सत्यमेव जयते

OFFICE OF THE CONTROLLER GENERAL OF PATENTS, DESIGNS AND TRADE MARKS, DEPARTMENT FOR PROMOTION OF INDUSTRY AND INTERNAL TRADE, MINISTRY OF COMMERCE AND INDUSTRY,
GOVERNMENT OF INDIA

# RECRUITMENT NOTIFICATION

# 2023

**FOR THE POSTS OF**

**EXAMINER OF PATENTS & DESIGNS**

**GROUP-A (GAZETTED)**

CONDUCTED BY:

Quality Council of India
(Ministry of Commerce & Industry, Government of India)
2nd Floor, Institution of Engineers Building, Bahadur Shah Zafar Marg,
New Delhi – 110003

Website: www.qcin.org

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# A. IMPORTANT

## 1. GENERAL INSTRUCTIONS

All candidates are mandatorily required to read this Information Bulletin in its entirety. The candidates are required to ensure that they fulfill all conditions as contained in this Information Bulletin. Due to the large number of candidates that are expected to apply for appearing in this examination, electronic systems will be used to analyse the information submitted by candidates. Accordingly, the admission to various stages of the examination will be purely provisional and would be subject to physical verification of documents. Mere issue of e-Admit Card to the candidate will not imply that a candidature has been finally cleared by the Competent Authority. The process of verification of documents and various conditions prescribed in this document will be conducted after the declaration of final list of qualified candidates.

## 2. HOW TO APPLY

Candidates are required to apply online by using the website www.qcin.org. No other mode of application will be accepted.

## 3. Examination Fees

There will be an examination fee of ₹1000/- (Rupees One Thousand only) for candidates belonging to General category and OBC category. For candidates belonging to SC /ST category, PWD/ Differently abled (PH) category and women applicants (from all categories) and any other person, the examination fee shall be ₹500/- (Rupees Five Hundred only).

## 4. RELAXATION / CONCESSION

The crucial date for claim of any kind of benefit, that is, reservation, fee concession,

age-relaxation, etc., shall be last date of submission of application.

The Competent Authority reserves the right to debar any candidate for any malpractice, including for a fraudulent claim of any kind of benefit / relaxation / concession.

## 5. VACANCIES

CGPDTM intends to recruit Examiners of Patents and Designs, General Central Service, Group 'A' Gazetted (Non-Ministerial) in Level 10 in Pay Matrix (₹ 56,100 – 1,77,500) plus applicable allowances, as admissible, in the Government of India. The vacancies are tentative, which may be decreased or increased depending upon the actual requirement at the time of final appointment.

# B. IMPORTANT DATES AT A GLANCE (TENTATIVE)

| S. No. | Activity | Date |
|---|---|---|
| 1. | Online application process starts | 14th July 2023 |
| 2. | Online application process concludes | 4th August 2023 |
| 3. | Issuance of e-Admit Card for Preliminary Examination | 14th August 2023 |
| 4. | Preliminary Examination | 3rd September 2023 |
| 5. | Declaration of result of Preliminary Examination | 13th September 2023 |
| 6. | Issuance of e-Admit Card for Mains Examination | 18th September 2023 |
| 7. | Mains Examination | 1st October 2023 |
| 8. | Declaration of result of Mains Examination | 16th October 2023 |
| 9. | Issuance of e-Admit Card for Interview | 22nd October 2023 |
| 10. | Interview | 11th and 12th November 2023 |
| 11. | Declaration of final list of qualified candidates | 17th November 2023 |

## C. OFFICE OF CGPDTM

The Controller General of Patents, Designs and Trade Marks (CGPDTM) administers the Industrial Property laws related to Patents (Patents Act 1970), Designs (Designs Act, 2000), Trade Marks (Trade Marks Act, 1999) and Geographical Indications (Geographical Indications of Goods (Registration & Protection) Act 1999) in the country. The CGPDTM is also the Registrar of Copyrights and Registrar of Semiconductor Integrated Circuits Layout-Design. The headquarter of the Office of Controller General of Patents, Designs & Trade Marks is located at Mumbai. The Rajiv Gandhi National Institute of Intellectual Property Management (RGNIIPM) and Patent Information System (PIS), Nagpur also function under the superintendence and administrative control of the CGPDTM.

The Patent Office is located at four places, that is, Chennai, Delhi, Kolkata and Mumbai. The Trade Marks Registry is located at five places, that is, Chennai, Delhi, Kolkata, Mumbai and Ahmedabad. The Designs Wing is located at Kolkata and the Geographical Indications Registry is located at Chennai. The Copyright Office and the Semiconductor Integrated Circuits Layout-Design Registry are located at Delhi. The RGNIIPM and PIS are located at Nagpur.

## D. EXAMINER OF PATENTS & DESIGNS

The Examiner of Patents & Designs is the backbone of the Patent Office who examines the patent application in accordance with section 12 of the Patents Act, 1970, which states as follows:

> *12. Examination of application.—(1) When a request for examination has been made in respect of an application for a patent in the prescribed manner under sub-section (1) or sub-section (3) of section 11B, the application and specification and other documents related thereto shall be referred at the*

*earliest by the Controller to an examiner for making a report to him in respect of the following matters, namely:—*

*(a) whether the application and the specification and other documents relating thereto are in accordance with the requirements of this Act and of any rules made thereunder;*

*(b) whether there is any lawful ground of objection to the grant of the patent under this Act in pursuance of the application;*

*(c) the result of investigations made under section 13; and*

*(d) any other matter which may be prescribed.*

*(2) The examiner to whom the application and the specification and other documents relating thereto are referred under sub-section (1) shall ordinarily make the report to the Controller within such period as may be prescribed.*

It may be noted that the Examiner of Patents & Designs also acts as Examiner under the Designs Act, 2000.

# E. VACANCIES

## 1. DISTRIBUTION (DISCIPLINE AND CATEGORY-WISE)

Total vacancies and the discipline-wise and category-wise distribution is as follows:

| S. No. | Discipline | SC | ST | OBC | EWS | UR | Total |
|---|---|---|---|---|---|---|---|
| 1 | Bio-Technology | 7 | 3 | 14 | 5 | 21 | 50 |
| 2 | Bio-Chemistry | 3 | 1 | 5 | 2 | 9 | 20 |
| 3 | Food Technology | 2 | 1 | 4 | 1 | 7 | 15 |
| 4 | Chemistry | 8 | 3 | 15 | 6 | 24 | 56 |
| 5 | Polymer Science and Technology | 1 | NIL | 3 | 1 | 4 | 9 |
| 6 | Bio-Medical Engineering | 8 | 3 | 15 | 5 | 22 | 53 |
| 7 | Electronics & Communication | 15 | 6 | 30 | 11 | 46 | 108 |
| 8 | Electrical Engineering | 4 | 1 | 8 | 3 | 13 | 29 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | Computer Science & Information Technology | 9 | 3 | 17 | 6 | 28 | 63 |
| 10 | Physics | 4 | 1 | 8 | 3 | 14 | 30 |
| 11 | Civil Engineering | 1 | NIL | 3 | 1 | 4 | 9 |
| 12 | Mechanical Engineering | 14 | 5 | 27 | 10 | 43 | 99 |
| 13 | Metallurgical Engineering | NIL | NIL | 1 | NIL | 3 | 4 |
| 14 | Textile Engineering | 1 | NIL | 2 | 1 | 4 | 8 |
| | **Total** | **77** | **27** | **152** | **55** | **242** | **553** |

## 2. DISTRIBUTION (PwBD)

Among the above 553 tentative posts, the details of vacancies reserved for Persons with Benchmark Disabilities (PwBD) category are as follows:

| S. No. | Category of Reservation/ Benchmark Disabilities | No. of Posts | | Total |
|---|---|---|---|---|
| | | Backlog | Fresh/ anticipated | |
| 1 | Locomotor disability (OA, OL, OAL, BL) including cerebral palsy, leprosy cured, dwarfism, acid attach victims and muscular dystrophy. | 1 | 6 | 7 |
| 2 | Blindness and Low vision (VH) | 5 | 5 | 10 |
| 3 | Hard of Hearing (HH) | 3 | 6 | 9 |
| 4 | Multiple disabilities from amongst persons under S. No. 1 to 3, except deaf-blindness. | 2 | 5 | 7 |
| | **Total:** | **11** | **22** | **33** |

**Note 1:** The number of vacancies given above is tentative and are subject to variation, dependent on the approval of Competent Authority and policy of the Government of India.

