paracetamol from p-amino phenol. Any other useful compounds.

2. CHARTS : Common Safety Symbols : Polymers and objects :

Symbols & formulae

Puzzles : Crossword, Identification of the words 3. WORKING MODELS/EXPT:

Ex: Electroplating (Deposition of Cu on metal rod). Purification of water by using alum. Electrolysis

of water.

Separation of pigments by Chromatography. Nylon preparation

Lemon battery. 4.PPT

PRESENTATIONS:

Mechanism of polymerisation 5. MODELS:

THERMOCOL: Preparation of 3D monomers & polymer.

3D structures of simple molecules. Ex H O, CH_4,$=CH_2$ etc

14. Science Fair:

MODELS:

THERMOCOL: Preparation of 3D monomers & polymer. 3D structures of simple molecules. Ex H_2O, CH_4,$=CH_2$, CH4 etc

Addition polymerisation

Condensation polymerisation

Electroplating

The Lemon Battery

A working voltaic cell made using a lemon and strips of copper and zinc.

Which is the anode and which is the cathode?

Zn is anode & Cu is cathode

What process goes on at the anode and cathode?

Oxidation at anode, reduction at cathode.

Which process are electrons lost? Oxidation

What role does the lemon play in the battery?

Salt bridge

CMR ENGINEERING COLLEGE

UGC AUTONOMOUS

(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)

Department of Humanities and Sciences

LAB IMPROVEMENT PROGRAM FOR FUTURE TRENDS (LIFT) PLANNER
A.Y-2024-25

BASIC ELECTRICAL ENGINEERING LAB

Basic Electrical Engineering Laboratory Details

CONTENTS

v OBJECTIVES AND RELEVANCE

This lab introduces the basic concepts of Electrical technology, which forms the core of the advanced concepts in the area of Electrical. The emphasis is laid on the basic circuit designing to the solutions of complex circuits, also concepts regarding working of electrical machines and measuring equipments is explored. In this lab we get the idea of flow of current and voltage in simple and complex circuits practically.

w SCOPE

The scope of this lab is to provide a thorough knowledge of the flow of voltage and current in electrical networks and circuits. To find the different application of machines and network reduction techniques. It also provides the insight of the working and applications of electrical machines and measuring instruments.

x PREREQUISITES

Before the start of the experiments one should have the knowledge of voltage, current, basic electrical components, relation between V and I w.r.t electrical components, difference between ac and dc.

y SYLLABUS – CMREC Autonomous

PART-A

S. No	Name of the Experiment
1	Verification of Ohms Law
2	Verification of KVL and KCL
3	Transient Response of Series RL, RC and RLC circuits using DC excitation
4	Verification of Thevenin's and Norton's theorems.
5	Verification of Superposition theorem
6	Resonance in series RLC circuit

7	Calculations and Verification of Impedance and Current of RL, RC and RLC series circuits
8	Load Test on Single Phase Transformer (Calculate Efficiency and Regulation)
9	Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star)
10	Measurement of Active and Reactive Power in a balanced Three-phase circuit
11	Performance characteristics of DC Shunt motor
12	Performance characteristics of three phase induction motor
13	No-Load Characteristics of a Three-phase Alternator

Exp1: Verification of Ohms Law

OBJECTIVE: This is the basic experiment to calculate the current flow and voltage across any elements.

PREREQUISITES: Basic circuit building, Understanding the meaning of voltage and current.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications.

c. Experimental determination of voltage and current in the circuit.

d. Verifying the practical values by comparing with theoretical calculations.

APPLICATIONS

1. Current and Voltage values in closed loop circuits.

2. Describe the relation of values of currents that flow through a junction point, in an electrical circuit.

3. Describe the relation of values of voltages in an electrical circuit loop, in an electrical circuit.

4. Calculation of component values in a electric circuit.

Exp2: Verification of KCL and KVL

OBJECTIVE: This is the basic experiment to calculate the current flow and voltage across any elements.

PREREQUISITES: Basic circuit building, Understanding the meaning of voltage and current.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications.

c. Experimental determination of voltage and current in the circuit.

d. Verifying the practical values by comparing with theoretical calculations.

APPLICATIONS

1. Current and Voltage values in closed loop circuits.

2. Describe the relation of values of currents that flow through a junction point, in an electrical circuit.

3. Describe the relation of values of voltages in an electrical circuit loop, in an electrical circuit.

4. Calculation of component values in a electric circuit.

Exp3: Transient Response of Series RL, RC and RLC circuits using DC excitation

OBJECTIVE: To plot the transient response of series RL, RC and RLC circuits.

PREREQUISITES: Basic circuit building and solutions of differential equations and series RL and RC circuits.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications.

c. Experimental determination of voltage and current in the circuit.

d. Verifying the practical values by comparing with theoretical calculations

APPLICATIONS:

- To know the behavior of the coil.

Exp 4: Verification of Thevenin's and Norton's Theorems.

OBJECTIVE: To verify thevenin's and norton's theorems theoretically and practically.

PREREQUISITES: Knowledge of mesh amd nodal techniques.

DESCRIPTION: a. Introduction to experiment and theoretical calculations- 45min.

b. Connection of experiment and its verifications.

c. Calculation of load currcnt.

d. Verifying the theoretical and practical values.

APPLICATIONS: Reduction of complexity circuit solving.

Exp 5: Verification of Superposition theorem.

OBJECTIVE: To verify superposition theorem theoretically and practically.

PREREQUISITES: Knowledge of mesh and nodal techniques.

DESCRIPTION: a. Introduction to experiment and theoretical calculations- 45min.

b. Connection of experiment and its verifications.

c. Calculation of current.

d. Verifying the theoretical and practical values.

APPLICATIONS: Reduction of complexity circuit solving.

Exp 6: Series resonance

OBJECTIVE: TO obtain the resonance condition and calculations of resonant frequency, bandwidth and q-factor

PREREQUISITES

Basic circuit building, Understanding the meaning of voltage and current, Knowledge of quality factor, bandwidth and selectivity of resonant circuit, Q - factor of other types of resonant forms.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications.

c. Experimental determination of voltage and current in the circuit.

d. Verifying the practical values by comparing with theoretical calculations

APPLICATIONS

3. Resonance can be employed to maintain AC circuit oscillations at a constant frequency.
4. Resonance can be exploited for its impedance properties: either dramatically increasing or decreasing impedance for certain frequencies.
5. Series resonance can be used as a "trap" if connected across a voltage source.
6. A parallel one can be used to tune a radio station.

Exp 7: Calculations and Verification of Impedance and Current of RL, RC and RLC series circuits

OBJECTIVE: TO calculate and Verify Impedance and Current of RL, RC and RLC series circuits

PREREQUISITES

Basic circuit building, Understanding the meaning of voltage and current, Knowledge of quality factor, bandwidth and selectivity of resonant circuit, Q - factor of other types of resonant forms.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications.

c. Experimental determination of voltage and current in the circuit.

d. Verifying the practical values by comparing with theoretical calculations

APPLICATIONS

5. Resonance can be employed to maintain AC circuit oscillations at a constant frequency.
6. Resonance can be exploited for its impedance properties: either dramatically increasing or decreasing impedance for certain frequencies.
7. Series resonance can be used as a "trap" if connected across a voltage source.
8. A parallel one can be used to tune a radio station.

Exp 8: Load Test on single phase transformer to calculate efficiency and regulation

PREREQUISITES: Basics of transformers and principle of operation of transformer.

DESCRIPTION

a. Introduction to experiment – 30 min

b. Connection of experiment and its verification.

c. Experimental determination of efficiency and regulation.

APPLICATIONS

1. Determination of efficiency of transformer.

2. Determination of regulation of transformer

Exp 9: Three Phase Transformer. Verification of relation between voltages and currents (Star-delta, Delta delta, Delta star, delta delta)

PREREQUISITES: Operation of three phase transformer and star delta connections.

DESCRIPTION

a. Introduction to experiment – 30 min

b. Connection of experiment and its verification.

APPLICATIONS:

4. Star-Star: Used for high voltage purpose,
5. Stat-Delta: Used for high voltage, high current.
6. Delta-Delta: Used for high current
7. Delta-Star: Used for high current, high voltage purpose.

Exp 10: Measurement of active and reactive power in a balanced three phase circuit:

PREREQUISITES: Basics of three phase circuits.

DESCRIPTION

a. Introduction to experiment – 30 min

b. Connection of experiment and its verification.

c. Measurement of active and reactive powers.

APPLICATIONS:

h) Used for commercial applications.

Exp 11: Performance characteristics dc shunt motor.

OBJECTIVE

To conduct the brake test on a given D.C shunt motor and to draw its performance curves.

PREREQUISITES

Basic laws of electromagnetism, principle of operation, types of DC generators and Motors. Basic knowledge about 3-point starter, field and armature peed control of DC motor

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications

c. Experimental determination of efficiency.

d. Graphical determination of efficiency, torque, speed and current.

APPLICATIONS

13. They are used for general lighting.
14. They are used to charge battery because they can be made to give constant output voltage.
15. They are used for giving the excitation to the alternators.

Exp 12: Performance characteristics of 3 phase induction motor:

OBJECTIVE

To conduct the brake test on a given three phase induction motor and to draw its performance curves.

PREREQUISITES

Basic laws of electromagnetism, principle of operation of three phase induction motor. Basic knowledge about auto transformer starter.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications

c. Experimental determination of efficiency.

d. Graphical determination of efficiency, torque, speed and current.

APPLICATIONS

6. Used for commercial applications.

Exp 13:No load characteristics of three phase alternators.

OBJECTIVE:To understand the performance of three phase alternator.

PREREQUISITES

Basic laws of electromagnetism, principle of operation of three phase alternator. Basic knowledge about three point starter.

DESCRIPTION

a. Introduction to experiment -30 min

b. Connection of experiment and its verifications

c. Graphical determination of OCC of alternator.

APPLICATIONS

2. Used for commercial applications.

EXPERIMENT

LEAD EXPERIMENT: OC and SC tests on Single Phase Transformer

OBJECTIVE: To conduct Open circuit and Short circuit tests on 1-phase transformer to pre-determine the efficiency, regulation and equivalent parameters.

PREREQUISITES

Principle of operation of transformer. Procedure for conducting OC and SC tests and theoretical knowledge on calculations of loses and efficiency.

DESCRIPTION

a. Introduction to experiment – 30 min

b. Connection of experiment and its verification.

c. Experimental determination of losses and efficiency.

APPLICATIONS

1. Determination of efficiency of transformer.
2. Determination of regulation of transformer

BEE LAB COURSE OUTCOMES:

C108/208.1	Identify Circuit Currents and Voltages using Kirchhoff's Laws
C108/208.2	Apply Ohm's Law to calculate voltage and current.
C108/208.3	Examine AC circuits to Solve for Resonance and Time Response
C108/208.4	Determine Characteristics & Efficiency for DC and AC Machines
C108/208.5	Measure Efficiency and Regulation of a Transformer

6. VIRTUAL LAB EXPERIMENT

PSPICE(Personal Computer Simulation Program with Integrated Circuit Emphasis) **SIMULATION OF Nodal analysis for DC circuits**

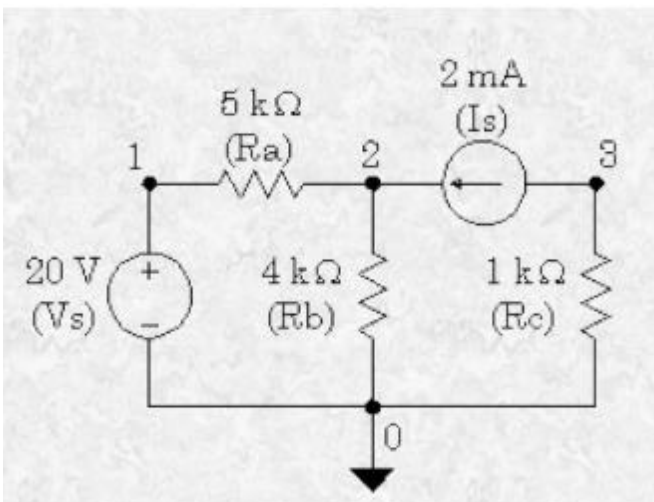
INTRODUCTION:

To obtain current and voltage in a DC circuit, the analysis is performed with the simple Load Bias Point.
If any AC sources are present in the circuit, those sources are set to zero. All capacitors are replaced by the pen-

circuit, and all inductors are replaced by short circuits. From the Analysis menu, choose Setup. The Analysis setup dialog box appears. Click the Enabled check box in the Bias Load Point option. To monitor a DC node voltage a VIEWPOINT is placed at that node. To obtain the DC current in a branch an IPROBE is placed in that branch. The reference direction of current for the circuit elements is from the first listed subscript to the second one. You may have to rotate the IPROBE from the Edit Menu (or use Ctrl R), so that the reading is in the assumed direction of current. To see the IPROBE direction of current, from the Analysis menu open the Examine Netlist file and check the order of element nodes.

AIM: To Simulate the DC Circuit for determining the all node voltages using PSPICE. **SOFTWARE REQUIRED:** PSPICE – Personal Computer Simulated Program with Integrated Circuit Emphasis.

Program:




```
Vs   1   0   DC   20.0V
Ra   1   2   5.0k
Rb   2   0   4.0k
Rc   3   0   1.0k
Is   3   2   DC   2.0mA
.END
```

Output : NODE VOLTAGE NODE VOLTAGE NODE VOLTAGE NODE VOLTAGE (1) 20.0000 (2) 13.3330 (3) -2.0000 <== Results VOLTAGE SOURCE CURRENTS NAME CURRENT Vs -1.333E-03 <== Current entering node 1 of Vs TOTAL POWER DISSIPATION 2.67E-02 WATTS JOB CONCLUDED TOTAL JOB TIME .26

7. SUGGESTED BOOKS

1. Electrical Machines, I.J. Nagrath and D. P.Kothari, TMH publishers, 3rd publishers

2. Electro Mechanics-I(D.C.Machines), S. Kamakshaiah, Right Publishers
3. Electrical Machines, P.S Bhimbra, Khanna publications.
4. Fundamentals of Electronic Devices and Circuits, David A. Bell 5th Ed.
5. Electronic Devices and Circuits – K. Lal Kishore, 2ed. 2005, BSP
6. Millman's Electronic Devices and Circuits – J.Millman, C.C Halkias and Satyabrata , 2ed. 1998, TMH.

8 USEFUL WEBSITES

3. http://www.svecw.edu.in/docs/eeeemlab.pdf
4. http://iitg.vlab.co.in/?sub=61&brch=168&sim=913&cnt=1698
5. www.vimicrosystems.com/vi/Web.../2_**Electrical**%20**Machines**%20**lab**
6. http://www.slideshare.net/sai55chaitanya/electrical-machines-2-lab-manual
7. http://www.sjcetpalai.ac.in/eee-labs
8. http://www.squ.edu.om/Portals/67/Form&Downloads/ECCE4356_Lab_Manual.pdf
9. http://www.nepindia.com/
10. http://electricallabs.lakeheadu.ca/yeartwo/eng2258/man2258.pdf

9 EXPERTS DETAILS

INTERNATIONAL

1. Mr. Clayton R Paul, BS, MS, PhD.
   Professor of Electrical and computer engineering,
   School of Engineering,
   Mercer University, Macom, Georgia-31207,
   www.faculty.mercer.edu.paul_cr.
2. Dr. Edward Wai-chau Lo, M.Phil.
   Honorary Associate Professor
   University of Hong Kong
   E-mail: eewclo@poly.edu.hk

NATIONAL

1. Prof. D.P. Kothari
   Dy. Director (Admin.), IIT – Delhi
   Hauzkhas, New Delhi - 110016
   E-mail: dpko71@yahoo.com / dkothari@ces.iitd.ernet.in
2. Dr. Sivaji Chakravorti
   Professor, EEE Department
   Jadavpur University
   Kolkatta - 700032, India
   E-mail: sivaji@dvu.a.c.in / s_chakravorti@ieee.org

REGIONAL

1. Prof. Dhanvanthri
   Head of EEE Department
   CVR Engineering College, Hyderabad
2. Prof. A.D. Rajkumar
   Electrical Engineering Dept.
   CVR Engineering College, Hyderabad

10. LAB SCHEDULE

The lab schedule should be planned once in a week. The week wise scheduled experiment should be completed.

CYCLE 1

Batches	week-1	week-2	week-3	week-4	week-5	week-6	week-7
B1	Demo	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6
B2	Demo	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.1
B3	Demo	Exp.3	Exp.4	Exp.5	Exp.6	Exp.1	Exp.2
B4	Demo	Exp.4	Exp.5	Exp.6	Exp.1	Exp.2	Exp.3
B5	Demo	Exp.5	Exp.6	Exp.1	Exp.2	Exp.3	Exp.4
B6	Demo	Exp.6	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5

CYCLE 2

Batches	week-1	week-2	week-3	week-4	week-5	week-6	week-7
B1	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7
B2	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.1
B3	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.1	Exp.2
B4	Exp.4	Exp.5	Exp.6	Exp.7	Exp.1	Exp.2	Exp.3
B5	Exp.5	Exp.6	Exp.7	Exp.1	Exp.2	Exp.3	Exp.4
B6	Exp.6	Exp.7	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5

VIVA SCHEDULE:

The viva schedule should be planned prior starting to the lab experiment.

ROUND – 1

Batches	week-1	week-2	week-3	week-4	week-5
B1,B2,B3	viva				
B4,B5,B6		viva			
B1,B2,B3			viva		
B4,B5,B6				viva	
B1 to B6					viva

ROUND - 2

Batches	week-1	week-2	week-3	week-4	week-5
SG1	viva				
SG2		viva			
SG3			viva		
SG4				viva	
SG5					viva

*SG: Selected Group with a maximum of 6 or 12 students

(C). SCHEME OF EVALUATION

LAB INTERNAL: 40 Marks							
Day to Day Evalution-10Marks					Internal Exam-10 marks		
Uniform	Observation & Record	Performance Of the Experiment	Result	Viva	Write up	Execution & Results	Viva
Marks-2	Marks-2	Marks-2	Marks-2	Marks-2	Marks-5	Marks-5	Marks-10
Total Marks-30							
PROJECT- 10							
TOTAL INTERNAL MARKS-40M (30M+10M)							

LAB EXTERNAL: 60 Marks				
Write up	Performance Of the Experiment	Calculations, Graph and Result	Viva	Record
Marks-15	Marks-15	Marks-10	Marks-10	Marks-10
Total Marks-60M				

11. PROJECT/PRODUCT/PAPER BASED LEARNING

ABSTRACT

This project will display the configuration, development, advancement, control and assessment of an automatic switching speed electric fan. This further venture of a smart electric fans than before that utilizing "clever innovation". The microcontroller base programmed fan framework introduced in this task is obliged to satisfy the necessity of advances "tomorrow will be better than today". The electric fan naturally switches the speed as indicated by the environment temperature changes. Generally, electronic gadgets create enough heat due to internal loss. There is a necessity to decrease heat to so that electronics devices won't lose their characteristic. The heat can be minimized in various methods. One of the method is temperature dependent dc fan implementing microcontroller. When environment temperature sensed by the sensor crosses the threshold value fan is switched on and temperature is reduced. The fan will remain on till the temperature reduces below the threshold value. This general idea is used in this project.

INTRODUCTION

The objectives of this project are to:- Enable the electric fan to consequently change the rate level as indicated by temperature changes. Develop an automatic fan framework that can change the speed level because of the environment temperature changes. Literature Survey - The advancements done in the topic around the globe Project Background Infrequently electric fan utilization is squandering force as a result of human demeanor. Human additionally generally requests something that effortlessly to be utilized without squandering vitality. To minimize or diminish the force use, this venture added to a programmed framework where pace is controlled by the room temperature. The microcontroller base programmed fan framework displayed in this venture is obliged to satisfy the necessity of advances "tomorrow will be more exceptional than today". The electric fan naturally switches the pace as per the earth temperature changes. This electric fan framework contains mix of sensor, controller, driver and engine with incorporation of installed controlled programming. 2 Problem Statement Most human feels the badly designed about changing the fan rate level physically when the room temperature changes. Along these lines, the programmed fan framework that consequently changes the velocity level as indicated by temperature changes is prescribed to be fabricated for tackling this issue

COMPONENTS

viii) Transformer
ix) Diodes (IN4007)
x) Resistors
xi) Capacitors
xii) Led
xiii) Relay
xiv) DC Motor
xv) NTC
xvi) Potentiometer
xvii) Transistor
xviii) Voltage regulator
xix) IC CA3140EZ

COMPONENT DESCRIPTION

1)Transformer:

Electrical power transformer is a static device which transforms electrical energy from one circuit to another without any direct electrical connection and with the help of mutual induction between two windings. It transforms power from one circuit to another without changing its frequency but may be in different voltage level.

This is a very short and simple **definition of transformer**, as we will go through this portion of tutorial related to electrical power transformer

2)Diode:

The most common function of a *diode* is to allow an electric current to pass in one direction (called the *diode's* forward direction), while blocking current in the opposite direction (the reverse direction). Thus, the *diode* can be viewed as an electronic version of a check valve.

3)Resistor:

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity

4)Capacitor:

capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field.[1] The effect of a capacitor is known as capacitance. While capacitance exists between any two electrical conductors of a circuit in sufficiently close proximity, a capacitor is specifically designed to provide and enhance this effect for a variety of practical applications by consideration of size, shape, and positioning of closely spaced conductors, and the intervening dielectric material. A capacitor was therefore historically first known as an electric condenser

5)LED:

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated.[5]When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm^2) and integrated optical components may be used to shape the radiation pattern.[6]

6)Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

7) DC MOTOR:

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications

8)NTC:

NTC thermistors are resistors with a negative temperature coefficient, which means that the resistance decreases with increasing temperature. They are primarily used as resistive temperature sensors and current-limiting devices

9)Potentiometer:

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage dividA potentiometer is an instrument for measuring voltage by comparison of an unknown voltage with a known reference voltage. If a sensitive indicating instrumenter. If only two terminals are used potentiometer is an instrument for measuring voltage by comparison of an unknown voltage with a known reference voltage. If a sensitive indicating instrument

10)Transistor:

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit.

11)Voltage regulator:

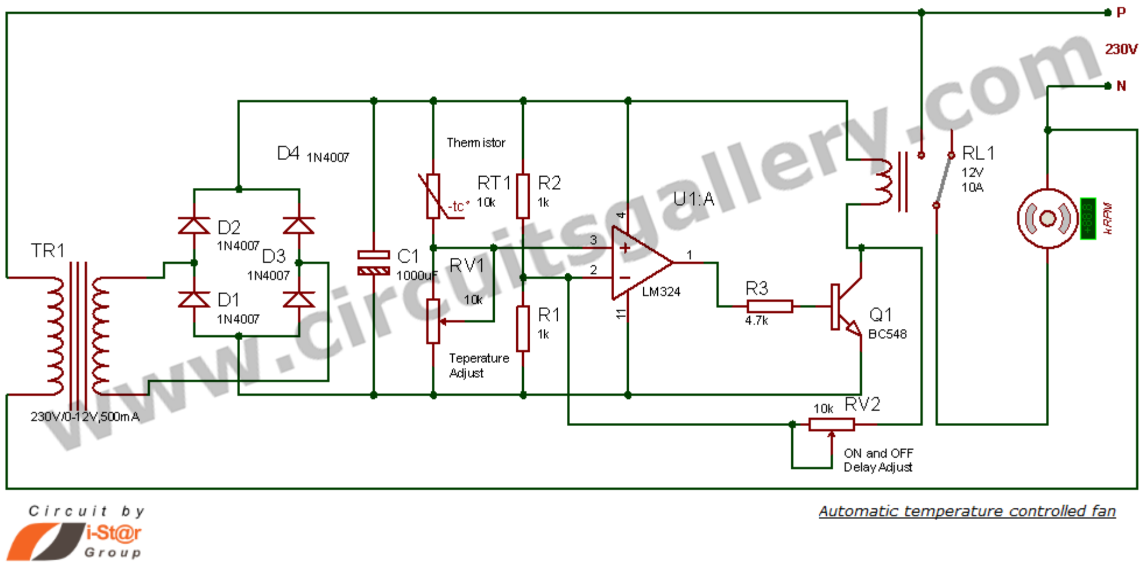
A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may use a simple feed-forwarddesign or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

12)Integrated Circuit:

The CA3140A and CA3140 BiMOS operational amplifiers feature gate protected MOSFET (PMOS) transistors in the input circuit to provide very high input impedance, very low input current, and high speed performance. The CA3140A and CA3140 operate at supply voltage from 4V to 36V (either single or dual supply). These operational amplifiers are internally phase compensated to achieve stable operation in unity gain follower operation, and additionally, have access terminal for a supplementary external capacitor if additional frequency roll-off is desired. Terminals are also provided for use in applications requiring input offset voltage nulling. The use of PMOS field effect transistors in the input stage results in common mode input voltage capability down to 0.5V below the negative supply terminal, an important attribute for single supply applications. The output stage uses bipolar transistors and includes built-in protection against damage from load terminal short circuiting to either supply rail or to ground.FN957 The CA3140A and CA3140 are intended for operation at supply voltages up to 36V (卤 18V).

CIRCUIT DIAGRAM



WORKING:

The basic working principle of temperature controlled DC fan is based on the working principle of the thermistor. The thermistor is a component which changes its resistance as its temperature changes. There are two types of thermistor available which are NTC i.e. negative temperature coefficient and other is PTC which is positive temperature coefficient.

In temperature controlled DC fan, we have used an NTC type thermistor. It is called NTC because its resistance increases when its temperature decreases and vice verse. Similarly, in PTC, its resistance increases when temperature increases and vice verse.

Op amp IC741 is used as a voltage comparator which compares the voltage between its two inputs i.e. inverting and non-inverting terminals. Pin number 2 is inverting terminal which is connected to the potentiometer and pin number 3 is a non inverting terminal which is connected in between thermistor and R1 which makes a voltage divider circuit. Thus the output of op amp is responsible for the speed of the fan.

When the temperature of surrounding increases, the temperature of thermistor also increases which causes its resistance to decrease, therefore voltage divider circuit causes more voltage across pin number 3. Thus the output voltage increases causing the speed of the fan to increase.

ADVANTAGES

1)It is very economical and easy to handle by the user.
2)Speed varies automatically so that it controls the speed without using it manually.
3)It is help full to disable people.
4)It is very easy to install in offices houses etc,
5)Save energy by slowing its speed in low temperature.

DISADVANTAGES

1)IC is the heart of the circuit if it is damages the whole system will be interrupted
2)Speed control is independent individual preference.

APPLICATIONS

Typical application include automotive, telecom laptop equipments many other portable and non-portable. Sometimes you could find fans used in conjunction with a heat sink to increase overall airflow.

12. MAPPING OF LAB WITH PROJECT/CONSULTANCY/R & D

The Machine tools lab course should be designed in such a way that it should meet the requirements of research and development as well as consultancy projects. Also the Proposals of Project/R&D/Consultancy are as follows:

Proposal 1: Project Design & Execution

Proposal 2: R& D Level Project Design & Execution

Proposal 3: Consultancy Task / Project Design & Development

PROPOSAL FOR R & D ACTIVITY:

1. An exact paper from a National/International journal in this entitled area/subject/area (IEEE Format) AND/OR

10. An article/white paper from a magazine /journal/weekly/any periodical in the entitled Subject AND/OR

- An Advanced technology development/ proposal/article publication from any source of information.

EXACT PAPER FROM A NATIONAL/INTERNATIONAL JOURNAL

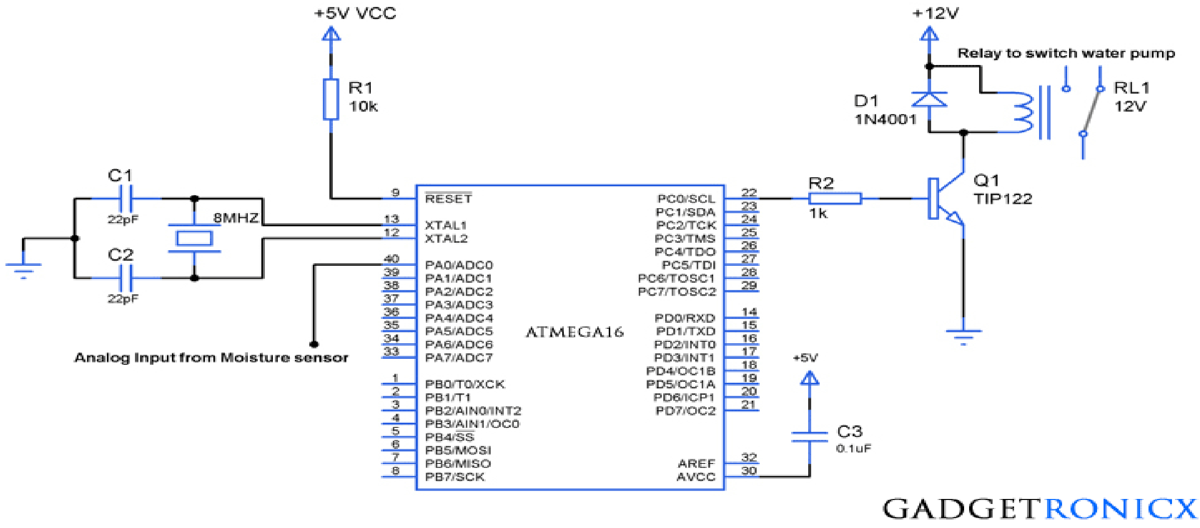
Title: Hybrid Electric car

PROPOSAL FOR PROJECT ACTIVITY

A Proposal of a hobby/mini/proto/general/model/proto type project with extended abstract, Block 9oui8ytrngf Diagram/Circuit/Flow diagram and clear references may be presented and executed.

