|| अंतरी पेटवू ज्ञानज्योत ||

NORTH MAHARASHSTRA UNIVERSITY

SYLLABUS FOR Ph. D.
ENTRANCE TEST

PAPER – I

GENERAL APTITUDE TEST

Ph. D. ENTRANCE TEST
Syllabus for PAPER-I

I. Research Aptitude :

Research: Meaning, characteristics and types;
Steps of research;
Methods of research;
Research Ethics;
Paper, article, workshop, seminar, conference and symposium;
Thesis writing: its characteristics and format.

II. Teaching Aptitude :

Teaching : Nature, objectives, characteristics and basic requirements;
Learners characteristics;
Factors affecting teaching;
Methods of teaching;
Teaching aids;
Evaluation systems.

III. Reading Comprehension :

A passage to be set with questions to be answered.

IV. General Awareness about Basic Science :

Basic Science up to the level of SSC.

V. Mathematical Reasoning:

Number series; letter series; codes;
Relationships; classification.

VI. Logical Reasoning :

Understanding the structure of arguments;
Evaluating and distinguishing deductive and inductive reasoning;
Verbal analogies : Word analogy-Applied analogy;
Verbal classification;
Reasoning Logical Diagrams : Simple diagrammatic relationship, multidiagrammatic relationship; Venn diagram; Analytical Reasoning.

VII. Data Interpretation :

Sources, acquisition and interpretation of data;
Quantitative and qualitative data;
Graphical representation and mapping of data.

VIII. Information and Communication Technology (ICT) :

ICT : meaning, advantages, disadvantages and uses;
General abbreviations and terminology;
Basics of internet and e-mailing.

IX. Environment Awareness :

People and environment interaction;
Sources of pollution;
Pollutants and their impact on human life, exploitation of natural and energy resources; Natural hazards and mitigation.

X. General Awareness about Higher Education System :

Structure of the institutions for higher learning and research in India; formal and distance education; professional/technical and general education; value education; governance, polity and administration; concept, institutions and their interactions.

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NORTH MAHARASHSTRA UNIVERSITY

SYLLABUS FOR Ph. D.
ENTRANCE TEST

PAPER – II

FACULTY : SCIENCE

Physics

1) Mathematical Methods of Physics

Dimensional analysis; Vector algebra and vector calculus; Linear algebra, matrices, eigenvalue problems; Linear differential equations; Special functions (Hermite, Bessel, Laguerre and Legendre); Fourier series, Fourier and Laplace transforms; Elements of complex analysis; Laurent series-poles, residues and evaluation of integrals; Elementary ideas about tensors; Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Elementary probability theory, random variables, binomial, Poisson and normal distributions.

2) Classical Mechanics

Newton's laws; Phase space dynamics, stability analysis; Central-force motion; Twobody collisions, scattering in laboratory and centre-of-mass frames; Rigid body dynamics, moment of inertia tensor, non-inertial frames and pseudoforces; Variational principles, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations; Symmetry, invariance and conservation laws, cyclic coordinates; Periodic motion, small oscillations and normal modes; Special theory of relativity, Lorentz transformations, relativistic kinematics and mass-energy equivalence.

3) Electromagnetic Theory

Electrostatics : Gauss' Las 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 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; Lorentz invariance of Maxwell's equations.

4) Quantum Mechanics

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigenvalue problems such as particle-in-a-box, harmonic, oscillator, etc/; Tunneling through a barrier; Motion in a central potential; Orbital angular momentum, Angular momentum algebra; spin; Addition of angular momenta; Hydrogen atom, Time- independent perturbation theory and applications; Variational method; WKB approximation. Time dependent perturbation theory and Fermi's Golden Rule; Selection rules; Identical particles, Pauli's exclusion principle, spin statistics connection.

5) Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences; Thermodynamic potentials, Maxwell relations; Chemical potential, phase equilibria; Phase space, micro- and macrostates; Microcanonical, canonical and grand-canonical ensembles and partition functions; Free Energy and connection with thermodynamic quantities; First-aid second-order phase transitions; Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation.

6) Electronics

Semiconductor device physics, including diodes, junctions, transistors, field effect devices, homo and heterojunction devices, device structure, device characteristics, frequency dependence and applications; Optoelectronic devices, including solar cells, 210 photodetectors and LEDs; High-frequency devices, including generators, and detectors; Operational amplifiers and their applications; Digital techniques and applications (registers, counters, comparators and similar circuits); A/D and D/A converters.

7) Experimental Techniques and data analysis

Data interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test; Transducers (temperature, pressure/vacuum, magnetic field, 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.

8) Atomic & Molecular Physics

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; width of spectral lines; LS &JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Electron spin resonance, Nuclear magnetic resonance, chemical shift; Rotational, vibrational, electronic, and Raman spectra and diatomic molecules; Frank – Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A & B coefficients; Laser, optical pumping, population inversion, rate equation.

9) 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; Diamagnetism, paramagnetism, and ferromagnetism; Electron motion in a periodic potential, band theory of metals, insulators and semiconductors; Superconductivity, type – I and type – II superconductors, Josephson junctions.

10) Nuclear and Particle Physics –

Basic nuclear properties; size, shape, charge distribution, spin and parity; Binding energy, semi-empirical mass formula; Liquid drop model; Fission and fusion; Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces; Isospin; 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; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness, basics of LHC.

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Electronics (Faculty of Science)

Unit—I :

Electronic Transport in semiconductor, PN Junction, Diode equation and diode equivalent circuit. Breakdown in diodes. Zener diodes, Tunnel diode, Semiconductor diodes, characteristics and equivalent circuits of BJT, JFET, MOSFET, IC fabrication-crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding. Thin film active and passive devices.

Unit—II :

Superposition, Thevenin, Norton and maximum Power Transfer Theorems. Network elements, Network graphs, Nodal and Mesh analysis, Zero and Poles, Bode Plots, Laplace, Fourier and Z-transforms. Time and frequency domain responses. Image impedance and passive filters. Two-port Network Parameters. Transfer functions, Signal representation. State variable method of circuit analysis. AC circuit analysis, Transient analysis.

Unit—III :

Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and JFET. Single stage amplifiers, Multistage amplifiers. Feedback in amplifiers, oscillators, function generators, multivibrators, Operational Amplifiers (OPAMP)-characteristics and Applications, Computational Applications, Integrator, Differentiator, Wave-shaping circuits, F to V and V to F converters. Active filters, Schmitt trigger, Phase locked loop.

Unit—IV :

Logic families, flip-flops, Gates, Boolean algebra and minimization techniques, Multivibrators and clock circuits, Counters-Ring, Ripple, Synchronous, Asynchronous, Up and down shift registers, multiplexers and demultiplexers, Arithmetic circuits, Memories, A/D and D/A converters.

Unit—V:

Architecture of 8085 and 8086 Microprocessors, Addressing modes, 8085 instruction set, 8085 interrupts, Programming, Memory and I/O interfacing, Interfacing 8155, 8255, 8279, 8253, 8257, 8259, 8251 with 8085 Microprocessors, Serial communication protocols, Introduction of Microcontrollers (8 bit)-8031/8051 and 8048.

Unit—VI :

MOS capacitor characteristics, MOS devices capacitances, Enhancement and depletion mode transistor action, Threshold voltage, body effect, MOS switches, nMOS inverter, CMOS inverter, Latch up in CMOS circuit, stick diagrams layout, floor planning based design rules. Structural design strategies, Silicon compilers, Logic level simulation, switch level simulation, schematic editor, layout editor, DRC Adhoc testing, structured design for testability. Coarse grid symbolic layout, gate matrix layout, stick layout, chip design process, cell design process, compaction,ground rules for successful design.