**Note 2:** The Competent Authority will consider the suitability of posts for various benchmark disabilities under the Rights of Persons with Disabilities (RPwD) Act, 2016 in accordance with the latest O.M.s and Notifications issued by Department of Empowerment of Persons with Disabilities (Divyangjan), Ministry of Social Justice and Empowerment, Government of India.

# F. ELIGIBILITY CONDITIONS

## 1. NATIONALITY

A candidate must be either:-

a) a citizen of India, or

b) a subject of Nepal, or

c) a subject of Bhutan, or

d) a Tibetan refugee who came over to India before 1st January, 1962 with the intention of permanently settling in India, or

e) a person of Indian origin who has migrated from Pakistan, Burma, Sri Lanka, East African countries of Kenya, Uganda, the United Republic of Tanzania, Zambia, Malawi, Zaire, Ethiopia and Vietnam with the intention of permanently settling in India.

Provided that a candidate belonging to categories (b), (c), (d) and (e) shall be a person in whose favour a Certificate of eligibility has been issued by the Government of India on or before the last date of submission of application. *Crucial date for claim of SC/ ST/ OBC/ EWS/ PwBD status or any other benefit viz. fee concession, reservation, age-relaxation, etc., where not specified otherwise, will be the last date of filling the online application.*

A candidate in whose case a Certificate of eligibility is necessary, may be admitted to the examination but the offer of appointment may be given only after the verification of necessary eligibility Certificate issued to him/her by the Government of India.

## 2. MINIMUM ESSENTIAL EDUCATIONAL QUALIFICATION

| S. No. | Discipline | Essential qualification: following Degree from a recognized university |
|---|---|---|
| 1 | Bio-Technology | Master Degree in Bio-Technology/ Micro Biology/ Molecular-Biology/ Bio Physics or equivalent |
| 2 | Bio-Chemistry | Master Degree in Biochemistry or equivalent |
| 3 | Food Technology | Bachelor Degree in Food Technology/ Engineering or equivalent |
| 4 | Chemistry | Master Degree in Chemistry or Bachelor Degree in Chemical Technology/ Engineering or equivalent |
| 5 | Polymer Science and Technology | Master Degree in Polymer Science or Bachelor Degree in Polymer Technology / Engineering or equivalent |
| 6 | Bio-Medical Engineering | Bachelor Degree in Bio-Medical Technology/ Engineering or equivalent |
| 7 | Electronics & Communication Engineering | Bachelor Degree in Electronics Technology/ Engineering or Electronics & Telecommunication Technology/ Engineering or equivalent |
| 8 | Electrical Engineering | Bachelor Degree in Electrical Technology/ Engineering or equivalent |
| 9 | Computer Science & Information Technology | Master Degree in Computer Science/ Information Technology or Bachelor Degree in Engineering/Technology in Computer Science/ Information Technology or equivalent |
| 10 | Physics | Master Degree in Physics or equivalent |
| 11 | Civil Engineering | Bachelor Degree in Civil Technology/ Engineering or equivalent |
| 12 | Mechanical Engineering | Bachelor Degree in Mechanical Engineering /Technology or equivalent |
| 13 | Metallurgical Engineering | Bachelor Degree in Engineering/Technology in Metallurgy or equivalent |
| 14 | Textile Engineering | Bachelor Degree in Textile Engineering /Technology or equivalent |

**Note:** The candidates must Note : Candidates must hold a degree in any of the above disciplines of any of the Universities incorporated by an Act of the Central

or State Legislature in India or other educational institutions established by an Act of the Parliament or declared to be deemed as a University under section 3 of the UGC Act, 1956.

## 3. AGE LIMIT AND AGE RELAXATION

a. A candidate must have attained the age of 21 years and must not have attained the age of 35 years as on the last date of submission of online application.

b. The upper age limit of 35 years will be relaxable by up to a maximum of 5 years, that is up to the maximum upper age limit of 40 years, in the case of Government servants in accordance with the instructions or orders issued by the Central Government.

c. The upper age limit prescribed above will be relaxable:

i. upto a maximum of five years if a candidate belongs to a Scheduled Caste or a Scheduled Tribe.

ii. upto a maximum of three years in the case of candidates belonging to Other Backward Classes who are eligible to avail reservation applicable to such candidates.

iii. upto a maximum of three years in the case of Defence Services personnel disabled in operations during hostilities with any foreign country or in a disturbed area and released as a consequence thereof.

iv. upto a maximum of five years in the case of ex-servicemen including Commissioned Officers and ECOs/SSCOs who have rendered at least five years Military Service as on the date on which online application process concludes and have been released:

a. on completion of assignment (including those whose assignment is due to be completed within one year as on the date on which online application process concludes) otherwise than by way of dismissal or discharge on account of misconduct or inefficiency, or

b. on account of physical disability attributable to Military Service, or

c. on invalidment.

v. upto a maximum of five years in the case of ECOs/SSCOs who have completed an initial period of assignment of five years Military Service as on the date on which online application process concludes and whose assignment has been extended beyond five years and in whose case the Ministry of Defence issues a certificate that they can apply for civil employment and that they will be released on three month notice on selection from the date of receipt of offer of appointment.

vi. Upto a maximum of 10 years in the case of candidates belonging to Persons with Benchmark Disabilities (PwBD) categories viz.

a. Locomotor disability (OA, OL, OAL, BL) including cerebral palsy, leprosy cured, dwarfism, acid attach victims and muscular dystrophy.

b. Blindness and Low vision (VH)

c. Hard of hearing (HH)

d. Multiple disabilities from amongst persons under clauses (a) to (c) except deaf-blindness.

**Note I:** Candidates belonging to the Scheduled Castes and the Scheduled Tribes and the Other Backward Classes who are also covered under any other clause 3(c) above, viz. those coming under the category of Ex-servicemen or PwBD, will be eligible for grant of cumulative age-relaxation under both the categories.

**Note II:** The term Ex-servicemen will apply to the persons who are defined as Ex-servicemen in the Ex-servicemen (Re-employment in Civil Services and Posts) Rules, 1979, as amended from time to time.

**Note III:** The age concession under clause 3(c)[(iv) and (v)] above will be admissible to Ex- Servicemen, i.e. a person who has served in the rank whether as

combatant or non-combatant in the Regular Army, Navy and Air Force of the Indian Union and who either has been retired or relieved or discharged from such service whether at own request or being relieved by the employer after earning pension.

**Note IV:** Notwithstanding the provision of age relaxation under clause 3(c)(vi) above, candidates of PwBD category will be considered to be eligible for appointment only if they (after such medical examination as the Government or appointing authority, as the case may be, may prescribe) are found to satisfy the requirements of physical and medical standards for the concerned posts to be allocated to the candidates of PwBD category by the Government.