ABSTRACT ON HOBBY PROJECT

AUTOMATIC IRRIGATION SYSTEM



INTRODUCTION AND CONSTRUCTION:-

3. The aim of the project is to control a motor based on the moisture in the soil. The design of the circuit is as follows. ATMEGA16 is the main processing IC.
4. A 8 MHz crystal oscillator is connected across the XTAL1 and XTAL2 (PIN 12 and 13). The crystal is connected with two 22pF capacitors.
5. The Master Clear pins is normally connected to Vcc via a pull-up resistor. A bypass button is connected to ground. This button is used to reset the microcontroller.
6. The output of the soil moisture sensor is given to PA0 (Pin 40) of the microcontroller
7.
8. In order to drive the relay which is connected to the motor, a transistor is used. The input to the transistor is given from PC0 (Pin 22) of microcontroller.

- One terminal of the relay coil is supplied with a 12 V DC. The other end of the coil is connected to the collector of the transistor. The contacts of the relay are given to the motor and AC supply.
- An LED is connected between the DC supply and the collector and glows only when the motor is running.

PROPOSAL FOR CONSULTANCY

OBJECTIVE: A programme/machine/product of utility may be proposed to develop for in house usage/ Industrial requirements may be useful for any outside agency that can be marketable in order to generate revenue through consultancy.

TESTING OF 2KVA 220V/220V 1-PHASE TRANSFORMER FOR EFFICIENCY

The physical basis of the transformer is mutual induction between two circuits linked by a common magnetic field. Transformer is required to pass electrical energy from one circuit to another, via the medium of the pulsating magnetic field, as efficiently and economically as possible. This could be achieved using either iron or

steel which serves as a good permeable path for the mutual magnetic flux. An elementary linked circuit is shown in Fig.1. The principle of operation of this circuit can be explained as follows:
Let an alternating voltage v1 be applied to a primary coil of N1 turns linking a suitable iron core. A current flows in the coil, establishing a flux Øp in the core. This flux induces an emf e1 in the coil to counterbalance the applied voltage v1. This e.m.f. is

$$e_1 = N_1 \frac{d\phi_p}{dt}.$$

Assuming sinusoidal time variation of the flux, let $\phi_p = \Phi_m \sin \omega t$. Then,

$$e_1 = N_1 \omega \Phi_m \cos \omega t, \quad \text{where} \quad \omega = 2\pi F$$

$$E_1 = 4.44 F N_1 \Phi_m$$

$$E_2 = 4.44 F N_2 \Phi'_m$$

From transformation ratio

$$\frac{e_1}{e_2} = \frac{\overline{E}_2}{\overline{E}_1} = \frac{N_2}{N_1}$$

FUNDED/UNFUNDED PROPOSALS (if any):
OBJECTIVE:
The proposals for AICTE grants like (SDPs, RPS and MODROBES etc) UGC grants, DST CPRI and other funding agencies by giving Title and abstract/objective OR Self Funded program proposals may be submitted for Management approvals

Not applicable.

PROPOSALS (WEEK WISE INDUSTRIAL VISITS)(IN HOUSE OR OUTSIDE VISIT)/TRAINING PROGRAMMES:

TABLE 1 : INDUSTRIAL VISITS

S.no	Type of industry	Nature of industry	Date of visit	No. of students participated	Year/ branch	remark

<u>GUIDELINES FOR SHADOW ENGINEERING (VIP)</u>
INDUSTRIAL VISITS (IIP – INNOVATIVE INDUSTRIAL LEARNING PROGRAM):
OBJECTIVES OF SHADOW ENGINEERING:

1. The program which uplifts the knowledge of the students related to laboratories.
2. To improve the industry-college interactions.
3. To create industry like environment for all the students in order to make future Assignment.
4.This program leads to matrixing with the students.

TABLE 2: INDUSTRIAL TRAINING (Shadow Engg)
(Career Visit Approval)

S.no	Name of the Course	Nature of industry	Duration of Training	Authority	Date of Training/Certificate No.	remarks

ACTIVITIES IN LIFT PROGRAMME:
CALIBRATION/INSTALLATION AND TESTING:

Calibration: Aim of this concept is to check
15. whether all the equipment is functioning correctly as per the standards
ii. To bring correctness in the errors of instrument or equipment.
iii. To rectify the errors if any

Installation: Aim of this concept is to make and maintain installation procedure for a new equipment or already existing equipment
Testing: Aim of this concept is to test the equipment after installation whether it Meets the existing standards.
The list of equipments (hardware/software):
Necessity of tools for development and testing:
Equipment to be calibrated:
Installation of supporting equipment if any:
PROCEDURE FOR CALIBRATION:

Any Equipment or Instrument or Gauge or Machine can be calibrated as the standard guidelines mentioned under:

1. Identify the Equipment/Instrument/Gauge/Machine which is under defective or to be calibrated or correction for error
2. Identify the type of error and estimate its frequency of variation.
3. Check with Master Standards or equipment/instrument/machine which is working correctly and meeting our requirements.
4. Estimate the frequency of deviations from normal mode.
5. If the equipment is under warranty, then inform to concerned supplier or agency who will carry out calibration.
6. If the equipment is out of warranty then we can compare the deviations and set the error rectification.

7. Generally as per the procedure, the equipment or instruments can be calibrated by the agencies and issue calibration certificate which consists of date of calibration, calibration next due date and remarks as mentioned in the following format.
8. Record and keep all the calibration certificates in safe custody.

After calibration the details of equipment should be submitted in following format.

S.No	Type of equipment	Certificate no	Certificate issued by	Date of calibration	Date of calibration due	Remarks
1	FT-3254 DC Ammeter (0-20)mA Digital type	316	Future Tech instruments P LTD			
2	FT-3264 Digital AC Ammeter (0-100)mA	316	Future Tech instruments P LTD			
3	FT-3213 DC Voltmeter (0-20)v Digital type	316	Future Tech instruments P LTD			
4	FT-3254 DC Ammeter (0-20)mA Digital type	316	Future Tech instruments P LTD			
5	FT-3264 Digital AC Ammeter (0-100)mA	316	Future Tech instruments P LTD			

iv. Calibration,Testing and Installation details equipment wise are mentioned as follows:

Case 1: Calibration of Equipment -------------------------------------- if any
Case 2: Installation of Equipment -------------------------------------- if any
Case 3: Testing of Equipment -- if any

Presently there is no new equipment is present for either testing or installations.

MAINTAINANCE AND TROUBLESHOOTING:

MAINTENANCE:

Maintenance and trouble shooting of each equipment in a laboratory must follow the following guidelines:
Maintenance Schedules:

- Preventive Maintenance Schedules of lab will be decided by lab in charge along with concerned HOD. The details of schedule should be recorded in the following template of format.

S.No	Type of equipment	Date of Maintenance	Type of Activity	Remarks

1	Experimental Setup for Magnetization ckts of Dc Shunt Gen.for Science lab.	13/06/2024	Finding magnetization characteristics	**Working in good condition**
2	Experimental Setup for Swinburne's test on DC Shunt M/C for Science lab.	13/06/2024	Finding the efficiency	**Working in good condition**
3	Experimental Setup for brake test on DC Shunt M/r for Science lab.	13/06/2024	Finding the efficiency	**Working in good condition**
4	Oc & SC test on 1Ph.T/F for science lab	13/06/2024	For sc and oc test	**Working in good condition**
5	Experimental Setup for brake test on 3Ph. Indution M/r for Science lab.	13/06/2024	Finding the efficiency	**Working in good condition**
6	Experimental Setup for Regulation of alternator by Synch. for Science lab.	13/06/2024	Finding the regulation	**Working in good condition**
7	Rectifier 100A for science lab.	13/06/2024	To conver DC into AC supply	**Working in good condition**
8	3Ph. Auto T/f 5KVA for science lab	13/06/2024		**Working in good condition**
9	1Ph. Auto T/f 15A for science lab	13/06/2024		**Working in good condition**
10	DHH Tachometer for science lab	13/06/2024	Find the no. of revolution	**Working in good condition**
11	Meters and Instruments for science lab PMVM MC 150/300V-5No.s,25/50V PMAM 10/20A,1/2A-5NO'S eACH	13/06/2024	Find voltage and current	**Working in good condition**

12	Meters and Instruments for science labPMAM MI 1A,5/10A-2 No's eachPMVM MI 150/300V, 300/600V-2No's each, 25/50V -1No	13/06/2024	Find voltage and current	**Working in good condition**
13	Meters and Instruments for science labWM LPF 75/150/300V 1/2A,300/600V 5/10A-2No's each	13/06/2024	Find voltage and current	**Working in good condition**
14	Meters and Instruments for science labWM UPF 75/150V 5/10A,300/600V 5/10A-2No's each	13/06/2024	Find voltage and current	**Working in good condition**
15	Rheostat 370 Ohm,1.7A	13/06/2024	To control the flow of current	**Working in good condition**
16	Rheostat 50 Ohm,5A	13/06/2024	To control the flow of current	**Working in good condition**
17	Rheostat 350 Ohm,2A	13/06/2024	To control the flow of current	**Working in good condition**
19	FT 2504D Dual (0-30)V/2 amp RPS Digital meters	13/06/2024	Supply the required voltage	**Working in good condition**
20	Decade resistances boxes 1Watt	13/06/2024	Variable resistance	**Working in good condition**
21	FT-1352 Decade capacitive box	13/06/2024	Variable capacitance	**Working in good condition**
22	FT-1342 Decade inductive box	13/06/2024	Variable inductance	**Working in good condition**
23	FT-2603 Function generator	13/06/2024		**Working in good**

				condition
24	FT-3254 DC Ammeter (0-20)mA Digital type	13/06/2024	Find the current	
25	FT-3264 Digital AC Ammeter (0-100)mA	13/06/2024	Find the current	**Working in good condition**
26	FT-3213 DC Voltmeter (0-20)v Digital type	13/06/2024	Find the current	**Working in good condition**
27	FT-1726 Two port networks parameter	13/06/2024	Find the n/w parameters	**Working in good condition**

6. Maintenance Reports duly signed by in charges as well as HODs and duly approved by Principal periodically.

TROUBLE SHOOTING SCHEDULES:

A proposal is to be made from each lab branchwise. The proposal should carry following details related to specific equipment in lab.

S.No., Equipment Name , Type of Problem (Too much Noise, Abnormal Sound, Corrupt Software, Anti Virus Problem, Missing of Display, CRT not working, Motor is not giving signal, Digital display is not working, Break of tools, Mis alignment of machine elements, PLC is not properly working), Expected Reasons (Bearing failure, Improper alignment of machine centres, Missing of vibration pads etc)

Trouble shooting exercises should be properly recorded in a separate format as mentioned below:

	Date of recording activity	**Equipment Name**	**Type of Trouble**	**Remedial Activity**	**Remarks**

16. ASSESSMENT AND ACCREDITATION PROCEDURE AS PER NABL

Accreditation is the formal recognition, authorization and registration of a laboratory that has demonstrated its capability, competence and credibility to carry out the tasks. It provides the feedback to laboratories as to whether they are performing according to technical competence as per guidelines of NABL (National Accreditation Board for Testing and Calibration Laboratories)

The laboratory should carry out the following important tasks towards getting ready for accreditation from NABL.

1. Preparation of methodology in each experiment
2. Preparation of Standard Operating procedure for each equipment
3. Preparation of Laboratory Manual as per the guidelines specified by Combined Lab Team (CLT) headed by Principal/HOD/Dean/incharge
4. Ensure Effective environmental conditions (temperature, humidity,storage and placement) in the laboratories by implementing proper housekeeping and cleaning of the equipments from dust, dirt etc.
5. Ensure Calibration of instruments/equipment (Only NABL accredited authorized laboratories provide calibration.
6. All the details of Calibration should be included in the format specified exclusively for calibration procedure.
7. Ensure proper implementation of all the documents, formats to be included in the lab manual.
8. Impart training for all the technicians working in labs about the importance of documentation, log sheets, operating procedure of the lab.
9. Incorporate Internal Lab audits for effective functioning of the laboratories. Audits may be once in a month or 3 months or at the end of the semester. The audit schedule will be decided by the Chairman and Principal of the CLT team.
10. Auditors should submit the detailed report of each lab duly signed to the Principal.
11. Each lab should maintain all the bills/invoices of each instrument or equipment in a separate file.
12. All the stock registers either consumable or non consumable should be updated whenever any purchases of consumables or equipment takes place.
13. All the safety precautions are properly displayed in front of each lab.
14. All the Lead experiments should be maintained separately in a record /record in a separate folder.
15. Based on Pre Assessment report submitted by auditor, corrective actions should be carried out by each lab in charge and that must be forwarded to concerned HOD and Principal.

CMR ENGINEERING COLLEGE
UGC AUTONOMOUS
(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)

DepartmentofComputerScience&Engineering

LaboratoryDetails(LIFTPlanner,LiftSchedule)

LIFT (Laboratory Improvement for Future Trends)Programming for Problem Solving(PPS)LAB

1. ObjectivesandRelevance
2. Scope
3. Prerequisites
4. Syllabus
5. LabSchedule
6. SuggestedBooks
7. UsefulLinks
8. Experts'Details
9. Mappingof LabwithActivities
10. LocalVisits
11. Testing

12. PreventiveMaintenanceSchedules

13. Troubleshooting

14. LEAD Programs

1. *ObjectivesandRelevance*

- Tounderstandthe basicpartsofcomputersystemand theirfunctionality
- ToimplementthevariousstepsinProgramdevelopment
- TodevelopprogramsinCto solveproblemswitha computer
- Totest Cprogramstomakeiterror-free
- To implement the basic data structures such as lists, stacks and queues toorganizedata
- Toimplementsimplesortingandsearchingmethods

2. *Scope*

- Anabilityto workwith computersystem
- An ability to understand and implement commonly used steps in programdevelopmentprocess
- An abilitytounderstandtheneedofprogrammingforrealworld
- AnabilitytounderstandpowerofClanguageinthecomputerscience
- An ability to design and develop programs in C language to solve problems withcomputer
- Anabilitytounderstandandimplementsomecommonlyuseddatastructuresin C
- Anabilitytounderstandsimple sortingandsearchingtechniquesin C
- An abilitytodeveloperror freeprograms
- Anabilitytoorganizedatain computermemory.

3. *Prerequisites*

- The student should be familiar with the following mathematical notations andterminology
    - Comparisonse.g.,A<B, A≤B, A≠B, etc
    - Decision making based on comparisons/results e.g., if A<B is true, the studentshould cometoknowthatB isbiggestand Ais smallest
    - Arithmetic operations e.g., A+B, A-B, A*B, quotient and remainder after divisionA/B
    - Otheroperationse.g., |A|, A^B, e^x, Logx, etc
    - Matrixoperationse.g.,addition/subtraction,multiplication,transpose,etc
- The C compiler

4. JNTUHSyllabus

Experiment/ week	NAMEOF PROGRAM
1	A) Sumofindividualdigitsofgiveninteger B) generatefirst ntermsofFibonacciseries C) generateprimenumbersbetween1 andn
2	A)calculatesumofseries

	SUM=1-x2/2!+x4/4!-x6/6!+x8/8!-x10/10! **B)**Rootsofa quadraticequation.
3	**A)**Calculationifs=ut+1/2at^2 **B)** program,whichtakestwointegeroperandsandoneo peratorform theuser(+,-,*,/,% useswitch)
4	WriteCprogramsthatusebothrecursiveandnon-recursivefunctions **i)** Tofindthe factorialofagiveninteger. **ii)** To findtheGCDoftwogivenintegers
5	**a)**findlargest integerinalist ofintegers **b)** programthatusesfunctionstoperform **i)**AdditionofTwoMatrices **ii)**MultiplicationofTwoMatrices
6	Usefunctionstoperformthefollowingoperations: **A)(i)**insertsub-stringintomainstringfromgivenpos. **(ii)**deletenCharactersfromagivenpositioningivenstring. **B)**givenstringisapalindromeornot
7	**A)** displaythepositionor index inthestringSwherethestringTbegins,or–1ifSdoesn't containT. **B)** countthe lines,wordsandcharactersinagiventext.
8	**A)** generatePascal'striangle **B)** constructapyramidofnumbers
9	**A)**geometricprogression: sum=1+x+x^2+x^3+...... +x^n
10	**A)** 2'scomplementof anumber **B)** convertaRomannumeraltoitsdecimalequivalent
11	**A)**usefunctionstoperformfollowingopsoncomplexnumbers**a)**read**b)**write**c)**add **d)**multiply(Usestructuretorepresentcomplexnumber)
12	**A)**programtocopyone fileto another **B)**toreversefirstncharactersinfile(file nameandnspecifiedoncommandline)
13	**A)**WriteaCprogramto display thecontentsofafile **B)**writeacprogramtomerge twofilesinto athirdfile
14	**A)** Write a C program that uses non recursive function to search for a Key value in agivenlistof integersusingLinear search. **B)** Write a C program that uses non recursive function to search for a Key value in agivensortedlistof integersusingBinary search.
15	**A)** Write a C program that implements the Selection sort method to sort a givenarrayof integers inascendingorder. **B)** Write a C program that implements the Bubble sort method to sort a given list ofnames inascendingorder.
16	WriteaCprogramthatusesfunctionstoperformthefollowingoperations: **i)** Createasinglylinkedlistofintegerelements. **ii)** Traversetheabovelistanddisplaytheelements
17	WriteaCprogramthatimplementsstack(itsoperations)usingasingly linkedlistto display agivenlistofintegers inreverseorder.Ex. input: 102346output:642310
18	WriteaCprogramthatimplementsQueue(itsoperations)usingasinglylinkedlistto display a.givenlistofintegers inthesameorder.Ex. input:10234 6output:1023 46
19	WriteaCprogramtoimplementthelinearregressionalgorithm.

20	WriteaCprogramtoimplementthepolynomialregressionalgorithm.
21	WriteaCprogramto implementtheLagrangeinterpolation.
22	WriteCprogramtoimplementthe Newton-Gregoryforwardinterpolation.
23	WriteaCprogramto implementTrapezoidalmethod.
24	Write aCprogramto implementSimpsonmethod.

MAINLINKAGEOFCPTHEORYWITH LABEXPERIMENTS:

UNIT–I

EXPERIMENTNO.:1,2,3,8,9,19,20,21&22

- Introduction to selectioncontrolstructures(orconditionalconstructs),loopcontrolstructures(oriterativecontr ol structures),

OBJECTIVE:

- Themainobjectiveistounderstandmakingdecisions,selectionofoperationbasedondecision,re petitive process

PREREQUISITES:

- Syntaxofrequiredstructures, flowofexecutionofthestructures,andknowledgeinmathematics.

DESCRIPTION:

1. Introductionto findingsumofindividualdigitsofanumber.
2. Introductionto Fibonacciseriesofnterms.
3. Introductiontoprimenumbers.
4. IntroductiontoPascal'striangle.
5. Introductionto pyramidofnumbers
6. Introductiontogeometricprogression

APPLICATIONS:

- Thesemechanismscanbeappliedinany programsthat solveseriesbasedproblems.

UNITII:

EXPERIMENTNO.:4&5

- Introductionoffunctionsandarrays.

OBJECTIVE:

- Themainobjectiveistounderstandtheconcepts-functionsandarrays

.

PREREQUISITES:

- Functionprototyping,callingandfunctiondefinitions
- The conceptofrecursion
- Arraydeclarationandaccessingelementsofarray

DESCRIPTION:

1. Introductionto factorialofanumber.
2. Introductionto GCDofnumbers
3. Introductionto largestandsmallestinalistofintegers
4. Introductiontomatricesandtheiroperations

APPLICATIONS:

- Themechanism-functions,isusedformodularprogrammingtoorganizelarge programs
- Themechanism-arrays,isusedtosolveanyproblemthatrequiresprocessinglistofelements.

UNITIII:

EXPERIMENTNO.:6,7 &10

- Introductionofpointersandstrings.

OBJECTIVE:

- Themainobjectiveistounderstandpointersandstrings

PREREQUISITES:

- Declaringpointertoanythingandstringoperations

DESCRIPTION:

1. Introductionto insertionanddeletionoperationsona string
2. Introductiontostringpalindrome
3. Introductiontosubstringofmainstring
4. Introductionto countingchars,words,linesin atext
5. Introductionto2'scomplementofbinarynumber
6. Introductionto Romannumeral

APPLICATIONS:

- Themechanism-pointers,canbe usedtomanagecomputermemory
- Themechanism-strings,canbe usedtoprocesstextbasedinformation

UNIT-IV

EXPERIMENTNO:11,12 &13

- Introductionofenumeratedtypes,structures,unionsandI/OinC.

OBJECTIVE:

- Themainobjectiveistounderstandtheconceptofuser-defineddatatypes(e.g.,enumeratedtypes,structures, unions) andInput/ Outputoperations inC

PREREQUISITES:

- Knowledgeofbasicdatatypes,purpose ofinput /output devices

DESCRIPTION:

1. Introductiontocomplexnumbersandtheiroperations.
2. Introductiontofileoperations-reading,writing,copying,mergingoffiles

APPLICATION:

- Themechanisms-user-defineddatatypes,areusedforabstractionofrealthings.
- Themechanisms-I/O,areusedtostorelargeamountofdataonadiskinapermanentform.

UNIT-V

EXPERIMENTNO:14,15,16,17,18

- Introductiontosearching,sortingandDatastructures

OBJECTIVE:

- Themainobjectiveistounderstandvarioussearchingandsortingtechniques,andbasicdatastructures(lists,stacks andqueues)

PREREQUISITES:

- ShouldbefamiliarwithClanguage

DESCRIPTION:

1. Introductiontosearchingtechniques
2. Introductiontosortingtechniques
3. Introductionto datastructures(lists,stacksandqueues)

APPLICATIONS:

ApplicationsofSearching:

- Forcomputerbaseddictionary/directorylook-up
- toremoveduplicatesininformation
- to search for desired links in web

etcApplicationsof Sorting:

- Usefulforsearchingmethods
- Findingranksofstudents
- Useful for any application that needs data in some sensible

orderApplicationsof Stack:

- ReversingDataseries
- Conversiondecimaltobinary
- Parsinginto tokens
- Backtrackingtheoperations
- UndooperationsinText Editor
- PagevisitedHistoryinwebbrowser
- TrackingofFunctioncalls
- Recursion
- Maintainingscopeandlifetimeoflocalvariables infunctions
- Infixtopostfixconversion
- Evaluatingpostfixexpression
- Towers of

HanoiApplicationsofQueue:

- Executionof Threads
- JobScheduling
- Eventqueuing
- MessageQueuing
- WireRouting

LEADPROGRAMS

We are tryingto doaLeadExperimentson:

- Towersof HanoiProblem
- Matrixoperations–Symmetric/Asymmetric,Transpose

5. A)**LABSCHEDULE:**

SECTION-A												
Batch	**week**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
B 1	De mo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Intern al test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B 2	De mo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Intern al test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B 3	De mo	Exp. 1	Exp. 2	Exp .3	Exp. 4&	Exp. 5	Exp. 6	**Inter nal**	Exp .7	Exp .8	Exp. 9&	Exp. 10
					Lead 1			**test1**			Lead 2	
B 4	De mo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Intern al test1**	Exp. 7	Exp .8	Exp.9 & Lead 2	Exp. 10
B 5	De mo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Intern al test1**	Exp. 7	Exp .8	Exp.9 & Lead 2	Exp. 10

Batches	**week**												
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
B 1	Exp . 11	Exp. 12	Exp. 13	Exp. 14	**Intern al test2**	Exp. 15	Exp. 16	Exp. 17	Exp.1 8	Exp.1 9 & 20	Exp.2 1 & 22	Exp.2 3 & 24	**Inter nal test3**
B 2	Exp . 11	Exp. 12	Exp. 13	Exp. 14	**Intern al test2**	Exp. 15	Exp. 16	Exp. 17	Exp.1 8	Exp.1 9 & 20	Exp.2 1 & 22	Exp.2 3 & 24	**Inter nal test3**
B	Exp .	Exp.	Exp.	Exp.	**Intern al**	Exp.	Exp.	Exp.	Exp.1	Exp.1 9	Exp.2 1	Exp.2 3	**Inter nal**

3	11	12	13	14	test2	15	16	17	8	& 20	& 22	& 24	test3
B4	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp. 15	Exp. 16	Exp. 17	Exp.18	Exp.19 & 20	Exp.21 & 22	Exp.23 & 24	**Internal test3**
B5	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp. 15	Exp. 16	Exp. 17	Exp.18	Exp.19 & 20	Exp.21 & 22	Exp.23 & 24	**Internal test3**

SECTION-B

Batches	**week**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
B6	Demo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Internal test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B7	Demo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Internal test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B8	Demo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Internal test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B9	Demo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Internal test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10
B10	Demo	Exp. 1	Exp. 2	Exp .3	Exp.4 & Lead 1	Exp. 5	Exp. 6	**Internal test1**	Exp .7	Exp .8	Exp.9 & Lead 2	Exp. 10

Batches	**week**												
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
B6	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp.15	Exp. 16	Exp. 17	Exp. 18	Exp. 19 & 20	Exp. 21 & 22	Exp.23 & 24	**Internal test3**
B7	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp.15	Exp. 16	Exp. 17	Exp. 18	Exp. 19 & 20	Exp. 21 & 22	Exp.23 & 24	**Internal test3**
B8	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp.15	Exp. 16	Exp. 17	Exp. 18	Exp. 19 & 20	Exp. 21 & 22	Exp.23 & 24	**Internal test3**
B9	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp.15	Exp. 16	Exp. 17	Exp. 18	Exp. 19 & 20	Exp. 21 & 22	Exp.23 & 24	**Internal test3**
B10	Exp. 11	Exp. 12	Exp. 13	Exp. 14	**Internal test2**	Exp.15	Exp. 16	Exp. 17	Exp. 18	Exp. 19 & 20	Exp. 21 & 22	Exp.23 & 24	**Internal test3**

(B)VIVASCHEDULE: The vivascheduleshouldbe plannedpriorstartingtothe labexperiment.

SECTION-A										
Batches	**week**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B1	Viva					viva				
B2		viva					viva			
B3			viva					viva		
B4				viva					viva	
B5					viva					Viva
Batches	**week**									
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B1	Viva					viva				
B2		viva					viva			
B3			viva					viva		
B4				viva					viva	
B5					viva					viva

SECTION-B										
Batches	**week**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B6	Viva					viva				
B7		viva					viva			
B8			viva					viva		
B9				viva					viva	
B10					viva					Viva

Batches	week									
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B6	Viva					viva				
B7		viva					viva			
B8			viva					viva		

B9				viva					viva	
B1 0					viva					viva

SchemeofEvaluation:

Internal :							
Day to Day Evalution-15					**Internal Exam-10**		
Uniform	Observation & Record	Performance Of the Experiment	Result	Viva	Write up	Execution & Results	Viva
Marks-3	Marks-3	Marks-3	Marks-3	Marks-3	Marks-4	Marks-3	Marks-3
Total Marks-25							

LAB EXTERNALS:				
S.NO	Write up	Results(by skill assistant)	Final Evaluation	Viva
1	1.Aim 2.Procedure 3.Program 4.Result etc	Based on observation, How the student is executed the program	Based on correctness of the program and Results	Based on understanding of Experiment and theoretical questions in the related subjects
Marks	20	10	10	10
Total Marks-50				

6. **SUGGESTEDBOOKS:**

TEXTBOOKS

- ComputerScience:AStructuredProgrammingApproachUsingC,B.A.Forouzanan d R.F.Gilberg,ThirdEdition,CengageLearning.
- ProgramminginC.P.DeyandMGhosh,OxfordUniversityPress.

REFERENCEBOOKS

- C&Datastructures–P.Padmanabham,ThirdEdition,B.S.Publications.
- CforAll,S.ThamaraiSelvi,R.Murugesan,AnuradhaPublications.
- ProblemSolvingandProgramDesigninC,J.R.HanlyandE.B.Koffman,7thEdition,Pearsoneducation.

- ProgramminginC,AjayMittal,Pearson.

