APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

CET campus, Thiruvananthapuram - 695 016
Ph: 0471 2598122; Fax: 2598522 www. ktu.edu.in Email: university@ktu.edu.in

KTU/RESEARCH5/1218/2022

18.04.2022

NOTIFICATION

APJ Abdul Kalam Technological University, Kerala invites applications from eligible candidates for Ph.D. admission in colleges affiliated to the University. Application must be submitted online as specified in the website (*app.ktu.edu.in*). Last date for submission of application is ***10.05.2022***. Further details regarding the notification and the Syllabus for Ph.D. Entrance Examination for the Academic Year 2022-23, are attached herewith.

Dr. Shalij P.R
DEAN (Research)

Copy to,
1. Public Relations Officer
2. JD (IT) for publishing in the website
3. PS to VC / PS to PVC / PA to Registrar / PA's to Dean (Research / Academic) / PA to CE
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* This is a computer system (Digital File) generated letter. Hence there is no need for a physical signature.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

(A StateGovernmentUniversity)
CET Campus, MBA Block, Thiruvananthapuram – 695 016.

Applications are invited for PhD admission in colleges affiliated to APJ Abdul Kalam Technological University (2022-23)

1. Types of Registration

a) PhD full time

b) PhD part time

2. Types of online submissionof application

a) PhD full timewith and without fellowship

b)PhD part timefor faculty working in colleges affiliated to this University

c) PhD part time for external candidates

d) PhD full time for QIP,NDF and JRF qualified candidates

(Disciplines of Engineering, Technology, Architecture,Basic Sciences & Mathematics, MCA and Management)

3. Fellowships

University fellowships to eligible full time scholars for 3 years– As per University Norms. (Candidates shall submit valid certificate to prove their reservation category.)

(Higher education scholarships for full time study in government engineering collegeswill be selected by the Directorate of Technical education after registration)

4. Eligibility

(i) Master's degree in Engineering/Technology, Architecture or a Master's degree by research in Engineering/Technology with a minimum CGPA* of 6.5

(ii) Master's degree in Basic Sciences or Mathematics with a minimum CGPA* of 6.5

(iii) Master's degree in Computer Applications with a minimum CGPA* of 6.5

(iv) For Ph D in Management, Master's degree in Management with a minimum CGPA* of 6.5 or equivalent PG Diploma in Management from National Institutes with a minimum CGPA* of 6.5/ Master's degree in Engineering/Technology in Management related streams with a minimum CGPA* of 6.5

Basic Sciences candidates can pursue full-time as well as part-time research with the following condition that for all streams other than Mathematics, a co-guide is mandatory from a sister institution/ research organization which is willing to extend its research facilities/laboratories for the scholar.

*60% for those Applicants for whom only percentage of marks is available in the mark list.

b) Exemption in the eligibility condition of SC/ST, Non Creamy layer OBC and differently abled

SC/ST/OBC(Non-Creamy Layers)/Differently-abled category candidates (with more than 40% disability) are eligible for admission with a minimum CGPA** of 5.5 in all cases (i) to (iv) above. Certificate of disability issued by District Medical Board is to be produced in the case of differently-abled candidates.

**55% for those Applicants for whom only percentage of marks is available in the mark list

d) External Part-time Candidates (Candidates working in firms/institutions not affiliated to the University and approved by the University) Only organisations/industries assessed and approved by the A P J Abdul Kalam Technological University of having good research facilities and research ambience are eligible to register their candidates for external registration of the University. Candidates in the same category who are working in institutions outside India, are permitted to apply only if the University has an MOU with the said organization

e) Students in their final/pre-final semester of PG are permitted to apply with the grades of their last results published, satisfying the eligibility criteria. Once selected, the students are supposed to submit their final mark list with grades satisfying the minimum eligibility requirement, to the place of research before taking admission. PG students (especially those in colleges affiliated to the University) who wish to apply for PhD should submit their M Tech thesis during the early submission window so

that their thesis viva will be over and hence results published in July itself, enabling the students to join in the odd semester. Students who are not able to produce their certificates in July shall take admission in the subsequent even semester only.

5. Application submission mode

Application must be submitted online as specified in web site app.ktu.edu.in

Last date of submission – **10.05.2022**

6. Application fee

All applicants except SC/ST – Rs 1100/-

SC/ST applicants Rs 550/-

7. Selection process

The selection will comprise of an entrance test evaluated out of 70 marks and an interview evaluated out of 30 marks.

The entrance test comprises of 2 parts – Part A (35 marks) and Part B (35 marks)

Part A Research Aptitude (35 marks, cutoff: 3.5 marks)

Analytical Skills (18 marks) + Basic English (5 marks) + Research Methodology (12 marks).

Part B Subject (35 marks, cutoff: 14 marks)

There will be at least 5 specialization sections (which includes compulsory section also) depending on the branch, with each section carrying 7 marks. All candidates will have to attempt 4 sections. Engineering, MCA and Physics candidates will have to attempt one section on Mathematics mandatorily. They will have to attempt another 3 sections which include their area of interest or nearest available area. The section on their area of interest will carry double weightage (14 marks) while the other three sections will carry 7 marks each. Candidates from Chemistry, Management and Architecture need not attempt Mathematics mandatorily. Separate Mathematics question papers will be put for the three categories, (i) Computer Science and MCA, (ii) Mathematics, and (iii) other Engineering streams (including Biotechnology and allied branches) and Physics.The branches are broadly identified as:-

1. Computer Science & Engineering and allied branches

2. Electronics Engineering and allied branches

3. Mechanical Engineering and allied branches

4. Electrical Engineering and allied branches

5. Civil Engineering and allied branches

6. Chemical Engineering and allied branches

7. Biotechnology* and allied branches

8. Physics

9. Mathematics

10. Chemistry

11. Management

12. Architecture and Planning

13. Computer Applications

(* Engineering Course)

Candidates should score an overall 45% marks (31.5/70) in the entrance test to appear for the interview.Candidates should score a minimum of 40% in the interview (12/30) and an overall 50% for selection (50/100).