***Note V:*** *Same as provided under clause 3(c) above, the age limits prescribed can in no case be relaxed. (Not understood)*

(d) The date of birth accepted by the Competent Authority is that entered in the Matriculation or Secondary School Leaving Certificate or in a Certificate recognized by an Indian University as equivalent to Matriculation or in an extract from a Register of Matriculates maintained by a University, which extract must be certified by the proper authority of the University or in the Higher Secondary or an equivalent examination Certificate. The certificate in support of date of birth is required to be submitted by a candidate at the time of online application. No other document relating to age like horoscopes, affidavits, birth extracts from Municipal Corporation, service records and the like will be accepted.

**Note 1:** Candidates should note that only the date of birth as recorded in the matriculation/secondary examination certificate or an equivalent certificate as on the date of submission of applications will be accepted by the competent authority and issued prior to the date of submission of application will be accepted by the Competent Authority, and no subsequent request for its change will be considered or granted.

**Note 2:** Candidates should also note that once a date of birth has been submitted

by them in the application form and entered in the records of the competent authority for the purpose of admission to the examination, no change will be allowed subsequently (or at any other examination of the competent authority) on any grounds whatsoever.

# G. SCHEME OF EXAMINATION

## 1. PHASES

The Examination will consist of three phases as follows:

i. Preliminary Examination for screening of candidates for the main examination;
ii. Mains Examination for shortlisting of candidates for Interview; and
iii. Interview.

## 2. DETAILS OF PHASES

The details of different phases are as follows:

### (i) Preliminary Examination

a. This examination is meant to serve as a screening test and the marks secured in this examination will not be considered towards the declaration of final list of qualified candidates.
b. This examination will be conducted in ONLINE mode only.
c. It will consist of one paper of objective type multiple choice questions and will comprise of 150 marks .
d. This examination will be of a duration of 2 hours.
e. A maximum of 150 questions, each question carrying one mark, will be present in this paper, which will consist of multiple-choice questions to test General English (15 marks), Verbal and Non Verbal Reasoning (30 marks),

Quantitative Aptitude (30 marks), General Knowledge and Current Affairs (30 marks), General Science (30 marks) and IP legislation in India, WIPO and related treaties (15 marks)

**f.** The number of candidates to be admitted to the mains examination, on the basis of result of the preliminary examination, **may be about twenty times of the total approximate number of vacancies to be filled through this recruitment process.** The minimum qualifying marks in preliminary exam for UR :30%; OBC/EWS :25% and others :20%

i) For example: A candidate has to score above mentioned percentage of marks category-wise of the total marks in preliminary examination for qualifying in the exam. Further, cut off of the preliminary exam will be prepared as per the vacancy and no. of candidates to be qualified for mains exam. This criterion is tentative and competent authority has the right to do modification as per requirements.

ii) For example: Let's consider the total vacancy are 100, then no. of candidates qualifying for mains exam shall be approximately 20 times of the vacancy i.e. 2000 candidates and accordingly will be the cut off of preliminary exam.

**(ii) Mains Examination**

a. The mains examination will be conducted in offline mode only and will consist of a written examination, which will consist of 2 papers i.e. Paper –I (OMR Based) and Paper –II (Descriptive answer). Paper I will be of 100 marks and Paper –II will be of 300 marks.

b. Paper-I will be of 2 hours duration and will comprise of a maximum of 100 objective type multiple-choice questions, each question carrying one mark, to test the General Knowledge and Current Affairs (20 Marks), General Aptitude (20 Marks), Elementary mathematics (20 Marks), English language proficiency (20 Marks) and knowledge related to intellectual property rights

(IPRs) (20 Marks).

c. Paper-II will test the knowledge of the candidate in the technical / scientific discipline of the vacancy applied for. Paper-II will be of 3 hours duration and will comprise of 300 marks having descriptive questions. Discipline-wise syllabus is given in Annexure.

**d. <u>The cumulative marks obtained in Paper-I and Paper-II will be assigned 80% weightage in the final list of qualified candidates.</u>**

e. As a general rule, candidates must write all the papers in their own handwriting and in no circumstances will they be allowed to take the help of a scribe. However, persons with disabilities may be eligible for the facility of a scribe in accordance with the relevant rules, O.M.s, guidelines, etc. The onus of justifying the existence of such circumstances and the resultant right to use a scribe shall be upon the candidate.

f. If a candidate's handwriting is not easily legible, the relevant answer shall be treated as incorrect.

**g.** The number of candidates to be eligible for interview **<u>may be about five times the total approximate number of vacancies to be filled through this recruitment process.</u>**

**(iii) Interview**

The interview will be of 100 marks and will test the candidate on the topics covered in the preliminary and mains examination. The marks obtained in interview **<u>will be given 20% weightage in the final list of qualified candidates.</u>**

## 3. MEDIUM OF EXAMINATION

The medium of examination for preliminary and mains examination as well as interview shall be English only.

## H. SENIORITY LIST

A common seniority list in various disciplines in respect of the final list of qualified candidates will be prepared by normalization procedure, which will be as follows:

i. The highest marks secured by a candidate in each discipline will be considered equal to 100%. The percentages (x) of other candidates in the same discipline will be calculated as per the following formula:

   (x) = 100 multiplied by marks secured by a candidate in a subject and divided by highest marks in that subject.

ii. For candidates that have secured equal normalized score, relative seniority be determined by date of birth, whereby a candidate with earlier date of birth (elder candidate) will be placed higher in the list compared to another with a later date of birth (younger candidate).

iii. In case of candidates with same normalized scores and same date of birth, the candidates may be placed in the seniority list as per alphabetical order (by first name).

# Important Instructions to Candidates

a) No request for change in examination centre shall be entertained.

b) Rights for the rules for the cut off of the all stages for all the posts in the examination are reserved by CGPDTM

c) If a candidate fails in such tests, his candidature will not be subsequently considered for any other post/ department. Candidates are therefore required to carefully go through these requirements.

d) The final allotment of posts is being made on the basis of merit-cum-preferences and once a post is allotted, no change of posts will be made by the QCI.

e) Success in the examination confers no right of appointment unless QCI is satisfied after such enquiry as may be considered necessary that the candidate is suitable in all respects for appointment to the service/ post.

f) The candidates applying for the examination should ensure that they fulfill all the eligibility conditions for admission to the examination. Their admission at all stages of the examination will be purely provisional, subject to their satisfying the prescribed eligibility conditions. If, on verification, at any time before or after the written examination, it is found that they do not fulfill any of the eligibility conditions, their candidature for the examination will be cancelled.

g) If candidates are found to indulge at any stage in any of the malpractices and fraudery their candidature for this examination will be cancelled and legal actions shall be taken by QCI. QCI may also report the matter to Police/ Investigating Agencies, as deemed fit.

h) Before applying, candidates must to go through the instructions given in the notice of examination very carefully.

i) Candidates seeking reservation benefits available for SC/ ST/ OBC/ EWS/ PwBD/ ESM must ensure that they are entitled to such reservation as per eligibility prescribed in the Notice.

j) The candidates must write their name, date of birth, father’s name and mother’s

name strictly as given in the matriculation certificate otherwise their candidature may be cancelled at the time of Document Verification or as and when it comes into the notice of the commission.

k) Candidates are advised to fill their correct and active e-mail addresses and mobile number in the online application as correspondence may be made through e-mail/ SMS.

l) In case of fake/ fabricated application/ registration by misusing any dignitaries name/ photo, such candidate/ cyber cafe will be held responsible for the same and liable for suitable legal action under cyber/ IT Act.

m) All decisions related to recruitment shall be made and enforced by QCI and will be applicable for all candidates.