- ProgrammingwithC,B.Gottfried,3rdedition,Schaum'soutlines,TMH.
- ProblemsolvingwithC,M.T.Somasekhara,PHI
- ProgrammingwithC,R.S.Bickar,UniversitiesPress.
- ComputerProgramming&DataStructures,E.Balagurusamy,4edition,TMH.
- ProgramminginC–StephenG.Kochan,IIIEdition,PearsonEducation.
- TheCProgrammingLanguage,B.W.KernighanandDennisM.Ritchie,PHI.
- CProgrammingwithproblemsolving,J.A.Jones&K.Harrow,DreamtechPress

7. USEFULLINKS

- *http://nptel.ac.in/courses/106105085/*
- *http://www.w3schools.in/c/*
- *http://fresh2refresh.com/c-tutorial-for-beginners/*
- *www.ro.feri.uni-mb.si/predmeti/mik_si/C_prir/CLIST.HTM*
- *http://www.tutorialspoint.com/cprogramming/*
- *http://www.cprogramming.com/tutorial/c-tutorial.html*
- *http://www.cprogrammingexpert.com/*
- *http://119.235.53.233:55557/index.php/others/category/1689-c*
- *http://www.programiz.com/c-programming*
- *http://www.eskimo.com/~scs/cclass/notes/top.html*
- *http://www.c4learn.com/*
- *http://www.jntuh-elsdm.in/*

Link	Topic	Type of content
• http://www.c4learn.com/index/overview-of-c/	Aboutc	text
• http://www.c4learn.com/index/data-types-in-c/ • http://www.programiz.com/c-programming/c-data-types	Datatypes	text
• http://www.c4learn.com/index/decision-making-in-c/	Decisionmaking	text
• http://www.c4learn.com/index/loop-control-statements/ • http://www.programiz.com/c-programming/c-decision-making-loops-examples	Loopcontrols	text
• http://nptel.ac.in/courses/106105085/	EntireCcourse	video
• http://www.w3schools.in/c/operators/ • http://www.c4learn.com/index/operators-in-c-programming/	operators	Text
• http://www.w3schools.in/c/functions/ • http://www.c4learn.com/index/function-in-c/ • http://www.programiz.com/c-programming/c-functions	Functions	text
• http://www.w3schools.in/c/arrays/ • http://www.c4learn.com/index/array-in-c-programming/	Arrays	Text

• http://www.w3schools.in/c/strings/ • http://www.c4learn.com/index/string-in-c/ • http://www.programiz.com/c-programming/c-	**Strings**	**Text**

strings		
• http://www.w3schools.in/c/pointers/ • http://www.c4learn.com/index/pointer-c-programming/ • http://www.programiz.com/c-programming/c-pointers	**Pointers**	**Text**
• http://www.w3schools.in/c/program/dynamic-memory-allocation/	**DMA**	**Text**
• http://www.w3schools.in/c/structures/ • http://www.c4learn.com/index/structure-in-c/ • http://www.programiz.com/c-programming/c-structures	**Structures**	**Text**
• http://www.w3schools.in/c/unions/	**unions**	**Text**
• http://www.w3schools.in/c/file-handling/ • http://www.c4learn.com/index/file-handling-in-c/ • http://www.programiz.com/c-programming/c-file-input-output • http://www.programiz.com/c-programming/c-input-output	**I/Oin C**	**Text**
• http://www.c4learn.com/index/storage-classes-in-c/	**Storageclasses**	**Text**
• http://www.c4learn.com/index/preprocessor-in-c/	**Preprocessor**	**Text**

8. EXPERTS DETAILSINTERNATIONAL

- Dr. C. Chandra Sekhar, Professor, Department of Computer Science and EngineeringIndianInstituteofTechnologyMadras, Chennai -600036,India
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- Prof.SureshChittineni,Professor,AnilNeerukondaInstituteofTechnology&Sciences,Vizag
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  Mobile:9989426145

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  Mobile:9010296405

9. MAPPINGOFLABWITHACTIVITY:

Labcanbemappedwiththefollowingactivities:

- **Debugging inC**
- **Computingtimecomplexity ofprogram**

- **AptitudeinC**
- **ProgrammingContest**
- **GraphicsinC**
- **ProgrammingModel**

ScheduleofAptitude/Debugging/TimeComplexity/Contest/Graphics:

week									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Kno wyo ursk ills	Aptitude/ Debuggin g	Graphics inC
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Kno wyo ursk ills	Aptitude/ Debuggin g	Graphics inC
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Kno wyo ur skills	Aptitude/ Debuggin g	Graphics inC
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Know your skill s	Aptitude/ Debuggin g	Graphics inC
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Know your skill s	Aptitude/ Debuggin g	Graphics inC

week									
11	**12**	**1 3**	**14**	**15**	**16**	**17**	**1 8**	**1 9**	**20**
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Know your skill s	TimeC omplexity	Programmin gContest
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Kno wyo ur skills	TimeC omplexity	Programmin gContest
tude/ ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Know your skill s	TimeC omplexity	Programmin gContest

tude/ggin g	Quiz /resoning	Aptitude/ Debuggin g	Know yourski lls	Aptitude/ Debuggin g	Quiz /resoning	Aptitude/ Debuggin g	Know your skill s	TimeC omplexity	Programmin gContest

DEBUGGINGINC:

Description:

A debugger is an efficient, flexible, and easy-to-use tool for viewing a program as itexecutes. It is superior to sprinkling output statements throughout a program. A debugger willallow you to *stop* program execution, *view* and *modify* variable values, and *re-run* the programfromthepointit wasstopped.Allthiscanbe achievedwithoutmodifyingtheprogram itself.

On-line documentation may often be read by highlighting a menu item (using the up-arrow or down-arrow keys) and pressing **F1**, by choosing **Help** within a dialog box, by highlightingadialogbox item(usingthe**Tab**key)andpressing **F1**,or by usingthe**Help**menu.

SettingupforDebugging

In order to use the debugger, the compiler must first be set-up to include debugginginformationinthe executableprogram.The IntegratedDevelopmentEnvironment(IDE)shouldbe configured to handle this for you automatically, but if the debugger appears to be ``broken"you should check these settings. Unless the settings have been changed from their default values,you*shouldnot*modifythem.

Open the **Options|Debugger**dialog box. **Source Debugging** should be *on*. The *Smart***Display Swapping** option should be set. **Inspectors** should be set for *Show Inherited*, *ShowMethods*,and*ShowBoth*.**ProgramHeapSize**shouldbe*64*K bytes.

DebuggingActions

Themostcommondebuggingactionsaresingle-steppingorrunning(fromthebeginningor from the last statement executed) a program, setting and using breakpoints, and looking atandmodifyingvariables. Let's look ateachof these inturn.

Note that many of these actions have ``short-cut" keys associated with them. You can use theshort cuts toavoidopeningmenustochooseactions.

RunningYourProgram

You are probably most familiar with using **Run|Run**to start your program from the beginning.However, **Run|Run**is really used to start your program from the point of last execution. Only ifthe program had completely finished or was aborted does **Run|Run**pick up at the beginning.There are twowaystosingle-step(executeonlyone statement atatime)yourprogram.

Run|Step over executes the next statement (this is the statement highlighted by the *run bar*),treating subroutines (function or procedure) as if they were a single statement. Thus, you will notbe able to watch the individual statements of your subroutines execute.

Run|Trace into executesthe next statement, treating subroutines as if they were collections of statements. With**Run|Trace into** you can watch your subroutines execute line-by-line. This will generally only workforsubroutineswhichyouwrite.Youcannottraceintolibraryfunctions.

Anytime you would prefer to return to normal execution rather than single-stepping,choose **Run|Run**. If you are in the middle of your program's execution and want to return to thebeginning, select **Run|Program reset**. If there is no *run bar* (i.e., you are at the very beginning ofyour program) you may single-step to start the program at its first statement (i.e., the firststatementofmain()).

How do you determine whether to use **Run|Step over** or **Run|Trace into**? Firstly, youneed to know that you can switch freely between the two. Once you start using one of them, youmay still use the other. Secondly, the choice between the two should be governed by how muchconfidence you have in any subroutines which would be executed in the next statement (if thereare no subroutines in the next statement, then there is no difference between **Run|Step over** and**Run|Traceinto**).

Run|Go to cursor is a primitive breakpoint, so I won't discuss it; see the on-linedocumentation.

<u>SettingandUsingBreakpoints</u>

If you suspect that there is a bug within a statement which is the 1,000th programstatement executed, it's not terribly convenient to single-step to it. Instead, you would like to runthe program until you get ``near'' the suspect statement or subroutine and then single-step theprogram. You would like to ``break'' (suspend) program execution at a particular point within theprogram---abreakpoint. Fromthatpoint,youcan use **Run|Stepover** or **Run|Traceinto**.

Breakpoints are set by moving the cursor to an executable statement where you wouldlike a break to occur and choosing **Debug|Toggle breakpoint**. This line is then highlighted. Repeatthis process until you have all the breakpoints which you want. Choosing **Run|Run**causes theprogram to execute until the first breakpoint is encountered. Choosing **Run|Run**again will runthe program until the next breakpoint (possibly the same one as before) occurs. Choosing**Debug|Togglebreakpoint**onalinewhichhasabreakpointalreadyset removesthebreakpoint.

Debug|Breakpointscontains several advanced breakpoint options. Among these areediting breakpoints, setting qualifier conditions for breakpoints, and setting a skip count for abreakpoint.Refertotheon-line documentationfordetails.

<u>ViewingandModifyingVariables</u>

Once you've gotten the program running and stopped at a particular statement (bysingle-stepping or by using breakpoints), you can look at the values of variables or expressions(actually, a variable is just a simple expression) and modify variables. Obviously, any terms whichyou reference within an expression must be defined within the current context. Expressions maynotcontainfunctioncalls.InTurbo C++,#define'd constantsmaynotbe apartofthe expression.

To check expression values, choose **Debug|Evaluate/modify**. Type an expression in the**Expression Field** and press the **Return** key (or press the **Evaluate** button). The value of theexpression will be displayed in the **Result** field. The on-line documentation contains informationforoptionalresultformattingandfordisplayingseveral elementsofanarray.

You can use the **Tab** key to move the cursor to the **New value** field and enter a new valuefor a simple variable (an integer, a single array element, a pointer, a single field within a structureorrecord,etc.).

Debug|Evaluate/modify can be tiresome to use if you would like to watch what happens to avariable each time a statement executes. Use **Debug|Watches**for this (refer to the on-linedocumentation). Turbo C++ has a mechanism for easily viewing compound variables (arrays andstructures).Thismechanism is**Debug|Inspect**(again,refertotheon-line documentation).

TIMECOMPLEXITY:

- The time complexity of a program is the amount of time the program requires for execution tocomplete.
- The timecomplexityofaprogramisexpressedintermsofstepsthe program has.
- Inthisactivity, studenthasto computernumberofsteps ina givenprogram.

APTITUDEINC:

In this activity, student has to find output of given C program. To find output of any program,studentmustbefamiliar withtheprogrammingmechanismsofC.

PROGRAMMINGCONTEST

- Itisaplatformforstudentstopreparethemselvestobecomesmartprogrammers
- The students are required to solve as many problems as they can within the time, whichare ofvaryingcomplexity

GRAPHICSIN C

- Graphicsprogrammingisusedfordevelopinggames,inmakingprojects,foranimationetc

MAKINGPROGRAMMINGMODEL:

- Using RAPTOR tool, we can create programming models of program design andproblemdomain
- RAPTOR is a flowchart-based programming environment, designed specifically to helpstudentsvisualizetheirmodels.

10. LOCALVISIT

S.No	Type ofindustry	Nature ofindustry	Date ofvisit	No. of studentsparticipated	Year/Branch	remarks
1	Local	S/WIndustry		15(70%above)students		
2	Local	S/WIndustry		15(70%above)students		

11. Installation&Testing(Method&Toolstobeused):

INSTALLATION:

Objective:

- ToinstallCsoftwarethat isusedtodevelopprogramsinClanguage

IDE(IntegratedDevelopmentEnvironment):

- IDEisasoftwarethatprovidesanenvironmentinwhichwecandevelopprogramsinC

Description:

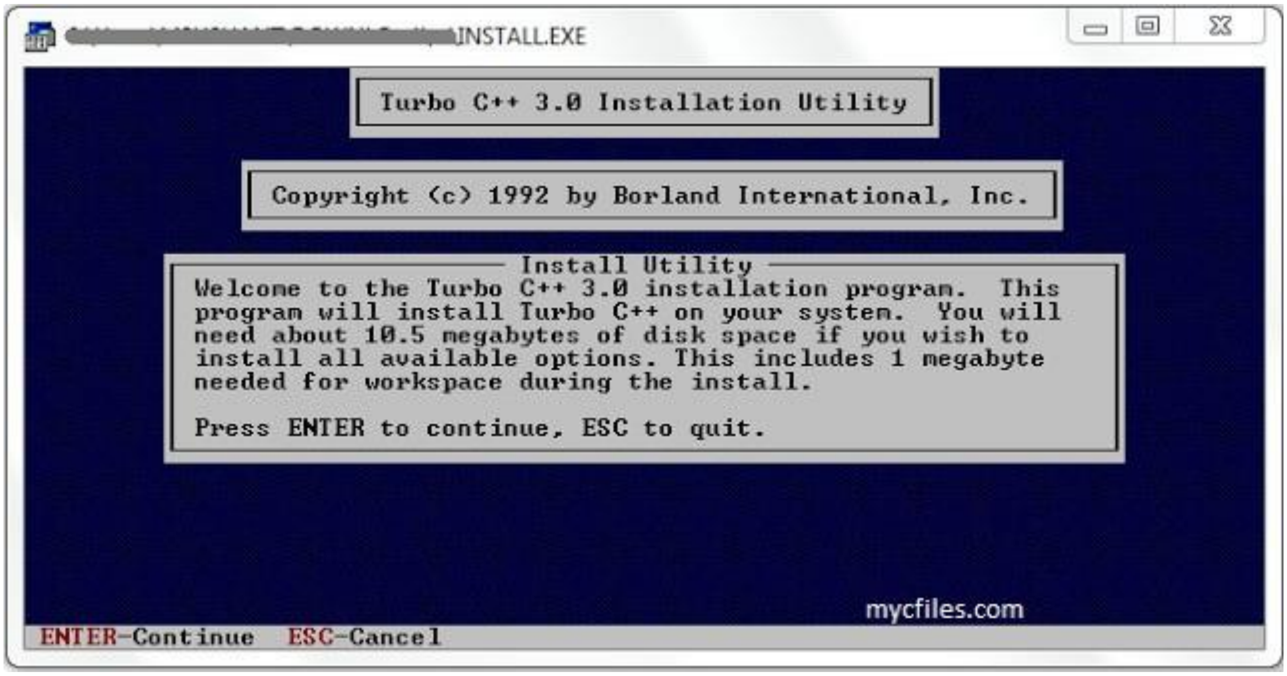
- Turbo C was an Integrated Development Environment and compiler for the C programminglanguage from Borland. It was first introduced in 1987 and was noted for its integrateddevelopment environment, small size, extremely fast compile speed and comprehensivemanuals.
- InMay1990,BorlandreplacedTurboCwithTurbo C++.

Steps:

Followthesestepsfordownloadingandinstallationof TurboCsoftware.

1. Firstyouneedto**downloadthecompiler**.
2. Afterfinisheddownloadunzipthe turbo cto folder& openthefolder.
Note: For the time of installation the folder should be present anywhere in Drive C..like desktop,documents, downloads..

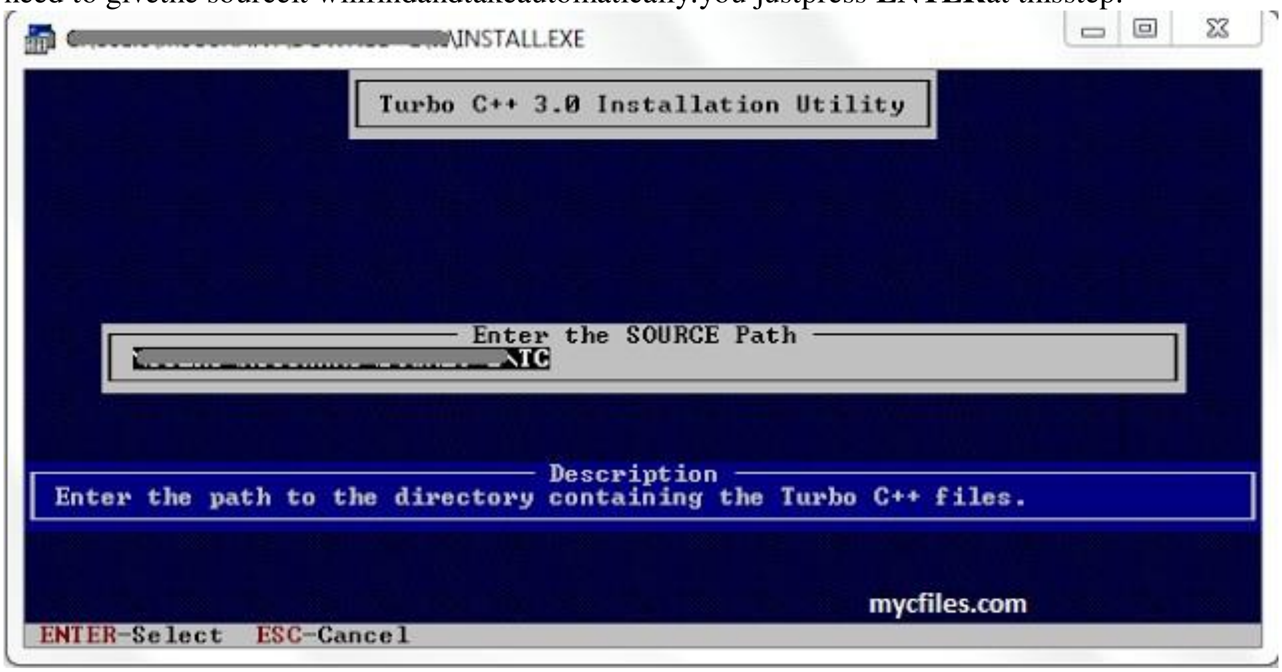
3. Runinstall.exeandpress **ENTER**tocontinue.



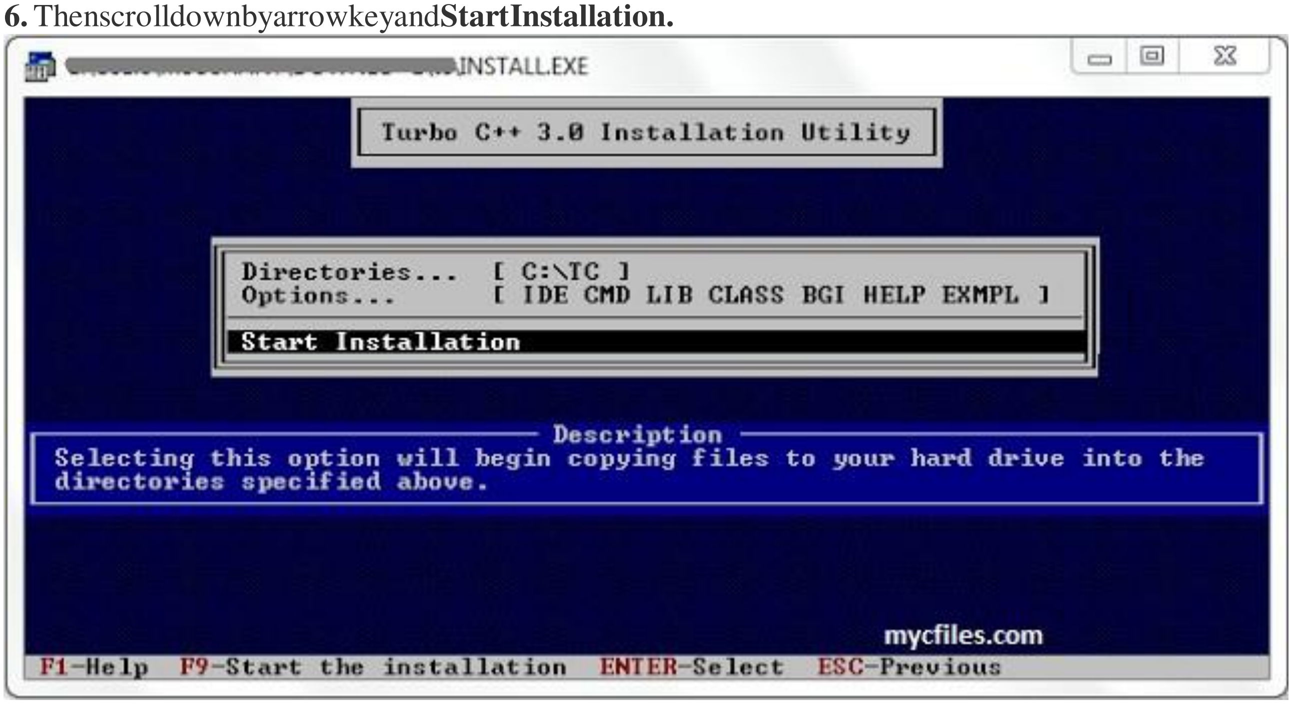
4. Enterthe SOURCEdriveto use:**C**


[redacted]\INSTALL.EXE
Turbo C++ 3.0 Installation Utility
Enter the SOURCE drive to use: C
Description
Enter the drive from which you wish the INSTALL utility to copy files.
Typically, this is the drive that contains the INSTALL disk.
mycfiles.com
ENTER-Select ESC-Cancel

5. Enter the SOURCE Path: source path is where you extracted the turbo c.zip file we don’t need to givethe sourceit willfindandtakeautomatically.you justpress **ENTER**at thisstep.



6. Thenscrolldownbyarrowkeyand**StartInstallation.**



Now you have successfully installed turbo c
compiler.Nowtoopentheturboccompiler

go toDrive C>TC>Bin> TC .exe

Youcanhaveshortcutondesktopso that noneedtofollow longpathtoopenTC.

Just open TC folder in drive Cselect TC.exe and right click on it, Click on send to> Desktop (createshortcut).

<u>HowtoCompileandRunCProgram</u>

How tocreateanew C Programusing TurboC++?

- Openthebinfolder(“C:\TC\BIN”)

- Clickon“TC”iconasshown below

Youwillseethefollowingscreen:

Now,ClickonFile->New.Please findimagebelow foryourreference

Write your C Program. Press F2 (or File->Save) to save your program. On pressing F2, pop window willopen(asshownbelow).Youneedtospecifythe name oftheprogram.

Note:

ForCProgram,use.Casextension.

ForC++Program,use .CPPas extension.

How torunaCProgramusingTurboC++ Version3.0?

- Installing Turbo C is very simple and effortless. Similarly, compiling and running CProgramis verysimpleand effortless. Pleasemakeanotethat,wecancompileandrunCProgramswithoutsavingit.
- To compile a C Program you can either press Alt+F9 or Compile->Compile. After youcompile yourC Programyou will seethefollowingscreen.

To run a C Program you can either press Ctrl+F9 or Run->Run. After you run your C Program you will seethe outputscreenasshownbelow.

TESTING:

- Aim of this concept is to test the program after development to check whether it meets thegivenrequirements.

Viewsof Testing:

Since it is evidence of correctness that we are looking for, we can view the testing of software asa jury or judge views evidence: the better **quality** of evidence (not necessarily the greater **quantity**), thestrongerthecasethattheprogramsatisfiestherequirements.Astheprogrammer,wearethepersonon trial: innocent until proven guilty. As the tester, we are the accuser: we must provide substantialevidence that the program does not meet the specifications. If strong evidence cannot be presented tothisend, theprogramisdeemedto be"correct enough" anditissetfreeintotheworld.

This analogy leads us to view testing as a process of finding bugs: some academics (Beizer, Marick andothers) feel the sole purpose of testing is to find bugs. Once the bugs are found (since there will *always*bebugsinanon-trivialsystem),testinggiveswaytothedebuggingphase:findtheline(s)ofcodeinerrorandcorrectthem.

GeneralTechniquesofTesting:

Therearetwomainmethodologiesoftesting:

- **white-boxtesting**
- **black-box testing**

White-boxtesting:

- Itexaminesthe internalstructureofaprogramandattemptstotesteachlogicalcase.
- White-box testing can be thought of as "transparent" box testing: the tester can see and

test aspecific section of code. For instance, in white-box testing, an IF-THEN-ELSE statement would betestedwithbothaTRUE conditionandaFALSEcondition.

- Unfortunately,thereare afewproblemswithwhite-boxtesting:
    - thetesteroftendoesnothaveaccesstothe sourcecode
- white-boxtestingcanbeexponentiallylarge(for*n*IF-THEN-ELSEstatements,thereare2^ndifferent combinationsofvalues)
- Theseproblemswithwhite-boxtestingleadtothemorepracticalblack-boxtestingmethodology.

Black-boxtesting:

- Itis also known as data-driven or input/output-driven testing in which the tester views theprogramasa black box,andassuch, the innerworkings ofthe programare unknown.
- The main tool used in black-box testing is the specification of the program: that is, the testerattempts to determine what input causes the output of the program to be different from whatthe specifications wouldrequire.
- As a general rule within black-box testing, the tester should test the "good" input (i.e. a positiveinteger), "bad" input (i.e. casual mistakes, such as 04 instead of the integer 4), and the "ugly"input (i.e. malicious mistakes, such as the string "Hello" instead of the integer 4). If you view"ugly"testingasunnecessary,andfeelthatthat"GarbageIn,GarbageOut"(GIGO)shouldb ethe motto of testing, note that others would strongly disagree: "[GIGO] is one of the worst cop-outs ever invented by the computer industry". If a program is designed to ensure that nuclearreactors run safely, and the user happens to type "1.0" instead of "1" (Garbage In), it would bedisastroustohaveameltdown(GarbageOut).
- Insummarythe mottoof properprogrammingshouldbe:"GarbageIn,Nice-error-messageOut."
- Wemaybeasking:

Thesemethods arefine, butwhatifIhave100000lines ofcodetotest?

Toanswerthisquestion,considerthefollowingquote:

> "tests must be designed and tested: designed by a process no less rigorous and no lesscontrolledthanthatusedfor code."

Hence, the processes used in creating a program (such as modularization, preconditions, post-conditions,documentation, etc.)arenecessaryfortesting.

For **example**, consider the concept of modularization in terms of testing: to test a program withmodulesA andB,test

- moduleA
- moduleB
- moduleA usedinconjunctionwithmoduleB

That is, aftertestingeachmodule,theintegrationofthemodulesneedstobetested.

Since programming is not a "blind" process (it should be somewhat deterministic), testing should bepredictable as well. A tester should be able to determine the output **before** the test is run. If this is notthe case, the code/specifications are not known well enough, and errors will go unnoticed, since thetesterwon't beable to realize whenthe"actual"output doesn'tmatchthe "specified"output.

Finally, since errors are detected in testing, it is strongly recommended that "**test suites**" are used. Atest suite is a file of test cases which can be used as input for a program, and as such, can be repeatedlyusedtoverifythatanerrorhas beenfixed.

SpecificTechniques ofTesting:

This section provides a small checklist of test considerations for specific types of programs. Note thatthese are by no means complete: for a given program, you may have to test all of these cases and more,depending on the specifications of your program. In addition, not all of these cases will be applicable toall ofyourprograms.

Numericallybased

- goodvaluesofdifferenttypes(i.e.positive,negative,zero)
- boundaryconditions
- maximum,minimum
- outsideofmaxandmin
- gapsindomain(i.e.primenumbers,evennumbers,etc).

String based

- delimiterproblems(missingortoomany)

- mixedcase(hello,Hello,HeLlo)
- inputistoo longforstring
- input haswhitespaceorotherdelimiter

Filebased

- fileexistsandcontainscorrectdata
- fileexistsbutdataiswrongtype/format
- fileexistsbutisempty
- fileexistsbutiscorrupt
- filedoesnot exist

- Booleanvaluesof0/false,1/true,andsomethingelse(e.g.7/Hello)
- ensurenestedstatementsaretestedthoroughly
- casestatementsshouldtestallconditions(includingELSEclause)

Logicbased

- ensure enteringconditionofloopistrue
- areexitvalueswhat areexpected?
- isthe loopexitedatthecorrectiteration
- loopbodyexecuteszero,once,ormultiple times

Loops

Datastructuresandpointers

- ordereddatastructure
  - firstelementadded/removed
  - middleelementadded/removed
  - lastelementadded/removed
- unordereddatastructure
  - emptystructure
  - singleitem
  - multipleitems
  - fullstructure
  - duplicateitems
- pointers
  - null
  - pointerisnotnull(i.e.points toobject)
  - twopointerspointingtosameobject (e.g.pointers AandBpointtoobjectX)
  - pointertoa listofmultipleobjects

Summary ofTesting:

Testing is a necessary stage in the software life cycle: it gives the programmer and user some sense ofcorrectness, though never "proof" of correctness. With effective testing techniques, software is moreeasily debugged, lesslikelyto "break,"more "correct",and,insummary,better.

12. *PREVENTIVEMAINTENANCESCHEDULE:*

Maintenance: Maintenance of each equipment in a laboratory must follow the followingguidelines:

- Preventive Maintenance Schedule of lab will be decided by lab in-charge along withconcerned HOD. The details of schedule should be recorded in the following template offormat.

S.No.	NameoftheEquipment	Dateof Maintenance	TypeofActivity	Remarks
1	Computer		Cleaning	
2	Data		Backup	
3	Software		Settings	

- Maintenance Reports duly signed by in charges as well as HODs and duly approved byPrincipalperiodically.

13. *TROUBLESHOOTINGSCHEDULES:*

Troubleshooting:

It is a form of problem solving, often applied to repair failed products or processes. It isa logical, systematic search for the source of a problem so that it can be solved, and so theproduct or process can be made operational again. Troubleshooting is needed to develop andmaintaincomplexsystemswherethesymptomsofaproblemcanhavemanypossible causes.