A relaxation of 5% for candidates belonging to SC/ST/OBC (belonging to Non Creamy Layer) / Differently-abled category (with more than 40% disability-as per the certificate issued by District Medical Board) will be granted as per the UGC norms. A relaxation of 5% more will be given to SC/ST candidates if sufficient number of candidates do not qualify, otherwise.

***Exemptions:-**

1. Candidates who are selected under the QIP (The Quality Improvement Program for teachers) and candidates with UGC-JRF fellowship are exempted from the Research Aptitude test and interview. They will be admitted directly for the research program. AICTE Doctoral Fellowship candidates will be admitted separately with separate notification.

2. Those candidates with GATE score/NET/CAT/KSCSTE fellowship holders or other recognized National level examinations / M Phil holders with minimum CGPA of 6 (General Category) and CGPA of 5.5 (for SC/ST/OBC (Non Creamy layers) / Differently-abled category candidates (with more than 40% disability – as per the certificate issued by District Medical Board)) will have to appear for only Part A of the entrance test. The marks obtained out of 35 will be scaled to 70. They will have to attend the interview out of 30 marks. However, they can choose to appear for both Part A and Part B, in which case the marks will not be scaled up.

3. Teachers of affiliated colleges under A P J Abdul Kalam Technological University with 5 years teaching experience will have to appear for Part A and only the section of questions pertaining to their area of interest or nearest from Part B. The marks out of 14 will be scaled to 35. They will have to attend the interview out of 30 marks. However they can choose to appear for Part A and the required 4 sections of Part B, in which case the marks will not be scaled up.**UGC-JRF qualified candidates and sponsored candidates under AICTE QIP scheme need not attend the aptitude test and interview**. However uploading all related documents is mandatory.

***For Conversion from Part Time to Full Time, appearing Part A and Part B in full is mandatory without availing any exceptions**.

Qualifying aptitude test and interview alone will not ensure PhD registration to the University. The candidate must identify a supervisor and place of research satisfying research regulations of the University and the appointed Doctoral Committee must recommend his/her registration to the University.

Date of aptitude test and venue will be announced in the University website.

8. Residential requirements of Part time scholars

All part-time research scholars irrespective of their place of working have to undergo a residential period of 180 days at their place of research, in a single spell or two, by availing eligible leave. ***Part time applications without NOCin the prescribed format from the Appointing authority will summarily be rejected.***

9. Mode of communications

All communications arebyEmail and intimations are through KTU web site as announcements.

10. Syllabus of Research aptitude test

Syllabus is attached as a separate document.

11. Format of questions

1. A systematic step-by-step procedure followed by logical process of reasoning is called

A. Experiment B. Observation C. Deduction D. Scientific Method

2. $\nabla \times \nabla\phi$, where ϕ is a scalar point function is

(A) a non-zero vector (B) $\nabla^2\phi$ (C) 1 (D) 0

Scientific calculators (Not programmable) are permitted for the examination.

Each correct answer carries 1 mark. (2 marks for questions from area of interest in Part B). Each wrong answer reduces 1/4 mark (1/2 mark for questions from area of interest in Part B).

12. Documents to be uploaded (in pdf form)

a) NOC in the format attached – Part time PhD (External & Internal)

b) Selection letter - full time PhD (QIP & JRF)

d) Certificate from the Head of Institutions (for M Tech on-going)

e) Course completion certificate from Institution (M Tech completed, result awaiting)

Dean (Research)

Note:-The terms and conditions prescribed are subject to changes effected in the University rules and norms from time to time.

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Format of NOC

In Letter head

No : Date:

To Whomsoever It May Concern

This NOC is issued to Mr./Mrs./Miss. (Name and address of employee) working in this institution as (designation) since (Date).

(Name of institution) have no objection in permitting Mr./Mrs./Miss. (Employee's name) to pursue PhD on part time basis with place of research in any college affiliated to APJ Abdul Kalam Technological University.

I have understood that, the part time research scholars are required to be residential in the place of research for a minimum period of 6 months in the first year.

This NOC is issued on request of (Employee's name)

Sincerely,

Appointing Authority.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
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Form of Certificate to be submitted by PG on-going students

In Letter head

No : Date:

To Whomsoever It May Concern

I do hereby certify that Mr./Mrs./Miss

..... is undergoing

final/pre-final semester M Tech degree in the stream .....

..... in .....(Name of College) affiliated to

.....

.....University. His/Her course will be over by.....

His CGPA until the final/pre-final semester is .....

Sincerely,

Head of Institution.

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Syllabus for the PhD Entrance Examination 2019-20

RESEARCH APTITUDE (common to all)

Analytical skills (18 questions)– Basic English (5 questions)– Research Methodology (12 questions)

Research Methodology

Introduction to Research: Definition - types of research - identifying and defining research problem – characteristics of good research. Literature review - theoretical framework – mathematical modeling - formulating research hypothesis - Developing research proposal - Experimentation - Basic instrumentation – static and dynamic characteristics of instruments – data acquisition system – data validation –statistical tools – design of experiments - test of hypothesis, correlation & regression analysis –numerical modelling – simulation – optimization – error estimate and analysis - preparation of research report- research support systems – software, journals, mathematical tools, citation and abstract data bases – search engines – research funding agencies – research establishments-ethics.