# ANNEXURE

## SYLLABUS

The syllabus for Paper-II of the mains examination in respect of different disciplines will be as follows:

| | |
|---|---|
| **1. BT** | **Bio Technology** |

**Microbiology:** Prokaryotic and eukaryotic cell structure; Microbial nutrition, growth and control; Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Nitrogen fixation; Chemical basis of mutations and mutagens; Microbial genetics (plasmids, transformation, transduction, conjugation); Microbial diversity and characteristic features; Viruses.

**Biochemistry:** Biomolecules and their conformation; Weak inter-molecular interactions in biomacromolecules; Chemical and functional nature of enzymes; Kinetics of single substrate and bi-substrate enzyme catalyzed reactions; Bioenergetics; Metabolism (Glycolysis, TCA and Oxidative phosphorylation); Membrane transport and pumps; Cell cycle and cell growth control; Cell signaling and signal transduction.

**Molecular Biology and Genetics:** Molecular structure of genes and chromosomes; DNA replication and control; Transcription and its control; Translational processes; Regulatory controls in prokaryotes and eukaryotes; Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extrachromosomal inheritance; Chromosomal variation; Population genetics; Transposable elements, Molecular basis of genetic diseases and applications.

**Process Biotechnology:** Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exo-polysacharides, antibiotics and pigments etc.; Microbial production, purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Chromatographic and membrane based bioseparation methods; Immobilization of enzymes and cells and their application for bioconversion processes. Aerobic and anaerobic biological processes for stabilization of solid / liquid wastes; Bioremediation.

**Bioprocess Engineering:** Kinetics of microbial growth, substrate utilization and product formation; Simple structured models; Sterilization of air and media; Batch, fed-batch and continuous processes; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids; Scale-up concepts; Design of fermentation media; Various types of microbial and enzyme reactors; Instrumentation in bioreactors.

**Plant and Animal Biotechnology:** Special features and organization of plant cells; Totipotency; Regeneration of plants; Plant products of industrial importance; Biochemistry of major metabolic pathways and products; Autotrophic and heterotrophic growth; Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, nutrient optimization; Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation. Techniques in raising transgencies.

**Characteristics of animal cells:** Metabolism, regulation and nutritional requirements for mass cultivation of animal cell cultures; Kinetics of cell growth and product formation and effect of shear force; Product and substrate transport; Micro & macro-carrier culture; Hybridoma technology; Live stock improvement;

Cloning in animals; Genetic engineering in animal cell culture; Animal cell preservation.

**Immunology:** The origin of immunology; Inherent immunity; Humoral and cell mediated immunity; Primary and secondary lymphoid organ; Antigen; B and T cells and Macrophages; Major histocompatibility complex (MHC); Antigen processing and presentation; Synthesis of antibody and secretion; Molecular basis of antibody diversity; Polyclonal and monoclonal antibody; Complement; Antigen-antibody reaction; Regulation of immune response; Immune tolerance; Hyper sensitivity; Autoimmunity; Graft versus host reaction.

**Recombinant DNA Technology:** Restriction and modification enzymes; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; cDNA and genomic DNA library; Gene isolation; Gene cloning; Expression of cloned gene; Transposons and gene targeting; DNA labeling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD; RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy.

**Bioinformatics:** Major bioinformatics resources (NCBI, EBI, ExPASy); Sequence and structure databases; Sequence analysis (biomolecular sequence file formats, scoring matrices, sequence alignment, phylogeny); Genomics and Proteomics (Large scale genome sequencing strategies; Comparative genomics; Understanding DNA microarrays and protein arrays); Molecular modeling and simulations (basic concepts including concept of force fields).

| **2. BC** | **Bio-Chemistry** |
|---|---|

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Amino acids, Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques and characterization: ion

exchange, size exclusion and affinity chromatography, electrophoresis, UV-visible, fluorescence and Mass spectrometry. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics including its regulation and inhibition, Vitamins and Coenzymes.

Metabolism and bioenergetics. Generation and utilization of ATP. Metabolic pathways and their regulation: glycolysis, TCA cycle, pentose phosphate pathway, oxidative phosphorylation, gluconeogenesis, glycogen and fatty acid metabolism. Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides. Photosynthesis: the Calvin cycle.

Biological membranes. Transport across membranes. Signal transduction; hormones and Neurotransmitters. DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications: PCR, site directed mutagenesis and DNA microarray.

Immune system. Active and passive immunity. Complement system. Antibody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immune electrophoresis, RIA and ELISA.

| **3. FT** | **Food Technology** |
|---|---|

**Food Chemistry and Nutrition:** Carbohydrates: Structure and functional properties of monooligo- polysaccharides including starch, cellulose, pectic substances and dietary fibre; Proteins: Classification and structure of proteins in food; Lipids: Classification and structure of lipids, Rancidity of fats, Polymerization and polymorphism; Pigments: Carotenoids, chlorophylls, anthocyanins, tannins and myoglobin; Food flavours: Terpenes, esters, ketones and

quinones; Enzymes: Specificity, Kinetics and inhibition, Coenzymes, Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases.

**Food Microbiology:** Characteristics of microorganisms: Morphology, structure and detection of bacteria, yeast and mold in food, Spores and vegetative cells; Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products; Foodborne disease: Toxins produced by Staphylococcus, Clostridium and Aspergillus; Bacterial pathogens: Salmonella, Bacillus, Listeria, Escherichia coli, Shigella, Campylobacter; Fermented food: Buttermilk, yoghurt, cheese, sausage, alcoholic beverage, vinegar, sauerkraut and soya sauce.

**Food Products Technology:** Processing principles: Canning, chilling, freezing, dehydration, control of water activity, CA and MA storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, cleaning in place and food laws.; Grain products processing: Milling of rice, wheat, and maize, parboiling of paddy, production of bread, biscuits, extruded products and breakfast cereals, Solvent extraction, refining and hydrogenation of oil; Fruits, vegetables and plantation products processing: Extraction, clarification concentration and packaging of fruit juice, Production of jam, jelly, marmalade, squash, candies, and pickles, pectin from fruit waste, tea, coffee, chocolate and essential oils from spices; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder.

**Food Engineering:** Mass and energy balance; Momentum transfer: Flow rate and pressure drop relationships for Newtonian fluids flowing through pipe, Characteristics of non- Newtonian fluids – generalized viscosity coefficient and Reynolds number, Flow of compressible fluid, Flow measurement, Pumps and compressors; Heat transfer: Heat transfer by conduction, convection, radiation, boiling and condensation, Unsteady state heat transfer in simple geometry, NTUeffectiveness relationship of co-current and counter current double pipe heat exchanger; Mass transfer: Molecular diffusion and Fick's Law, Steady state mass transfer, Convective mass transfer, Permeability of films and laminates; Mechanical operations: Energy requirement and rate of operations involved in size reduction of solids, high pressure homogenization, filtration, centrifugation, settling, sieving, flow through porous bed, agitation of liquid, solid-solid mixing, and single screw extrusion; Thermal operations: Energy requirement and rate of operations involved in process time evaluation in batch and continuous sterilization, evaporation of liquid foods, hot air drying of solids, spray and freeze-drying, freezing and crystallization; Mass transfer operations: Properties of air-water vapor mixture; Humidification and dehumidification operations.

| **4. CY** | **Chemistry** |
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**Inorganic Chemistry**

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.

5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.
9. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods.
10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV- vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

**Physical Chemistry**

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.

5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

**Organic Chemistry**

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
10. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
11. Synthesis and reactivity of common heterocyclic compounds containing one or

two heteroatoms (O, N, S).