Unit—VII :

Basic principles of amplitude, frequency and phase modulation, Demodulation, Intermediate frequency and principle of superheterodyne receiver, Spectral analysis and signal transmission through linear systems, Random signals and noise, Noise temperature and noise figure. Basic concepts of information theory, Digital modulation and Demodulation PM, PCM, ASK, FSK, PSK, Time-division Multiplexing, Frequency-Division Multiplexing, Data Communications-Circuits, Codes and Modems; Basic concepts of signal processing and digital filters.

Unit—VIII :

Characteristics of solid state power devices-SCR, Triac, UJT, Triggering circuits, converters, choppers,inverters, converters. AC regulators, speed control of a.c. and d.c. motors. Stepper and synchronous motors; Three phase controlled rectifier; Switch mode power supply; Uninterrupted power supply.

Unit—IX :

Optical sources-LED, Spontaneous emission, Stimulated emission, Semiconductor Diode LASER, Photodetectors-*p-n* photodiode, PIN photodiode, Phototransistors, Optocouplers, Solar cells, Display devices. Optical Fibres-Light propagation in fibre, Types of fibre, Characteristic parameters, Modes, Fibre splicing, Fibre optic communication system-coupling to and from the fibre, Modulation, Multiplexing and coding, Repeaters, Bandwidth and Rise time budgets.

Unit—X :

Transducers-Resistance, Inductance Capacitance, Peizoelectric, Thermoelectric, Hall effect, Photoelectric, Techogenerators, Measurement of displacement, velocity, acceleration, force, torque, strain, speed and sound temperature, pressure, flow, humidity, thickness, pH, position. Measuring Equipment-Measurement of R, L and C, Bridge and Potentiometers voltage, current, power, energy, frequency/time, phase, DVMs, DMMs, CRO, Digital storage oscilloscope, Logic probes, Logic State Analyser, Spectrum Analyzer, Recorder, Noise and Interference in instrumentation, instrumentation amplifiers, Radio Telemetry, Analytical Instruments-Biomedical instruments-ECG, blood pressure measurements, spectrophotometers, Electron Microscope, X-ray diffractometer.

DSP: Basic DSP operations: Convolution, Correlation, Digital filters, discrete transformation and modulation.

Unit—XI :

Open-loop and close-loop control system, Error amplifier, on-off controller, Proportional (P), Proportional-Integral (PI). Proportional-Derivative (PD), PID controllers, Dynamic Behaviour of control systems-servomechanism, characteristics parameters of control systems-Accuracy, Sensitivity, Disturbances, Transient response, Stability, Routh-Huewitz criterion, Bode plots, Nyquist criterion, Controlling speed, Temperature and position using analog/digital control circuits.

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Biochemistry

1. Structure of pro and eukaryotic cells, Membrane structure and function, Intracellular compartments, protein sorting, secretory and endocytic pathways, membrane channels and pumps, ligand and voltage gated channels, Na/K pump.

2. Biochemistry of specialised tissues, biochemical basis of blood clotting, vision, muscle contraction, nerve impulse transmission and hormone action.

3. Principles of toxicology – general classification and nature, definition and purpose of toxicology, dose response relationship, synergism, antagonism, ED_{50}, LD_{50}, chronic exposure.

4. Microbial fermentation, Antibotics, organic acids and vitamins, Microbes in decomposition and recycling processes, Symbiotic and asymbiotic N2 - fixation, Microbiology of water, air, soil and sewage, Microbes as pathological agents in plants, animals and man.

5. Antigen : Structure and functions of different classes of immunoglobulins, Primary and secondary immune response, Lymphocytes and accessory cells, Humoral and cell mediated immunity, MHC, Mechanism of immune response and generation of immunological diversity. Application of immunological techniques.

6. Enzyme kinetics (negative and positive cooperativity), Regulation of enzymatic activity, Active sites, Coenzymes, Activators and inhibitors, isoenzymes, allosteric enzymes, ribozyme, abzyme .

7. Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions, Primary structure of proteins and nucleic acids, Conformation of proteins and polypeptides (secondary, tertiary, and quaternary structure), Ramachandran plot.

8. Glycolysis and TCA cycle, Glycogen breakdown and synthesis, Gluconeogenesis, interconversion of hexoses and pentoses, Amino acid metabolism, Coordinated control of metabolism.

9. Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols.

10. Energy metabolism (concept of free energy), Thermodynamic principles in biology, Energy rich bonds, Weak interactions, Coupled reactions and oxidative phosphorylations, Group tranfers, Biological energy tranducers, Bioenergetics.

11. The law of DNA constancy and C-value paradox, Numerical and structural changes in chromosomes, Molecular basis of spontaneous and induced mutation and their role in evolution.

12. DNA replication, amplification and rearrangements. Organization of transcriptional units - Mechanism of transcription in prokaryotes and eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), Ribonucleoproteins, Structure of mRNA, Genetic code and protein synthesis, DNA damage and repair, Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept, DNA methylation, Transposition, Regulatory sequences and transcription factors.

13. Lysogeny and lytic cycle in bacteriophages, Bacterial transformation, Host cell restriction, Trasduction, Complementation, Molecular recombination, DNA ligases, Topoisomerases, gyrases, Methylases, Nucleases, Restriction endonucleases, Plasmids and bacteriophage based vectors, cloning, cDNA and genomic libraries, S1 Nuclease mapping, restriction mapping.

14. Cell and tissue culture in plants and animals, Primary culture, Cell line, Cell clones, Callus cultures, Somaclonal variation, Micropropogation, Somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Gene transfer methods in plants and in animals, Transgenic biology, Artificial seeds, Hybridoma technology.

15. General aspects and sources of natural products, introduction to primary and secondary metabolites, types of secondary metabolites, general properties, physiological role and importance of alkaloids, saponins, steroids, terpenoids and tannins.

16. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, Cytophotometry and flow cytometry.

17. Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electrofocussing, Ultracentrifugation (velocity and buoyant density).

18. Principles and techniques of nucleic acid hybridization, Sequencing of proteins and nucleic acids, Southern, Northern and South-Western blotting techniques, Polymerase chain reaction.

19. Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, UV, ORD/CD Visible, IR and NMR spectroscopy, Atomic absorption spectroscopy.

20. Principles and applications of tracer techniques in biology, Radiation dosimetry, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography, Liquid scintillation spectroscopy.

21. Principles and practice of statistical methods in biological research, samples and populations, Basic statistics — average, statistics of dispersion, coefficient of variation, Standard error, Confidence limits, Probability distributions (binomial, poisson and normal), Tests of statistical significance, Simple correlation of regression, Analysis of variance.

22. IPR - Patents, Trade secrets, Copyrights, Trademarks and Geographical Indications, IPR and Plant Genetic Resources (PGRs), '*Sui Generis*' system, Plant Variety Protection and UPOV, Plant variety protection in India, Plant breeders rights, Biodiversity and farmer's rights.

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Biotechnology

1. Structure, classification, genetics, reproduction and physiology of bacteria and viruses (of bacteria, plants and animals), Mycoplasma protozoa and yeast, Virology : General features, Capsids and their arrangements, Viriods and Prions, Lytic cycle and lysogeny of Lambda, One step growth curve, phage typing, Life cycle of HIV and Adeno viruses.

2. Structure and functions of different classes of immunoglobulins, Primary and Secondary immune response, Lymphocytes and accessory cells, Humoral and cell mediated immunity, MHC, Mechanism of immune response and generation of immunological diversity; Genetic control of immune response, Application of immunological techniques.

3. Enzyme kinetics (negative and positive cooperativity), Regulation of enzymatic activity, Active sites, Coenzymes, Activators and inhibitors, isoenzymes, allosteric enzymes, Ribozyme and abzyme.

4. Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions, Primary structure of proteins and nucleic acids, Conformation of proteins and polypeptides (secondary, tertiary, and quanternary structure), Structure carbohydrates, polysaccharides, glycoproteins and peptido-glycans.

5. Structure and organisation of membranes, Glyconjugates and proteins in membrane systems, ion transport/Na/KATPase/Molecular basis of signal transduction in bacteria, plants and animals, Model membranes, Liposomes.