MATHEMATICS (common to all engineering branches and physics)

Calculus (Single and Multi variables);vector calculus; Calculus of functions of complex variables; Ordinary differential equations; Partial Differential Equations; Laplace Transforms; Fourier series; Fourier Transforms; Probability and statistics, Probability distributions; Matrices (rank, system of linear algebraic equations, Eigen values and Eigen Vectors, diagonalization & quadratic form). Numerical Methods (Solution of equations, Numerical Integration & solution of first order ODE)

MATHEMATICS (common to Computer Science and Computer Applications)

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions. Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition. Calculus: Limits, continuity and differentiability. Maxima and minima. Integration. Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

AR – ARCHITECTURE AND PLANNING

Section 1: Architectural Design, Construction and Management

Visual composition in 2D and 3D; Principles of Art and Architecture; Organization of space; Architectural Graphics; Computer Graphics– concepts of CAD, BIM, 3D modeling and Architectural rendition; Programming languages and automation. Anthropometrics; Planning and design considerations for different building types; Site planning; Circulation- horizontal and vertical; Barrier free design; Space Standards; Building Codes; National Building Code.

Elements, construction, architectural styles and examples of different periods of Indian and Western History of Architecture; Oriental, Vernacular and Traditional architecture; Architectural developments since Industrial Revolution; Influence of modern art on architecture; Art nouveau, Eclecticism, International styles, Post Modernism, Deconstruction in architecture; Recent trends in Contemporary Architecture; Works of renowned national and international architects.

Behavioral characteristics and applications of different building materials viz. rubble, mud, timber, bamboo, wood substitutes, brick, concrete, Special concretes (HPC, RPC, FRC, Light weight concrete, Polymer concrete, etc),other cement products, steel, glass, FRP, AAC, different polymers, composites, renewable and non- renewable building materials.

Building construction techniques, methods and details, Sustainable materials and construction techniques, Building systems and prefabrication of building elements; Principles of Modular Coordination; Estimation, specification, valuation, professional practice; Construction planning and equipment; various project management techniques e.g. PERT, CPM etc.

Section 2: Building Technology and Building Science

Principles of strength of materials; Structural elements in wood, steel and RCC; Structural systems in RCC and Steel; Form and Structure; Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems; Principles of disaster resistant structures, Special Concrete technology -Guniting, Under water concreting, Self compacting concrete, pre cast concrete, pre stressed concrete, post stressed concrete etc.

Assessment and performance evaluation of buildings, Non destructive testing of building structures, Light weight technology in building construction, Techniques for optimization of material use in building structures, conventional and alternate technology in building construction, sustainable structures and building techniques.

Thermal Comfort – its concept, various theories and standards, equipment for evaluation and research in thermal comfort, Indoor and Outdoor thermal comfort, Passive environment control systems in buildings – its concept, examples and various applications, Evaluation of traditional buildings – in various climates/seasons, various traditional designs and their analysis, Lessons from the past, scope for research in indoor and outdoor thermal comfort, energy efficient solutions in active systems for thermal comfort.

Architectural Acoustics – its concept, various theories and standards, equipment for evaluation and research in acoustics, Acoustic requirements of different types of buildings, Indoor and Outdoor acoustics, materials for sound absorption, acoustic correction, scope for research in acoustics.

Light & Illumination - its concept, various theories and standards, equipment for evaluation and research in light & illumination, passive lighting solutions, passive lighting and thermal comfort, active lighting systems, energy efficient lighting solutions, PSALI – Permanent Supplementary Artificial Lighting of Interiors, recent developments.

Section 3: Sustainable Architecture

Ecosystem- natural and man-made ecosystem; Ecological principles; Concepts of Environmental Impact Analysis; Environmental considerations in planning and design; Natural ventilation and air movement; Climate responsive design; Solar architecture; Green Building- Concepts and Rating; ECBC; Building Performance Simulation and Evaluation; Environmental pollution- types, causes, controls and abatement strategies, Carbon sequestration.

Exploitation of natural resources – the present scenario and statistics, sustainable way of using natural resources, reusing and recycling materials, products from demolition waste, building waste management, Sustainable technologies – Optimizing consumption of non-renewable materials, Energy use in different stages (construction, operation & demolition) of building, Energy efficient solutions, conventional and non conventional energy resources, renewable and non- renewable energy resources.

Sustainable design methods – Placement and Orientation, Use of sustainable materials, appropriate structural system and technology, Efficient HVAC systems, Optimization of spaces, efficient utilization of spaces, considering the usage period and providing exact solutions, educating the users and the society.

Examples of sustainable architecture – example in various contexts, sustainable concepts in traditional architecture, philosophy and works of Laurie baker, Buildings with Mud, Ferro-cement Buildings and building components, Buildings with Bamboo, Buildings with steel, Buildings with special structures, Light weight Buildings, well known sustainable architects.

Section 4: Urban Design, Urban Planning and Housing

Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Section 5: Planning Techniques and Management

Tools and techniques of Surveys – Physical, Topographical, Landuse and Socio-economic Surveys; Methods of non-spatial and spatial data analysis; Graphic presentation of spatial data; Application of G.I.S and Remote Sensing techniques in urban and regional planning; Decision support system and Land Information System.

Urban Economics; Law of demand and supply of land and its use in planning; Social, Economical and environmental cost benefit analysis; Techniques of financial appraisal; Management of Infrastructure Projects; Development guidelines such as URDPFI; Planning Legislation and implementation – Land Acquisition Act, PPP etc.; Local self-governance.

BT - BIOTECHNOLOGY

Section 1: Concepts in Biochemistry and Microbiology

Introduction to biochemistry and biomolecules, biochemistry of water, acid and base chemistry, importance of buffers in cellular mechanism and pH regulation, Membrane transport mechanisms. Role of carbohydrates, proteins, lipids and nucleic acids in cellular functions; Chemical Properties and reactions of carbohydrates, proteins, lipids and nucleic acids. Microscopic techniques, Staining techniques: cell staining- simple staining, gram staining and acid fast staining; staining of specific structures. Study of microbial structure - Eukaryotic and prokaryotic cell structure and function, Microbial nutrition and cultivation: Cultivation of microorganisms, Microbial Growth Control of microorganisms, Industrial microbiology- Microorganisms as biofertilizers and biopesticides, commercially important microorganisms for industrial fermentation.