12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
13. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

**Interdisciplinary topics**

1. Chemistry in nanoscience and technology
2. Catalysis and green chemistry
3. Medicinal chemistry
4. Supramolecular chemistry
5. Environmental chemistry

| **5. PS** | **Polymer Science & Technology** |
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**Chemistry of high polymers:** Monomers, functionality, degree of polymerizations, classification of polymers, glass ransition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

**Polymer Characterization:** Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

**Synthesis and properties:** Commodity and general purpose thermoplastics: PE,

PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

**Polymer blends and composites:** Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic- plastic, rubberplastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

**Polymer Technology:** Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization, vulcanization kinetics.

**Polymer rheology:** Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

**Polymer processing:** Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

**Polymer testing:** Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness.

Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

| 6. BM | Bio Medical Engineering |
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Biomedical Engineering is a interdisciplinary field that develops and perfects tools and techniques that extend and enhance the capability of a clinician in medical procedures, and helps in the monitoring and control of the physiological parameters of patients. Biomedical engineering graduates should have background knowledge of Electrical, Electronics, Mechanics, material Science Communication and Instrumentation Engineering besides the exposure to anatomy and physiology including clinical monitoring with safety analysis.

Students must have sufficient knowledge in the theory and practice of Biomedical Instrumentation. Biosignal Processing, Medical Image Processing, Rehabilitation Engineering, Biomaterials, Medical devices and Biosensors.

**Biomedical Instrumentation:** "Introduction to Biomedical medical instrumentation, Recording Systems, Blood pressure measurement, Electrocardiograph, ECG leads, artifacts , vector cardiograph, Phonocardiograph , defibrillators, pacemakers, fixed, demand, heart- lung machine, Electroencephalograph, Block diagram, 10-20 electrode placement , recording of evoked potential , sensory and motor, EEG telemetry, Electromyography, Block diagram. recording system, Hemodyalisis Machine, electrical Hazards and Safety.

**Anatomy and Physiology:** Skeletal system, Nervous system and special senses, Cardiovascular system, Respiratory system, Digestive System.

**Medical Physics and Biochemistry:** Introduction to Biochemistry, Carbohydrate Metabolism, Protein Metabolism, Lipid Metabolism, Nucleic and Metabolism,

Vitamins- water soluble and fat soluble, Minerals - Sodium, Potasim, Calcium, Magnesium and phosphate.

**Biomedical Signal Processing:** Discrete and continuous Random variables, Probability distribution and density functions. Gaussian and Rayleigh density functions, Correlation between random variables. Stationary random process, Ergodicity, Power special density and autocorrelation function of random processes. Noise power spectral density analysis, Noise bandwidth, noise figure of systems, Data Compression Techniques, Cardio logical, Signal Processing, Adaptive Noise Canceling, neurological Signal Processing.

**Medical Image Processing:** Digital Image representation, steps in image processing, Elements of Digital Image processing systems. Fundamentals: Elements of visual perception, sampling and quantization, basic relationship between pixels. Imaging Geometry — some basic transforms, perspective transforms, Image Transform — Fourier transform, Discrete Fourier transform, Fast Fourier transform, properties of 2 - D Fourier transform, Image Enhancement - Spatial domain methods, Frequency domain methods, Enhancement by point processing, spatial filtering, Enhancement in the Frequency domain, Image Restoration - Degradation model, Algebraic approach to restoration, Inverse Filtering, Wiener Filter constraint least square1; restoration, Restoration in the spatial domain, Image Compression-_Redundancy, Compression models, Lossy, compression, Image compression standards, Image Segmentation - Detection of Detection of Discontinuity — Edge linking and boundary detection, Thresholding Region oriented segmentation Image representation - Represent- ion schemes. Boundary descriptors, Regional descriptors, Recognition and interpretation - Elements of Image analysis patterns and pattern classes, Decision and theoretic methods, structural methods, Interpretation.

**Microprocessor-based Medical Instrumentation:** 8086 Processor-Introduction, 8086 Architecture, Pin configuration, 8086 in min/max node, Addressing modes, Instruction set of 8086, Assembler directive, Assembly language programming, Peripherals & interfacing With 8086-Serial & parallel I/O (8251A and 8255), Programmable interval timer 8253, Programmable DMA controller 8257, programmable interrupt controller 8259A, Keyboard and display controller 8279, ADC / DAC interfacing, 80286 Processor-Features of 80286, internal architecture of 80286, real addressing mode virtual addressing mode, privilege, protection, basic bus operation of 80286, fetch cycles of 80286, Advance In Microprocessors-Features of Pentium processor, Pentium - I, Pentium - II, Pentium - III, Pentium - IV, Introduction to microcontroller 8051, architecture of 8051, Register set of 8051.

**Biomaterials:** Properties of Materials. Classes of materials used in medicine. Metals, Polymers, Hydrogels Bioresorbablc and Biodegradable Materials, Ceramics, Natural materials composites thin films, grafts, Coatings medical fibers and Biological functional materials, Smart materials, Pyrolytic Carbon for long-term medical implants textured and Porous materials non-fouling surfaces, Host reactions to: inflammation, Wound healing and the Foreign body response. Systemic toxicity and Hypersensitivity. Blood coagulation and Blood-material Interactions. Tumorigenesis, Testing biomaterials Applications of materials in medicine, Dentistry and Biology Cardiovascular medical devices Nonthrombogenic treatments and Strategies. Orthopedic biomaterials, Performance of drug delivery systems, Sutures. Burn dressings and Skin substitutes Sterilization of implants and Devices implants and Device failure. Surface properties with Biological responses. Implant retrieval and Evaluation. Standards development and regulation of medical products using biomaterials. Nano bio materials.

**Biomechanics:** Introduction to Fluid Mechanism, Basic laws governing conservation of mass, momentum and energy, laminar flow, Coquette flow and Hager - poise Ville equation, turbulent flow, Flow Dynamical Study of Circulating System, Heart and blood vessels, Ventricular pressure, volume, ECG time Based cyclic, variation. Determination of ventricular wall diastolic, systolic modules vs. stress properties and their physiological connotation, Intra- ventricular blood, Flow analysis of velocity and pressure gradient, Arterial impedance relating pulse pressure and flow rate, microcirculatory, flow, transcapillary fluid movements in systemic circulation, physiological factors controlling blood pressure, heart valves, Biomechanical stress strain model Muscle in terms of its elastic and contractile elements parameters, Lung Mechanics Lung structure and function, methods of determining ling pressure and volume, airway resistance and conductance.

| 7. **EC** | **Electronics and Communications Engineering** |
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**Materials and Components**

Structure and properties of Electrical Engineering materials; Conductors, Semiconductors and Insulators, magnetic, Ferroelectric, Piezoelectric, Ceramic, Optical and Super- conducting materials. Passive components and characteristics Resistors, Capacitors and Inductors; Ferrities, Quartz crystal Ceramic resonators, Electromagnetic an Electromechanical components.

**Physical Electronics, Electron Devices and ICs**

Electrons and holes in semiconductors, Carrier Statistics, Mechanism of current flow in a semiconductor, Hall effect; Junction theory; Different types of diodes and their characteristics; Bipolar Junction transistor; Field effect transistors; Power switching devices like SCRs, CTOs, power MOSFETs; Basics of ICs - bipolar, MOS and CMOS types; basic of Opto Electronics.

**Signals and Systems**

Classification of signals and systems: System modelling in terms of differential and difference equations; State variable representation; Fourier series; Fourier representation; Fourier series; Fourier transforms and their application to system analysis; Laplace transforms and their application to system analysis; Convolution and superposition integrals and their applications; Z-transforms and their applications to the analysis and characterisation of discrete time systems; Random signals and probability, Correlation functions; Spectral density; Response of linear system to random inputs.