Type of Problem, Expected Reasons, Trouble shooting exercises should be properlyrecorded inaseparateformatasmentionedbelow:

S.No.	Date ofrecordi ng activity	Equipment /SoftwareName	TypeofTrouble	RemedialActivity	Remarks
1		Turbo C	Librariesnot linked	Directory management	
2		Turbo C	Linkedbutnot executed	Module management	
3		Turbo C	Sourcefileis missing	Bakfile management	

14. LEADPROGRAMS(BRANCH/SECTIONWISE)

LEADPROGRAMS

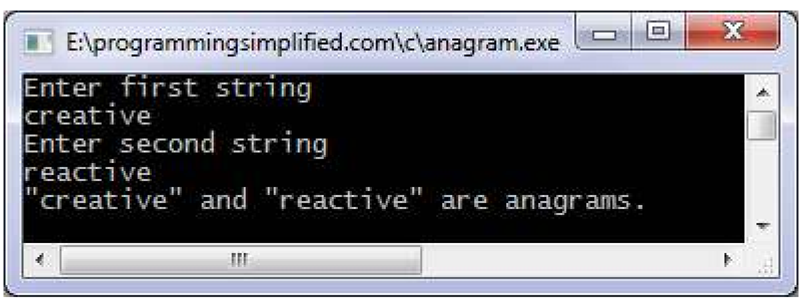
LEAD1.Write aCanagramprogrammingcode

```
#include<stdio.h>

int check_anagram(char [], char

[]);intmain()
{
  char a[100],
  b[100];int flag;

  printf("Enter first
  string\n");gets(a);

  printf("Enter second
  string\n");gets(b);

  flag = check_anagram(a,

  b);if(flag ==1)
    printf("\"%s\"and\"%s\"areanagrams.\n",a,b);

  else
    printf("\"%s\"and\"%s\"arenotanagrams.\n",a,b);


  return0;
}

intcheck_anagram(chara[],charb[])
{
  int first[26]={0},second[26]={0},c=0;
```

```
while(a[c]!= '\0')
{
  first[a[c]-
  'a']++;c++;
}

c= 0;

while(b[c]!='\0')
{
  second[b[c]-
  'a']++;c++;
}

for(c=0; c<26; c++)
{
  if (first[c] !=
    second[c])return0;
}

return1;
}
```

Download Anagram

program.Outputofprogram:



LEAD2.Cprogrammingcodeto mergetwosortedarrays

```
#include<stdio.h>
```

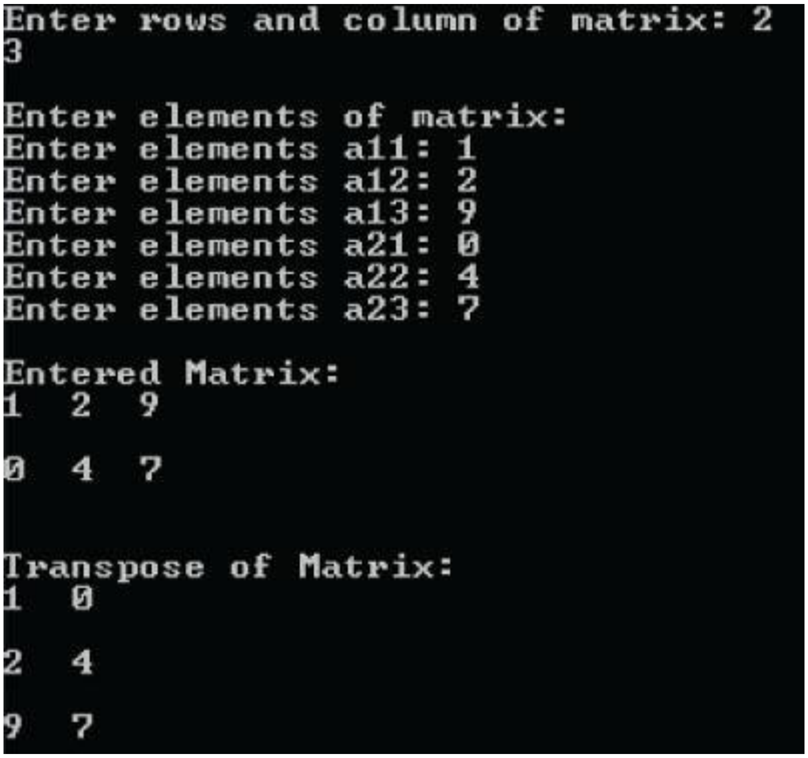
```
voidmerge(int [],int,int [],int,int []);

intmain(){
 inta[100],b[100],m,n,c,sorted[200];

 printf("Input number of elements in first
 array\n");scanf("%d",&m);

 printf("Input%dintegers\n",m);fo
 r (c = 0; c < m; c++)
 {scanf("%d",&a[c]);
 }

 printf("Input number of elements in second
 array\n");scanf("%d",&n);

 printf("Input %d integers\n",
 n);for (c = 0; c < n; c++)
 {scanf("%d",&b[c]);
 }

 merge(a, m,b,n,sorted);

 printf("Sortedarray:\n");

 for (c = 0; c < m + n; c++)
   {printf("%d\n",sorted[c]);
 }

 return0;
}

void merge(int a[], int m, int b[], int n, int sorted[])
 {inti,j,k;

 j= k= 0;

 for (i = 0; i< m + n;)
   {if (j < m && k < n)
   {if(a[j]<b[k]){
```

```
        sorted[i] =
        a[j];j++;
       }
       else{
        sorted[i] =
        b[k];k++;
       }i+
       +;
     }
     else if (j == m)
       {for(; i<m+n;){
        sorted[i] =
        b[k];k++;
        i++;
       }
     }
     else {
       for(;i< m+ n;) {
        sorted[i] =
        a[j];j++;
        i++;
       }
     }
   }
 }
```

LEAD1.Cprogramto findthetransposeofagivenmatrix.

```
#include
<stdio.h>intmain()
{
   int a[10][10], trans[10][10], r, c, i,
   j;printf("Enter rows and column of matrix:
   ");scanf("%d%d",&r,&c);


/* Storing element of matrix entered by user in array a[][].
   */printf("\nEnterelementsofmatrix:\n");
   for(i=0; i<r;
   ++i)for(j=0;j<c;+
   +j)
   {
      printf("Enter elements a%d%d:
      ",i+1,j+1);scanf("%d",&a[i][j]);
   }
/* Displaying the matrix a[][]
   */printf("\nEntered Matrix:
   \n");for(i=0;i<r; ++i)
   for(j=0;j<c;++j)
   {
      printf("%d",a[i][j]);
```

```
    if(j==c-
        1)printf("\n\n
        ");
}

/* Finding transpose of matrix a[][] and storing it in array trans[][].
 */for(i=0;i<r; ++i)
 for(j=0;j<c;++j)
 {
   trans[j][i]=a[i][j];
 }

/*Displayingthetranspose,i.e,Displayingarraytrans[][].*/printf("\nTranspose
 ofMatrix:\n");
 for(i=0; i<c;
 ++i)for(j=0;j<r;+
 +j)
 {
    printf("%d",trans[i][j]);i
    f(j==r-1)
        printf("\n\n");
 }
 return0;
}OUTPUT:
```



```
Enter rows and column of matrix: 2
3

Enter elements of matrix:
Enter elements a11: 1
Enter elements a12: 2
Enter elements a13: 9
Enter elements a21: 0
Enter elements a22: 4
Enter elements a23: 7

Entered Matrix:
1  2  9

0  4  7


Transpose of Matrix:
1  0

2  4

9  7
```

LEAD2#

ToImplementInfixToPrefixConversion

AlgorithmforconvertingInfixtoPrefix:

- ReversetheExpression andparsetheinputsintheexpressiononebyone.
- Iftheinputisanoperand,thenplaceitintheoutputbuffer.
- Iftheinputis anoperator,push itintothestack.
- If the operator in stack has equal or higher precedence than input operator,thenpop theoperatorpresentin stackandadd itto outputbuffer.
- Iftheinputisanclosebrace,pushitintothestack.
- If the input is a open brace, pop elements in stack one by one until weencounteropenbrace.Discardbraceswhilewritingtooutputbuffer.

After completing all processing, reverse the data in output buffer.And the resultwillbeourprefix notation ofthegiven expression.

Infix Expression:(a-b)/ (c+d)

ReversethegivenExpression:)d +c(/)b -a(

Input:)

Inputis closebrace.So,placeitinto thestack.

```
|      |
|)     |        Output:
 --------
```

***Input:**d*

Placetheoperandinoutputbuffer.

```
|      |
|)     |        Output:d
 --------
```

***Input:**+*

Placetheoperatorinto thestack.

```
|       |
|+      |
|)      |       Output:d
 --------
```

***Input:**c*

Placetheoperandinoutputbuffer

```
|       |
|+      |
|)      |       Output:dc
 --------
```

Input:(

Pop'+'and')'

```
|       |
|       |
|       |       Output:dc+
```

Input:/

Pushtheoperatorinto thestack.

```
|       |
|       |
|/      |        Output:dc+
 --------
```

***Input:**)*

Push closebraceintothestack.

```
|       |
|)      |
|/      |        Output:dc+
 --------
```

***Input:**b*

Placetheoperandinoutputbuffer.

```
|       |
|)      |
|/      |        Output:dc+b
 --------
```

***Input:**-*

Placetheoperatorinto thestack.

```
|-      |
|)      |
|/      |        Output:dc+b
 ---------
```

***Input:**a*

Placetheoperandinoutputbuffer.

```
|-      |
|)      |
|/      |        Output:dc+ba
```

Input:(

Popallelements untilweget closebrace.

```
|      |
|      |
|/     |        Output:dc+ba-
 --------
```

Nomoreinputto parse.So,pop allotherelementsfromthestack

```
|      |
|      |
|      |        Output:dc+ba-/
```

Reversetheoutput.

PrefixNotation:-/ab+cd

```
#include
 <stdio.h>#include
 <stdlib.h>#include
 <string.h>#defineOPER
 ATORS7

 struct node
    {int
    data;
    structnode*next;
 };

 structnode*top =NULL;

 /*Operatorsandits precedence*/
```

```
charprecedence[OPERATORS][2]={{'(',0},{'+',1},{'-',1},
                    {'*',2},{'/',2},{'%',2},
                    {')', 3}};

/* create a node with given data
*/structnode*createNode(intdata){
    struct node *ptr = (struct node *) malloc(sizeof (struct
    node));ptr->data=data;
    ptr->next=NULL;
}

/* Push the given data into the stack
*/voidpush(int data){
    struct node *ptr =
    createNode(data);if(top ==NULL){
          top =
          ptr;return
          ;
    }
    ptr->next =
    top;top =ptr;
}

/*Popthetop element fromthestack */
```

```
intpop() {
    struct        node
    *ptr;int data;
    if      (top       ==
          NULL)retur
          n-1;
    ptr=top;
    top      =      top-
    >next;data = ptr-
    >data;free(ptr);
    return (data);
}

/* get the index of the given operator
*/intgetIndex(intdata){
    inti;
    for(i =0;i<OPERATORS; i++){
          if (data ==
                precedence[i][0])return
                i;
    }
}

/* string reverse operation
*/voidstrrev(charstr[]){
```

```
    inti=0,j=0;char
    ptr[100];while(str[
    i]!='\0')
        i++;
    for (i = i-1; i>=0; i--)
        {ptr[j]=str[i];
        j++;
    }
    ptr[j] =
    '\0';strcpy(str,p
    tr);
}

/*infixtoprefix conversion*/
void infix2prefix(char infix[], char postfix[])
    {int i,j=0,data;
    intindex1,index2;
    for(i=0;i<strlen(infix);i++){
        /* if the given i/p is operand, place in output buffer
        */if(tolower(infix[i])>='a'&&tolower(infix[i]<='z'))
            postfix[j++] =
        infix[i];elseif(infix[i]==
        '('){
            /*
             * ifthei/pis open brace,poptheelementsone
```

```
         * byone until we encounterclosebrace
         */
        data= pop();
        while (data != ')' && data != -1)
              {postfix[j++]=data;
              data =pop();
        }
  }elseif(infix[i]==')'){
        /* if the i/p is close brace, push it into stack
        */push(infix[i]);
  } else {
        data= pop();
        if (data == -1) {
              /* stack is empty.. so, push current i/p
              */push(infix[i]);
              continue;
        }elseif (data== ')'){
              /*
               * ifstacktopelementisclosebrace,then
               * pushcurrentinputtostack
               */push(data);
              push(infix[i]);
```

```
            continue;
        }
        index1 =
        getIndex(data);index2=getI
        ndex(infix[i]);

        /*Precedencemanipulationb/wstackoperatorandcurrenti/p*/

        while (precedence[index1][1] > precedence[index2][1])
            {postfix[j++]=data;
            data =pop();
            if (data == -1 || data == ')')
                {push(infix[i]);
                break;
            }
            index1=getIndex(data);
        }
        if(data != -1) {
            push(data);pu
            sh(infix[i]);
        }

    }
}
```

```
        /* Pop the remaining data from stack after all
        processing*/while(1){
                if ((data = pop()) == -
                        1)break;
                postfix[j++]= data;
        }
        postfix[j]= '\0';
    }


    int main () {
        char str[100],
        output[100];printf("Enter ur
        Expression:");fgets(str, 100,
        stdin);str[strlen(str) - 1] =
        '\0';strrev(str);
        infix2prefix(str,output);
        /* reverse the output to get prefix notation
        */strrev(output);
        printf("Ouput: %s\n",
        output);return0;
    }OUTPU
```

T:

ENTERUREXPRESSION:(a-b)/(c+d)

Output:/-ab+cd

LEAD1.Linearsearchformultipleoccurrences

```
#include

<stdio.h>intmain()
{
  intarray[100],search,c,n,count=0;

  printf("Enter the number of elements in
  array\n");scanf("%d",&n);

  printf("Enter %d numbers\n",

  n);for(c=0 ; c <n ; c++)
    scanf("%d",&array[c]);

  printf("Enter the number to
  search\n");scanf("%d",&search);

  for(c= 0 ; c <n ;c++)
  {
    if ( array[c]== search)
    {
      printf("%d is present at location %d.\n", search,
          c+1);count++;
    }
  }
  if(count==0)
    printf("%d is not present in array.\n",
  search);else
    printf("%dispresent%dtimesinarray.\n",search,count);
```

```
  return0;
}
```

LEAD2./* WriteaCProgramtoaccept twomatrices andcheck iftheyareequal
*/

```
#include
<stdio.h>#include<
stdlib.h>

voidmain()
{
 intA[10][10],B[10][10];
 int i,j,R1,C1,R2,C2,flag =1;

 printf("Enter the order of the matrix
 A\n");scanf("%d%d",&R1,&C1);

 printf("Enter the order of the matrix
 B\n");scanf("%d%d",&R2,&C2);

 printf("Enter the elements of matrix
 A\n");for(i=0;i<R1; i++)
 {
  for(j=0;j<C1;j++)
  {
   scanf("%d",&A[i][j]);
  }
 }

 printf("Enter the elements of matrix
 B\n");for(i=0;i<R2; i++)
 {
```

```
 for(j=0;j<C2;j++)
 {
  scanf("%d",&B[i][j]);
 }
}

printf("MATRIX A
is\n");for(i=0;i<R1; i++)
{
 for(j=0;j<C1;j++)
 {
  printf("%3d",A[i][j]);
 }
 printf("\n");
}

printf("MATRIX B
is\n");for(i=0;i<R2; i++)
{
 for(j=0;j<C2;j++)
 {
  printf("%3d",B[i][j]);
 }
 printf("\n");
}

/* Comparing two matrices for equality

*/if(R1 ==R2&&C1==C2)
{
 printf("Matrices can be
 compared\n");for(i=0;i<R1; i++)
 {
  for(j=0;j<C2;j++)
  {
   if(A[i][j]!=B[i][j])
   {
    flag =
    0;break;
   }
```

```
   }
  }
 }
 else
 {printf(" Cannot be compared\n");exit(1);
 }

 if(flag==1 )
  printf("Two matrices are
 equal\n");else
  printf("But,twomatricesarenotequal\n");

}
```

MECH-D

LEAD 1:Program to print all the perfect numbers between 1 and 2000 in cprogramming

```
#include<stdio.h>#i
nclude<conio.h>voi
dmain()
{
    longint
    n,i,j,sum;clrscr();p
    rintf("\n");
    for(i=1;i<=2000;i++)
    {
        sum=0;
        for(j=1;j<i ||
            j==1;j++)if(i%j==0)
                sum=sum+j;if
        (i==sum)
        {
            for(j=1;j<i ||
                j==1;j++)if(i%j==0)
```

```
            printf("\n THE SUM OF THIS FACTORS ARE %ld
            .\n",sum);printf("SO%ld ISPERFECTNUMBER\n\n",i);
         }
     }
     getch();
}
```

LEAD2:writea programto evaluatea multiple-choicetest

```
#define     STUDENTS     3
#define     ITEMS        25
main( )
    charkey[ITEMS+1],response[ITEMS+1];
     int   count, i,
        student,n,correct[IT
        EMS+1];
/*Reading of Correct answers
   */printf("Input keytotheitems\n");

       for(i=0; i < ITEMS;
     i++)scanf("%c",&key[i]);


    scanf("%c",&key[i]);
   key[i]='\0';


   /*Evaluation begins*/
for(student=1;student<=STUDENTS;student++)
      {
```

```
response[i]= '\0';

for(i=0; i< ITEMS;
   i++)correct[i]=0;

for(i=0; i< ITEMS ;
  i++)if(response[i]==key
  [i])
  {
    count = count +1
    ;correct[i]=1;
  }

/*printingofresults*/



printf("\n");
printf("Student-%d\n",student);
printf("Score is %d out of %d\n",count,
ITEMS);printf("Responsetotheitemsbelowarewrong\n");


    n = 0;
for(i=0; i< ITEMS ;
  i++)if(correct[i]==0)
  {
printf("%d",i+1);                    n= n+1;
   }
  if(n ==
    0)printf("NIL\n
    ");
  printf("\n");

 }/* Go tonextstudent */
/*Evaluationandprintingends*/

}
```

ECE-A:

LEAD1#

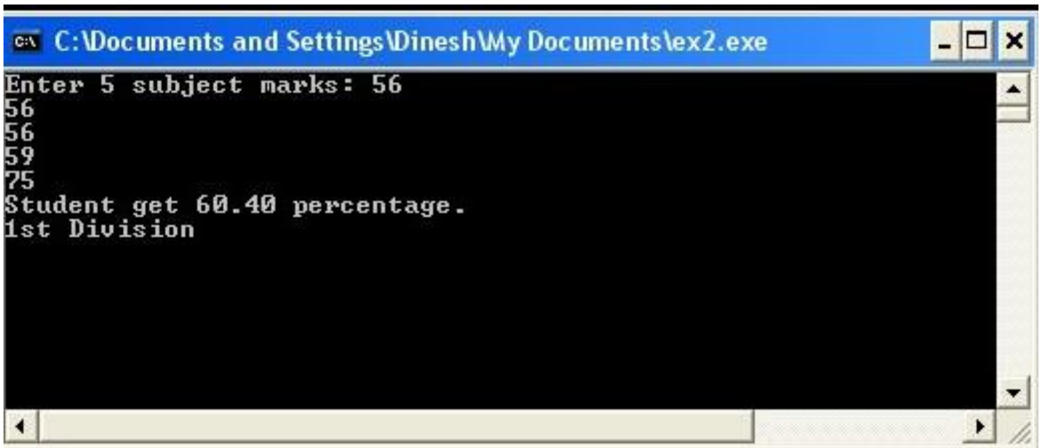
Write a C program to calculate the division obtained by the

student.Ans.

```
/*c program for read 5 subject marks and calculate percentage & division
ofstudent*/

/*we assume total marks is

500*/#include<stdio.h>

intmain()

{

 float m1,m2,m3,m4,m5,avg,per;

 //m=marksprintf("Enter5 subjectmarks: ");

 scanf("%f %f %f %f

 %f",&m1,&m2,&m3,&m4,&m5);per=(m1+m2+m3+m4+

 m5)*100/500;

 printf("Student get %0.2f percentage.

 \n",per);if(per>=60)

   printf("1stDivision");

 else if(per>=50 &&

   per<=59)printf("2ndDivision

   ");

 else if(per>=40 &&

   per<=49)printf("3rdDivision

   ");

 else

   if(per<40)pri

   ntf("Fail");
```

```
 return0;

}
```

OUTPUT:



LEAD2#

Source code of simple quick sort implementation using array ascending order in cprogramminglanguage

```
#include<stdio.h>

void quicksort(int

[10],int,int);intmain(){

  intx[20],size,i;

  printf("Enter size of the array:

  ");scanf("%d",&size);

  printf("Enter%delements:",size);
```

```
  for(i=0;i<size;i++)scanf("
  %d",&x[i]);quicksort(x,0,si
  ze-1);printf("Sorted
  elements:
  ");for(i=0;i<size;i++)
   printf("
  %d",x[i]);return0;
}
void quicksort(int x[10],int first,int
    last){intpivot,j,temp,i;
     if(first<last){
         pivot=first;
         i=first;j=la
         st;while(i<
         j){
             while(x[i]<=x[pivot]&&i<last)i
                 ++;
             while(x[j]>x[pivot])
                 j--;
             if(i<j){
                 temp=x[i];
                  x[i]=x[j];x
                  [j]=temp;
```

```
            }

        }


        temp=x[pivot];x[piv

        ot]=x[j];x[j]=temp;q

        uicksort(x,first,j-

        1);quicksort(x,j+1,la

        st);

    }

}
```

Output:

```
Enter size of the array:

5Enter5 elements: 38 0 12

Sortedelements:0 1238
```

ECE-B

LEAD 1.Write a c program to Store Information of 10 students UsingStructure

```
#include
<stdio.h>structstu
dent{
   char
   name[50];intro
   ll;
   floatmarks;
};
intmain(){
```

```
struct student
s[10];inti;
printf("Enter information of
students:\n");for(i=0;i<10;++i)
{
   s[i].roll=i+1;
   printf("\nFor roll number
   %d\n",s[i].roll);printf("Enter name:
   ");scanf("%s",s[i].name);
   printf("Enter marks:
   ");scanf("%f",&s[i].mark
   s);printf("\n");
}
printf("Displaying information of
students:\n\n");for(i=0;i<10;++i)
{
 printf("\nInformation for roll number
 %d:\n",i+1);printf("Name: ");
 puts(s[i].name);
 printf("Marks:%.1f",s[i].marks);
}
return0;
}
```

Output

```
Enter        information        of

students:Forroll number1
Entername: Tom
Entermarks:98

For  roll  number
2Enter      name:
JerryEntermarks:
89
.
.
.
Displayinginformationofstudents:
```

Informationforrollnumber1:
Name:
TomMarks:
98
.
.
.

LEAD2.WriteaCprogramtosort 5numbers usingheap sortingmethod.

Ans.

```
/* cprogramfor heapsorting method*/

#include<stdio.h>#includ
e<conio.h>voidmanage(int
*,int);

void heapsort(int *, int,
int);intmain()
{
 intarr[20];
 inti,j,size,tmp,k;
 printf("\n\t-------Heapsortingmethod --------- \n\n");
 printf("Enter the number of elements to sort :
 ");scanf("%d",&size);
 for(i=1;i<=size;i++)
 {
   printf("Enter %d element :
   ",i);scanf("%d",&arr[i]);manag
   e(arr,i);
 }
 j=size;
 for(i=1;i<=j;i++)
 {
```

```
   tmp=arr[1];arr[
   1]=arr[size];arr[
   size]=tmp;size--
   ;
   heapsort(arr,1,size);
  }
  printf("\n\t-------Heapsortedelements --------- \n\n");
  size=j;
  for(i=1; i<=size;
     i++)printf("%d",arr
     [i]);
  getch();

  return0;
 }


 voidmanage(int*arr,int i)
 {
  int
  tmp;tmp=a
  rr[i];
  while((i>1)&&(arr[i/2]<tmp))
  {
   arr[i]=arr[i/2];
   i=i/2;
  }
  arr[i]=tmp;
 }


 voidheapsort(int*arr,inti,intsize)
 {
  int
  tmp,j;tmp=arr[
  i];j=i*2;while(
  j<=size)
  {
   if((j<size)&&(arr[j]<arr[j+1]))
      j++;
   if(arr[j]<arr[j/2])
      break;arr[j/2]
   =arr[j];
```

```
  j=j*2;
 }
 arr[j/2]=tmp;
}
```

*/*************OUTPUT***************/*

ScreenshotforHeapsortingCprogram

1ECE-CLEAD

1) Writeaprogramtosort alistand find itsmedian.

```
#defineN10

  main()
  {
     inti,j,n;
     floatmedian,a[N],t;

     printf("Enter the number of
     items\n");scanf("%d",&n);
   /*Reading items into arraya*/

     printf("Input %d values
     \n",n);for(i =1;i <=n ;i++)
```

```
    /*Sortingbegins*/for(i =
1 ;i<=n-1; i++)
       {     /* Trip-i
begins*/for(j= 1 ;j<=n-i;j++)
          {
              if (a[j]<=a[j+1])
              { /*Interchangingvalues*/

                t=a[j];
                a[j] =
                a[j+1];a[j+1]
                =t;
              }
              elsecontinue;
          }
       }/* sorting ends */
/* calculation of median*/if(n
%2 ==0)
          median = (a[n/2] + a[n/2+1])/2.0
       ;else
          median=a[n/2+1];

    /*Printing*/
for (i = 1 ; i <= n ;
           i++)printf("%f",a[i]
           );
       printf("\n\nMedianis%f\n",median);

   }
```

LEAD

2) Writea programofbookshopinventory

```
#include
            <stdio.h>#i
  nclude
            <string.h>s
  tructrecord
  {
     char
            author[20];c
     har
            title[30];fl
     oat    price;struct
     {
        char
              month[10];int
              year;
     }
     date;
     char
           publisher[10];int
           quantity;
};
int look_up(struct record table[],char s1[],char s2[],int
   m);voidget (charstring []);
  main()
  {
char title[30],
author[20];intindex,no_of
_records;
char response[10],
quantity[10];structrecord
book[]={
{"Ritche","CLanguage",45.00,"May",1977,"PHI",10},
{"Kochan","ProgramminginC",75.50,"July",1983,"Hayden",5},
{"Balagurusamy","BASIC",30.00,"January",1984,"TMH",0},
{"Balagurusamy","COBOL",60.00,"December",1988,"Macmillan",25}
                            };

    no_of_records = sizeof(book)/ sizeof(struct
    record);do
    {
      printf("Enter title and author name as per the
      list\n");printf("\nTitle:  ");
      get(title);printf("A
      uthor:
```

```
                    ");
        get(author);
```

```
    if(index != -1)     /*Book found*/

    {
       printf("\n%s %s %.2f %s %d
              %s\n\n",book[index].author,book
              [index].title,book[index].price,b
              ook[index].date.month,book[ind
              ex].date.year,book[index].publis
              her);

       printf("Enter number of
       copies:");get(quantity);
       if(atoi(quantity)<book[index].quantity)

         printf("Cost of %d copies =
            %.2f\n",atoi(quantity),book[index].price*
            atoi(quantity));
       else
         printf("\nRequiredcopiesnotinstock\n\n");
      }
      else
         printf("\nBooknotinlist\n\n");

      printf("\nDo you want any other book? (YES /
      NO):");get(response);
    }
    while(response[0] == 'Y' || response[0] ==
    'y');printf("\n\nThankyou.Goodbye!\n");
}
voidget(charstring[])
{
  charc;int
  i = 0;do
  {
    c =
    getchar();string
    [i++]=c;
  }
  while(c!='\n');
```

```
  }

 intlook_up(structrecordtable[],chars1[],chars2[],intm)
  {
     inti;
     for(i = 0; i <m; i++)
        if(strcmp(s1, table[i].title) ==
           0&&strcmp(s2, table[i].author) ==
           0)return(i);         /*bookfound           */
return(-1);                /*booknotfound        */

  }
```

ECE-D

LEAD1:CProgramto implementarraysearch

```
#include
<stdio.h>#include<
conio.h>

voidmain()
{
 intarray[10];
 int i, N, keynum,

 found=0;clrscr();

 printf("Enter the value of
 N\n");scanf("%d",&N);

 printf("Enter the elements one by
 one\n");for(i=0;i<N; i++)
 {
  scanf("%d",&array[i]);
 }
 printf("Input array
 is\n");for(i=0;i<N; i++)
```

```
{
 printf("%d\n",array[i]);
}
printf("Enter the element to be
searched\n");scanf("%d",&keynum);


for(i=0; i<N; i++)
{
 if( keynum== array[i])
 {
  found =
  1;break;
 }
}
if(found==
 1)printf("SUCCESSFULSEARCH\n");
else
 printf("SearchisFAILED\n");

}
```

LEAD2:CProgramTo SortNames

```
#include
<stdio.h>#include
<conio.h>#include
<string.h>

voidmain()
{
```

```
char name[10][8], Tname[10][8],
temp[8];inti,j,N;

clrscr();

printf("Enter the value of
N\n");scanf("%d",&N);

printf("Enter %d names\n",
N);for(i=0;i<N; i++)
{
 scanf("%s",name[i]);
 strcpy(Tname[i],name[i]);
}

for(i=0;i<N-1;i++)
{
 for(j=i+1;j<N;j++)
 {
  if(strcmpi(name[i],name[j])>0)
  {
   strcpy(temp,name[i]);str
   cpy(name[i],name[j]);str
   cpy(name[j],temp);
  }
 }
}

printf("\n-------------------------------------------------------
-----------------------------------------------------------------\n");
printf("InputNames\tSortednames\n");printf("
-----------------------------------------------------------------\n");
for(i=0;i<N; i++)
{
 printf("%s\t\t%s\n",Tname[i],name[i]);
}
printf("-----------------------------------------------------------\n");

}
```