Section 2: Cell and Molecular Biology

Comparison between Prokaryotic and Eukaryotic cells, plant and animal cells, Cell cycle - An overview of cell cycle; Components of cell cycle control system; Necrosis and Apoptosis. Membrane transport–by Simple diffusion, Facilitated diffusion and Active transport. Co- transport. Na-K ATPase. Signal Transduction. Animal cell culture- development, culture techniques, cell lines, cell culture media, Behavior of cells in culture conditions, division, their growth pattern, metabolism of estimation of cell number, Development of cell lines, characterization and maintenance of cell lines, stem cells, cryopreservation, common cell culture contaminants.Products and their Applications, Transgenics and Prospectives, Principles of invitro fertilization.

Organization of Nucleic Acids & Gene Expression: Structure and Different forms of DNA and RNA, DNA Replication in Prokaryotes and Eukaryotes,. Transcription, translation, posts translational Modifications. Recombinant DNA Technology & Applications, Gene Therapy Combating Disease. DNA fingerprinting, Directed mutagenesis, Antisense Technology.

Section 3: Chemical Engineering Fundamentals

Concepts of Solution Chemistry- normality, molarity, molality, vapor pressure, partial pressure, concept of ideal gas and equations of state. Basics of fluid flow- Newtonian and non-Newtonian fluids, Bernoulli equation, Friction factors and dimensional analysis; Heat Transfer- Steady and unsteady heat conduction, convection and radiation, concept of boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators; Mass Transfer- Fick's laws, mass transfer coefficients, film, , heat and mass transfer analogies; HTU & NTU concepts; design and operation of equipment for mass transfer operations- distillation, absorption and drying ; Reaction Engineering-Reaction rates, Ideal and non-ideal reactors, residence time distribution; Basic concepts of process modelling, simulation, controller modes.

Section 4: Bioinformatics

Basics of Bioinformatics- DNA sequencing, Genome project, various types of databases- sequence databases, structural databases; Sequence Analysis-bimolecular sequence file formats; Sequence alignment- Scoring matrices; Pair wise and multiple sequence alignment, Local and global alignment, BLAST; Molecular phylogeny - Basic concept of Phylogenic tree construction; DNA sequence annotation, Tools for sequence comparison and analysis; Structural genomics- Gene Structure, sequence analysis Gene prediction software; Functional genomics- Gene finder, genetic mapping, and linkage analysis, genetic maps; Sequence analysis of proteins-hierarchies of protein structure, protein 3D structure prediction, Visualization tools; Introduction to homology modeling, Computer-Aided Drug Design (CADD) in Drug discovery, Docking & Simulation software; Post-translational modification, Molecular interaction studies - Basic concepts on Protein-protein, protein-nucleic acid, protein-ligand interaction.

Section 5: Bioprocess Engineering and Process Biotechnology

Chemical engineering principles applied to biological system, Principle of reactor design, ideal and non-ideal multiphase bioreactors, mass and heat transfer; Rheology of fermentation fluids, Aeration and agitation; Media formulation and optimization; Kinetics of microbial growth, substrate utilization and product formation; Sterilization of air and media; Batch, fed-batch and continuous processes; Various types of microbial and enzyme reactors; Instrumentation control and optimization; Unit operations in solid-liquid separation and liquid-liquid extraction; Process scale-up, economics and feasibility analysis

Engineering principle of bioprocessing- Upstream production and downstream; Bioprocess design and development from lab to industrial scale; Microbial, animal and plant cell culture platforms; Production of biomass and primary/secondary metabolites; Biofuels, Bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins; Industrial application of chromatographic and membrane based bioseparation methods; Immobilization of biocatalysts (enzymes and cells) for bioconversion processes; Bioremediation-Aerobic and anaerobic processes for stabilization of solid / liquid wastes

CH - CHEMICAL ENGINEERING

Section 1: Process Calculations and Chemical Engineering Thermodynamics

Mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations.

Laws of thermodynamics; Thermodynamic properties of pure substances: Equations of State and residual properties; properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibrium: vapour liquid equilibrium; chemical reaction equilibrium.

Section 2: Fluid Mechanics

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Section 3: Heat Transfer

Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Section 4: Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Section 5: Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non- isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysts.

Section 6: Instrumentation and Process Control

Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Section 7: Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost rate of return, payback peñod, Net present value and discounted cash flow mte of return.

Optimization in process design and sizing of Chemical Engineering equipments such as heat exchangers, evaporators, distillation column and absorption columns.

CY - CHEMISTRY

Section 1: Organic Chemistry

Stereo chemistry: Concept of Chirality, configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic groups. Stereoselective and stereo specific synthesis. Conformational analysis, Geometrical isomerism. Configurational and conformational effects and neighbouring group participation on reactivity and selectivity/specificity.

Spectroscopy: Applications of UV-visible, IR, NMR and Mass spectroscopy in the structural determination of organic molecules.

Reaction Mechanisms: Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle.Methods of determining reaction mechanisms. Major organic reaction mechanisms -Substitution, Addition, Elimination -Molecular rearrangements reactions, Reaction intermediates.

Organic Synthesis: Synthesis of – alkenes, alkynes, arenes and compounds containing various functional groups, Uses of Mg, Li, Cu, B, Zn and Si based reagents in organic synthesis. Coupling reactions; Concepts of multistep synthesis - retrosynthetic analysis. Selectivity inorganic synthesis. Protection and deprotection of functional groups. Concepts of asymmetric synthesis, Carbon-carbon bond forming reactions through enolates enamines and silylenol ethers. Michael addition reaction. Cram and Felkin-Anh models.