**Network theory**

Network analysis techniques; Network theorems, transient response, steady state sinusoidal response; Network graphs and their applications in network analysis; Tellegen's theorem. Two port networks; Z, Y, h and transmission parameters. Combination of two ports, analysis of common two ports. Network functions : parts of network functions, obtaining a network function from a given part. Transmission criteria : delay and rise time, Elmore's and other definitions effect of cascading. Elements of network synthesis.

**Electromagnetic Theory**

Analysis of electrostatic and magnetostatic fields; Laplace's and Piossons's equations; Boundary value problems and their solutions; Maxwell's equations; application to wave propagation in bounded and unbounded media; Transmission lines : basic theory, standing waves, matching applications, misconstrue lines; Basics of wave guides and resonators; Elements of antenna theory.

**Electronic Measurements and instrumentation**

Basic concepts, standards and error analysis; Measurements of basic electrical quantities and parameters; Electronic measuring instruments and their principles of working : analog and digital, comparison, characteristics, application. Transducers;

Electronic measurements of non electrical quantities like temperature, pressure, humidity etc; basics of telemetry for industrial use.

**Analog Electronic Circuits**

Transistor biasing and stabilization. Small signal analysis. Power amplifiers. Frequency response. Wide banding techniques. Feedback amplifiers. Tuned amplifiers. Oscillators. Rectifiers and power supplies. Op Amp PLL, other linear integrated circuits and applications. Pulse shaping circuits and waveform generators.

**Digital Electronic Circuits**

Transistor as a switching element; Boolean algebra, simplification of Boolean functions, Karnaguh map and applications; IC Logic gates and their characteristics; IC logic families : DTL, TTL, ECL, NMOS, PMOS and CMOS gates and their comparison; Combinational logic Circuits; Half adder, Full adder; Digital comparator; Multiplexer Demultiplexer; ROM and their applications. Flip flops. R-S, J.K, D and T flip-flops; Different types of counters and registers Waveform generators. A/D and D/A converters. Semiconductor memories.

**Control Systems**

Transient and steady state response of control systems; Effect of feedback on stability and sensitivity; Root locus techniques; Frequency response analysis. Concepts of gain and phase margins: Constant-M and Constant-N Nichol's Chart; Approximation of transient response from Constant-N Nichol's Chart; Approximation of transient response from closed loop frequency response; Design of Control Systems, Compensators; Industrial controllers.

**Communication Systems**

Basic information theory; Modulation and detection in analogue and digital systems; Sampling and data reconstructions; Quantization & coding; Time division and frequency division multiplexing; Equalization; Optical Communication : in

free space & fiber optic; Propagation of signals oat HF, VHF, UHF and microwave frequency; Satellite Communication.

**Microwave Engineering**

Microwave Tubes and solid state devices, Microwave generation and amplifiers, Waveguides and other Microwave Components and Circuits, Misconstrue circuits, Microwave Antennas, Microwave Measurements, Masers, lasers; Microwave propagation. Microwave Communication Systems terrestrial and Satellite based.

**Computer Engineering**

Number Systems. Data representation; Programming; Elements of a high level programming language PASCAL/C; Use of basic data structures; Fundamentals of computer architecture; Processor design; Control unit design; Memory organisation, I/o System Organisation. Microprocessors : Architecture and instruction set of Microprocessors 8085 and 8086, Assembly language Programming. Microprocessor Based system design typical examples. Personal computers and their typical uses.

| **8. EE** | **Electrical Engineering** |
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**Circuit Theory:** Circuit components; network graphs; KCL, KVL; circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis: RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits; coupled circuits; balanced 3-phase circuits; Two-port networks.

**Signals & Systems:** Representation of continuous–time and discrete-time signals & systems; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

**E.M. Theory:** Maxwell's equations, wave propagation in bounded media. Boundary conditions, reflection and refraction of plane waves. Transmission line: travelling and standing waves, impedance matching, Smith chart.

**Analog Electronics:** Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET. Diode circuits: clipping, clamping, rectifier. Biasing and bias stability. FET amplifiers. Current mirror; Amplifiers: single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. OPAMP circuits. Filters; sinusoidal oscillators: criterion for oscillation; single- transistor and OPAMP configurations. Function generators and wave-shaping circuits. Linear and switching power supplies.

**Digital Electronics:** Boolean algebra; minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip- flops, counters and shift-registers. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Logic implementation using programmable devices (ROM, PLA, FPGA).

**Energy Conversion:** Principles of electromechanical energy conversion: Torque and emf in rotating machines. DC machines: characteristics and performance analysis; starting and speed control of motors; Transformers: principles of operation and analysis; regulation, efficiency; 3-phase transformers. 3-phase induction machines and synchronous machines: characteristics and preformance analysis; speed control.

**Power Electronics and Electric Drives:** Semiconductor power devices: diode, transistor, thyristor, triac, GTO and MOSFET–static characteristics and principles

of operation; triggering circuits; hase control rectifiers; bridge converters: fully-controlled and half- controlled; principles of thyristor choppers and inverters; DC-DC converters; Switch mode inverter; basic concepts of speed control of DC and AC Motor drives applications of variable-speed drives.

**Analog Communication:** Random variables: continuous, discrete; probability, probability functions. Statistical averages; probability models; Random signals and noise: white noise, noise equivalent bandwidth; signal transmission with noise; signal to noise ratio. Linear CW modulation: Amplitude modulation: DSB, DSB-SC and SSB. Modulators and Demodulators; Phase and Frequency modulation: PM & FM signals; narrowband FM; generation & detection of FM and PM, Deemphasis, Preemphasis. CW modulation system: Superhetrodyne receivers, AM receivers, communication receivers, FM receivers, phase locked loop, SSB receiver Signal to noise ratio calculation for AM and FM receivers.

**Control Systems:** Elements of control systems; blockdiagram representation; open-loop & closed-loop systems; principles and applications of feed-back. Control system components.

**LTI systems:** time- domain and transform-domain analysis. Stability: Routh Hurwitz criterion, root-loci, Bodeplots and polar plots, Nyquist's criterion; Design of lead-lad compensators. Proportional, PI, PID controllers. Statevariable representation and analysis of control systems.

**Microprocessors and Microcomputers:** PC organisation; CPU, instruction set, register set, timing diagram, programming, interrupts, memory interfacing, I/O interfacing, programmable peripheral devices.

**Measurement and Instrumentation:** Error analysis; measurement of current, voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency; bridge measurement. Signal conditioning circuit; Electronic measuring

instruments: multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyzer, distortion-meter. Transducers: thermocouple, thermistor, LVDT, strain-gauge, piezo-electric crystal.

**Power Systems:** Analysis and Control: Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer and distribution; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults. Concept of system stability: swing curves and equal area criterion. Static VAR system. Basic concepts of HVDC transmission.

**Power System Protection:** Principles of overcurrent, differential and distance protection. Concept of solid state relays. Circuit breakers. Computer aided protection: Introduction; line bus, generator, transformer protection; numeric relays and application of DSP to protection.

**Digital Communication:** Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM), Digital modulation and demodulation schemes: amplitude, phase and frequency keying schemes (ASK, PSK, FSK). Error control coding: error detection and correction, linear block codes, convolution codes. Information measure and source coding. Data networks, 7-layer architecture.

| **9. CS** | **Computer Science and Information Technology** |
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**Digital Logic:** Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

**Computer Organization and Architecture:** Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface

(Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

**Programming and Data Structures:** Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

**Algorithms:** Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and- conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes – P, NP, NP-hard, NP- complete.