6. Glycolysis and TCA cycle, Amino acid metabolism, Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols, Energy metabolism (concept of free energy), Thermodynamic principles in biology, Energy rich bonds, Weak interactions, Coupled reactions and oxidative phosphorylations, Group tranfers, Bioenergetics.

7. DNA replication, amplification and rearrangements. Organization of transcriptional units, Mechanism of transcription in prokaryotes and eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), Ribonucleoproteins, Structure of mRNA, Genetic code and protein synthesis, DNA damage and repair.

8. Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept, DNA methylation, Transposition, Regulatory sequences and transcription factors.

9. Genetic engineering concepts, Restriction endonucleases: types and mode of action, Nucleases: exo- and endo-nucleases (DNAses, RNAses), DNA-ligases, Alkaline phosphatases and DNA modifying enzymes, DNA and RNA marker, Host cells: prokaryotic hosts and eukaryotic hosts.

10. Cloning and expression vectors: Choice of vectors, Plasmids, Cosmids, Artificial chromosomes, Shuttle vectors and Phagemids, Ti and Ri plasmids: General features, basis of tumor formation, mechanism of DNA transfer, role of virulence genes, use of reporter genes, Vectors in human gene therapy (viral and non viral vectors), Identification of Recombinant DNA (Direct and indirect methods).

11. Techniques in Genetic Engineering: Restriction mapping of DNA fragments and map construction, Blotting techniques - Southern, Northern, Dot and Western Blotting, DNA sequencing - Maxam and Gilbert technique, Sanger's dideooxynucleotide method, automated DNA sequencing, Polymerase chain reaction - Principle, Types and applications, Chemical synthesis of DNA.

12. Cell and tissue culture in plants and animals, Primary culture, Cell line, Cell clones, Callus cultures, Somaclonal variation, Micropropogation, Somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Gene transfer methods in plants and in animals, Transgenic biology, Artificial seeds, Hybridoma technology.

13. Microbial fermentations: Production, recovery and applications of Ethanol, Glycerol, Citric acid, L-Glutamic acid, L-Tryptophan, Vitamin-B_{12} and Riboflavin, Penicillin, Streptomycin, Tetracyclines.

14. Microbial biotransformation - Basic concept involved, Types of bioconversion reactions (Oxidation, Reduction, Hydrolytic reactions, Condensations), Transformation of steroids and sterols, Transformation of nonsteroid compounds - L-Ascorbic acid, Prostaglandins, Antibiotics.

15. Biodiversity and its Conservation : Alpha (α) and Beta (β) biodiversity, Extinction, endangered species, Reasons of concern for loss of biodiversity, Steps to preserve biodiversity, *In situ* and *ex situ* conservation and gene banks, Conventions on biological diversity.

16. Environment and Energy: Fossil fuels - Non renewable sources of energy, Renewable sources of energy – Biomass (Sources and utilization of biomass, Production of biogas from biomass), Hydrogen (as a new biofuel, production of biohydrogen), Energy rich crops, Biodiesel, Advantages of biofuels.

17. Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electrofocussing, Differential centrifugation, Density gradient centrifugation, Ultracentrifugation.

18. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Principles of biophysical methods used for analysis of biopolymer structure, UV, Visible, IR and NMR spectroscopy, Atomic absorption spectroscopy.

19. Principles and applications of tracer techniques in biology, Radiation dosimetry, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography; Liquid scintillation spectroscopy.

20. Drug Development Process: Concept of LD_{50} and ED_{50} and their significance, Pharmacokinetics and Pharmacodynamics, Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity and other tests, Clinical trial design: Trial size and study population.

21. Bioinformatics: Overview of various primary and secondary databases of protein and nucleic acid sequences, Use of sequences to determine phylogenetic relationship, Methods for searching sequence databases (FASTA and BLAST algorithms), Statistical analysis and evaluation of BLAST results.

22. Intellectual Property Rights : Patents, Trade secrets, Copyrights, Trademarks and Geographical Indications, IPR and Plant Genetic Resources (PGRs), '*Sui Generis*' system, Plant Variety Protection and UPOV, Plant variety protection in India, Plant breeders rights, Biodiversity and farmer's rights.

23. Principles and practice of statistical methods in biological research, samples and populations; Basic statistics—average, statistics of dispersion, coefficient of variation, Standard error, Confidence limits, Probability distributions (binomial, poisson and normal); Tests of statistical significance, Simple correlation of regression, Analysis of variance.

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Botany

1. Principles of taxonomy as applied to the systematics and classification of Plant Kingdom, Taxonomic structure, Biosystematics, Plant geography, Floristics.
2. Patterns of variation in morphology and life history in plants, broad outlines of classification and evolutionary trend among algae, fungi, bryophytes and pteridophytes, Principles of palaeobotany, Economic importance of algae, fungi and lichens.
3. Comparative anatomy and developmental morphology of gymnosperms and angiosperms, Histochemical and ultrastructural aspects of development, Differentiation and morphogenesis.
4. Androegenesis and gynoegenesis, Breeding systems, Pollination biology, structural and functional aspects of pollen and pistil, Male sterility, Self and inter-specific incompatibility, Fertilization, Embryo and seed development.
5. Plants and civilization : Centres of origin, utilization, cultivation and improvement of plants of food, drug, fibre and industrial values, Unexploited plants of potential economic value, Plants as a source of renewable energy, Genetic resources and their conservation.
6. Water Relations, Mineral nutrition, Photosynthesis and photorespiration, Nitrogen, Phosphorous and Sulphur metabolism, Stomatal physiology, Source and sink relationship.
7. Physiology and biochemistry of seed dormancy and germination, Hormonal regulation of growth and development, Photo- regulation, Growth responses, Physiology of flowering, Senescence.
8. Principles of plant breeding: Important conventional methods of breeding self and cross pollinated and vegetatively propagated crops, Non-conventional methods, Polyploidy, Genetic variability, Plant diseases and defensive mechanism.
9. Structure of pro- and eukaryotic cells, Membrane structure and function, Intracellular compartments, Cytoskeleton, Ultrastructure of nucleus, mitochondria and chloroplasts, cell cycle, Structural organisation of pro- and eukaryotic chromosome, polytene and lampbrush chromosomes.
10. Interactions between environment and biota, Concept of habitat and ecological niches, Limiting factors, Energy flow, food chain, food web and trophic levels, Ecological pyramids, Biotic community concept, structure, dominance, fluctuation and succession, N.P.C. and S Cycles in nature.
11. Ecosystem dynamics and management: Stability and complexity of ecosystems, Speciation and extinction, Principles of conservation, Conservation strategies, Sustainable development.
12. Physico-chemical properties of water, Kinds of aquatic habitats (fresh water and marine), Distribution and impact of environmental factors on the aquatic biota, Productivity.
13. Structure, classification, genetics, reproduction and physiology of bacteria and viruses (viruses of bacteria and plants), Mycoplasma and yeast (a general account).
14. Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions, Primary structure of proteins and nucleic acids, Conformation of proteins and polypeptides (secondary, tertiary and quaternary structure), Ramachandran plot, Structure carbohydrates, polysaccharides, glycoproteins and peptido-glycans.