Pericyclic Reactions and Photochemistry: Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlations. Photochemistry of alkenes,arenes and carbonyl compounds. Photooxidation and photoreduction.Di-π-methane rearrangement, Barton reaction.

Heterocyclic Compounds: Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.

Biomolecules: Structure and properties of mono- and di-saccharides,amino acids, peptides, proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.

Section 2: Inorganic Chemistry

Main Group Elements: Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon. Chemistry of noble gases, pseudohalogens, and interhalogen compounds. Acid-base concepts.

D and f block elements: Coordination chemistry – structure and isomerism, theories of bonding. Jahn-Teller distortion. spectroscopic and magneticproperties of transition metal complexes. Reaction mechanisms and stability of co ordination complexes. Recovery. Periodic properties, spectra and magnetic properties of f- block elements

Organometallics: 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal - carbene complexes and metallocenes. Fluxional molecules. Types of organometallic reactions. Catalytic properties of organometallic compounds.

Bioinorganic Chemistry: Na/K pump, oxygen transport, electron transfer reactions, nitrogen fixation, metalloenzymes

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg'slaw, ionic crystals – structure of AX,AX2,ABX3-spinels, band theory, metals and semiconductors.

Radioactivity: Decay processes, half-life of radioactive elements, Nuclear reactions

Instrumental Methods of Analysis:-UV-visible, NMR, ESR and mass Spectroscopy. GC, HPLC, Polarography, Cyclic voltamtery, Ion selctive electrodes, and thermoanalytical methods.

Section 3: Physical Chemistry

Equilibrium: Laws of thermodynamics. Standard states. Thermochemistry. Thermodynamic functions: Criteria of spontaneity and equilibrium. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients, Partial Molar quantities. Concepts in Chemical equilibria. Fundamentals of Electro chemistry, Non-ideal solutions. Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Potentiometric and conductometric titrations. Phase rule. Clausius-Clapeyron equation. Phase diagram of one (CO_2, H_2O, S) and two component systems (Examples). Fractional distillation. Azeotropes and eutectics. Kinetics: Transition state theory: Eyring equation, thermodynamic aspects. Potential energy surfaces and classical trajectories. Elementary, parallel, opposing and consecutive reactions.Steady state approximation. Mechanisms of complex reactions. Kinetics of polymerization, enzyme catalysis, photochemical and photophysical processes. Fast reaction kinetics: relaxation and flow methods.

Surfaces and Interfaces: Types of adsorption-Adsoptions isotherms- Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity.Self-assembly.Physical chemistry of colloids, micelles and macromolecules.

Quantum mechanics: Postulates, Time dependent and time independent Schrödinger equations. Born interpretation .Particle in a box. Harmonic oscillator. Rigid rotor. Hydrogen atom: atomic orbitals. Multi-electron atoms: orbital approximation. Variation and first order perturbation techniques. Chemical bonding: Hybridisation. Applications of LCAO-MOT. Hückel approximation and its application.

Group Theory and Molecular Spectroscopy: Point groups and character tables. Origin of selection rules for rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Einstein coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Fundamentals of NMR.

Section 4: Polymer Chemistry

Polymers: Introduction to Polymers, molecular weight (MW) and its distribution, Glass transition temperature. Determination of molecular weight; GPC and spectroscopic techniques to determine chemical composition and molecular microstructure.

Polymerization: Reactivity of functional groups; kinetics; molecular weight in open and closed system -Carother's equation; stoichiometric control of MW; cyclization vs. linear polymerization, Crosslinking and gel point; process condition; Classification of polymerization reactions, mechanism and kinetics of chain and ionic polymerization reactions. molecular weight and its distribution; chain transfer, inhibition, retardation, auto-acceleration; energetic characteristics, Living polymerization reactions (both radical and ionic). Nitroxide-mediated polymerization (NMP); atom transfer radical polymerization. Comparisons of ionic and chain polymerizations. Co-polymerization (chain and ionic)

Stereoregular (coordination or Ziegler-Natta) Polymerization, stereoisomerism in polymers; metallocene polymerization; ring opening polymerization; group transfer polymerization; metathesis polymerization. polymers in solution -Thermodynamics of polymer solutions; fractionation of macromolecules-Chain dimensions, freely joined chain; effect of geometric and volume restrictions; frictional properties of macromolecules in dilute solution

Reaction of macromolecules – Structure and properties of solid polymers; structure- super molecular property relationship. Reactions with polyolefins, polyenes, pendant groups; polymer degradation; mechanism of stabilization, catalyst quenchers, end-capping. Naturally occurring polymers, biodegradable, biosynthesis, polymers from bio/renewable resources. Characterisation of Polymers- Mechanical, Thermal and Dielectric characterisation.

Section 5: Nano Chemistry

Bonding in atoms and bulk solids. Electronic conduction, system classification confined to one, two or three dimension and their effect on properties, top-down and bottom-up processes. Characterization using SEM, EPMA, TEM,EDX,EELS, AES, LEED, RHEED, confocal and two photon microscopy, XRD, XRF, XAS, IR, Raman spectroscopy, Luminescence, and XPS, Proximal probe technique -AFM, STM, STS, POSAP spectroscopy.

Synthesis of bulk nanostructured materials – Methods for Synthesis of nanomaterials. Self assembly- Self Assembled Monolayers (SAM) - Vapour Liquid Solid (VLS) approach - Chemical Vapour Deposition (CVD) -Langmuir-Blodgett (LB) films - Spin coating – Templated self assembly Electrochemical approaches: Thin films -Epitaxy -Lithography. One dimensional and Two dimensional nanostructures: Evaporation-condensation -Vapor- liquid - solid (VLS) - surface and bulk diffusion – kinetics – growth of various nanowires –control of size –precursors and catalysts - single- and multi-wall CNT - Si nanowires – density and diameter – doping in nanowires

Inorganic nanostructures

Optical properties, excitons, pn junctions, phonons, quantum confinement, quantum dots, characterization and application of quantum dots, nanomagnetism in technology and the challenges.