**Theory of Computation:** Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

**Compiler Design:** Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

**Operating System:** Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

**Databases:** ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

**Information Systems and Software Engineering:** information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

**Computer Networks:** ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

**Web technologies:** HTML, XML, basic concepts of client-server computing.

| 10.PH | Physics |
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**Mathematical Methods of Physics**

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley- Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

**Classical Mechanics**

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence.

**Electromagnetic Theory**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations,

boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

**Quantum Mechanics**

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

**Thermodynamic and Statistical Physics**

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro- canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

**Electronics and Experimental Methods**

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo-

and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting,

**Mathematical Methods of Physics**

Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

**Classical Mechanics**

Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

**Electromagnetic Theory**

Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

**Quantum Mechanics**

Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein- Gordon and Dirac equations. Semi-classical theory of radiation.

**Thermodynamic and Statistical Physics**

First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

**Electronics and Experimental Methods**

Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques.

High frequency devices (including generators and detectors).

**Atomic & Molecular Physics**

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

**Condensed Matter Physics**

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and

semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

**Nuclear and Particle Physics**

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

| **11.CE** | **Civil Engineering** |
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**Engineering Mechanics**:

Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane, moment of force, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system.

First and Second Moment of area, Mass moment of Inertia.

**Static Friction. Kinematics and Kinetics**:

Kinematics in Cartesian Co-ordinates, motion under uniform and nonuniform acceleration, motion under gravity. Kinetics of particle: Momentum and Energy principles, collision of elastic bodies, rotation of rigid bodies.

**Strength of Materials:**

Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength.

Deflection of beams: Macaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Elastic stability of columns, Euler's Rankine's and Secant formulae.

**Structural Analysis**:

Castiglianio's theorems I and II, unit load method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution,

Rolling loads and Influences lines: Influences lines for Shear Force and Bending moment at a section of beam. Criteria for maximum shear force and bending Moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses.

Arches: Three hinged, two hinged and fixed arches, rib shortening and temperature effects.

Matrix methods of analysis: Force method and displacement method of analysis of indeterminate beams and rigid frames.

Plastic Analysis of beams and frames: Theory of plastic bending, plastic analysis, statical method, Mechanism method.

Unsymmetrical bending: Moment of inertia, product of inertia, position of Neutral Axis and Principle axes, calculation of bending stresses.

**Design of Structures: Steel, Concrete and Masonry Structures:**

**Structural Steel Design:**

**Design of Concrete and Masonry Structures:**

Concept of mix design. Reinforced Concrete: Working Stress and Limit State method of design–Recommendations of I.S. codes Design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity, Cantilever and Counter fort type retaining walls.

Water tanks: Design requirements for Rectangular and circular tanks resting on ground.

Prestressed concrete: Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

Design of brick masonry as per I.S. Codes

**Fluid Mechanics, Open Channel Flow and Hydraulic Machines: Fluid Mechanics**:

Fluid properties and their role in fluid motion, fluid statics including forces acting on plane and curved surfaces.

Kinematics and Dynamics of Fluid flow: Velocity and accelerations, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions.

Continuity, momentum and energy equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, sluice gates, weirs.

**Dimensional Analysis and Similitude:**

Buckingham's Pi-theorem, dimensionless parameters.

**Laminar Flow:**

Laminar flow between parallel, stationary and moving plates, flow through tube.

Boundary layer: Laminar and turbulent boundary layer on a flat plate, laminar sub layer, smooth and rough boundaries, drag and lift. Turbulent flow through pipes: Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line.

**Open channel flow**:

Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, rapidly varied flow, hydraulic jump, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation.

**Hydraulic Machines and Hydropower:**

Hydraulic turbines, types classification, Choice of turbines, performance parameters, controls, characteristics, specific speed. Principles of hydropower development.

**Geotechnical Engineering:**

Soil Type and structure – gradation and particle size distribution – consistency limits.

Water in soil – capillary and structural – effective stress and pore water pressure – permeability concept – field and laboratory determination of permeability – Seepage pressure – quick sand conditions – Shear strength determination – Mohr Coulomb concept.

Compaction of soil – Laboratory and field tests.

Compressibility and consolidation concept – consolidation theory – consolidation settlement analysis.

Earth pressure theory and analysis for retaining walls, Application for sheet piles and Braced excavation.

Bearing capacity of soil – approaches for analysis – Field tests – settlement analysis – stability of slope of earth walk.

Subsurface exploration of soils – methods

Foundation – Type and selection criteria for foundation of structures – Design criteria for foundation – Analysis of distribution of stress for footings and pile – pile group action-pile load test. Ground improvement techniques.

**Construction Technology, Equipment, Planning and Management:**
**Construction Technology:**

**Engineering Materials:**

Physical properties of construction materials with respect to their use in construction - Stones, Bricks and Tiles; Lime, Cement, different types of Mortars and Concrete.

Specific use of ferro cement, fibre reinforced C.C, High strength concrete. Timber, properties and defects - common preservation treatments.

Use and selection of materials for specific use like Low Cost Housing, Mass Housing, High Rise Buildings.

**Construction:**

Masonry principles using Brick, stone, Blocks – construction detailing and strength characteristics.

Types of plastering, pointing, flooring, roofing and construction features. Common repairs in buildings.

Principles of functional planning of building for residents and specific use - Building code provisions.

Basic principles of detailed and approximate estimating - specification writing and rate analysis – principles of valuation of real property.

| 12.ME | Mechanical Engineering |
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**Mechanics:**

Mechanics of rigid bodies: Equations of equilibrium in space and its application; first and second moments of area; simple problems on friction; kinematics of particles for plane motion; elementary particle dynamics.

Mechanics of deformable bodies: Generalized Hooke’s law and its application; design problems on axial stress, shear stress and bearing stress; material properties for dynamic loading; bending shear and stresses in beams;. determination of principle stresses and strains

- analytical and graphical; compound and combined stresses; bi-axial stresses - thin walled pressure vessel; material behaviour and design factors for dynamic load; design of circular shafts for bending and torsional load only; deflection of beam for statically determinate problems; theories of failure.

**Engineering Materials:** Basic concepts on structure of solids; common ferrous and non- ferrous materials and their applications; heat-treatment of steels; non-metals- plastics, ceramics, composite materials and nano-materials.

**Theory of Machines:** Kinematic and dynamic analysis of plane mechanisms. Cams, Gears and epicyclic gear trains, flywheels, governors, balancing of rigid rotors, balancing of single and multicylinder engines, linear vibration analysis of mechanical systems (single degree of freedom), Critical speeds and whirling of shafts.

**Manufacturing Science:**

Manufacturing Process: Machine tool engineering – Merchant's force analysis; Taylor's tool life equation; conventional machining; NC and CNC machining process; jigs and fixtures. Non-conventional machining – EDM, ECM, ultrasonic, water jet machining etc; application of lasers and plasmas; energy rate calculations. Forming and welding processes- standard processes. Metrology - concept of fits and tolerances; tools and gauges; comparators; inspection of length; position; profile and surface finish.

Manufacturing Management: System design: factory location- simple OR models; plant layout - methods based; applications of engineering economic analysis and break- even analysis for product selection, process selection and capacity planning; predetermined time standards. System planning; forecasting methods based on regression and decomposition, design and balancing of multi model and stochastic assembly lines; inventory management – probabilistic inventory models for order time and order quantity determination; JIT systems; strategic sourcing; managing inter plant logistics. System operations and control: Scheduling algorithms for job

shops; applications of statistical methods for product and process quality control - applications of control charts for mean, range, percent defective, number of defectives and defects per unit; quality cost systems; management of resources, organizations and risks in projects. System improvement: Implementation of systems, such as total quality management, developing and managing flexible, lean and agile organizations.