15. Glycolysis and TCA cycle, Glycogen breakdown and synthesis, Amino acid metabolism, Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols. Coupled reactions and oxidative phosphorylations.
16. Principles of Mendelian inheritance, structural organization of prokaryotic and eukaryotic chromosome, Linkage and crossing over, Gene Structure and regulation of gene expression, Fine structure of gene, coding and non-coding sequences, satellite DNA, DNA replication, DNA damage and repair.
17. Mechanism of transcription in prokaryotes and eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), Ribonucleoproteins, Structure of mRNA, Genetic code and protein synthesis. Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept, DNA methylation, Transposition, Regulatory sequences and transcription factors.
18. The law of DNA constancy, Numerical and structural changes in chromosomes, Molecular basis of spontaneous and induced mutation and their role in evolution.
19. Principles and methods of genetic engineering and Gene targeting, Application in agriculture, health and industry.
20. Cell and tissue culture in plants, Callus cultures, Somaclonal variation, Micropropogation, Somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Gene transfer methods in plants, Transgenic biology, Artificial seeds.
21. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and Ultracentrifugation (velocity and buoyant density).
22. Principles and techniques of nucleic acid hybridization, Sequencing of proteins and nucleic acids, Southern, Northern and South-Western blotting techniques, Polymerase chain reaction.
23. Principles and applications of tracer techniques in biology, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography.

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Microbiology

1. **Prokaryotic and eukaryotic cellular organization:** Structure of bacterial (proteobacteria and archaebacteria), fungal and algal cells, classification, reproduction, Cell wall, intracellular and extracellular components, biochemical shuttles across mitochondrial membrane, structure and function of cytoskeleton, its role in motility, protein trafficking, cell membrane structure, model, lipid bilayer, membrane composition, hydropathy plots, intracellular compartments, cellular transport, ion channels and pumps, P and F type ATPases, group transfer and translocation, economic importance.

2. **Virus:** Structure of plant, animal, bacterial viruses, classification, strategies for cultivation and assays, identification, and virus-host interactions, viroids, satellite viruses and satellite RNAs, prions and viral diseases, process of infection (DNA and RNA viruses).

3. **Bacterial taxonomy:** Nomenclature, structural and biochemical systematic, numerical taxonomy, phylogenetic, chemotaxonomy, Bergey's Manual (8, 9th edn., vol. I- IV), microbial biodiversity.

4. **Microbial physiology:** Cell division, Growth pattern, diauxic growth, synchronous and continuous culture, growth kinetics, stress response, Nutrition, physiology of motility and bioluminescence, Bacterial chemotaxis, Quorum sensing, physiology of methanogens and extremophiles, physical and chemical methods of microbial growth.

5. **Molecules and basic biochemistry:** Structure of atoms, molecules and chemical bonds, Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins), Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.), Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties), Conformation of proteins and its Reverse turns, Ramachandran plot, domains, motifs and folds, Structural polymorphism of DNA, DNA topology, RNA and two-dimensional structure of tRNA, micro-RNA, Structure polysaccharides, glycoproteins and peptido-glycans, Helix-coil transition, Energy terms in biopolymer conformational calculation.

6. **Microbial enzymes:** Enzyme kinetics (negative and positive cooperativity), purification, Immobilized enzymes, Enzyme applications, Principles of catalysis, Mechanism of enzyme catalysis, Regulation of enzymatic activity, Active sites, Coenzymes, Activators and inhibitors, isoenzymes, allosteric enzymes, Hill's plot, Ribozyme and abzyme, Non-aqeuous enzymology.

7. **Microbial metabolism:** Glycolysis, pentose phosphate pathway and TCA cycle, Glycogen breakdown, synthesis and regulation, Gluconeogenesis, interconversion of hexoses and pentoses, peripheral metabolism, Amino acid metabolism, Co-ordinated control of metabolism, Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols.

8. **Energy metabolism:** Concept of free energy, Thermodynamic aspect, Energy rich bonds, Weak interactions, Coupled reactions and oxidative phosphorylations, inhibitors and uncouplers of ETC, ATP structure and cycles, Mitochondrial and bacterial ETC, Reverse ETC, Nitrogen metabolism, Autotrophic metabolism, Carbon dioxide fixation pathways, Bacterial photosynthesis and photo-phosphorylation, Anaerobic respiration and methanogenesis.

9. **Microbial genetics:** DNA replication, Mutation, Mutation rate, Site directed mutagenesis, Repair, Gene transfer in bacteria (transformation, transduction, conjugation, transfection nad sex duction) and fungi (parasexual cycle), Molecular recombination mechanism, Genetic map, Restriction modification systems, plasmid and bacteriophage genetics, Lysogeny and lytic cycle in bacteriophages, transposons, structural and numerical alterations of chromosomes (ploidy, deletion, inversion, translocation).

10. **Molecular biology:** Fine structure of gene, prokaryotic and eukaryotic genome organisation (structure of chromatin, coding and non-coding sequences, satellite DNA), DNA damage and repair, DNA replication, amplification and rearrangements.

11. **Organization of transcriptional units:** Mechanism of transcription of prokaryotes and eukaryotes, transcription activators and repressors, RNA polymerases, RNA processing (capping, polyadenylation, splicing, introns and exons), RNA editing, RNA transport, Ribonucleo-proteins, mRNA. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins, protein targeting and degradation.

12. **Regulation of gene expression:** Pro-and eukaryotes, Attenuation and anti-termination, Operon concept, DNA methylation, Heterochromatization, Transposition, Regulatory sequences and transcription factors, Role of chromatin in regulating gene expression and gene silencing, Environmental regulation of gene expression.

13. **Genetic engineering:** Principles and methods of genetic engineering and Gene targeting, Molecular tools, Plasmids and bacteriophage based vectors for cDNA and genomic libraries, cloning strategies in prokaryotic and eukaryotic, rDNA screening, analysis and confirmation, metabolic engineering and metabolomics, applications in agriculture, health and industry.

14. **Bioinformatics:** Data mining, Sequence analysis tools, Concept of microbial genomics, High throughput cloning of ORFs, DNA microarray, metagenomics, protein genomics, sequencing, folding and experimental approach to protein-protein interactions.

15. **Microbial fermentation:** Design aspects, construction, kinetics and applications of bioreactors, Aeration, agitation, fermentation broth rheology, various process variables, Medium engineering, Production of therapeutic antibotics, clinical dextran, organic acids, nucleotides, biopolymers, biomass (SCP, mushrooms), vitamins, biogas, bioethanol, biosurfactants, β-carotene, SK, SD, amylase and protease, and, vaccines. Drug design and microbial quality control, validation aspects in pharmaceutical products.

16. **Applied environmental aspects:** Microbes in food production, prevention of food spoilage and food borne illness, Role decomposition and recycling processes, Microbiology of water, air, soil and sewage, Microbes as pathological agents in animals and man, Waste water treatment, Bioremediation, Phytoremediation, Biofertilizer and Bioinsecticides.

17. **Microbial ecology**: Basic concept of habitat and Ecological niche, Interactions between environment and biota, Limiting factors, Energy flow, food chain, food web and trophic levels, Ecological pyramids and recycling, Biotic community-concept, structure, dominance, fluctuation and succession, Microbial communities and methods to quantitate microbial communities, Microbial interactions with plant roots (Rhizosphere and miycorhizhae) and aerial structure (phyllosphere), Pathogenic interactions with plants, *Agrobacterium* genetics.

18. **Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity, Lymphocytes and accessory cells, B and T cell epitopes, structure and function of antibody molecules, Antibody generation and antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, Genetic control of immune response, Primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria), viral (HIV) infections and cancer, Congenital and acquired immune-deficiencies and vaccines, Detection of antibody molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immune-fluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

19. **Microscopic techniques:** Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, staining techniques, microscopy of living cells, Principles of light and electron (scanning and transmission) microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

20. **Seperation techniques:** Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electrofocussing, Ultracentrifugation (velocity and buoyant density).

21. **Molecular biology techniques:** Principles and techniques of nucleic acid hybridization and Cot curves, Sequencing of proteins and nucleic acids, Southern, Northern and South-Western blotting techniques, Polymerase chain reaction, Methods for measuring nucleic acid and protein interactions.

22. **Biophysical methods:** Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, UV, ORD/CD Visible, NMR and ESR spectroscopy, Hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.