Chemistry of carbon, light emission from organic molecules, synthetic metals, carbon nanotubes, nano cuboids, graphene, carbon quantum dots. Carbon nano tube as nano test tube for quantum dot synthesis, functionalized nano particles for biological applications, biomineralization. DNA as a nanotechnology building block, directed assembly using bio- molecules, molecular motors, biological motors, artificial photosynthesis, solar energy transduction.

CE-CIVIL ENGINEERING

Section 1: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler's equations of motion; Impulse-momentum; Energy methods; Principles of virtual work.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural steel - composition, material properties and behaviour; Concrete - constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen. Construction Management: Types of construction projects; Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis - PERT and CPM.

Concrete Structures: Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete; Analysis of beam sections at transfer and service loads.

Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Plastic analysis of beams and frames.

Section 2: Geotechnical Engineering

Soil Mechanics: Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Darcy's law; Seepage through soils - two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One-dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand.

Foundation Engineering: Sub-surface investigations - scope, drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and

Coulomb; Stability of slopes - finite and infinite slopes, method of slices and Bishop's method; Stress distribution in soils - Boussinesq's and Westergaard's theories, pressure bulbs; Shallow foundations - Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations - types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

Section 3: Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's law.

Irrigation: Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

Section 4: Transportation Engineering

Transportation Infrastructure: Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.

Highway Pavements: Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.

Traffic Engineering: Traffic studies on flow, speed, travel time - delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

Section 5: Environmental Engineering

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes

for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Section 6: Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps – scale, coordinate system; Distance and angle measurement- Levelling and trigonometric leveling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry – scale, flying height; Remote sensing – basics, platform and sensors, visual image interpretation; Basics of Geographical Information System (GIS) and Geographical Positioning System (GPS)

CA - Computer Applications

Section 1: Computer Organization, Architecture and Digital Logic

Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface(interrupt and DMA mode).

Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Section 2: Programming and Databases

Programming in C. Recursion.

ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization,indexing (eg. B and B+ trees). Transactions and concurrency control.

Section 3: Data Structure & Algorithms

Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide and conquer. Graph search, minimum spanning trees, shortest paths.

Section 4: Software Engineering

Software Process Models: Software Process, Process Lifecycle, Waterfall models, Predictive Models.

Agile Project Management: Agile Process Models, Extreme Programming (XP), Agile design principles,Scrum, Scrum roles and Scrum project phases.

Software Requirements: Functional and Non-Functional Requirements. Quality Control, Quality Assurance, Risk Management.

Estimation and Scheduling of Software Projects: Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing.Software Testing. Verification and Validation.

Section 5: Operating Systems & Compilers

Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

Section 6: Computer Networks

Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPV4/IPV6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP,HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

CS- COMPUTER SCIENCE

Section 1: Computer Organization, Architecture and Digital Logic

Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Section 2: Programming & Databases

Programming in C. Recursion.

ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Section 3: Data Structure & Algorithms

Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.

Section 4: Theory of Computation

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and contex-free languages, pumping lemma. Turing machines and undecidability.

Section 5: Operating Systems & Compilers

Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

Section 6: Computer Networks

Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

EE – ELECTRICAL AND ELECTRONICS

Section 1: Power Electronics and Drives

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

Section 2: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Section 3: Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Section 4. Renewable Energy

Solar energy - Solar radiation measurement, estimation of average solar radiation. Solar photovoltaic power generation- equivalent circuit, characteristics, Maximum power point tracking. Solar thermal power generation.

Wind power - wind energy estimation, design of wind mills, grid interfacing.

Small hydro power – classification-types of turbines - Design of small hydro power plants.

Geothermal power generation. Power generation from ocean energy and landfill gas.

Fuel cells- types-energy output, efficiency and emf of a fuel cell.

Section 5: Electronics (Analog and Digital)

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085Microprocessor: Architecture, Programming and Interfacing.

EC – ELECTRONICS AND COMMUNICATION

Section 1: Communication

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its

mitigation; Basics of TDMA, FDMA and CDMA. Mobile communication systems, cellular concepts, fading and multipath propagation, Doppler effect, digital communication, sampling modulation methods, multiple access techniques and receivers

Section 2: Signal and Image Processing

Continuous-time signals: Fourier series and Fourier transform representations, sampling and quantization; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution and correlation, poles, zeros and stability of a system, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

Image representation, simple image formation model, Colour image fundamentals, 2D Image transforms, Image Enhancement, Image Restoration, Image segmentation, Image Compression.

Section 3: VLSI and Embedded systems

VLSI

MOSFET Modeling& Fabrication: MOS modeling - MOS Capacitor – Surface Potential, Flat band Voltage, C-V characteristics, Threshold Voltage, Regions of Operation, Small Signal Capacitance. MOSFET - Output characteristics, transfer characteristics, sub-threshold characteristics, Second order effects (basic concepts)

VLSI Technology –Basic Concepts of Oxidation, Diffusion, Ion Implantation, Epitaxy, Lithography, CMOS IC Fabrication Sequence.

Analog VLSI Design :MOSFET Amplifiers – Common Source, Source Follower, Common Gate, Cascode Stage, MOS Differential Amplifier, Current Mirrors.

Digital VLSI Design: CMOS Inverters – DC characteristics, switching characteristics, power dissipation in CMOS circuits, CMOS logic families – Pass transistor logic, transmission gate logic, realization of functions.

Memories - Read Only Memory – 4x4 MOS ROM Cell Arrays, Random Access Memory – SRAM –Six Transistor CMOS SRAM Cell, DRAM – Three transistor Dynamic Memory Cell.