**Thermodynamics, Gas Dynamics and Turbine:**

Basic concept of First –law and second law of Thermodynamics; concept of entropy and reversibility; availability and unavailability and irreversibility.

Classification and properties of fluids; incompressible and compressible fluids flows; effect of Mach number and compressibility; continuity momentum and energy equations; normal and oblique shocks; one dimensional isentropic flow; flow or fluids in duct with frictions that transfer.

Flow through fans, blowers and compressors; axial and centrifugal flow configuration; design of fans and compressors; single problems compresses and turbine cascade; open and closed cycle gas turbines; work done in the gas turbine; reheat and regenerators.

**Heat Transfer:**

Conduction heat transfer- general conduction equation - Laplace, Poisson and Fourier equations; Fourier law of conduction; one dimensional steady state heat conduction applied to simple wall, solid and hollow cylinder & spheres.

Convection heat transfer- Newton's law of convection; free and forces convection; heat transfer during laminar and turbulent flow of an incompressible fluid over a flat plate; concepts of Nusselt number, hydrodynamic and thermal boundary layer their thickness; Prandtl number; analogy between heat and momentum transfer- Reynolds, Colbum, Prandtlanalogies; heat transfer during laminar and turbulent flow through horizontal tubes; free convection from horizontal and vertical plates.

Black body radiation - basic radiation laws such as Stefan-Boltzman, Planck

distribution, Wein's displacement etc.

Basic heat exchanger analysis; classification of heat exchangers.

**I .C. Engines:**

Classification, thermodynamic cycles of operation; determination of break power, indicated power, mechanical efficiency, heat balance sheet, interpretation of performance characteristics, petrol, gas and diesel engines.

Combustion in SI and CI engines, normal and abnormal combustion; effect of working parameters on knocking, reduction of knocking; Forms of combustion chamber for SI and CI engines; rating of fuels; additives; emission.

Different systems of IC engines- fuels; lubricating; cooling and transmission systems. Alternate fuels in IC engines.

**Steam Engineering:**

Steam generation- modified Rankine cycle analysis; Modern steam boilers; steam at critical and supercritical pressures; draught equipment; natural and artificial draught; boiler fuels solid, liquid and gaseous fuels. Steam turbines - principle; types; compounding; impulse and reaction turbines; axial thrust.

Steam nozzles- flow of steam in convergent and divergent nozzle; pressure at throat for maximum discharge with different initial steam conditions such as wet, saturated and superheated, effect of variation of back pressure; supersaturated flow of steam in nozzles, Wilson line.

Rankine cycle with internal and external irreversibility; reheat factor; reheating and regeneration, methods of governing; back pressure and pass out turbines.

Steam power plants - combined cycle power generation; heat recovery steam generators (HRSG) fired and unfired, cogeneration plants.

**Refrigeration and air-conditioning:**

Vapour compression refrigeration cycle - cycle on p-H & T-s diagrams; eco-friendly refrigerants - R134a,123; Systems like evaporators, condensers, compressor, expansion devices. Simple vapour absorption systems.

Psychrometry - properties; processes; charts; sensible heating and cooling; humidification and dehumidification effective temperature; air-conditioning load calculation; simple duct design.

| 13.MT | Metallurgical Engineering |
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**Thermodynamics and Rate Processes:** Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry- single electrode potential, electro-chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high temperature corrosion – characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws, mass transfer coefficients; momentum transfer – concepts of viscosity, shell balances, Bernoulli's equation, friction factors.

**Extractive Metallurgy**: Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyrohydro- and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making – principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

**Physical Metallurgy**: Crystal structure and bonding characteristics of metals,

alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminum alloys; surface treatments; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; industrial ceramics, polymers and composites; electronic basis of thermal, optical, electrical and magnetic properties of materials; electronic and opto- electronic materials.

**Mechanical Metallurgy:** Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; super-plasticity; fracture – Griffith theory, basic concepts of linear elastic and elasto-plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

**Manufacturing Processes**: Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming – fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Metal joining – soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; welding metallurgy, problems associated with welding of steels and aluminium

alloys, defects in welded joints; powder metallurgy; NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.

| 14.TF | Textile Engineering |
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**Textile Fibres:** Classification of textile fibres; Essential requirements of fibre forming polymers; Gross and fine structure of natural fibres like cotton, wool and silk. Introduction to important bastfibres; properties and uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting Tg and Tm; Process of viscose and acetate preparation. Polymerization of nylon-6, nylon-66, poly (ethylene terephthalate), polyacrylonitrile and polypropylene; Melt Spinning processes, characteristic features of PET, polyamide and polypropylene spinning; wet and dry spinning of viscose and acrylic fibres; post spinning operations such as drawing, heat setting, tow-to-top conversion and different texturing methods.

Methods of investigating fibre structure e.g., Density, X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods (DSC, DMA/TMA, TGA); structure and morphology ofman-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

**Yarn manufacture and yarn structure & properties:** Principles of opening, cleaning and mixing/blending of fibrous materials, working principle of modern opening and cleaning equipments; the technology of carding, carding of cotton and synthetic fibres; Drafting operation, roller and apron drafting principle, causes of mass irregularity introduced by drafting; roller arrangements in drafting systems;

principles of cotton combing, combing cycle, mechanism and function, combing efficiency, lap preparation; recent developments in comber; Roving production, mechanism of bobbin building, roving twist; Principle of ring spinning, forces acting on yarn and traveler; ring & traveler designs; mechanism of cop formation, causes of end breakages; working principle of ring doubler and two for one twister, single and folded yarn twist, properties of double yarns, production of core spun yarn, compact spinning, principle of non conventional methods of yarn production such as rotor spinning, air jet spinning, wrap spinning, twist less spinning and friction spinning.

Yarn contraction, yarn diameter, specific volume & packing coefficient; twist strength relationship in spun yarns; fibre configuration and orientation in yarn; cause of fibre migration and its estimation, irregularity index, properties of ring, rotor and air-jet yarns.

**Fabric manufacture and Fabric Structure:** Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with

shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttle-less weaving machines, principles of multiphase and circular looms.

Principles of weft and warp knitting; basic weft and warp knitted structures.

Classification, production and areas of application of nonwoven fabrics.Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, leno and double cloth constructions. Peirce's equations for fabric geometry; elastica model of plain woven fabrics; thickness, cover and maximum sett of woven fabrics.

**Textile Testing**: Sampling techniques, sample size and sampling errors. Measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity and trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarns and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength, bursting strength and abrasion resistance. FAST and Kawabata instruments and systems for objective fabric evaluation.Statistical data analysis of experimental results.Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

**Preparatory Processes:** Chemistry and practice of preparatory processes for cotton, wool and silk. Mercerization of cotton.Preparatory processes for nylon, polyester and acrylic and polyester/cotton blends.

**Dyeing:** Classification of dyes. Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate dye classes. Dyeing polyester/cotton and polyester/wool blends. Batchwise and continuous dyeing machines. Dyeing of cotton knitted fabrics and machines used. Dye fibre interaction. Introduction to thermodynamics and kinetics of dyeing.Methods for determination of wash, light and rubbing fastness.Evaluation of fastness properties with the help of grey scale.

**Printing:** Styles of printing. Printing thickeners including synthetic thickeners. Printing auxiliaries. Printing of cotton with reactive dyes. Printing of wool, silk,

nylon with acid and metal complex dyes. Printing of polyester with disperse dyes. Methods of dye fixation after printing. Resist and discharge printing of cotton, silk and polyester. Printing of polyester/cotton blends with disperse/reactive combination. Transfer printing of polyester. Developments in inkjet printing.