23. **Biostatistics:** Principles and practice of statistical methods in biological research, samples and populations; Basic statistics: average, statistics of dispersion, coefficient of variation, Standard error, Confidence limits, Probability distributions (biomial, poisson and normal); Tests of statistical significance, Simple correlation of regression, Analysis of variance.

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Zoology

1. **Biodiversity and Taxonomy :** Species concept, Biological nomenclature theories of biological classification, Structural biochemical and molecular systematics, DNA finger printing, numerical taxonomy, Biodiveristy, characterization, generation, maintenance and loss, Magnitude and distribution of biodiversity, economic value, wildlife biology, conservation strategies.

2. **Animal behaviour:** Feeding, learning, social and sexual behaviour of animals, Parental care, Circadian rhythms, Mimicry, Migration of fishes and birds, Sociobiology.

3. **Parasitology:** Important human and veterinary parasites (protozoans and helminths), Life cycle and biology of Plasmodium, Trypanosoma, Ascaris, Wuchereria, Fasciola,Schistosoma and Leishmania, Molecular, cellular and physiological basis of host-parasite interactions.

4. **Entomology:** Arthropods and vectors of human diseases (mosquitoes, lice, flies, and ticks), Mode of transmission of pathogens by vectors, Chemical biological and environmental control of arthropod vectors, Biology and control of important insect pests of agricultural importance, Plant host-insect interaction, insect-pest management, useful insects, Silkworm.

5. **Fisheries:** Fish and Fisheries in India with respect to the management of fresh water, estuarine, coastal water systems and man-made reservoirs, Fish food value, preservation, and marketing.

6. **Evolutionary biology :** Origin of life (including aspects of prebiotic environment and molecular evolution), Concepts of evolution, Theories of organic evolution, Mechanisms of speciation, Hardy-Weinberg genetic equilibrium, genetic polymorphism and selection, Origin and evolution of economically important microbes, plants and animals.

7. **Environmental biology :** Concept and dynamics of ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles, Types of ecosystems, Population ecology and biological control, Community structure and organisation, Environmental pollution, Sustainable development, Economic importance of microbes, plants and animals.

8. **Physiology:** Thermoregulation, digestion, respiration, **c**irculation, excretion, Physiology of reproduction, Nervous system, CNS, Neuro-endocrinology, Types of endocrine glands, classification of hormones, mechanism of their action, Stress and adaptation.

9. **Cell Biology:** Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes), Mechanism of cell division (mitosis and meiosis) and cell differentiation; Cell-cell interaction, Malignant growth, Immune cells, Structure of prokaryotic and eukaryotic cell, Membrane structure and function, Intracellular compartments, protein sorting, secretory and endocytic pathways, Cytoskeleton, Nucleus, Mitochondria and chloroplasts and their genetic organisation, cell cycle, Structure and organisation of chromatin, polytene and lamphrush chromosomes, Biochemistry and molecular biology of cancer, Oncogenes, Chemical carcinogenesis.

10. **Biochemistry :** Structure of atoms, molecules and chemical bonds, Principles of physical chemistry, Thermodynamics, kinetics, dissociation and association constants, Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions, Structure, function and metabolism of carbohydrates, lipids and proteins, Enzymes and coenzyme, Respiration and photosynthesis, Enzyme kinetics (negative and positive cooperativity), Regulation of enzymatic activity, Active sites, Coenzymes, Activators and inhibitors, Isoenzymes, Allosteric enzymes, Ribozyme and Abzyme.

11. **Metabolism:** Glycolysis and TCA cycle, Glycogen breakdown and synthesis, Gluconeogenesis, interconversion of hexoses and pentoses, Amino acid metabolism, Coordinated control of metabolism, Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols.Energy metabolism (concept of free energy), Thermodynamic principles in biology, Energy rich bonds, Weak interactions, Coupled reactions and oxidative phosphorylations, Group transfers, Bioenergetics.

12. **Genetics :** Principles of Mendelian inheritance, chromosome structure and function, Linkage and genetic mapping, Extrachromosomal inheritance (episomes, mitochondria and chloroplasts), chromosome aberrations, Transposons, Sex-linked inheritance and genetic disorders, Somatic cell genetics, Genetic and metabolic disorders, Hormonal imbalances, Drug metabolism and detoxification, Genetic load and genetic counselling.

13. **Molecular Biology:** The law of DNA constancy and C-value paradox, Numerical changes in chromosomes, Prokaryotic genome organization, Eukaryotic genome organisation (structure of chromatin, coding and non-coding sequences, satellite DNA), Fine structure of gene, DNA replication, amplification and rearrangements, DNA damage and repair.

14. **Organization of transcriptional units:** Mechanism of transcription of prokaryotes and eukaryotes, RNA processing , Ribonucleoproteins, Structure of mRNA, Genetic code and protein synthesis. Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept, DNA methylation, Transposition, Regulatory sequences and transcription factors, Genomics, Proteomics.

15. **Recombinant DNA technology:** Principles and methods of genetic engineering and Gene targeting, DNA ligases, Topoisomerases, Gyrases, Methylases, Nucleases, Restriction endonucleases, Plasmids and bacteriophage based vectors, cDNA and genomic libraries. Applications of recombinant DNA technology in agriculture, health, pharmaceutical and other industry. Cell and tissue culture in plants and animals, Primary culture, Cell line, Cell clones, Callus cultures, Transgenic biology.

16. **Developmental Biology:** Gametogenesis in animals **,** Molecular events during fertilization,Cleavage patterns and fatemaps, Concepts of determination, competence and induction,totipotency and nuclear transfer experiments, Cell differentiation and differential gene activity. Morphogenetic determinants in egg cytoplasm, Role of maternal contributions in early embryonic development, Genetic regulation of early embryonic development in Drosophila.

17. **Immunology:** Antigens, Structure and functions of different classes of immunoglobulins, Primary and secondary immune response, Lymphocytes and accessory cells, Humoral and cell mediated immunity, MHC, Mechanism of immune response and generation of immunological diversity; Genetic control of immune response, Application of immunological techniques.

18. **Microscopy:** Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy, Cytophotometry and flow cytometry, Principles of histology and histochemistry.

19. **Separation techniques**: Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electrofocusing, Ultracentrifugation (velocity and buoyant density).

20. **Techniques in Molecular Biology:** Principles and techniques of nucleic acid hybridization and Cot curves, Sequencing of proteins and nucleic acids, Southern, Northern and South-Western blotting, Polymerase chain reaction, Methods for measuring nucleic acid and protein interactions.

21. **Characterization of biomolecules:** Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, UV, ORD/CD Visible, NMR and ESR spectroscopy, Atomic absorption spectroscopy.

22. **Radiobiochemistry:** Principles and applications of tracer techniques in biology, Radiation dosimetry, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography, Cerenkov radiation, Liquid scintillation spectroscopy.

23. **Animal tissue culture:** Principles, significance, scope of animal tissue culture, establishment of cell lines, organ culture methods, behaviour of organ explants, transplants and cell hybridization.

24. **Biostatistics:** Principles and practice of statistical methods in biological research, samples and populations; average, statistics of dispersion, coefficient of variation, Standard error, Confidence limits, Probability distributions (binomial, Poisson and normal);Tests of statistical significance, Simple correlation of regression, Analysis of variance.

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Mathematics

UNIT – 1 :

Analysis: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Boreltheorem. Continuity, uniform continuity, differentiability, mean value theorem.Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, Lebesgue measure, Lebesgue integral.Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation. Metric spaces, compactness, connectedness. Normed Linear Spaces. Spaces of Continuous functions as examples.

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.

UNIT – 2 :

Linear Algebra: 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.

Number Theory: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots.

Algebra: Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields.

UNIT – 3 :

Differential Equations: 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, Series solution. First and second order partial differential equations. 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 Analysis: 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 interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler and Runge-Kutta methods.