Data Path Subsystems - Adders – Static Adder, Carry-By pass adder, Linear Carry-Select adder, Square-root carry-select adder. Multipliers – Array multiplier.

Characterizing Sequential Elements - Delays, Sequencing static circuits - Sequencing Methods: FF, Latches, Pulsed Latches, Max Delay Constraints, Min Delay Constraints,

Embedded Systems

8051 Microcontroller – features, architecture, addressing modes, instruction set. Interrupts in 8051 – Types, interrupt source, interrupt handling. Serial Communication- RS232 interface, registers in UART, modes of operation.

Introduction to Embedded Systems – Components of Embedded System hardware – Software associated with embedded system. Serial Communication Standards – UART, SPI. Serial Bus Protocols – I2C Bus, CAN Bus and USB Bus. Memory devices and systems – memory map – DMA – I/O Devices – Interrupts.

Embedded Architecture, Structure, Layers, Embedded System standards – General purpose & market specific, Embedded system models – Life cycle model

Section 4. Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 5: Electromagnetics

Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

Section 6: Devices and Circuit Theory

Electronic Devices

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

Analog Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

Digital Circuits

Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits,

code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

MA- MATHEMATICS

Section 1: Algebra

Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots.

Groups, homomorphisms, cosets, Lagrange's Theorem, group actions, Sylow Theorems,symmetric group Sn, conjugacy class, rings, ideals, quotient by ideals, maximal and prime ideals, fields, algebraic extensions, finite fields

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem.Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

Section 2: Real analysis and topology

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Limits, Continuity, Differentiability, Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral.

Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Jacobian, gradient, line integrals, surface integrals, vector fields, curl, divergence, Stoke's theorem.

Metric spaces, compactness, connectedness. Topological spaces, base of open sets, product topology, continuity, connectedness, path connectedness, compactness, Separation axioms, Urysohn's lemma, Tietze extension, Tychonoff's theorem.

Section 3: Complex Analysis

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations.

Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem, Rouche's theorem, Morera's theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Section 4: Differential Equations and Numerical Methods

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs.

Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods. Numerical solutions to Heat and Wave equations.

Section 5: Discrete Mathematics

Partially Ordered Sets, Lattices, Boolean Algebra, Boolean Functions, Finite state machines, Basic Graph Theory, Paths and Circuits, Eulerian and Hamiltonian graphs, Matrix representation of Graphs, Planar and Dual graphs, Directed graphs, Trees, Spanning trees.

Section 6: Probability and Stochastic Process

Sample space, Events, probability, simple theorems on probability, Conditional Probability, independence of events, Bayes theorem, Discrete and Continuos random variables, Binomial, Poisson, Uniform, Exponential and normal distributions, Expectation and moments, Moment generating functions, Conditional distribution of a random variable, Inequalities: Markov, Chebyshev, Jensen, Holder, Central limit theorem.

MT - MANAGEMENT

Section 1: Fundamentals of Management

Evolution of Scientific management; Systems and contingency approach for understanding organizations; Management – System Concept, Process, Theories and Approaches, Management Functions – Planning, Organizing, Staffing, Directing, Coordinating and Controlling. Communication – Types, Process and Barriers. Decision Making – Concept, Process, Organisation Structure and Design – Types, Authority, Responsibility, Centralisation, Decentralisation and Span of Control- Business Communication Importance and nature of business communication, Effective communication skills; Oral and Non-Verbal communication, Barriers and gateways in communication and Do's and Don't of business writing, Commercial letters; Writing business and academic reports; Public speaking, listening and Negotiations; conducting and attending interview and meetings.

Section 2: Economics for Managers

Managerial Economics-Nature and scope; Objective of a firm-what, why, for whom, when to produce and how much to produce; Theory of Supply and Theory of Demand -Demand-Elasticity of demand; Consumer equilibrium-utility and indifference curve approach; Price, income and substitution effects; Fundamentals of demand estimation and forecasting; Short-run and long-run production functions; Cost curves and economics of scale; Price and output determination under perfect competition, monopoly, monopolistic, competition, and oligopoly; Pricing strategies and tactics; Macroeconomics-National Income— measurement methods; Inflation—types, measurement and control; Balance of Payments; Monetary and Fiscal Policies.

Section 3: Human Resource Management

Significance of OB & Theories; Individual behaviour– Personality, Perception, Values, Attitude, Learning and Motivation; Decision-making; Understanding and managing group processes-Transactional Analysis- Team Building, Leadership, Group Dynamics interpersonal and group dynamics; Applications of Emotional Intelligence in organizations. Leadership and influence process; Work Motivation. Understanding arid Managing organizational system—Organizational design and structure, Work stress, Organizational Change and development; Organizational Culture & Climate Work Force Diversity & Cross Culture Organisational Behaviour; Conflict Management; Emotions & Stress Management. Human Resource Planning, Methods of manpower search; Attracting, Selecting and retaining human resources; Recruitment and Selection, Induction, Training and Development; Job Analysis, Job Evaluation and Compensation Management; Strategic Role of HRM; Competency Mapping & Balanced Scoreboard; Career Planning and Development; Performance Management and Appraisal ; Organization Development, Change & OD Interventions; Talent Management & Skill Development; Employee Engagement & Work Life Balance; Industrial Relations: Disputes & Grievance Management, Labour Welfare and Social Security Trade Union & Collective Bargaining; International Human Resource Management; HR Challenge of International Business; Employee empowerment; Green HRM

Section 4: Operations Management

Scope of Operations Management; Facility Location; Types of Manufacturing Systems and Layouts; Layout Planning and Analysis; Material Handling : Principles & Equipments; Line Balancing; Production Planning and Control in Mass Production, in Batch and Job Order manufacturing; Capacity Planning; Product Planning and Selection, Process Planning, Aggregate Planning and Master Production Scheduling; Maintenance Management, Work Study : Method Study and Work Measurement, Material Management, Material Management; An Overview, Material Requirement Planning and Inventory Control; MRP II, JIT; Purchase Management; Stores Management; Quality Assurance, Statistical Quality Control, Causes of variations, Quality control charts, (X and R charts); Process under control and out of control, Warning limits; Control charts for attributes -fraction defectives and number of defects Acceptance sampling. Total Quality Management; ISO-9000. World Class Manufacturing; Kaizen, Jidoka, Kanban, Six Sigma, Benchmarking; Operation Research – Transportation, Queuing Decision Theory, Project Management-PERT / CPM; Formulation of linear programming problem -special cases like degeneracy, unboundedness, infeasibility and multiple optimal solutions. Transportation and Assignment models; minimization, unbalanced problems, degeneracy in transportation models; Game theory; Simulation.