CSEA

LEAD 1) Write a program using while loop that will calculate the sum of everythirdintegerbeginningwith i=2 forvaluesofi that arelessthan100.

```
#include<stdio.h>#i
nclude<conio.h>voi
dmain()
{
        int
        i,sum=0,n=100;clrsc
        r();
        printf("\n\n THE SERIES IS UNDER : \n\n\n");i=2;
        while(i<=n)
        {
            sum=sum+i;if
            (i==2)
                printf("%d",i);e
            lse
                printf(" +
            %d",i);i=i+3;
        }
        printf("\n\n\n THE SUMMATION IS
        %d",sum);getch();
}
```

LEAD2)CProgramto GenerateElectricityBill

```
/generating electricity bill using structure in

C#include<stdio.h>


/**ThisblockdefinesthestructureBillhaving


    fieldsforfirstname,lastname,address,
```

```
   previousunitandpresentunit.Thestructure
   mustbedefinedbeforemainfunction*/
structBill{
   charfirstName[10];
   charlastName[10];
   charAddress[20];
   floatpreviousUnit;
   floatpresentUnit;
};
/**Thisisthefunctiondefinitionthat
   calculatesthecost.Herestructureispassed
   as an argument*/
floatgenerateBill(structBilltemp){
   float diff;
   diff=temp.presentUnit-temp.previousUnit;
```

```
    if(diff> 20){

        returndiff*4.75;

    }else{

        return20*4.75+(diff-20)*7.75;

    }

}

intmain(){

    structBillbill;/*Declarationofstructurevariable*/

    printf("Fillupthefollowing:\n");

    printf("FirstName:");

    gets(bill.firstName);//accessingmember

    printf("LastName:");

    gets(bill.lastName);

    printf("Address:");

    gets(bill.Address);
```

```
printf("PreviousUnit:");
```

```
scanf("%f",&bill.previousUnit);

printf("PresentUnit:");

scanf("%f",&bill.presentUnit);

printf("\a\n\n***********ElectricityBill***************\n\n\a");

printf("Name:%s%s",bill.firstName,bill.lastName);

printf("\nAddress:%s",bill.Address);

printf("\nPreviousUnit:%.3f         CurrentUnit:
%.3f",bill.previousUnit,bill.presentUnit);

printf("\nCost:%.3f\n\n",generateBill(bill));

return0;
```

CSE-B

LEAD1.CProgramtocheckifa givenmatrix isan identitymatrix

```
voidmain()
{
 intA[10][10];
 inti,j,R,C,flag =1;
```

```
printf("Enter the order of the matrix
A\n");scanf("%d%d",&R,&C);

printf("Enter the elements of matrix
A\n");for(i=0; i<R;i++)
{
 for(j=0;j<C;j++)
 {
  scanf("%d",&A[i][j]);
 }
}
printf("MATRIX A
is\n");for(i=0; i<R;i++)
{
 for(j=0;j<C;j++)
 {
  printf("%3d",A[i][j]);
 }
 printf("\n");
}

/* Check for unit (or identity) matrix

*/for(i=0; i<R;i++)
{
 for(j=0;j<C;j++)
 {
   if((A[i][i]!=1)||((i!=j)&&(A[i][j]!=0)))
   {
   flag =
   0;break;
   }
 }
}

if(flag==1 )
 printf("It is identity
matrix\n");else
 printf("Itisnotaidentitymatrix\n");
```

```
}
```

LEAD2.CProgramtoconvertBinarynumbertoDecimal

```
#include<stdio.h>
intmain(){
 longintbnum,dec=0,j=1,rem,bnum1,flag=0;

 printf("Enter any binary number :
 ");scanf("%ld",&bnum);bnum1=bnu
 m;
 while(bnum!=0){rem=bn
  um%10;if((rem==0)||(re
  m==1))
  {
   flag=1;dec=dec+
   rem*j;j=j*2;bnu
   m=bnum/10;
  }
  else
  {
   flag=0;
   break;
  }
 }
 if(flag==1)
 {
  printf("\nThedecimaleqivalentvalueofbinary%ldis:%ld",bnum1,dec);
 }
 else
 {
  printf("\n\nEntertheBinarynumber!!!");
```

```
 }
 return 0;
}
```

CSE–C:

LEAD1#

Writea CProgramtocheckif a given matrixisanidentitymatrix*/

```
#include<stdio.h>

voidmain()

{

intA[10][10];

inti,j,R,C,flag =1;

printf("Enter the order of the matrix

A\n");scanf("%d%d",&R,&C);

printf("Enter the elements of matrix

A\n");for(i=0;i<R; i++)

{

for(j=0;j<C;j++)
```

```
{
scanf("%d",&A[i][j]);
}
}
printf("MATRIX A
is\n");for(i=0;i<R; i++)
{
for(j=0;j<C;j++)
{
printf("%3d",A[i][j]);
}
printf("\n");
}

/*Checkforunit(oridentity)matrix*/

for(i=0;i<R;i++)
{
for(j=0;j<C;j++)
{
if(A[i][j]!=1 &&A[j][i]!=0)
{
flag=0;
```

```
break;
}
}
}

if(flag== 1 )
printf("It is identity
matrix\n");else
printf("Itisnotaidentitymatrix\n");
}
```

Output

Run1

Enter the order of the matrix

A2 2

Enter the elements of matrix

A2 2

1 2

MATRIX A

is2 2

1 2

It is not a identity

matrixRun2

Enterthe orderof thematrixA

2 2

Enter the elements of matrix

A1 0

0 1

MATRIX A

is1 0

0 1

Itis identitymatrix

CSELEAD2#

.Cprogramtosortgivenlistofelements usingMergesort

Ans.

/* c program for merge sorting

*/#include<stdio.h>#include<con

io.h>

```
void merge(int [],int ,int ,int
);voidpart(int[],int ,int);
intmain()
{
 int
 arr[30];inti
 ,size;
 printf("\n\t-------Mergesortingmethod ---------\n\n");
 printf("Enter total no. of elements :
 ");scanf("%d",&size);
 for(i=0;i<size;i++)
 {
   printf("Enter %d element :
   ",i+1);scanf("%d",&arr[i]);
 }
 part(arr,0,size-1);
 printf("\n\t-------Mergesortedelements         \n\n");
 for(i=0;         i<size;
 i++)printf("%d
 ",arr[i]);getch();
 return0;
}
```

```
voidpart(intarr[],intmin,intmax)
{
 int
 mid;if(min<
 max)
 {
   mid=(min+max)/2;part(ar
   r,min,mid);part(arr,mid+
   1,max);merge(arr,min,mi
   d,max);
 }
}


voidmerge(intarr[],intmin,intmid,intmax)
{
  int
  tmp[30];int
  i,j,k,m;j=mi
  n;m=mid+1;
  for(i=min;j<=mid&&m<=max;i++)
  {
     if(arr[j]<=arr[m])
     {
```

```
        tmp[i]=arr[j];
        j++;
    }
    else
    {
        tmp[i]=arr[m];
        m++;
    }
}
if(j>mid)
{
    for(k=m; k<=max;k++)
    {
        tmp[i]=arr[k];
        i++;
    }
}
else
{
    for(k=j;k<=mid; k++)
    {
       tmp[i]=arr[k];
       i++;
```

```
    }
  }
  for(k=min; k<=max;
    k++)arr[k]=tmp[k];
}
/************* OUTPUT
*****************/Outputofmergesort
Cprogram
Enter the number of element to
sort:5Enter1 element :65
Enter2 element:87
Enter3 element:6
Enter4 element:14
Enter5 elements:46
------mergesortedelements----
6   1446    6587
```

CSE-D

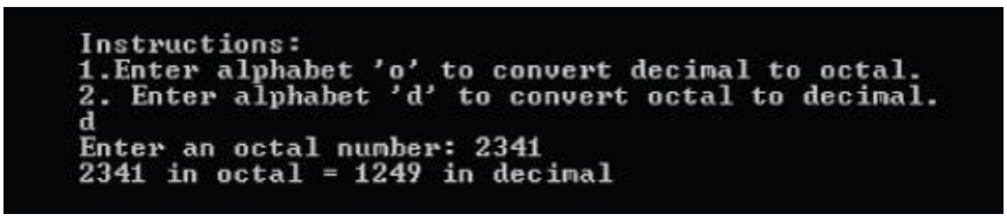
LEAD 1. Write a c program to Convert Octal Number to Decimal and ViceVersa

```
/* C programming source code to convert either octal to decimal or decimal
tooctal accordingtodataentered byuser.*/

#include<stdio.h>
```

```
#include<math.h>
int     decimal_octal(int
n);int  octal_deciaml(int
n);intmain()
{
  int
  n;char
  c;
  printf("Instructions:\n");
  printf("1.  Enter  alphabet  'o'  to  convert  decimal  to
  octal.\n");printf("2. Enter alphabet 'd' to convert octal to
  decimal.\n");scanf("%c",&c);
  if(c=='d'||c== 'D')
  {
     printf("Enter an octal number:
     ");scanf("%d",&n);
     printf("%dinoctal=%dindecimal",n,octal_decimal(n));
  }
  if(c=='o'||c== 'O')
  {
     printf("Enter a decimal number:
     ");scanf("%d",&n);
     printf("%dindecimal=%dinoctal",n,decimal_octal(n));
  }
  return0;
}

intdecimal_octal(intn)/*Functiontoconvertdecimaltooctal*/
{
   int rem, i=1,
   octal=0;while(n!=0)
   {
      rem=n%8;n/=
      8;octal+=rem
      *i;i*=10;
   }
   return octal;
}

intoctal_decimal(intn)/*Functiontoconvertoctaltodecimal*/
```

```
{
   int decimal=0, i=0,
   rem;while(n!=0)
   {
      rem =
      n%10;n/=10;
      decimal+=rem*pow(8,i);
      ++i;
   }
   returndecimal;
}
```

Output



```
Instructions:
1.Enter alphabet 'o' to convert decimal to octal.
2. Enter alphabet 'd' to convert octal to decimal.
d
Enter an octal number: 2341
2341 in octal = 1249 in decimal
```

LEAD 2. Code for Circular link list with create, insert, delete, display operationsusingstructurepointerin CProgramming

```
#include<stdio.h>

#include<conio.h>


structcircular

{

   inti;

   structcircular*next;
```

```
};


struct circular
*temp;struct circular
*head;struct circular
*p;struct circular
*mid;structcircular*m
ove;

intcnt=0;


void
create(void);void
insert(void);void
display(void);void
del(void);

voidmain()
{
   int
   ch=0;clrscr()
   ;while(ch!=5
   )
   {
```

```
printf("\n1.CREATE");p
rintf("\n2.INSERT");pri
ntf("\n3.DELETE");prin
tf("\n4.DISPLAY");prin
tf("\n5.EXIT");
scanf("%d",&ch);



if(ch==1)
{
   create();
   cnt++;c
   nt++;
}

if(ch==2)
{
   insert();
   cnt++;
}
if(ch==3)
{
   del();
```

```
            cnt--;
        }

        if(ch==4)
        {
            display();
        }

        if(ch==5)
        {
            break;
        }
    }
    getch();
}
voidcreate()
{
    head=(struct circular *)malloc(sizeof(struct
    circular));head->next=head;
    printf("ENETERTHEDATA");
    scanf("%d",&head-
    >i);temp=head;
```

```
    temp->next=(struct circular *)malloc(sizeof(struct
    circular));temp=temp->next;
    temp-
    >next=head;printf("ENETERTH
    EDATA");
    scanf("%d",&temp->i);


}
voidinsert()
{
    intadd,t;

    printf("\n\t ENTER ANY NUMBER BETWEEN 1 AND
    %d",cnt);scanf("%d",&add);
    p=head;
    t=1;
    while(t<add)
    {
        p=p-
        >next;t++;
    }
    printf("%d",p-
    >i);clrscr();
    mid=(structcircular*)malloc(sizeof(structcircular));
```

```
    printf("ENETERTHEDATA");
    scanf("%d",&mid-
    >i);mid->next=p-
    >next;
    p->next=mid;
}

voiddisplay()
{
    p=head;
    printf("%d-->",p-
    >i);p=p-
    >next;while(p!=head
    )
    {
        printf("%d-->",p-
        >i);p=p->next;
    }
}

voiddel(void)
{
    intadd,t;

    printf("\n\tENTERANYNUMBERBETWEEN1AND%d",cnt);
```

ACADEMIC PLANNER

Subject: Data Structures

S.NO **CONTENT**

(1) - Preamble/Introduction
(2) - Prerequisites
(3) - Objectives and Outcomes
(4) - Syllabus
1.JNTU/R23-CMREC
2.GATE
3.IES
(5) - List of Expert Details (Local/National/International with Contact details/Profile link/Blogs/their research Contribution towards the subject)
(6) - Journals with min 5 ref paper for literature study
(7) - Subject -Lesson plan
(8) - Suggested Books (prescribed and References)
(9) - Websites for self learning Resources like
(10) - Question Banks
1.JNTUH/Model papers
2. GATE
(11) - Two case study presentations with Project / Product/Model/prototypes/ Industrial applications.
(12) - Assignment Question/Innovative Assignments sets.
(13) -Listof topics for students Seminars with Guidelines
(14) - STEP/Course material in softcopy
(15) - Expert Lectures with topics & Schedules (if any)

1.Preamble/Introduction

Data Structure can be defined as the group of data elements which provides an efficient way of storing and organising data in the computer so that it can be used efficiently. Some examples of Data Structures are arrays, Linked List, Stack, Queue, etc. The idea is to reduce the space and time complexities of different tasks. Data Structures are the main part of many computer science algorithms as they enable the programmers to handle the data in an efficient way.

2. Prerequisites

A course on "Programming for Problem Solving

.

3. Course objectives

- Exploring basic data structures such as stacks and queues.
- Introduces a variety of data structures such as hash tables, search trees, tries, heaps, graphs.
- Introduces sorting and pattern matching algorithms

Course outcomes

- Ability to select the data structures that efficiently model the information in a problem.
- Ability to assess efficiency trade-offs among different data *structure implementations and combinations.*
- *Implement and know the application of algorithms for sorting and pattern matching.*
- Design programs using a variety of data structures, including hash tables, binary and general tree structures, search trees, tries, heaps, graphs, and AVL-trees.

4. 1 Syllabus (JNTUH)CS203ES: DATA STRUCTURES

(Common to All Branches)

B. Tech I YearIISem **L T P C**

3 1 0 4

UNIT - I

Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks- Operations, array and linked representations of stacks, stack applications, Queues- operations, array and linked representations.

UNIT - II

Dictionaries: linear list representation, skip list representation, operations - insertion, deletion and searching.

Hash Table Representation: hash functions, collision resolution-separate chaining, open addressing-linear probing, quadratic probing, double hashing, rehashing, *extendible hashing.*

UNIT - III

Search Trees: Binary Search Trees, Definition, Implementation, Operations- Searching, Insertion and Deletion, AVL Trees, Definition, Height of an AVL Tree, Operations – Insertion, Deletion and Searching, Red –Black, Splay Trees.

UNIT - IV

Graphs: Graph Implementation Methods. Graph Traversal Methods.

Sorting: Heap Sort, External Sorting- Model for external sorting, Merge Sort.

UNIT - V

Pattern Matching and Tries: Pattern matching algorithms-Brute force, the Boyer – Moore algorithm, the Knuth-Morris-Pratt algorithm, Standard Tries, Compressed Tries, Suffix tries.

4.2 **GATE Syllabus**:

- Arrays, Stacks, Queues
- Linked Lists
- Trees, Binary search trees, Binary heaps.
- Graphs

4.3 IES Syllabus:

- Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

- Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.

5. Expert Details (Guest Lect. / Seminars)

INTERNATIONAL:

1. Jack Snoeyink, Professor, Ph.D. 1990, Stanford University. Computational geometry; algorithms for geographical information systems and structural biology; geometric modeling and computation; algorithms and data structures; theory of computation.

2. Michael T. Goodrich,**Distinguished Professor** ,**Dept. of Computer Science** Bren School of Info. and Computer Sciences , **Dept. of EECS** (by courtesy) **Samueli School of Engineering** ,**University of California, Irvine**

NATIONAL:

1. Yashwant kanetkar, Director of KICIT, a training company and KSET
2. Prof. E Balagurusamy, Member, Union Public Service Commission.
3. V Rajaraman , CONSULTANT , Advisor, Max Life,Chennai , India

REGIONAL:

4. Mrs. P. Madhavi, professor, CMREC Medchal, Hyderabad.
5. Mrs. Sravanthi Reddy Asst professor, VNR VJIET Nizampet, Hyderabad.
6. Mrs. Shamila Asst professor, MREC Dulapally,Hyderabad.

6. Journals with min 5 ref paper for literature study

1. https://link.springer.com/chapter/10.1007/978-3-642-04820-3_11
2. https://link.springer.com/chapter/10.1007/978-1-4757-5362-2_14

3. https://www.researchgate.net/publication/224238658_Data_structures_and_algorithms_in_pen-based_computing_environments

4. https://arxiv.org/pdf/2102.06939.pdf

5. http://www.ijirt.org/master/publishedpaper/IJIRT101357_PAPER.pdf

7. Subject (lesson) Plan

S.NO	Topic (JNTU syllabus)	Sub-Topic	NO. OF LECTURES REQUIRED	Suggested Books	Teaching Methods
UNIT – I					
1	**Introduction to Data Structures**	Abstract Data types	**L1**	**T1**	**M1**
2		Linear List-singly linked list implementation, insertion, deletion, and searching operations on linear list	**L2-L4**	**T1**	**M2(PPT)**
3		Stacks-operations	**L5**	**T1**	**M1**
4		Array and Linked list representations of stacks, Stack applications	**L6-L7**	**T1**	**M2(PPT)**
5		Queues Operations, array and Linked Representations	**L8-L9**	**T1**	**M1**
UNIT – II					
9	**Dictionaries**	Linear list Representation	**L10**	**T1**	**M1**
10		Skip List Representation	**L11**	**T1**	**M1**
11		Operations- insertion, deletion and Searching	**L12-L13**	**T1**	**M**
12		Hash Functions	**L14**	**T1**	**M1**

13	**Hash Table Representation**	Collision Resolution-separate chaining	**L15-L16**	**T1**	**M1**
14		Open addressing-Linear Probing	**L17**	**T1**	**M2(PPT)**
15		Quadratic Probing, Double Hashing	**L18-L19**	**T1**	**M2(PPT)**
16		Rehashing, Extendible Hashing	**L20-L21**	**T1**	**M1**
		UNIT-III			
17		Binary Search Trees, Definition	**L22**	**T1**	**M1**
18	**Search Trees**	BST Implementation, Operations-Searching, Insertion and Deletion	**L23-L25**	**T1**	**M2(PPT)**
19		AVL Trees, Definition, Height of an AVL Tree	**L26**	**T1**	**M1**
20		Operations-Insertion, Deletion and searching	**L27-L28**	**T1**	**M1**
21		Red-Black Trees	**L30**	**T1**	**M1**
		Splay Trees	**L31**	**T1**	**M1**
		UNIT –IV			
22	**Graphs**	Graph Introduction, Implementation Methods	**L32-L33**	**T1**	**M1**

23	**Sorting**	Graph Traversal Methods	**L34-L35**	**T1**	**M1**
24		Heap sort	**L36**	**T1**	**M2(PPT)**
25		External Sorting	**L37**	**T1**	**M2(PPT)**
26		Model for External Sorting	**L38**	**T1**	**M1**
		Merge Sort	**L39-40**	**T1**	**M2(PPT)**
UNIT –V					
27	**Pattern Matching and Tries**	Pattern Matching Algorithms Introduction	**L41**	**T1**	**M1**
28		Brute Force Algorithm	**L42-43**	**T1**	**M1**
29		The Boyer-Moore Algorithm	**L44-L45**	**T1**	**M1**
30		The Knuth-Morris-Pratt Algorithm	**L46-L47**	**T1**	**M2(PPT)**
31		Standard Tries	**L48**	**T1**	**M1**
32		Compressed Tries	**L49**	**T1**	**M1**
		Suffix Tries	**L50**	**T1**	**M1**

M1-Black Board

M2-PPT

8. Suggested Books (Text / Ref)

1. 1.FundamentalsofDataStructuresinC,2ndEdition, E. Horowitz, S. SahniandSusan Anderson Freed, *Universities Press*.
2. Data Structures using C – A. S. Tanenbaum, Y. Langsam, and M.J. Augenstein,*PHI/PearsonEducation*.
3. Data Structures using C by Reema Thareja second edition, Oxford University press.

9. Websites for self learning

1. https://www.edureka.co/blog/c-data-structures/
2. https://www.tutorialspoint.com/introduction_to_data_structures_and_algorithms/index.asp
3. https://nptel.ac.in/courses/106/102/106102064/
4. https://www.javatpoint.com/data-structure-tutorial
5. https://cosmolearning.org/courses/data-structures-and-algorithms/

10. Model papers-JNTUH

Code No: 123BP
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year I Semester Examinations, November/December - 2016
DATA STRUCTURES
(Common to CSE, IT)

Time: 3 Hours **Max. Marks:75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A
(25 Marks)

1.a) What is linked list? Write advantages of doubly linked list over singly linked list. [2]
b) What is recursion? Give the properties of a recursive definition of an algorithm. [3]
c) What is a stack? List the applications of stack. [2]
d) Show the detailed contents of stack to evaluate the given postfix expression. [3]
{1 2 3 + * 3 2 1 - + *}
e) Define a graph. List different graph traversal techniques. [2]
f) What are binary trees? Mention different types of binary trees with example. [3]
g) What is hashing? [2]
h) What is sorting? What is searching? [3]
i) Define AVL tree? Give example. [2]
j) What is B-tree of order m? Draw a B-tree of order 3.

PART-B ***(50 Marks)***

2.a) What is amortized complexity? Explain different methods to arrive atamortized costs foroperations.

b) Write a C program to implement insertion to the immediate left of the K^{th} node in singlylinked list. [5+5]

OR

3. Given an ordered linked list whose node is represented by 'key' as information and 'next' as link field. Write a C program to implement deleting number of nodes (consecutive) whose 'key' values are greater than or equal to 'K_{min}' and lessthan 'K_{max}'. [10]

4.a) Write a C program to implement multiple stacks using singlearray.

*b) Converttheinfixexpressiona/b–c+d*e–a*cintopostfixexpressionand*

trace that postfix expression for given data a = 6, b = 3, c = 1, d = 2, e = 4. [5+5]

5. a)Explain the insertion operation of Binary search tree with example.

b) Describe in detail about the deletion operation of Binary search tree with example.[5+5]

6.a) Construct a binary tree having the following traversalsequences: Preorder traversal:

A B C D E F G HI

Inorder traversal: B C A E D G H FI

b) Implement Depth First Search(DFS)algorithm. [5+5]

OR

7.a) Define a Max Heap. Construct a max heap for the following:

{12, 15, 9, 8, 10, 18, 7, 20, 25}

b) What is a graph? Explain various representations of graphs. [5+5]

8.a) Write an algorithm for Heap sort.

b) Apply selection sort on the following elements:

{21, 11, 5, 78, 49, 54, 72, 88} [5+5]

OR

9. What is collision? Explain different collision resolution techniques with examples.

[10]

10.a) Build an AVL tree with the followingvalues:

{15, 20, 24, 10, 13, 7, 30, 36, 25, 42, 29}

b) Write Knuth-Morris-Pratt patternmatchingalgorithm. [5+5]

OR

11.Write short noteson:

a)Red-Blacktrees b) splay trees c)b-trees. [3+3+4]

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABA'DR15

B.Tech II Year I Semester Examinations, March -2017

DATA STRUCTURES

(Common to CSE, IT)

Time:3Hours Max. Marks:75

This question paper contains two parts A añd B.

PartAiscompulsorywhichcarries25marks.AnswerallquestionsinPartA. Part B consists of 5 Units. Answer any one full question from each unit. Eachquestioncarries10marksandmayhavea,b,cassubquestions.

PART —A (25 Marks)

1.a) Whatarethedisadvantagesofanarray? [2]

Explainhowtofindtheperformanceofanalgorithm. [3]

Whatarethedisadvantagesofqueuewhichisimplementedusingarrayandhow toovercomeit? [2]

.d) Differentiate. between doubly andcircular linkedlists. ;§3]i

e) Explainhowbinarytreeisrepresentedusinganarrayandlinkedlist [2]
Explainthethreadedbinarytreewithsuitableexample [3]

DefineHashClashing. [2]

CompareSelectionsortandQuicksortwithanexample. [3j

i) Writeanalgorithmtoinsertanelementintothebinarysearchtree. [2]. ExplainthepropertiesofRed-

ii) Blacktree: [3]

PART-B **(50 Marks)**

W 2.a) program to concatenate singly linked lists.

b) Howtwo.dimensionalarraysarerepresentedinmemory?Alsoobtaintheformula for calculating the address of any element stored in the array; in case of column majororder. {5+5]

OR

3.a) Write a program to implement a sparsematrix.

b) How can we represent a polynomial in a linkedlist?

4.a) Explain the' Towers of Hanoi problem with anexample.

b) WriteaprogramtoimplementtheoperationsofQueue.

OR

5.a) WritearecursiveproceduretocompiitethenthFibonaccinumber.

b) What are the applications ofqueue?

6.a) Write an algorithm to find the components of agraph.

b) Define Priority Queue? Explain with anexample.

OR

7.a) Differentiate between BFS andDFS.

b) DefineBinarytree.ExplaintheBinarytieerepresentationsWithanexample.

Writ~~ã .algorithm of Linear.Search.

8.a)

b)

Sort the following list of‘elements by usiirgInsertionSort ’’'

15, 28,46, 10, 35,54, 5,17 [5+5j

OR

9.a) Insert the following list of elements into the hash table by using LinearProbing

(size of the hash table is 10)

36, 48, 66, 27, 23, 87, 10, 12

b)Explairi‘thdRadixsortwith‘anexample.

10.a) Construct the AVL tree of the followingdata

20, 40, 25, 18, 15, 5, 10, 46, 60

b) Drawflowchartofsplayingoperationsofsplaytree.

:.:.:. ..:"“... **OR** ::.:.:.: :::.

11.a) Consider the string = “GCATCGCAGAGAGTATACAGTACG” andsearchstring is “AGTATACA” using the KMP algorithm

b) DefineBinarytree.ExplaintheBinarytree representationsWithanexample.

[5+5]

11.Two case study presentations with Project /Product/ Model /prototypes/ Industrial applications.

Some database queries

• Given the name of an employee, find his/her id and salary.
• Find the total profit of all projects in the year 2000.
• Find employees who have a higher salary than another employee who was their boss in some project.

Employee

Sno	Name	Salary
1	Ramesh	60000
2	suresh	50000
..	……	…..

Project Assignment

Id	Boss Id	project
1	2	API
2	4	GUI
…	….	….

Project profit

Id	Year	Profit

API	2019	-100000
GUI	2020	30000

Some database updates

• Change the salary of an employee.
• Add a new employee or project.
• Assign an employee to work on a project

Hashing to identify almost-anagrams

Two strings x_1 and x_2 are anagrams if and only if they contain the same set of letters. This can be checked e.g. by sorting the letters of each string. The strings are *almost-anagrams* if they contain the same letters except for one character change or addition. For example, `test` and `taste` are almost-anagrams, and so are `glad` and `lads`.

We want to use hashing to identify almost-anagrams. As a building block we will use a hashing method to identify anagrams. We note that letters in the English alphabet can be converted to integers in $\{0, \ldots, 255\}$, e.g., in Java one can call `x.getBytes()` to return an array of bytes corresponding to the letters of a string `x`. In the following, we let x_i denote the integer corresponding to the ith character of a string x. We will make use of the prime number $p = 2^{31} - 1$, which in Java can be computed as `p = (1<<31)-1`.

a) Let T be an array of 256 integers in the range $\{0, \ldots, p\}$, and consider the hash function $h(x) = (T[x_1] + T[x_2] + T[x_3] + T[x_4] + T[x_5]) \bmod p$. Observe that if x and x' are anagrams, then $h(x) = h(x')$. Conversely, it is possible to show that if x and x' are not anagrams, and the integers in T are chosen at random, then the probability that $h(x) = h(x')$ is $1/p$. Use this fact to identify all anagrams in the collection of 5-letter words, by inserting their hash values in an associative array. Can you express the expected running time in terms of n (the number of strings), k (the number of anagrams reported), and p?

Note that for any pair x, y of almost-anagrams of length 5, it is possible to remove one letter from each of x and y to produce anagrams (not necessarily English words). For example, `tests` and `stats` can have `a` and `e` removed, respectively, to produce strings that both contain the letters `sstt`. Conversely, if we have two strings x and y such that removing one letter from each gives anagrams, then x and y are almost-anagrams. This suggests that we can identify almost-anagrams in a set S of n of 5-letter strings by identifying anagrams in the set S' of $5n$ 4-letter strings obtained by removing a character from one of the strings in S.

b) Write a procedure that inserts all hash values of elements in S' in an associative array, where each hash value is associated with the set of strings in S that lead to this hash value. For example, `tests` should be in the set of strings associated with $h(\text{test})$, $h(\text{tess})$, $h(\text{tets})$, $h(\text{tsts})$, and $h(\text{ests})$.