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Statistics

1. Mathematical Methods :

Countability, supremum and infimum of sets of real numbers. Limit point of a set – open sets, closed sets etc. (developed through general metric space and Rn being considered as a special case), compactness. Continuous functions, uniform continuity, absolute continuity. Sequences and series of real numbers, limit superior, limit inferior and limit of a sequence. Cauchy sequences, convergence of series, tests for convergence of series, absolute convergence, Cauchy products.

Algebra of Matrices, Linear Systems of Equations, Eigen Values and Quadratic Forms.

2. Sample Surveys :

Objectives of sample survey, planning for sample survey. Basic issue related to estimation [biased and unbiased estimator, mean square error (MSE)] and confidence interval, Concept of sampling distribution of statistic, Sampling and non-sampling errors.

Simple random sampling with and without replacement, Systematic sampling and related results on estimation of population total, mean and proportion, Stratified sampling, Formation of strata and number of strata, Allocation problems and estimation problems.

Inclusion probabilities, Horwitz-Thompson estimator and its properties, PPSWR, PPSWOR methods (including Lahiri's scheme) and related estimators of a finite population mean, Midzuno sampling design, πps design, Ratio and Regression estimators based on SRSWOR method of sampling, Their properties and MSEs, Cluster sampling, Estimator of population mean and its properties, Two-stage sampling with equal number of second stage units, Double sampling and its uses in ratio and regression estimation.

3. Probability Distributions :

M.g.f., p.g.f., c.g.f., characteristic function of random variables, Moments: raw moments, Central moments, Factorial moments, Joint p.m.f. of discrete random variables, Joint p.d.f. of continuous random variables, Marginal and conditional density using joint density, Conditional expectation and variance, Independence of random variables, Bivariate exponential distribution: joint p.d.f., Marginal p.d.f.s, properties, Multivariate normal distribution: joint p.d.f., Marginal p.d.f., Conditional p.d.f., Joint m.g.f., Multinomial distribution: joint p.m.f., Marginal p.m.f., Conditional p.m.f., Joint m.g.f., Function of random variables, Joint density of functions of random variables using Jacobian of transformation, Convolution of random variables.

Linear and multiple regression, Regression Function, Best linear regression function, Multiple and Partial Correlation, Sampling distribution of statistics from univariate normal random sample, Non-central Chi-square, t and F- distributions and their properties, Distribution of linear and quadratic forms in i.i.d. Standard normal variables (Technique based on m.g.f.), Independence of two linear forms, Independence of two quadratic forms and independence of linear form and quadratic form, Fisher Cochran's theorem, Distribution of r^{th} order statistics, Joint distribution

of several order statistics and their functions, Distribution of function of order statistics, Extreme values and their asymptotic distributions with applications.

4. Probability Theory :

Algebra of sets, fields and Sigma-fields (σ-fields), Minimal fields, Minimal σ-field, limit of sequences of subsets, sigma-field generated by a class of subsets, Borel fields. Probability measure on a sigma-field, probability space, continuity of a probability measure, real and vector-valued random variables (r. v. s), distribution functions (d. f.), discrete r. v. s, r. v. s of the continuous type, decomposition of a d. f. Expectation of a real r. v. Linear properties of expectations. Characteristic functions and their simple properties. Convergence of a sequence of r. v. s., convergence in distribution, convergence in probability, almost sure convergence and convergence in quadratic mean and their interrelations. Monotone convergence theorem and dominated convergence theorem.

Independence of two events and n (> 2) events, sequence of independent events, independent classes of events, independence of r. v.s, Borel zero-one law, Khintchin's weak law of large numbers, Kolmogorov strong law of large numbers, continuity theorem for characteristic functions, Lindeberg's CLT.

5. Stochastic Processes :

Markov chains with stationary transition probabilities, properties of transition functions, classification of states, Stationary distribution of a Markov chain, existence and uniqueness, convergence to the stationary distribution. Methods based on Markov chains for simulation of random vectors. MCMC algorithm. Gambler's ruin problem, Transient states. Estimation of transition probabilities. Numerical Illustrations and calculations of transition probabilities. Branching processes. Introduction to Wiener Process and Brownian Motion. Poisson process, Birth and Death processes. Finite state continuous time Markov chains. Simple queuing systems, Stationary solution for $M/M/1$, $M/M/s$, $M/M/\infty$ using birth and death process approach. Estimation of transition probabilities, estimation of functions of transition probabilities in Markov chains.

6. Multivariate Analysis :

Singular and nonsingular Multivariate normal distribution, pdf and mgf, singular and nonsingular normal distributions, distribution of a linear form and a quadratic form of normal variables, marginal and conditional distributions. Multiple regression and multiple and partial correlation coefficients, Definition and relationships. MLE's of the parameters of multivariate normal distribution and their sampling distributions Wishart distribution, Properties of the Wishart Distribution. Tests of hypothesis about the mean vector of a multinormal population, Hotelling's T^2-statistic; Rao's U-statistic and their distribution, Applications of Hotelling's T^2-statistic.

Introduction to Principle Components, Canonical correlation coefficients, Cluster Analysis. Classification problem, Discriminant analysis, Mahalanobis D^2-statistic. MANOVA for one way and two ways classified data, Wilk's Λ criteria.

7. Statistical Inference :

Sufficiency, completeness, uniformly minimum variance unbiased estimators, C-R inequalities, exponential class of densities and its properties, some special classes of distributions admitting complete sufficient statistics, extensions of these results to multi-parameter situation. Test function, Neyman-Pearson lemma for test functions. Uniformly most powerful tests for one sided alternative for one parameter exponential class of densities and extension to the distributions having monotone likelihood ratio property. Confidence Intervals, shortest expected length confidence intervals, relations with testing of hypotheses, uniformly most accurate confidence intervals.

Consistency and asymptotic normality (CAN) of real and vector parameters, Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem. Non Parametric Tests.

8. Linear Models and Design of Experiments :

Gauss-Markov set up, Least square estimation, Estimability of linear parametric function, necessary and sufficient condition for estimability, Best Linear Unbiased Estimator (BLUE), Gauss-Markov theorem, Variances and covariances of BLUE's. Estimation space, Error space, their ranks, Simultaneous estimates of linear parametric function, Estimation of error variance, Estimation with correlated observations, Least square estimates with restriction on parameters, Method of generalized least squares, Distribution of error sum of squares and Regression sum of squares, distribution of BLUE's, their independence (Under the normality assumption), Distribution of conditional error sum of squares, Distribution of sum of squares due to null hypothesis, Test of hypothesis for one or more than one estimable linear parametric function, Test of hypothesis of equality of all estimable functions to zero, Testing of sub hypothesis for full rank model, Power of F-test, Simultaneous confidence interval for n linearly independent estimable parametric functions, One way and two way classified data.

One way classification models, random effect model for one way classification, Two way classification model with equal number of observations per cell with and without interactions, General two way block designs, various characteristics of general two way block design: connectedness, balancedness and orthogonality, Balanced Incomplete Block Design (BIBD). 2^k full factorial designs, analysis of single as well as more than one replicates using ANOVA, technique of confounding, total and partial confounding in 2^k full factorial designs.

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Industrial Chemistry

1) Unit Processes in Organic Synthesis

a) Amination– Liquor ammonia, metal-acid reductions, manufacture of aniline by reduction of nitrobenzene.
b) Alkylation –Alkylating agents, manufacture of ethyl benzene.
c) Oxidation – Liquid phase oxidation, technical oxidation of benzene.
d) Esterification –Interesterification, manufacture of cellulose acetate.
e) Hydrogenation – Types of hydrogenation reactions, hydrogenation of fatty oils.

2) Industrial Organic Chemistry

a) Dyes – Valance bond and molecular orbital theories, synthesis of Fast Red A and Rosaniline.
b) Paints and Pigments – Definition, classification, manufacture of Tio_2 by sulphate and chloride methods.
c) Oil and Oleochemical Industries – Definition, characterization and classification of oils, acid/sap/iodine values of oils, manufacture of soaps.
d) Fermentation – Manufacture of chloramphenicol and penicillin.