Section 5: Financial Management & Accounting

Cost of capital; Concept and importance, Computations of cost of various sources of finance; Weighted Average Cost of Capital; Capital Structure decisions; Theories of capital structure, Factors determining capital structure. Optimum capital structure; Management of working capital - Cash, Receivables and Inventory Management, Internal Financing and Dividend Policy; Financial Modelling. Value & Returns – Time Preference for Money, Valuation of Bonds and Shares, Risk and Returns; Capital Budgeting – Nature of Investment, Evaluation, Comparison of Methods; Risk and Uncertainty Analysis Dividend – Theories and Determination Mergers and Acquisition – Corporate Restructuring, Value Creation, Merger Negotiations, Leveraged Buyouts, Takeover Portfolio Management – CAPM, APT Derivatives – Options, Option Payoffs, Option Pricing, Forward Contracts & Future Contracts Working Capital Management – Determinants, Cash, Inventory, Receivables and Payables Management, Factoring International Financial Management, Foreign exchange market. Management Accounting: Nature, scope and tools; Management Accounting vs. Financial accounting; Financial analysis, Ratio analysis, Funds-Flow Statement, Cash-flow Statement Budgeting: Types of budgets and their preparation, Performance budgeting and Zero-base budgeting. Marginal costing : Break—even analysis. Decision involving alternative choices. Standard Costing: Accounting Principles and Standards, Preparation of Financial Statements Financial Statement Analysis – Ratio Analysis, Funds Flow and Cash Flow Analysis, Preparation of Cost Sheet, Marginal Costing, Cost Volume Profit Analysis Standard Costing & Variance Analysis Financial Management,

Section 6: Management Information System

Computers in business; Elements of computer system; Data Files- Types/Organization; Master & Transaction File; Relevance of Data Base Management; Systems and Integration of Applications; Basics of Data Processing; Data Hierarchy & Data File Structures. Network Fundamentals, Analog and Digital Signals, Band width, functions of MODEM, Network Topology, Network Applications. Electronic payment system, LAN, WAN, MAN, digital library; Security, advertising & marketing on the internet, e-CRM. consumer search & resource discovery, computer based education & training, digital copyrights. Malware-Viruses, Securing, public key and private key encryption; cloud security; TPS, MIS, DSS, ESS; Artificial Intelligence and Big Data; Data Warehousing, Data Mining and Knowledge Management; Enterprise Resource Planning – ERP Modules, ERP implementation

Section 7: Marketing Management

Marketing Management: Nature and scope of marketing; Environment scanning; Marketing information system and Marketing research; Market segmentation, Targeting and positioning; Product decisions —product mix, product life cycle, new product development, branding and packaging decisions; Pricing methods and strategies; Promotion decisions— promotion mix, advertising, sales promotion, publicity and personal selling; Channel management - Types and functions, Selection, Cooperation and conflict management, vertical marketing implementation and systems, Marketing channels and value networks, VMS, IMC, Advertising and Sales promotion New issues in marketing - Globalization, Consumerism, Green Marketing, Direct Marketing, Network Marketing, Event Marketing- Theories and Models of Consumer Behaviour Brand Management – Role of Brands, Brand Equity, Equity Models, Brand Name Decisions, Brand Extensions and Loyalty Logistics and Supply Chain Management, Drivers, Value creation, Supply Chain Design, Designing and

Man Service Marketing – Managing Service Quality and Brands,– Relationship Building, Strategies, Values and Process Retail Marketing – Types of Retail Outlets.

ME- MECHANICAL ENGINEERING

Section 1: Mechanics and Materials

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.

Section 2: Mechanics Of Machine and Machine Design

Mechanics of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 3: Thermal Engineering

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective

heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Power Engineering: Air and gas compressors; Properties of steam, vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines, Steam and Gas turbines

Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

Section 4: Manufacturing

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design.Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Section 5: Industrial Engineering

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Simulation: Discrete and continuous system, areas of application - Monte Carlo Simulation. Discrete event simulation and their applications in queuing and inventory problems. Random number generation and their techniques. Analysis of simulation data.

PY - PHYSICS

Section 1: Classical Mechanics

D'Alembert's principle, cyclic coordinates, variational principle, Lagrange's equation of motion, central force and scattering problems, rigid body motion; small oscillations, Hamilton's formalisms; Poisson bracket; special theory of relativity: Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Section 2: Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Section 3: Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; one-, two- and three-dimensional potential problems; particle in a box, transmission through one dimensional potential barriers, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scattering theory.

Section 4: Thermodynamics and Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, phase equilibria, critical point.

Section 5: Atomic and Molecular Physics

Spectra of one- and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Section 6: Solid State Physics & Electronics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation.

Semiconductor devices: diodes, Bipolar Junction Transistors, Field Effect Transistors; operational amplifiers: negative feedback circuits, active filters and oscillators; regulated power supplies; basic digital logic circuits, sequential circuits, flip-flops, counters, registers, A/D and D/A conversion.

Section 7: Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy, Electric and magnetic moments; nuclear models, liquid drop model: semi-empirical mass formula, Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.