- **Customer Billing System C Project**

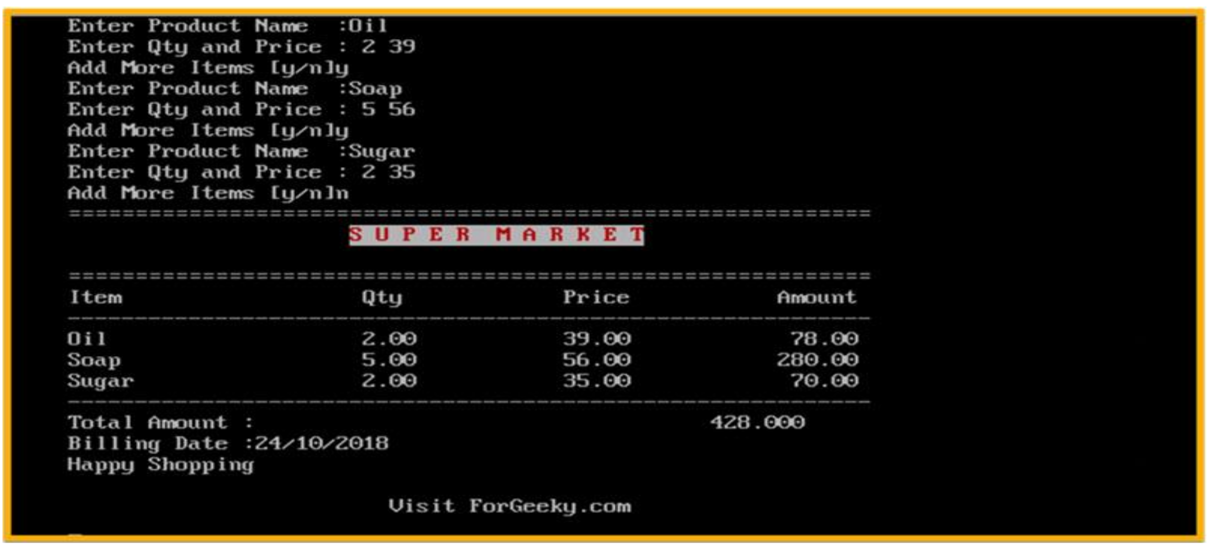
A real-time customer billing console application. It is a mini project developed especially to generate customer billing for the medical store, cafes, shops, super market, etc.

The entire program has been written with C - language only. The program is compiled in [Turbo C++]() using turbo c compiler.

```
#include<stdio.h>
#include<conio.h>
#include<dos.h>
//To avoid floting point error
voiddummy (float a)
{
float *p=&a;
}
structbill
{
char item[40];
float qty, price;
}b[100];
intmain()
{
clrscr();
int i=0, c=1;
char ch;
float amt, total=0;
Do
{
```

```
flushall();
printf("Enter Product Name  :");
gets(b[i].item);
printf("Enter Qty and Price : ");
scanf("%f%f",&b[i].qty, &b[i].price);
flushall();
printf("Add More Items [y/n]");
scanf("%c",&ch);
if(ch=='y')
{i++;c++;};
}
while(ch=='y');
printf("==============================================================");
textcolor(RED);
textbackground(WHITE);
printf("\t\t\t\t\t\t\b\b\b");
cprintf("S U P E R  M A R K E T\n");
puts("\n==============================================================")
;
printf("%-10s%15s%17s%17s\n", "Item", "Qty", "Price", "Amount");
puts("------------------------------------------------------------");
for(i=0;i<c;i++)
{
amt=b[i].qty*b[i].price;
total=total+amt;
printf("%-9s %16.2f\t%10.2f\t%11.2f\n",b[i].item, b[i].qty,b[i].price, amt);
```

```
}
puts("------------------------------------------------------------");
structdate d;
getdate(&d);
printf("Total Amount :\t\t\t\t\%.3f\n",total);
printf("Billing Date :%d/%d/%d\n",d.da_day,d.da_mon,d.da_year);
puts("Happy Shopping\n");
puts("\t\t\tVisit ForGeeky.com");
getch();
}
```



12. Assignment Questions:

I .ASSIGNMENT

1. What is a Data Structure and Explain its types? - CO1
2. Explainthe following: - CO2
   a) Stack using Arrays
   b) Stack using Linked List
3. What is Hash function? Explain about Double hashing? -CO3
4. Explain the operations of Binary search tree? -CO4
5. Explain Queues operations? -CO2

II. ASSIGNMENT

1. What is An AVL Trees? Explain its Operations? -CO1
2. Compare Merge sort with Heap sort? -CO3
3. Explain about Red-Black trees? -CO4
4. Explain Brute force algorithm? -CO3
5. Explain Boyer-Moore Algorithm? -CO3

INNOVATIVE QUESTIONS

- You can implement a C**ontact book application** using Doubly Linked List
- Make a **Dictionary** using Binary trees
- WhatsApp List (LRU Cache Problem
- Travel planner Using Graphs
- Contact list search using Tries

13. List of topics for students Seminars with Guidelines

1. Singly Linked list operations

2. AVL Trees

3. Merge sort

4. B+ Tree Implementation

5.Brute force algorithm

14. Step/Course material in softcopy

15. Expert Lectures with topics & Schedules(if any)

CMR ENGINEERING COLLEGE

UGC AUTONOMOUS

(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)

DATASTRUCTURES

LABMANUAL

PREFACE

This laboratory manual is prepared by the Department of ComputerScience and engineering for Data Structures Laboratory (CS207ES). This lab manualcan be used as instructional book for students, staff and instructors to assistinperformingandunderstandingtheexperiments.Inthemanual,experiments as per syllabus and experiments that are beyond the syllabusbutexpectedforuniversitylaboratoryexaminationaredisplayed.Thismanual will be available in electronic form from College’s official website, forthebettermentofstudents.

LISTOFEXPERIMENTS:

1. Write a program that uses functions to perform the following operationsonsinglelinkedlist:
   i) Creationii)Insertioniii)Deletioniv)Traversal
2. Write aprogramthatusesfunctionstoperformthefollowingoperationsondoublylinkedlist:
   i) Creation ii)Insertion iii)Deletion iv)Traversal
3. Write a program that uses functions to perform the following operationsoncircularlinkedlist:
   i) Creation ii)Insertion iii)Deletion iv)Traversal
4. Write aprogramthatimplement stack(itsoperations)using
   i) Arrays ii)Pointers
5. Write aprogramthatimplementQueue(its operations)using
   i) Arrays ii)Pointers
6. Writeaprogramthatimplementthefollowingsortingmethodsto sortagivenlistofintegersinascendingorder
   i) BubbleSort ii)SelectionSortiii)InsertionSort
7. Write a program that uses both recursive and non-recursive functions toperform thefollowingsearchingoperationsforakeyvalueinagivenlistofIntegers
   i) LinearSearch ii)BinarySearch
8. Writeaprogramtoimplementthetreetraversalmethods.
9. Writeaprogram toimplementthegraph traversalmethods.

WEEK-I

1. **Writeaprogramthatusesfunctionstoperformthefollowingoperations onsinglelinkedlist:**

i) Creation ii)Insertion iii)Deletion iv) TraversalAim: To implement single linked list and its operations such ascreation,insertion,deletion andTraversal.

Program:

```
#include<stdio.h>#include<
conio.h>#include<stdlib.h>s
tructnode

{

    intinfo;

    structnode*link;

};

structnode*first;voidcreat
e();void traverse();void
search();voidinfirst();void
inlast();

void
inafter();voiddelfirst
();voiddelend();
```

```
voiddelinfo();voidm
ain()

{

    int
    ch;charop;d
    o{

    printf("\nMenu\n1.Create\n2.Insert at first\n3.Insert
atend\n4.Insertafternode\n5.Traversal\n6.Deletefirst\n7.DeleteLast\n8.Deleteinfo\n9.Search\n10.Exit\
n");

    printf("Enteryourchoice:");scanf("%d",&c
    h);

    switch(ch)

    {

        case1:

            create();brea
            k;

        case2:

                infirst();bre

                ak;
        case3:

                inlast();brea

                k;
        case4:

                inafter();break;
```

```
case5:
        traverse();break;

case6:  delfirst();brea
        k;

case7:  delend();break;

        delinfo();brea
case8:  k;

        search();break;
case9:
        exit(0);

case10:

default:
printf("\nInvalidChoice");
    }
    printf("\nBacktomenu(y/n)");op=getch();

    }while(op=='y');

}
```

```
voidcreate()
{
        structnode*ptr,*cptr;charch;
        ptr=(structnode*)malloc(sizeof(structnode));printf("\nEnter first node
        information :");scanf("%d",&ptr->info);
        first=ptr;do
        {
                cptr=(structnode*)malloc(sizeof(structnode));printf("\nEnter next
                node information : ");scanf("%d",&cptr->info);
                ptr-
                >link=cptr;ptr=cptr;
                printf("pres(y/n)formorenodes:");ch=getch();
                }while(ch=='y');ptr-
                >link=NULL;
}
voidsearch()
{
        structnode*ptr;intdata;
```

```
ptr=first;
printf("\nEntervaluetosearch:");scanf("%d",&data
);while(ptr!=NULL)
{
    if(ptr->info==data)
    {
        printf("\n%dispresentinthelist",data);return;
    }
            ptr=ptr->link;
}
printf("Elementdoesnotexist");
}

voidtraverse()
{
structnode*ptr;printf("\nTraversingoflinkedlist:");ptr=
first;
while(ptr!=NULL)
{
    printf("%5d",ptr->info);ptr=ptr-
    >link;
```

```
}
}
voidinfirst()
{
	structnode*ptr;
	ptr=(structnode*)malloc(sizeof(structnode));if(ptr==NULL)
	{
		printf("Overflow");return;
	}
	printf("\nEnteravaluetoinsertatthebeginig:");scanf("%d",&ptr->info);
	ptr-
	>link=first;first=ptr;
}

voidinlast()
{
	structnode*ptr,*cptr;
	ptr=(structnode*)malloc(sizeof(structnode));while(ptr==NULL)
	{
		printf("\noverflow");return;
```

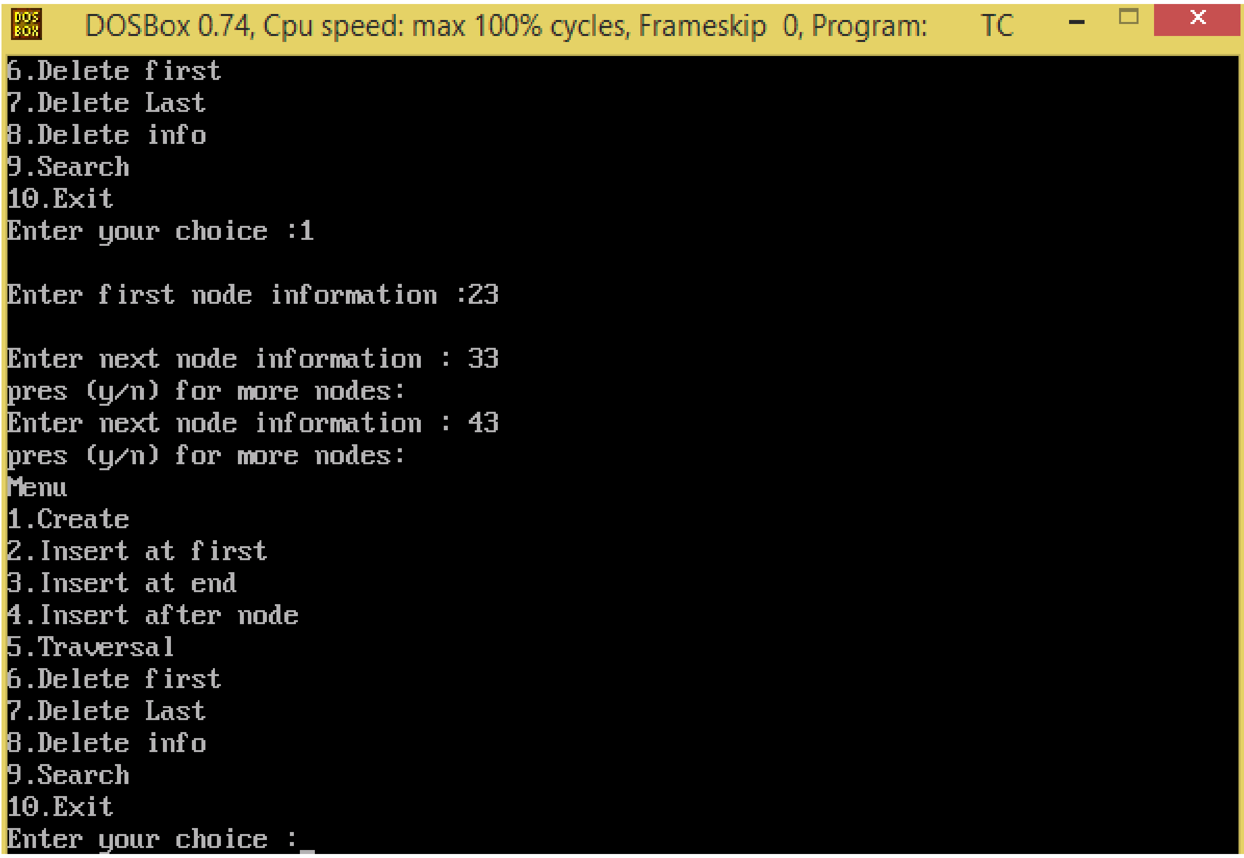
```
}
printf("\nEnterdatatoinsertatend:");scanf("%d",&ptr->info);
cptr=first;
while(cptr->link!=NULL)cptr=cptr-
>link;
cptr->link=ptr;ptr-
>link=NULL;
}
voidinafter()
{
structnode*ptr,*cptr;intdata;
ptr=(structnode*)malloc(sizeof(structnode));if(ptr==NULL)
{printf("OVERFLOW");return;
}
printf("\nEnterdatatoinsert:");scanf("%d",&ptr-
>info);
printf("Entervalueafterwhichyouwanttoinsert:");scanf("%d",&data);
cptr=first;
while(cptr->info!=data)
```

```
cptr=cptr->link;
ptr->link=cptr->link;cptr-
>link=ptr;
}
voiddelfirst()
{
    structnode*ptr;if(first==
    NULL)
    {
        printf("Underflow\n");return;
    }
    ptr=first;first=ptr-
    >link;free(ptr);
}

voiddelend()
{
structnode*ptr,*cptr;if(first==NU
LL)
{
printf("Underflow/n");return;
}
```

```
ptr=first;

while(ptr->link!=NULL)

{

cptr=ptr;ptr=ptr-
>link;

}

cptr->link=NULL;free(ptr);

}

voiddelinfo()

{

structnode*ptr,*cptr;intdata;if(fir
st==NULL)

{

printf("Underflow\n");return;

}

ptr=first;

printf("Enternodetobedeleted:");scanf("%d",&data);

while(ptr->info!=data)

{

cptr=ptr;
```

```
ptr=ptr->link;
}
cptr->link=ptr->link;free(ptr);

}
```

Output:


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :1
Enter first node information :23
Enter next node information : 33
pres (y/n) for more nodes:
Enter next node information : 43
pres (y/n) for more nodes:
Menu
1.Create
2.Insert at first
3.Insert at end
4.Insert after node
5.Traversal
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :_

```
DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
4.Insert after node
5.Traversal
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :2

Enter a value to insert at the beginig:13

Menu
1.Create
2.Insert at first
3.Insert at end
4.Insert after node
5.Traversal
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :3

 Enter data to insert at end :63
```

```
DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
1.Create
2.Insert at first
3.Insert at end
4.Insert after node
5.Traversal
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :5

Traversing of linked list :   13   23   33   43   63
Menu
1.Create
2.Insert at first
3.Insert at end
4.Insert after node
5.Traversal
6.Delete first
7.Delete Last
8.Delete info
9.Search
10.Exit
Enter your choice :
```

WEEK-II

2. Writeaprogramthatusesfunctionstoperformthefollowingoperations ondoublelinkedlist:

ii) Creation ii)Insertion iii)Deletion iv) TraversalAim: To implement double linked list and its operations such ascreation,insertion,deletion andTraversal.

```
#include<stdio.h>#in
clude<conio.h>structn
ode
{
        intinfo;
        struct node
        *lpt;structnode*rp
        t;
};
struct node
*first;voidcreate();
void traverse();void
ftraverse();void
btraverse();void
insert_beg();void
insert_end();void
del_beg();void
del_end();voidmain
()
{
        intop,ch;clrsc
        r();while(ch!=
        8)
        {
        printf("\nMENU\n 1.Creation\n 2.Insert Begin\n 3.Insert
End\n4.Forward Traverse\n 5.Backward Traverse\n 6.Delete Begin\n
7.DeleteEnd\n8.Exit\n");
        printf("Enter your choice :
        ");scanf("%d",&op);
        switch(op)
        {
           case1:
                      create();b
                      reak;
           case2:
                      insert_beg();b
                      reak;
```

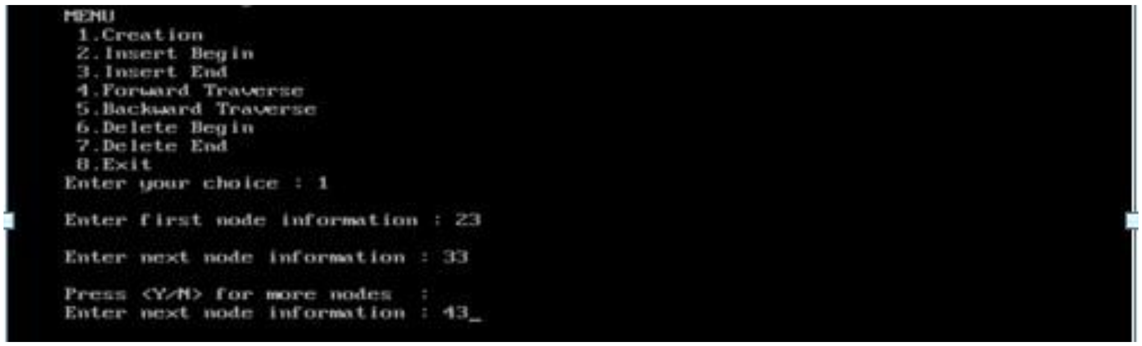
```
case3:
        insert_end();b
        reak;
case4:
        ftraverse();b
        reak;
case5:
        btraverse();b
        reak;
case6:
        del_beg();b
        reak;
case7:
        del_end();b
        reak;

 case 8:exit(0);
 default:printf("\nInvalidCase");
 }

}


getch();
}
voidcreate()
{
        struct node
        *ptr,*cpt;charch;
        ptr=(structnode*)malloc(sizeof(structnode));printf("
        \nEnter first node information : ");scanf("%d",&ptr-
        >info);
        ptr->lpt =
        NULL;first=ptr;
        do
        {
                cpt=(structnode*)malloc(sizeof(structnode));printf("
                \nEnter next node information : ");scanf("%d",&cpt-
                >info);
                ptr->rpt =
                cpt;cpt->lpt
                =ptr;ptr=cpt;
                printf("\nPress <Y/N> for more
                nodes:");ch=getch();
        }while(ch=='y'||ch=='Y');
```

```
        ptr->rpt=NULL;
}
voidftraverse()
{
        struct node*ptr;
        printf("\n====== Forward Traversing ===========\n");ptr=first;
        while(ptr!=NULL)
        {
                printf("%d\t",ptr-
                >info);ptr=ptr->rpt;
        }
}
voidbtraverse()
{
        struct node*ptr;
        printf("\n========== Backward
        Traversing\n");ptr=first;
        while(ptr-
                >rpt!=NULL)ptr=ptr
                ->rpt;
        while(ptr!=NULL)
        {
                printf("%d\t",ptr-
                >info);ptr=ptr->lpt;
        }
}

voidinsert_beg()
{
        struct node*ptr;
        ptr=(structnode*)malloc(sizeof(structnode));if(ptr==NU
        LL)
        {
                printf("\n
                Overflow");return;
        }
        printf("\nEnter       new       node:
        ");scanf("%d",&ptr->info);
        ptr->rpt            =
        first;first->lpt    =
        ptr;first=ptr;
        printf("\nNewnodeisinserted\n");
}
voidinsert_end()
```

```
{
        structnode*ptr,*cpt;
        ptr=(structnode*)malloc(sizeof(structnode));if(ptr==NULL)
        {
                printf("\nOverflow");r
                eturn;
        }
        printf("\nEnternewnodeinformation:");scanf(
        "%d",&ptr->info);
        cpt=first;
        while(cpt->rpt!=NULL)

                cpt=cpt-
        >rpt;cpt->rpt=ptr;
        ptr->lpt= cpt;ptr-
        >rpt=NULL;
        printf("Insertionisdone\n");
}
voiddel_beg()
{
        struct node
        *ptr;if(first==NU
        LL)
        {
                printf("\nUnserflow");return;
        }
        ptr= first;
        first = ptr-
        >rpt;first->lpt=
        NULL;free(ptr);
        printf("Deletionisdone\n");
}
voiddel_end()
{
        struct node
        *ptr,*cpt;if(first==NUL
        L)
        {
                printf("\nUnderflow");return;
        }
        ptr=first;
        while(ptr->rpt!=NULL)
        {
```

```
                cpt=ptr;
                ptr= ptr->rpt;
        }
        cpt->rpt =
        NULL;free(ptr);
        printf("\nDeletionisdone");
}
```

Output:



```
MENU
 1.Creation
 2.Insert Begin
 3.Insert End
 4.Forward Traverse
 5.Backward Traverse
 6.Delete Begin
 7.Delete End
 8.Exit
Enter your choice : 3

Enter new node information :53
Insertion is done

MENU
 1.Creation
 2.Insert Begin
 3.Insert End
 4.Forward Traverse
 5.Backward Traverse
 6.Delete Begin
 7.Delete End
 8.Exit
Enter your choice : _

====== Forward Traversing ===========
13      23      33      43      53
MENU
 1.Creation
 2.Insert Begin
 3.Insert End
 4.Forward Traverse
 5.Backward Traverse
 6.Delete Begin
 7.Delete End
 8.Exit
Enter your choice : 6
Deletion is done

MENU
 1.Creation
 2.Insert Begin
 3.Insert End
 4.Forward Traverse
 5.Backward Traverse
 6.Delete Begin
 7.Delete End
 8.Exit
Enter your choice : _
```

WEEK-III

3. Writeaprogramthatusesfunctionstoperformthefollowingoperations oncircularlinkedlist:

iii) Creation ii)Insertion iii)Deletion iv) TraversalAim: To implement circular linked list and its operations such ascreation,insertion,deletion andTraversal.

```
#include<stdio.h>#i
nclude<stdlib.h>stru
ctnode
{
   intdata;
   structnode*next;
};
struct node*head;

void beginsert ();void
lastinsert ();void
randominsert();void
begin_delete();voidlas
t_delete();
voidrandom_delete();voiddisplay();voidse
arch();
voidmain()
{
  intchoice=0;
   while(choice!=7)
   {
      printf("\n*********MainMenu*********\n");printf("\nChooseone
      optionfromthefollowinglist...\n");

printf("\n===============================================
======n");
     printf("\n1.Insertinbegining\n2.Insertatlast\n3.DeletefromBeginning
\n4.Delete from last\n5.Search for anelement\n6.Show\n7.Exit\n");
      printf("\nEnteryourchoice?\n");sca
      nf("\n%d",&choice);switch(choice)
      {
          case1:begins
          ert();
```

```
    break;
            case2:
            lastinsert();b
            reak;
            case3:begin_delet
            e();break;
            case4:
            last_delete();b
            reak;
            case5:
            search();br
            eak;case
            6:
            display();
            break;case
            7:
            exit(0);b
            reak;def
            ault:
            printf("Pleaseentervalidchoice..");
        }
    }
}
voidbeginsert()
{
    struct node
    *ptr,*temp;intitem;
    ptr=(structnode*)malloc(sizeof(structnode));if(ptr
    ==NULL)
    {
        printf("\nOVERFLOW");
    }
    else
    {
        printf("\nEnterthenodedata?");scanf
        ("%d",&item);
        ptr-
        >data=item;if(head=
        =NULL)
        {
            head=ptr;
            ptr->next=head;
        }
        else
```

```
        {
            temp =head;
            while(temp-
                >next!=head)temp=temp-
                >next;
            ptr->next =
            head;temp-
            >next=ptr;head=ptr;
        }
        printf("\nnodeinserted\n");
    }

}
voidlastinsert()
{
    struct node
    *ptr,*temp;intitem;
    ptr=(structnode*)malloc(sizeof(structnode));if(ptr
    ==NULL)
    {
        printf("\nOVERFLOW\n");
    }
    else
    {
        printf("\nEnter
        Data?");scanf("%d",&ite
        m);
        ptr->data =
        item;if(head==NUL
        L)
        {
            head=ptr;
            ptr->next=head;
        }
        else
        {
            temp =head;
            while(temp->next!=head)
            {
                temp=temp->next;
            }
            temp->next=ptr;ptr-
            >next= head;
        }

        printf("\nnodeinserted\n");
```

}

```
}

voidbegin_delete()
{
    struct node
    *ptr;if(head==NU
    LL)
    {
        printf("\nUNDERFLOW");
    }
    elseif(head->next==head)
    {
        head =
        NULL;free(hea
        d);
        printf("\nnodedeleted\n");
    }

    else
    {    ptr= head;
        while(ptr -> next !=
            head)ptr=ptr ->next;
        ptr->next = head-
        >next;free(head);
        head=ptr-
        >next;printf("\nnodedeleted\
        n");

    }
}
voidlast_delete()
{
    structnode*ptr,*preptr;if(he
    ad==NULL)
    {
        printf("\nUNDERFLOW");
    }
    elseif(head ->next==head)
    {
        head =
        NULL;free(hea
        d);
        printf("\nnodedeleted\n");
```

```
}
else
{
```

```
            ptr =head;
            while(ptr ->next!=head)
            {
                preptr=ptr;
                ptr= ptr->next;
            }
            preptr->next = ptr ->
            next;free(ptr);
            printf("\nnodedeleted\n");

        }
    }

    voidsearch()
    {
        struct node*ptr;int
        item,i=0,flag=1;ptr
        =head;
        if(ptr ==NULL)
        {
            printf("\nEmptyList\n");
        }
        else
        {
            printf("\nEnter item which you want to
            search?\n");scanf("%d",&item);
            if(head ->data==item)
            {
            printf("itemfoundatlocation%d",i+1);flag=
            0;
            }
            else
            {
            while(ptr->next!=head)
            {
                if(ptr->data==item)
                {
                    printf("itemfoundatlocation%d",i+1);flag=0
                    ;
                    break;
                }
                else
                {
                   flag=1;
```

```
            }i++
            ;
            ptr=ptr->next;
        }
        }
        if(flag!= 0)
        {
            printf("Itemnotfound\n");
        }
    }

}

voiddisplay()
{
    struct node
    *ptr;ptr=head;if(he
    ad==NULL)
    {
        printf("\nnothingtoprint");
    }
    else
    {
        printf("\nprintingvalues...\n");

        while(ptr-> next!=head)
{

            printf("%d\n",ptr-
    >data);ptr=ptr->next;
        }
        printf("%d\n",ptr ->data);
    }

}
```

Output:

```
*********Main Menu*********

Choose one option from the following list ...

===============================================n
1.Insert in begining
2.Insert at last
3.Delete from Beginning
4.Delete from last
5.Search for an element
6.Show
7.Exit

Enter your choice?
1

Enter the node data?23
```

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
Enter your choice?
1

Enter the node data?23

node inserted

*********Main Menu*********

Choose one option from the following list ...

===============================================n
1.Insert in begining
2.Insert at last
3.Delete from Beginning
4.Delete from last
5.Search for an element
6.Show
7.Exit

Enter your choice?
2

Enter Data?78
```

```
6.Show
7.Exit

Enter your choice?
6

 printing values ...
23
78

*********Main Menu**********

Choose one option from the following list ...