3) Pharmaceutical Chemistry

a) Antibiotics – Definition, classification, examples.
b) Anti AIDS/HIV – Definition and drugs.
c) Cancer therapy – Types of cancers and therapies.
d) Synthesis of prazasin, methyldopa and benzocane.
e) Manufacture of aspirin.

4) Agrochemical Industry

a) Agrochemicals and Pesticides – Definition, classification, nomenclature, principles of pest control.
b) Formulation of pesticides – Definition, types, a.i., EC, solvents, Granules, Direct impregnation method.
c) Chemistry of pesticides – phorate, captan, terbufos, warfarin, DEET, metaldehyde.

5) Industrial Polymers

a) Polymers and polymerizations – Definition, types.
b) Chemistry, technology of production, properties and applications of phenol-formaldehyde based resins, epoxy resins and curing agents, polyamides, polyolefins, acrylics, polyvinyls and co-polymers.

6) Industrial Waste, Hazards and Management

a) Chemical industry hazards and prevention – flammability, explosion, ignition, pressure, temperature, noise.

b) Green chemistry – Introduction and importance, twelve principles, environmentally benign synthetic approaches (polymer supported/microwave/ionic liquids mediated organic syntheses).

c) Industrial management – Meaning of planning, organizing, directing and controlling, entrepreneurship and factors affecting entrepreneurship

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Pesticides & Agrochemicals

1. Introduction to pests (agriculture and public health pests), pesticides (classification, nomenclature, principles of pest control) & IPM concept.

2. I) Introduction & chemistry of pesticides :

   a) Insecticides – Decamethrin , Propaxor
   b) Fungicides – Captan, Carbendazim
   c) Rodenticides – Bromadiolone, Zinc phosphide
   d) Nematicides – Aldicarb, Diazinon
   e) Fumigants – Methyl bromide, Ethylene dibromide
   f) Repellents – DEET, DMP

   II) Manufacture of Lindane, Parathion, Phorate, 2, 4-D.

3. Formulation of pesticides – Introduction, a.i., necessity and types of formulation, technical process for preparation of granules,(Direct impregnation, Extrusion, agglomeration) and emulsifiable concentrates; Controlled release formulations (microcapsulation and chemical systems).

4. Fertilizers – Synthetic fertilizers (urea, triple super phosphate, potassium nitrate, potassium chloride), fluid fertilizers (nitrogenous fluids), soil amendments, fertility management.

5. Herbicides & PGRs- Introduction, chemistry of herbicides (2,4-D, dicamba, propanil, simazine) & PGRs (daminozide, IAA, tecnazene, chloramequat chloride).

6. Pesticide Residues & Toxicology- Introduction, effect of residues on human life, birds, animals, basic principles of toxicology (exposure routes, interactions, dose response relationships, GLP for toxicity studies), toxicology of organophosphates and carbamates (signs and symptoms of poisoning, biotransformation, cholinesterase inhibition action and antidote mechanisms).

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Polymer Chemistry

1. Polymers:

Basic concepts and definition:- Polymer, Degree of polymerization, functionality,

Classification of polymers:- Thermoplastic and Thermosets**,** Step growth and Chain polymers, natural and synthetic polymers, Plastics/Fibers/Elastomers/Resins,

Methods of polymerization and kinetics:-Free radical chain polymerization, cationic polymerization, anionic polymerization, co-ordination polymerization,

Step growth polymers and Kinetics:- Concept of equal reactivity, Catalyzed and Uncatalyzed step polymerization of polyester, Carother's equation,

Techniques of polymerization:- Bulk, Solution, Suspension, Emulsion and Interfacial polymerization,

2. Polymer Characterization:

1. Analysis of polymers- Chemical (elemental), Flame test, Colour and solubility test.
2. Number and weight average molecular weights and their determinations.
3. Thermal behavior and analysis (DTA, DSC, TGA, TMA) of polymers, applications of these techniques.
4. Viscoelastic behavior of polymers, factors affecting viscoelastic behavior, applications and measurement of viscoelastic properties (by DMA).

3. Processing of polymers :

Processing of plastics, elastomers, fibers, paints and varnishes, compounding, extrusion techniques and processes based on extrusion, injection moulding and processes based on injection moulding, compression moulding and transfer moulding.

4. Structure and properties of polymers:

Glass transition temperature and its determination, Tacticity of polymer chains, Estimation of crystallinity: – XRD, Densities, Heat of fusion.

5. Preparation, Properties and Applications of commercial polymers:

PE, PVC, Polyamides, PET, epoxy resin, silicon polymers.

6. Additives for polymers:

Fillers, plasticizers, lubricants, antiaging additives, flame retarders, colourants, blowing agents, cross linking agents.

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Physical Chemistry

1) Quantum Chemistry :

Plansks theory, wave particle duality, uncertainty principle, postulates of quantum mechanics, Schrodinger equation, particle in a box, operators, harmonic Oscillator, rigid rotator, hydrogen atom and emission spectrum of hydrogen atom. Variation principle and Hiickel approximation for conjugated dienes. Term symbols, selection rules and spectroscopic states. Theoretical treatment of rotational, vibrational electronic and spin spectroscopies.

2) Thermodynamics and Chemical Equilibrium :

Second and third laws of thermodynamics, Entropy and force energy. Free energy functions, Maxwells relations phase equilibrium and rule. Effect of temperature and pressure on equilibrium constant, Le-chateliars principle. The chemical potential and chemical equilibrium. Fugacity and activity, Partial molar quantities, Solubility of gases in liquids. Phase diagrams, Osmotic pressure, Determination of activity coefficients.

3) Statistical Thermodynamics :

Ensembles partition function, Translational, Vibrational, rotational partition functions. Entropy calculations. Boltzmam, Bose Einstein and Fermi-Diral Statistics, Heat capacities of Solids. Einstein and Debye theories, Equilibrium Constant Calculations.

4) Chemical Kinetics :

Types of reactions, Opposing reactions, Consecutive reactions, Parallel reactions, Chain reactions. Temperature dependence of reaction rates, collision theory, Activated Complex theory of reaction rates, Reactions in solution, Diffusion controlled reactions. Acid-Base catalysis, Enzyme catalysis. Fast reactions, Relaxation methods to study rates of reactions.

5) Electrochemistry :

Ion activities and mean ionic activity coefficients, Diffusion and ionic mobility, Debye Hiickel theory, limiting law. Electrode kinetics, polarization, The Tafel equation, Diffusion Over potential, Fuel cells.

6) Surfaces and colloids :

Surface tension, Capillarity, Insoluble surface films, Structure of surface films, Surfactants and micelles, Cell membranes, colloidal sols – particle size distribution. Electrical double layer, Stability of Colloids, Emulsions.

7) Nuclear Chemistry and solid State :

Nuclear reactions, Nuclear models, the shell model and liquid drop model, Radioactive decay and equilibrium, Q-value, fission and fusion, Bethe's notation for nuclear reactions, Compound nuclear theory, The fission energy, The four factor formula, Breeder reactors.

The Bond model of solids, Closest packing of spheres, ionic crystals, Crystal energies. radius ratio rule. Insulators and semiconductors. Defects in solids, point and line defects. Effects due to dislocations. Solid solutions. Superconductivity

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Organic Chemistry

1) Aromaticity – Huckel's rule & concept of aromaticity (n) annulenes & heteroannulenes Fullerenes.

2) Stereochemistry & Confirmational Analysis :

(a) Never Method of asymmetric synthesis (including Enzymatic & Catalytic nexus) Enantio & diastereo selective synthesis, Effects of confirmation on reactivity in acyclic compounds & Cyclohexanes.
(b) CD & ORD

3) Name Reactions :

Favorskii reaction, Stone Enamine reaction, Michael addition, mannich reaction, Sharpless asymmetric, Epoxidation, Ene reaction, Bartin reaction, Hofmann-Loffler Freytag reaction, Shapiro reaction, Baeyer-villiger reaction, Suzuki Coupling, Still Coupling, Sonogashira Coupling, Buckhwald Coupling, Biginelli reaction.