===============================================n
1.Insert in begining
2.Insert at last
3.Delete from Beginning
4.Delete from last
5.Search for an element
6.Show
7.Exit

Enter your choice?
_
```

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
5.Search for an element
6.Show
7.Exit

Enter your choice?
5

Enter item which you want to search?
23
item found at location 1
*********Main Menu**********

Choose one option from the following list ...

===============================================n
1.Insert in begining
2.Insert at last
3.Delete from Beginning
4.Delete from last
5.Search for an element
6.Show
7.Exit

Enter your choice?
```

Week-IV

Writeaprogramthatimplementstack(itsoperations)using

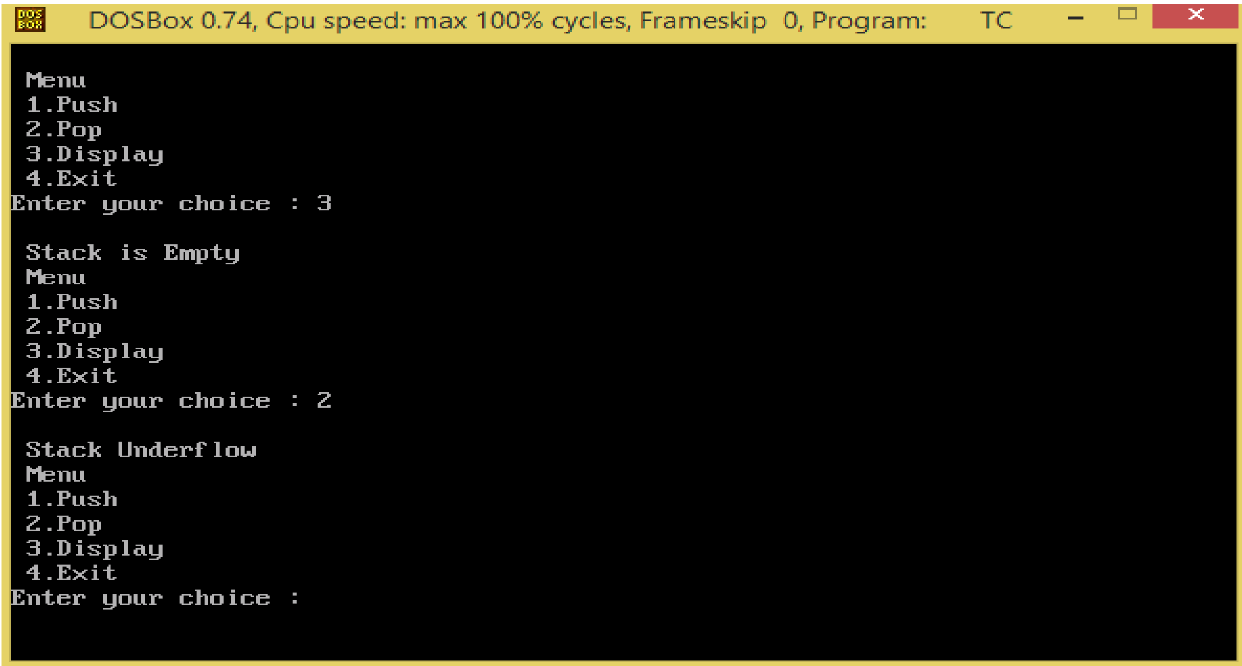
i) Arrays ii)Pointers

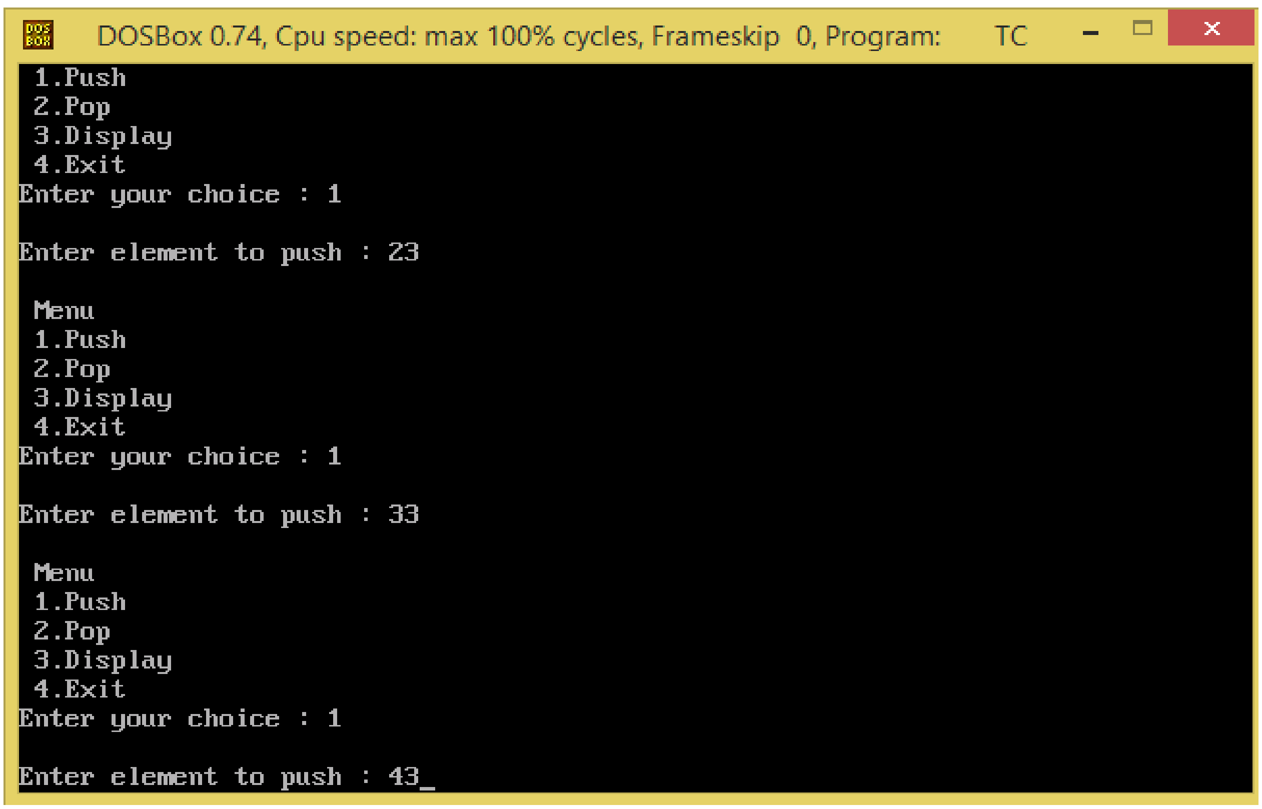
Aim: To implement Stack and its operations using ArrayProgram:

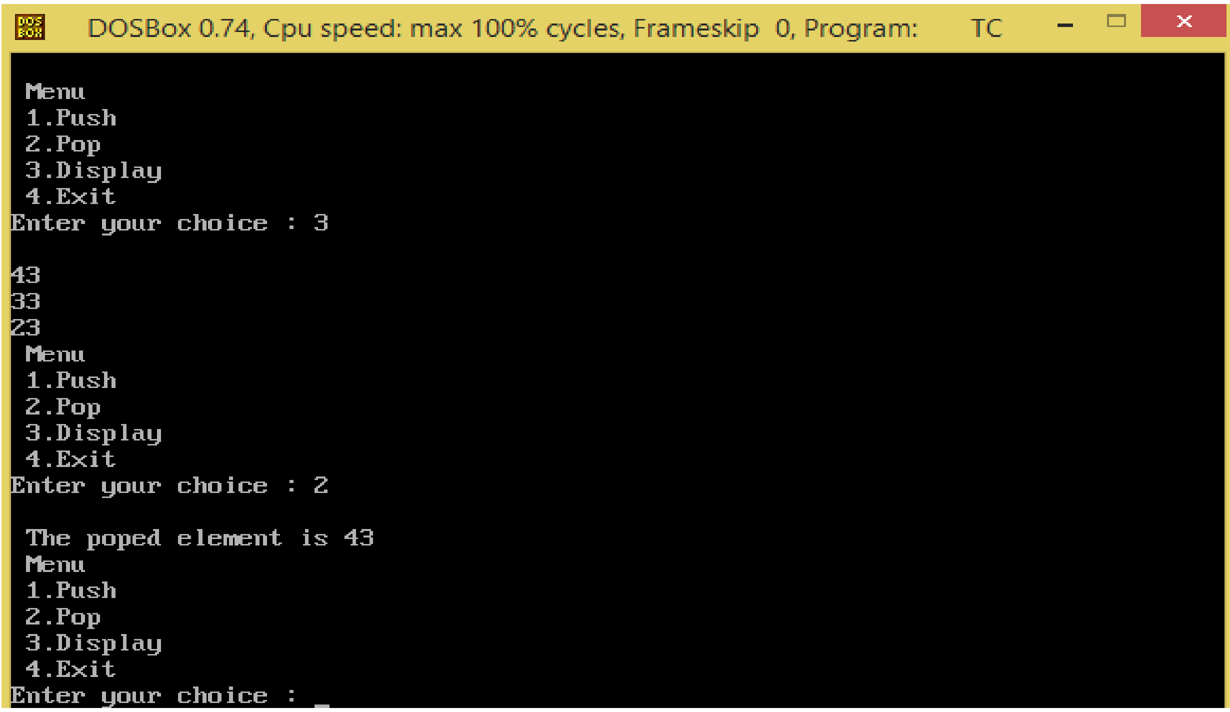
```
#include<stdio.h>#i
nclude<conio.h>#inc
lude<stdlib.h>#defin
emax5
int stack[max],top=-
1,ele,temp;voidpush();
void pop();void
display();voidm
ain()
{
	intch;clr
	scr();whi
	le(1)
	{
		printf("\nMenu");
		printf("\n 1.Push\n 2.Pop\n 3.Display\n
		4.Exit\n");printf("Enteryour choice:");
		scanf("%d",&ch);swi
		tch(ch)
		{
		case1:
			push();b
			reak;
		case2:
			pop();
			break;
		case3:
			display();
			break;
		case 4:exit(0);
		default:printf("\nInvalidChoice");
	}
	}
	getch();
}
voidpush()
```

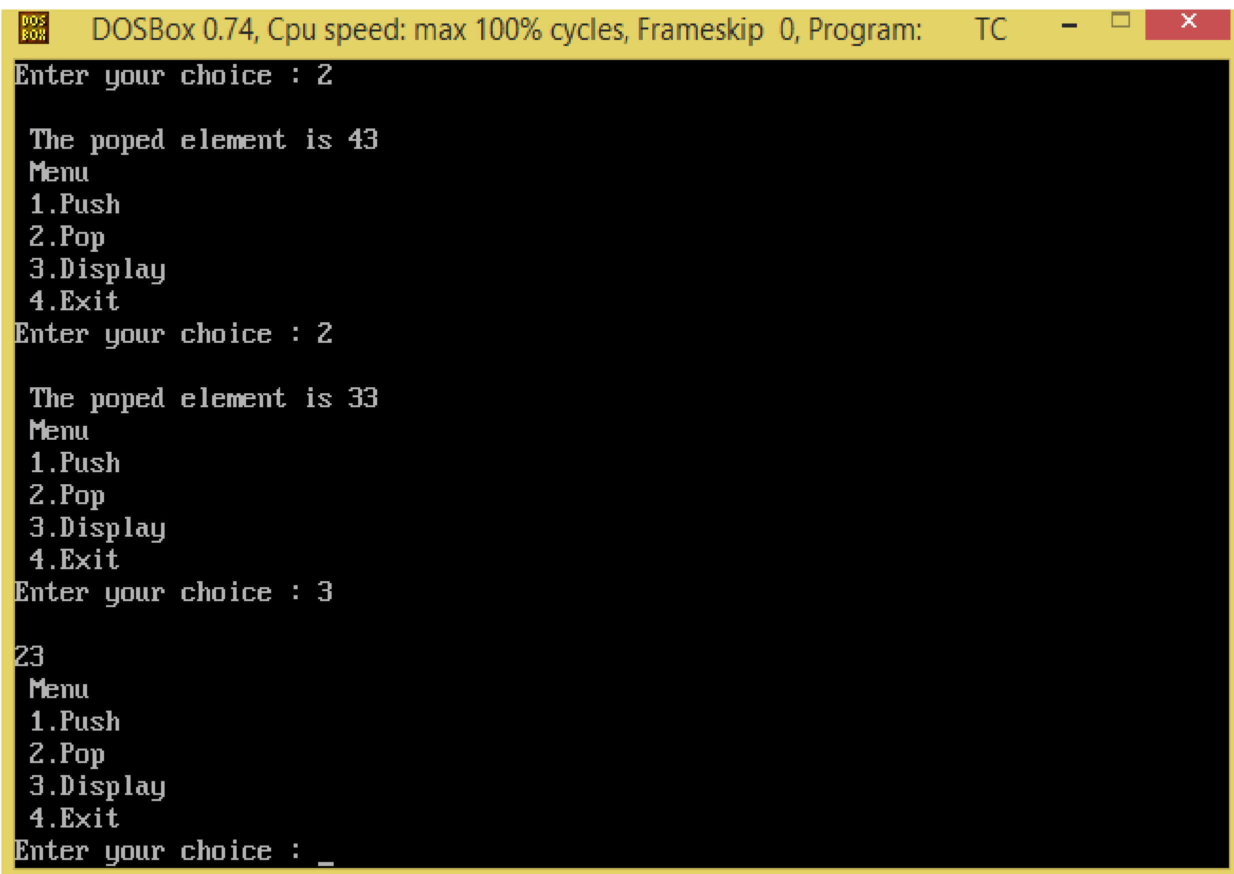
```
{
        if(top==max-1)
                printf("\nStackOverflow");
        else
        {
                printf("\nEnter element to push :
                ");scanf("%d",&ele);
                top++;stack[top]=
        }       ele;
}
voidpop()
{
        if(top==-1)
        {
                printf("\n Stack
                Underflow");return;
        }
        else
        {
                ele =
                stack[top];top--;
        }
        printf("\nThepoped elementis%d",ele);
}
voiddisplay()
{
        int
        i;if(top==-1)
                printf("\n StackisEmpty");
        else
        {
                for(i=top;i>=0;i--)
                        printf("\n%d",stack[i]);
        }
}
```

Output:


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 3
Stack is Empty
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 2
Stack Underflow
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice :


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 1
Enter element to push : 23
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 1
Enter element to push : 33
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 1
Enter element to push : 43_


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 3
43
33
23
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 2
The poped element is 43
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : _


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Enter your choice : 2
The poped element is 43
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 2
The poped element is 33
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : 3
23
Menu
1.Push
2.Pop
3.Display
4.Exit
Enter your choice : _

4b)

Aim:ToimplementStackanditsoperationsusingLinkedlistsProgram:

```
#include<stdio.h>#in
clude<conio.h>structn
ode
{
	intinfo;
	struct node*link;
};
struct node
*top;voidpush();
void pop();void
display();voidm
ain()
{
	intch;clr
	scr();
	printf("\nStackusingLinkedLists");whil
	e(1)
	{
		printf("\nMenu");
		printf("\n 1.Push\n 2.Pop\n 3.Display\n
		4.Exit\n");printf("\nEnter your Choice:");
		scanf("%d",&ch);swi
		tch(ch)
		{
		case1:
			push();b
			reak;
		case2:
			pop();
			break;
		case3:
			display();
			break;
		case4:
			exit(0);
		default:
			printf("\nInvalidChoice");
		}
	}

}
```

```
voidpush()
{
        struct node*ptr;
        ptr=(structnode*)malloc(sizeof(structnode));if(ptr==NULL)
        {
                printf("Overflow\n");r
                eturn;
        }
        printf("\nEnter data to push
        :");scanf("%d",&ptr->info);
        ptr->link =
        top;top =ptr;
}
voidpop()
{
        struct node
        *ptr;if(top==NUL
        L)
        {
                printf("\nUnderflow");return;
        }
        ptr=top;
        printf("%d is poped from the stack ",ptr->info);top
        =top->link;
        free(ptr);
}
voiddisplay()
{
        struct node *ptr;printf("\nTraversing
        of stack:\n");ptr=top;
        while(ptr!=NULL)
        {
                printf("%d\n",ptr-
                >info);ptr=ptr->link;
        }
}
```

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
 Stack using Linked Lists
 Menu
 1.Push
 2.Pop
 3.Display
 4.Exit

 Enter your Choice :1

Enter data to push :11

 Menu
 1.Push
 2.Pop
 3.Display
 4.Exit

 Enter your Choice :1

Enter data to push :22
```

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
 1.Push
 2.Pop
 3.Display
 4.Exit

 Enter your Choice :2
22 is poped from the stack
 Menu
 1.Push
 2.Pop
 3.Display
 4.Exit

 Enter your Choice :3

Traversing of stack:
11

 Menu
 1.Push
 2.Pop
 3.Display
 4.Exit

 Enter your Choice :_
```

Week-V

WriteaprogramthatimplementQueue(itsoperations)using

i) Arrays ii)Pointers

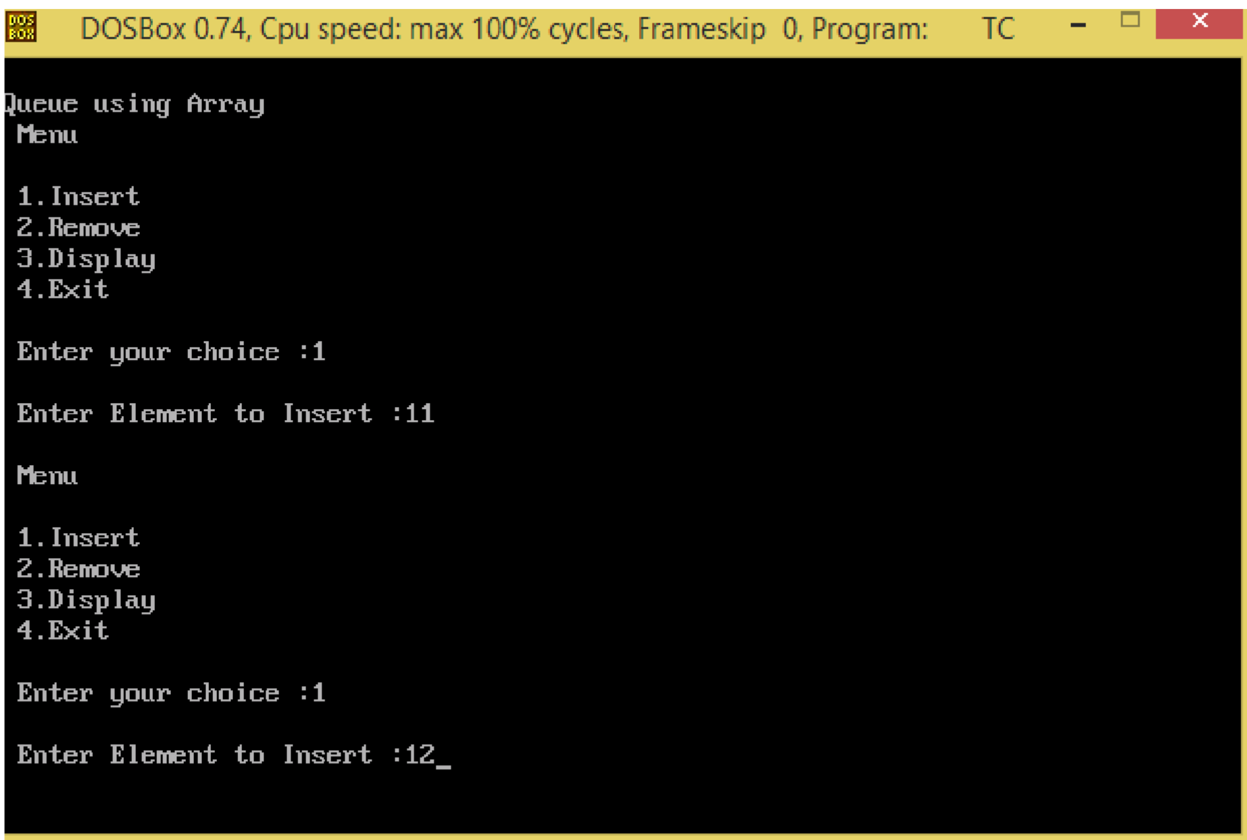
Aim:ToimplementQueueanditsoperationsusingArrayProgram:

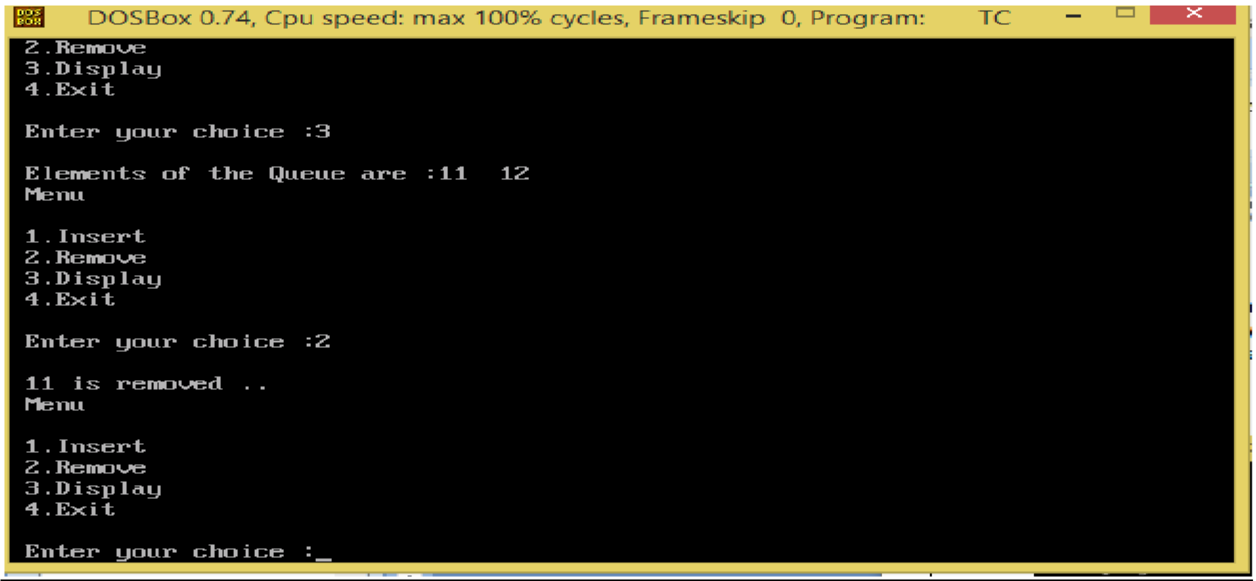
```
	#include<stdio.h>#i
nclude<conio.h>#defineM
5
intque[M];int
front = -1;int
rear = -1;void
insert();void
remov();void
display();voidm
ain()
{
	intch;ch
	=0;clrscr
	();
	printf("\nQueue using
	Array");while(1)
	{
	printf("\nMenu\n");
	printf("\n 1.Insert\n 2.Remove\n 3.Display\n
	4.Exit\n");printf("\nEnter yourchoice:");
	scanf("%d",&ch);swi
	tch(ch)
	{
	case1:
		insert();b
		reak;
	case2:
		remov();b
		reak;
	case3:
		display();
		break;
	case4:
		exit(0);
	default:
		printf("\nInvalidChoice");
	}
```

```
    }
}

voidinsert(int x)
{
        if(rear ==M-1)
        {
                printf("\n Queue is
                Full");return;

        }
        elseif(front==-1 &&rear==-1)
        {


                front=0;
                rear=0;
        }
        else
             rear=rear+1;
        printf("\n Enter Element to Insert
        :");scanf("%d",&x);
        que[rear]=x;
}
voidremov()
{
        intele;
        if(front==-1||front> rear)
        {
                printf("\n Underflow
                ");return;
        }
        else
        {
                ele =
                que[front];if(front
                ==rear)
                {
                        front =rear=-1;
                }
                else
                {
                        front =front+1;

                }
        }
        printf("\n%disremoved..",ele);
```

```
}
voiddisplay()
{
        inti;
        if(front==-1&&rear==-1||front==rear)
        {
                printf("\n Queue is
                Empty");return;
        }
        printf("\nElementsoftheQueueare:");for(i=fr
        ont;i<=rear;i++)
                printf("%d\t",que[i]);
}
```

Output:





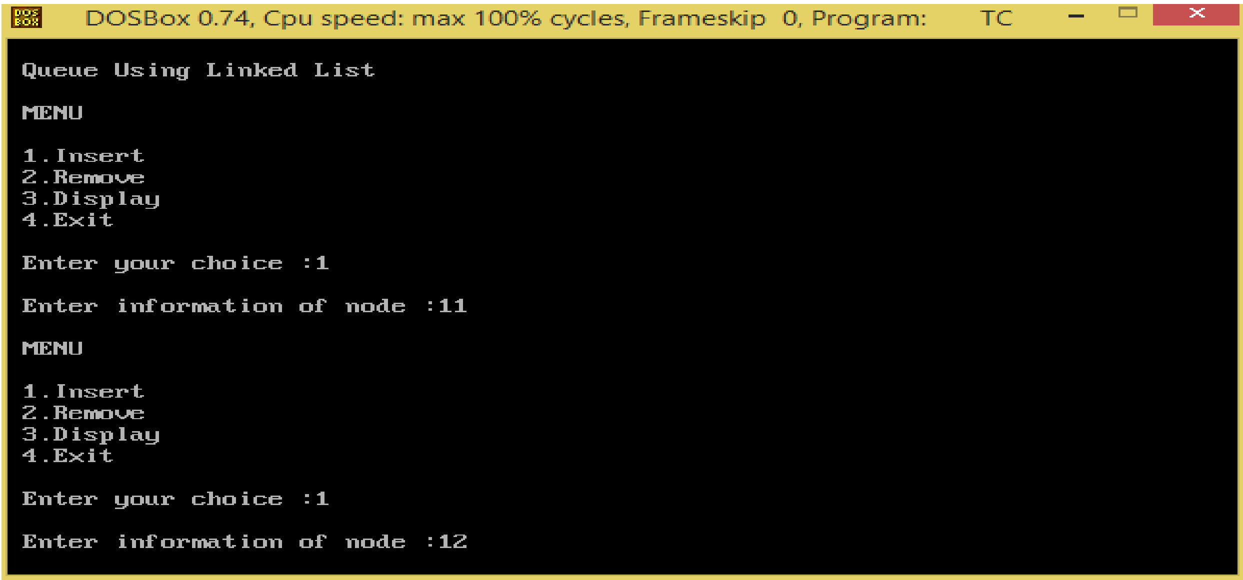
b) Aim:ToimplementQueueanditsoperationsusingLinkedListProgram:

```
#include<stdio.h>#in
clude<conio.h>structn
ode
{
        intinfo;
        struct node*link;
};
struct node
*front,*rear;voidinsert();
void
remov();void
display();voidm
ain()
{
        intch;clr
        scr();
        printf("\n Queue Using Linked
        List\n");while(1)
        {
                printf("\nMENU\n");
                printf("\n 1.Insert\n 2.Remove\n 3.Display\n
                4.Exit\n");printf("\nEnter yourchoice:");
                scanf("%d",&ch);swi
                tch(ch)
                {
```

```
				case1:
					insert();b
					reak;
				case2:
					remov();b
					reak;
				case3:
					display();
					break;
				case4:
					exit(0);
				default:
					printf("\nInvalidChoice");
			}
		}
}
voidinsert()
{
	struct node
	*ptr;intitem;
	ptr=(structnode*)malloc(sizeof(structnode));printf("\n Enter
	information of node :");scanf("%d",&item);
	ptr-
	>info=item;ptr-
	>link=NULL;if(fr
	ont==NULL)
		front=ptr;
	else
		rear-
		>link=ptr;rear=p
}		tr;
voidremov()
{
	intval;
	struct node
	*ptr;if(front==NU
	LL)
	{
		printf("\n Queue is
		Underflow\n");return;
	}
	if(front==rear)
	{
		free(front);rea
		r=NULL;
```

```
        }
        else
        {
                ptr=front;
                front = ptr-
                >link;free(ptr);
        }
}
voiddisplay()
{
        struct node*ptr;
        printf("\n Traversing of Queue
        \n");ptr=front;
        if(front==NULL)
                printf("\nQueueisempty\n");
        else
        {
                printf("\n Queue elements are
                :\n");while(ptr!=NULL)
                {
                        printf("%d\t",ptr-
                        >info);ptr=ptr->link;
                }
                printf("\n");
        }
}
```

Output:


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Queue Using Linked List
MENU
1.Insert
2.Remove
3.Display
4.Exit
Enter your choice :1
Enter information of node :11
MENU
1.Insert
2.Remove
3.Display
4.Exit
Enter your choice :1
Enter information of node :12

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
Enter your choice :3

Traversing of Queue

Queue elements are :
11      12

MENU

1.Insert
2.Remove
3.Display
4.Exit

Enter your choice :2

MENU

1.Insert
2.Remove
3.Display
4.Exit

Enter your choice :
```

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
Enter your choice :2

MENU

1.Insert
2.Remove
3.Display
4.Exit

Enter your choice :3

Traversing of Queue

Queue elements are :
12

MENU

1.Insert
2.Remove
3.Display
4.Exit

Enter your choice :_
```

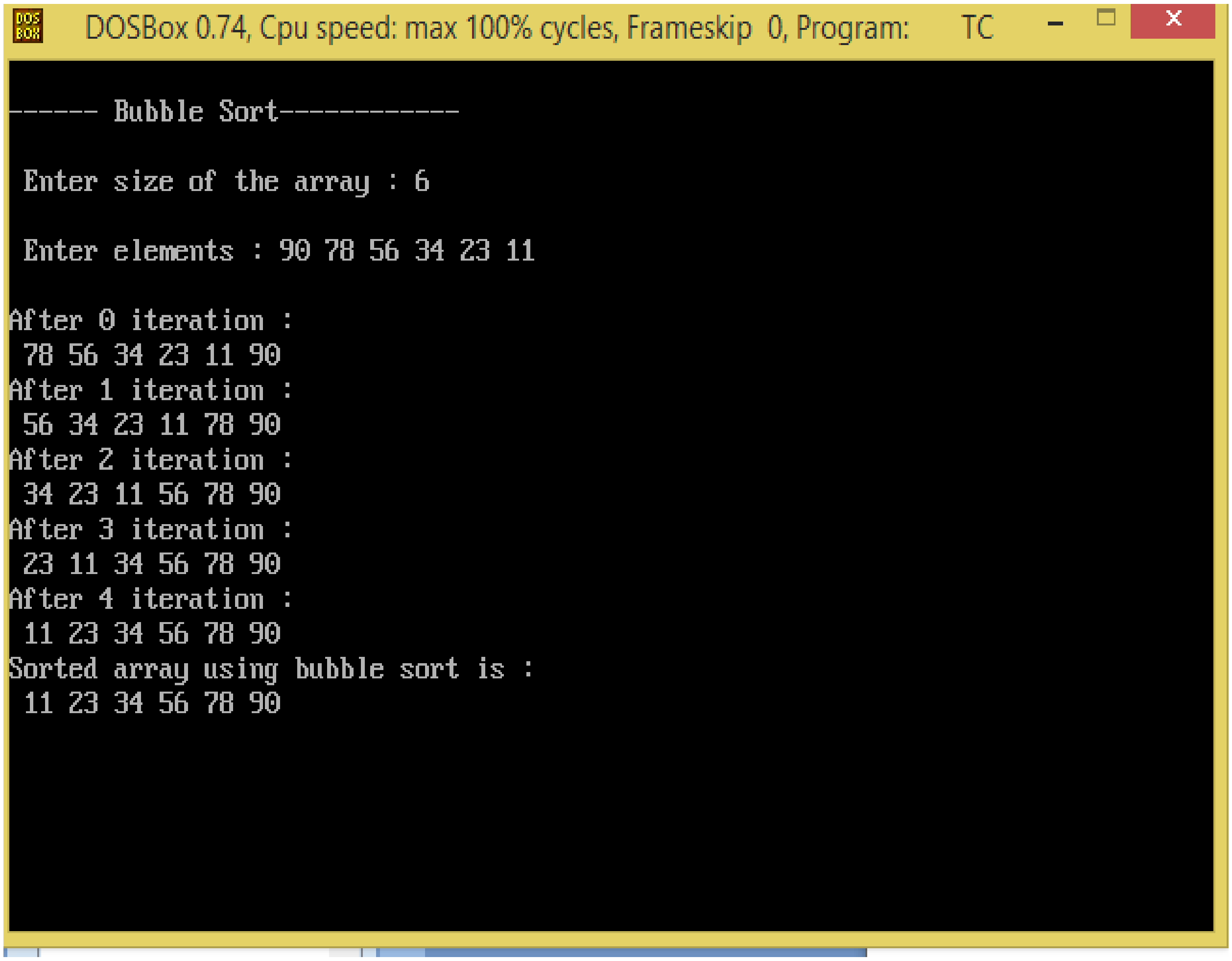
WEEK-VI

Writeaprogramthatimplementsthefollowingsortingmethodstosort agivenlistofintegers inascendingorder

i) BubbleSort ii)SelectionSort iii)InsertionSort

Aim:-ToimplementBubblesortsortingalgorithm.Program:

```
#include<stdio.h>#in
clude<conio.h>voidma
in()
{
	int
	a[10],i,j,n,temp,k;clrscr
	();
	printf("\n------ BubbleSort ----------------\n");
	printf("\nEntersizeofthe
	array:");scanf("%d",&n);
	printf("\n Enter elements :
	");for(i=0;i<n;i++)scanf("%d",&
	a[i]);for(i=0;i<n-1;i++)
	{
		for(j=0;j<n-i-1;j++)
		{
			if(a[j]>a[j+1])
			{
				temp=a[j];a[j]=
				a[j+1];a[j+1]=t
				emp;
			}
		}
		printf("\nAfter %d iteration
		:\n",i);for(k=0;k<n;k++)
			printf("%3d",a[k]);
}
printf("\nSorted array using bubble sort is
:\n");for(i=0;i<n;i++)
printf("%3d",a[i]);getch();
}
```

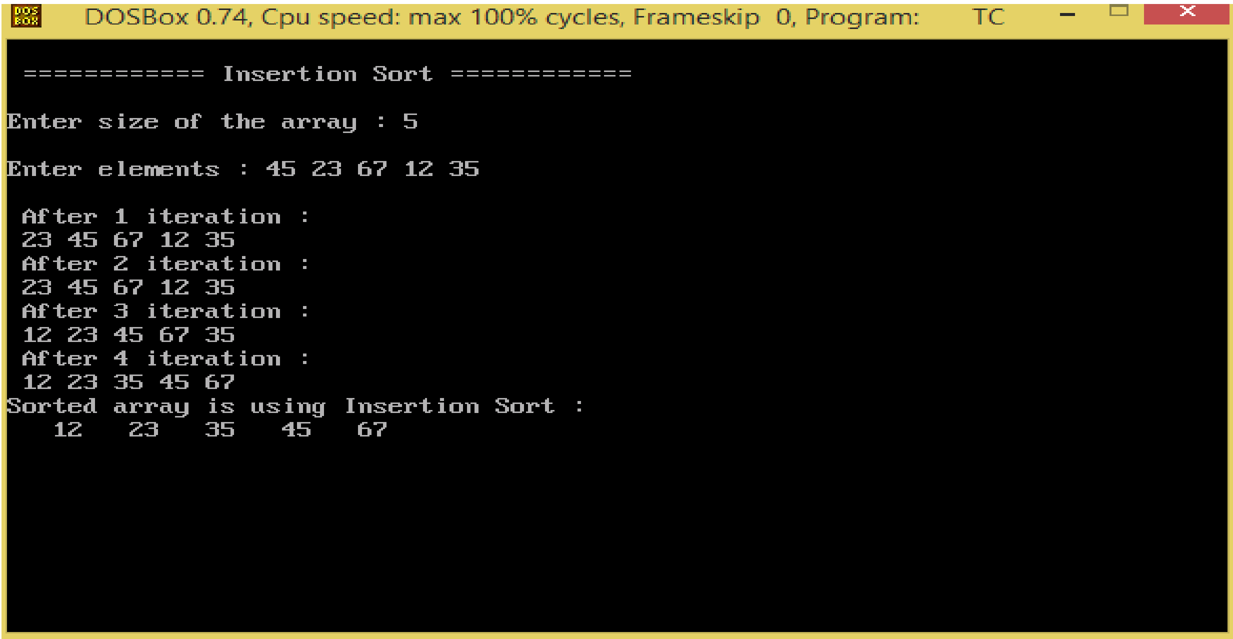

DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
------ Bubble Sort------------
Enter size of the array : 6
Enter elements : 90 78 56 34 23 11
After 0 iteration :
78 56 34 23 11 90
After 1 iteration :
56 34 23 11 78 90
After 2 iteration :
34 23 11 56 78 90
After 3 iteration :
23 11 34 56 78 90
After 4 iteration :
11 23 34 56 78 90
Sorted array using bubble sort is :
11 23 34 56 78 90

II)

Aim:-ToimplementInsertionSortsortingalgorithm

Program:

```
#include<stdio.h>#include<coni
o.h>
voidinsertsort(intarr[],intsize);void
main()
{
        int
        a[10],i,j,n,temp,k;clrscr
        ();
        printf("\n ============ Insertion Sort
        ============\n");printf("\nEntersizeofthearray:");
        scanf("%d",&n);printf("\nEnter
        elements:");for(i=0;i<n;i++)sca
        nf("%d",&a[i]);insertsort(a,n);
        getch();
}
voidinsertsort(inta[],int n)
{
        int
        i,j,temp,k;for(i=1;i
        <n;i++)
        {
                temp=a[i];for(j=i;j>0&&temp<a[j-
                1];j--)
                        a[j]=a[j-
                1];a[j]=temp;
                printf("\n After %d iteration
                :\n",i);for(k=0;k<n;k++)
                        printf("%3d",a[k]);
}
printf("\nSorted array is using Insertion Sort
:\n");for(i=0;i<n;i++)
printf("%5d",a[i]);
}
```



III)

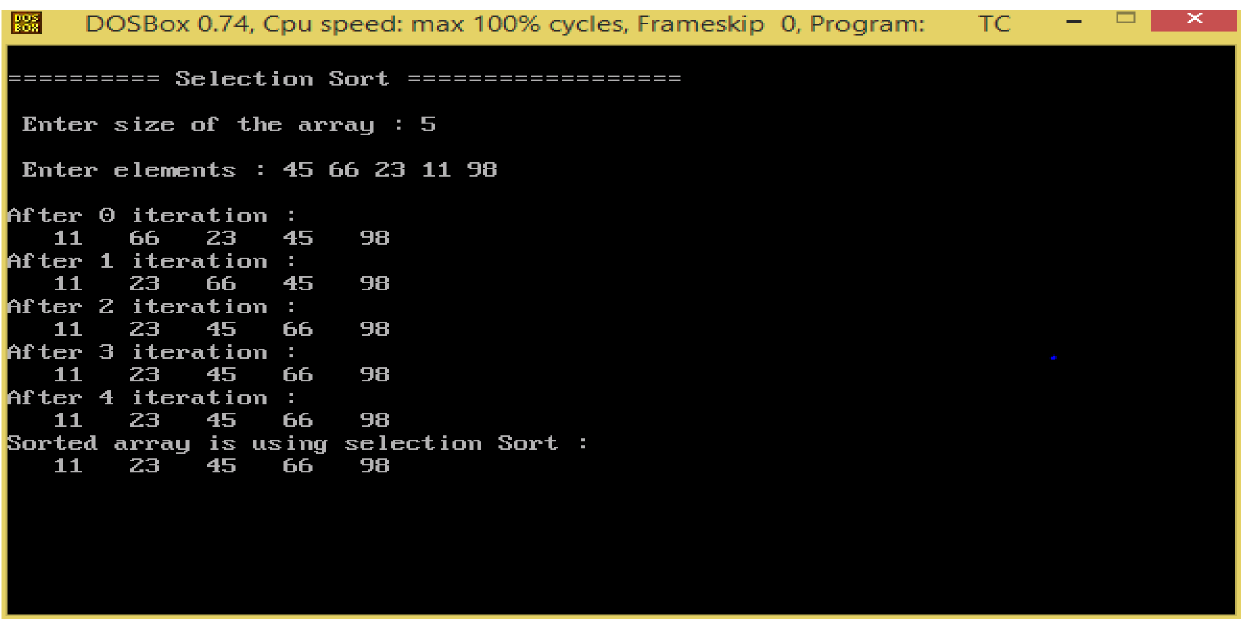
<u>Aim:-</u>ToimplementSelectionSortsortingalgorithm

<u>Program:</u>

```
#include<stdio.h>#include<coni
o.h>
voidselectsort(intarr[],intsize);void
main()
{
        int
        a[10],i,j,n,temp,k;clrscr
        ();
        printf("\n==========SelectionSort
==================\n");
        printf("\nEntersizeofthe
        array:");scanf("%d",&n);
        printf("\n Enter elements :
        ");for(i=0;i<n;i++)scanf("%d",&
        a[i]);selectsort(a,n);
        getch();
}
voidselectsort(inta[],intn)
{
        inti,j,temp,min,k;
```

```
        for(i=0;i<n;i++)
        {
                min=i;for(j=i+1;j<n;j++)
                {
                        if(a[j]<a[min])
                                min=j;
                }
                        temp=a[i];a[i]=
                        a[min];a[min]=
                        temp;
                        printf("\nAfter %d iteration
                        :\n",i);for(k=0;k<n;k++)printf("%5d",
                        a[k]);
        }


printf("\nSorted array is using selection Sort
:\n");for(i=0;i<n;i++)
printf("%5d",a[i]);
}
```

Output:



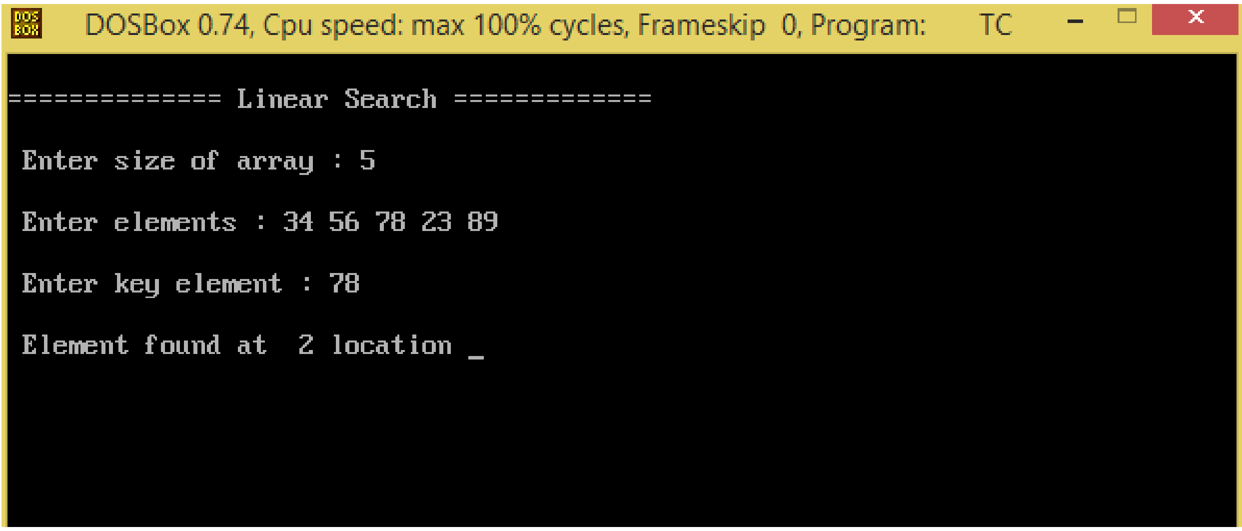
WEEK-VII

Write a program that uses both recursive and non-recursivefunctionstoperformthefollowingsearchingoperationsforakeyvalueinagivenlist ofIntegers

i) LinearSearch ii)BinarySearch

Aim:-ToimplementLinearsearchsearchingalgorithmProgram:

```
#include<stdio.h>vo
idmain(){
	intarr[20];
	int
	size,key,j,flag=0,k,n;clrscr
	();
	printf("\n=========== Linear Search
	==========\n");printf("\nEnter sizeofarray:");
	scanf("%d",&size);
	printf("\n Enter elements :
	");for(k=0;k<size;k++)scanf("%
	d",&arr[k]);
	printf("\nEnterkey
	element:");scanf("%d",&key);

	for(j=0;j<size;j++)
	{
		if(arr[j]==key)
		{
			flag=1;
			break;
		}
	}
	if(flag==1)
		printf("\nElementfoundat%dlocation",j);
	else
		printf("\nElementnotfound");

getch();
}
```



ii) Aim:-

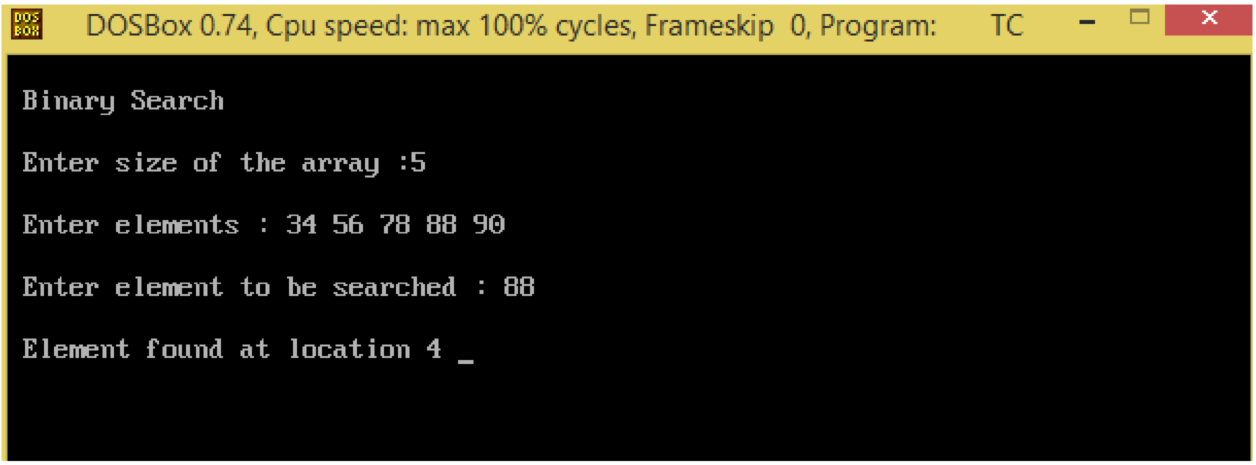
ToimplementBinarySearchsearchingalgorithmProgram:

```
#include<stdio.h>#include<coni
o.h>
int binsearch(int arr[],int size,int
item);intmain()
{
        Intarr[20];
        int
        item,size,pos,i;clrsc
        r();
        printf("\n Binary Search\nEntersizeofthearray
        :");scanf("%d",&size);
        printf("\n Enter elements :
        ");for(i=0;i<size;i++)scanf("%d"
        ,&arr[i]);
        printf("\nEnterelement tobe searched:
        ");scanf("%d",&item);pos=binsearch(arr,size,ite
        m);
        if(pos==-1)
                printf("\nElementnotfound");
        else
                printf("\nElementfound atlocation%d",pos+1);
        return0;
}
```

```
intbinsearch(intarr[],intsize,intitem)
{
int low=0,high=size-
1,mid;while(low<=high)
{
        mid=(low+high)/2;if(arr[mid]==item)
                returnmid;
        else
                if(item<arr[mid])
                high=mid-1;
        else
                low=mid+1;
}
```

```
return(-1);
}
```

Output:



WEEK–VIII

8. Write a program to implement the tree traversal methods.AIM:Toimplement BinaryTreetraversaltechniques

PROGRAM:

```
#include<stdio.h>#in
clude<conio.h>typedef
structbin
{
        int data;
        struct bin
        *left;structbin*rig
        ht;
}node;
void
insert(node*,node*);voidino
rder(node*);
void
preorder(node*);void
postorder(node*);node*g
et_node();voidmain()
{
        intchoice;chara
        ns='n';
        node*new1,*root;ro
        ot=NULL;clrscr();
        do{
        printf("\n \t\tBinary Tree
        \n");printf("\n1.Create\n");
        printf("\n2.Inorder\n");
        printf("\n3.Preorder\n");
        printf("\n4.Postorder\n");
        printf("\n 5.
        Exit\n");printf("Enteryourchoic
        e:");scanf("%d",&choice);switc
        h(choice)
        {
                case1:
                        root =
                        NULL;do
                        {
                          new1=get_node();
```

```
                printf("\nEntertheelement:");scanf
                ("%d",&new1-
                >data);if(root==NULL)
                    root = new1;
                elseinsert(root,new1);
                printf("\nDoyouwanttoentermoreelements(y/n):");ans=getch();
               }while(ans == 'y' || ans ==
               'Y');clrscr();
               break;
          case2:
               if(root==NULL)
                 printf("treeisnot created!");else
               inorder(root);bre
               ak;
          case3:
               if(root==NULL)
               printf("treeisnotcreated!");preo
               rder(root);
               break;
          case4:
               if(root==NULL)
               printf("treeisnotcreated!");post
               order(root);
               break;
     }
     }while(choice!=5);
     }
node*get_node()
{
     node*temp;
     temp=(node*)malloc(sizeof(node));tem
     p->left=NULL;
     temp->right =
     NULL;returntemp;
}
voidinsert(node *root,node *new1)
{
     char ch;
     printf("\n Wheretoinsertleft/rightof%d",root->data);ch=getch();
     if(ch=='R'||ch=='r')
```

```
        {
                if(root->right==NULL)
                {
                        root->right =
                }
                else
        }               new1;insert(root->right,new1);
        else
        {
                if(root->left==NULL)
                {
                        root->left =
                }
                else
                        new1;insert(root-
        }
}
                        >left,new1);
```

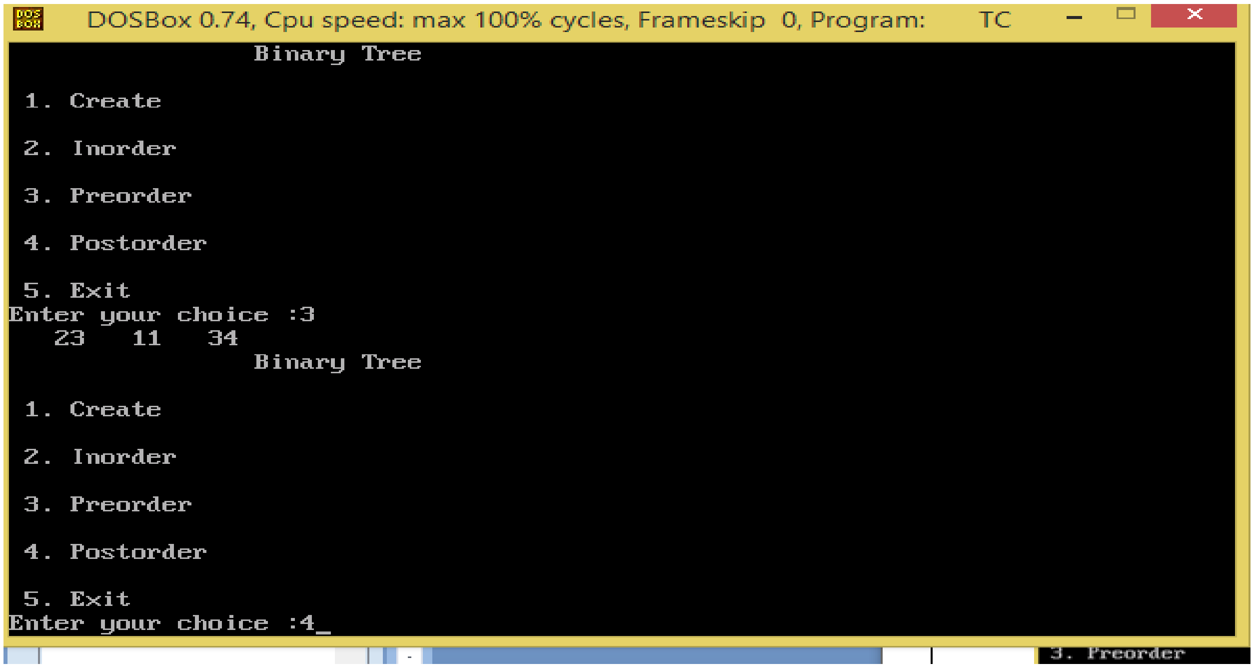
```
voidinorder(node*temp)
{
        if(temp!=NULL)
        {
                inorder(temp-
                >left);printf("%5d",temp-
                >data);inorder(temp->right);
        }
}
voidpreorder(node*temp)
{
        if(temp!=NULL)
        {
                printf("%5d",temp-
                >data);preorder(temp-
                >left);preorder(temp->right);
        }
}
voidpostorder(node*temp)
{
        if(temp!=NULL)
        {
                postorder(temp-
                >left);postorder(temp-
                >right);printf("%5d",temp-
                >data);
        }
```

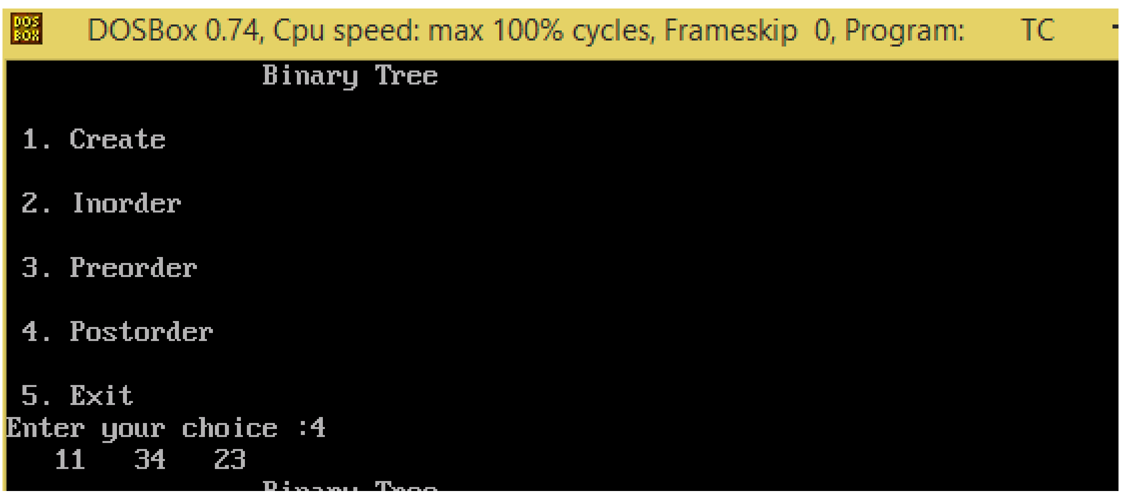
}

Output:

```
DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
                    Binary Tree

 1. Create

 2. Inorder

 3. Preorder

 4. Postorder

 5. Exit
Enter your choice :1

 Enter the element:23

 Do you want to enter more elements(y/n):
 Enter the element:34

 Where to insert left/right of 23
 Do you want to enter more elements(y/n):
 Enter the element:11

 Where to insert left/right of 23
 Do you want to enter more elements(y/n):
 Enter the element:
```

```
DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
                    Binary Tree

 1. Create

 2. Inorder

 3. Preorder

 4. Postorder

 5. Exit
Enter your choice :2
   11    23    34
                    Binary Tree

 1. Create

 2. Inorder

 3. Preorder

 4. Postorder

 5. Exit
Enter your choice :3_
```


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Binary Tree
1. Create
2. Inorder
3. Preorder
4. Postorder
5. Exit
Enter your choice :3
23 11 34
Binary Tree
1. Create
2. Inorder
3. Preorder
4. Postorder
5. Exit
Enter your choice :4_
3. Preorder


DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Binary Tree
1. Create
2. Inorder
3. Preorder
4. Postorder
5. Exit
Enter your choice :4
11 34 23

WEEK-IX

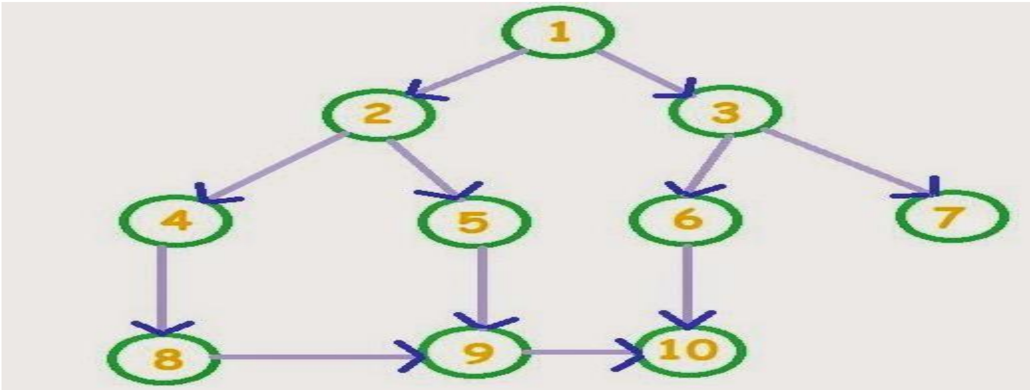
9. I) Write a program to implement the graph traversal methods.AIM: To implement the Depth First Search Graph traversalmethods

PROGRAM:

```
#include<stdio.h>

#include<stdlib.h>                                          */
intsource,V,E,time,visited[20],G[20][20];

voidDFS(inti)

{

    intj;visited[i]=1;p
    rintf("%d-
    >",i+1);for(j=0;j<V
    ;j++)

    {

        if(G[i][j]==1&&visited[j]==0)
            DFS(j);

    }

}

intmain()

{

    inti,j,v1,v2;printf("\t\t\tGraphs
    \n");printf("Enter the no of
    edges:");scanf("%d",&E);

    printf("Enterthenoofvertices:");scan
    f("%d",&V);

    for(i=0;i<V;i++)

    {
```

```
for(i=0;i<V;i++)
{
    for(j=0;j<V;j++)
        printf(" %d
    ",G[i][j]);printf("\n");
}
printf("Enter the source:
```

OUTPUT:




```
                                Graphs
Enter the no of edges:11
Enter the no of vertices:10
Enter the edges (format: V1 V2) : 1 2
Enter the edges (format: V1 V2) : 1 3
Enter the edges (format: V1 V2) : 2 4
Enter the edges (format: V1 V2) : 2 5
Enter the edges (format: V1 V2) : 3 6
Enter the edges (format: V1 V2) : 3 7
Enter the edges (format: V1 V2) : 4 8
Enter the edges (format: V1 V2) : 5 9
Enter the edges (format: V1 V2) : 6 10
Enter the edges (format: V1 V2) : 8 9
Enter the edges (format: V1 V2) : 9 10
 0  1  1  0  0  0  0  0  0  0
 0  0  0  1  1  0  0  0  0  0
 0  0  0  0  0  1  1  0  0  0
 0  0  0  0  0  0  0  1  0  0
 0  0  0  0  0  0  0  0  1  0
 0  0  0  0  0  0  0  0  0  1
 0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  1  0
 0  0  0  0  0  0  0  0  0  1
 0  0  0  0  0  0  0  0  0  0
Enter the source: 1
 1-> 2-> 4-> 8-> 9-> 10-> 5-> 3-> 6-> 7->
```

II) Write a program to implement the graph traversal methods.AIM:ToimplementtheBreadthFirstSearchGraphtraversalmethods

PROGRAM:

```
#include<stdio.h>

int G[20][20],q[20],visited[20],n,front = 1, rear = 0
;voidbfs(intv)

{

    inti;visited[v]
    =1;

 for(i=1;i<=n;i++)if(G[v][i]
  &&
  !visited[i])q[++rear]=i;

   if(front <=
    rear)bfs(q[front
    ++]);

 }


intmain()

{

 intv,i,j;


 printf("\n Enter the number of
 vertices:");scanf("%d",&n);

 for(i=1;i<=n;i++)

 {

  q[i]=0;
```

```
else

 printf("\n%disnotreachable",i);
```