4) Pericyclic Reactions :

Selection rules & Stereochemistry of Electrocyclic reactions, Cycloaddition & Sigmatropic Shifts, Sommelet, Hauser, Cope & Claisen rearrangements

5) Photochemistry :

Cis-trans isomensation paterno Buchi reactions Nomish Type I & II reactions, photoreduction of ketons Oli-pi methane reamangement**,** Photochemistry of arenes.

6) Heterocyclic Chemistry :

Synthesis & heactivity of foran, thiophene, pyrrole, quinoine & isoquinoline & indole, Skraup Synthesis, fisher indole synthesis.

7) Reagents in Organic Synthesis :

Complex metal hydrides, Gitman's reagent, Lithium dimethyl cuprate, lithium disopropyalamide (LDA) dicyclohexyl Carbodimide, 1,3-dithiane, trimethyl silyiodide, tri-n-butyltin hydride, wordward prevost hydroxylation, Osmium tetroxide, DDQ, Selenium dioxide, Phase transfer catalysts, Crewn Ethers & Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast, B-cyclodextrin, Grubbs Catalyst.

8) Spectroscopy :

Applications of Mass UV VIS, IR & NMR Spectroscopy for Structural Elucidation of compound.

9) Protecting Group :

For OH , NH_2 – CAH & Carbonyl of ketone & aldehyde.

10) Green Chemistry & Microwave reactions.

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Inorganic Chemistry

1. Chemistry of transition elements and coordination compounds-bonding theories, spectral and magnetic properties.

2. Reaction mechanisms: Ligand substitution, Isomerization, insertion, oxidative addition, reductive elimination and photochemical reactions.

3. d-block organometallic compounds - synthesis, bonding and structure and reactivity.

4. Organometallics in homogenous catalysis: Catalysis steps, hydrogenation of alkenes, hydroformylation, Wacker process, alkene polymerization.

5. Cages and metal clusters: Structure, synthesis.

6. Coordination compounds in biology and medicines, redox chemistry of Iron porphyrins, cytochromes, therapeutic uses of coordination compounds as anticancer, antiarthritis drugs.

7. Analytical chemistry: a) Separation techniques- Solvent extraction, GC-HPLC, ion exchange chromatography. b) Electroanalytical methods- polarography and voltammetric methods. c) Thermoanalytical methods- Thermogravimetric analysis (TGA), Differntial thermal analysis (DTA) and radio analytical techniques.

8. Physical Characterization of Inorganic compounds – Electron paramagnetic resonance (EPR) & Mossbauer spectroscopy.

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Analytical Chemistry

1. Concepts of Analytical Chemistry:

Qualitative and quantitative analysis. Accuracy, precision, mean and standard deviation. Analytical data processing. Solvent extraction- Determination of partition ratios, Continuous separation and countercurrent processes.

2. Decomposition and Dissolution of Samples :

Acids as solvents. Oxidizing and non-oxidizing acidic and alkaline fluxes. Use of chlorine and bromine at high temperatures. Dry and wet ashing methods.

3. Instrumental Methods of Analysis:

Principle, instrumentation and applications of following techniques:
pH metry, potentiometry, conductometry, polarography, voltametry, electrogravimetry, coulometry, x-ray diffraction spectrometry.

4. Spectroscopic Methods of Analysis:

UV and Visible spectrophotometry, Infra-red spectroscopy, Nuclear magnetic resonance spectroscopy, Mass spectrometry, Flame emission and Atomic absorption spectroscopy.

5. Chromatographic Methods of Analysis:

Paper chromatography, Thin layer chromatography, Ion exchange chromatography, Size exclusion chromatography, High performance liquid chromatography, Gas chromatography.

6. Special Analytical Methods :

Neutron activation analysis, Isotope dilution analysis, Thermal methods of analysis such as TGA, DTA, DSC and thermometric titrations.

7. Analysis of Organics and Medicinal:

Determination of hydrocarbons by combustion method, carbonyl compounds by DNP method, nitrogen compounds by Kjeldahl and Duma's method and sulphur compounds by oxygen flask method. Assay of aspirin and sulpha drugs, Assay of vitamins A, B_1, B_2, C and D. Enzyme assay. Bioassay of antibiotics.

8. Analysis of Foods and Bio-analysis:

Estimation of carbohydrates, fats and proteins from food. Analysis of foods such as milk, flour, honey, jams-jellys and beverages. Analysis of urine and blood. Forensic examination of saliva, blood and hairs. Forensic toxicology.

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Geology

(i) **Geomorphology:** Landforms-their types and development; weathering, transport and erosion; landforms in relation to rock type, structure and tectonics. Soils-their development and types. Geomorphic processes and their impact on various landforms and associated dynamics-slope, channel, coastline, glacial and aeolian; evolution of major geomorphological features of the Indian sub-continent; geomorphometric analysis and modelling.

(ii) **Sedimentology:** Classification of sedimentary rocks; petrography of rocks of clastic, chemical and biochemical origin. Sedimentary textures and structures. Diagenesis; marine, non-marine and mixed depositional environments. Facies association, sedimentation and tectonics; basin analysis; Reconstruction of palaeoenvironments using radioactive and stable isotopes.

(iii) **Paleontology:** Origin and evolution of life; fossils and their uses; species concept; functional morphology, classification and evolution of important invertebrate, vertebrate and plant fossils; biomineralisation and trace fossils; types of microfossils and their applications; palaeobiogeography and palaeoecology; evolution of man. Oxygen and carbon isotopic studies on fossils; analysis of palaentological record for tracing plate tectonics processes.

(iv) **Stratigraphy:** Recent developments in stratigraphic classification: Litho bio and chrono stratigraphic units and their interrelationships; modern methods of stratigraphic correlation; steps in stratigraphic studies; approaches to palaeogeography; Earth's climatic history. Rocks of Phanerozoic Eon in India-their intercontinental correlation with special reference to type localities; boundary problems in stratigraphy; geodynamic evolution of the Indian subcontinent through the Phanerozoic.

(v) **Structural Geology and Geotectonics:** Concepts of stress and strain; strain analysis using deformed objects; geometric classification of folds; mechanics of folding; folding in shear zones; geometry of superposed folding; structural analysis in terrains with multiple deformation; foliation and lineation; geometry and mechanics of shear zones; brittle ductile and ductile structures in shear zones; geometry of thrust sheets. Classification of unconformities; map patterns and their uses in the determination of large-scale structures. Isostasy; seismicity; sea-floor spreading and plate tectonics; orogenesis; orogenic belts of India; evolution of the Himalaya and Himalayan tectonics.

(vi) **Mineralogy:** Concept of symmetry, point group lattice and space group; principles of crystal chemistry; principles of optical and X-ray mineralogy. Structural classification of minerals; structure and its interrelation with physical and chemical properties of minerals important phase diagrams of major rock forming minerals and ore minerals; principles of geothermo-barometry.

(vii) **Geochemistry:** Abundances of elements; structure and atomic properties of elements; the Periodic Table; geochemical classification and distribution of elements in the earth; principles of geochemical cycling; principles of ionic substitution in minerals; laws of thermodynamics; concepts of free energy, activity, fugacity and equilibrium constant; thermodynamics of ideal, nonideal and dilute solutions; element partitioning in mineral/rocks formation and concept of distribution coefficients; concept of P-T-X. Eh-pH diagrams and mineral stabilities; radioactive decay schemes, growth of

daughter isotopes and radiometric dating; stable isotopes and their fractionation. Mineral/Mineral assemblages as 'sensors' of ambient environments.

(viii) **Petrology:** Phase equilibria studies of single, binary, temary and quaternary silicate systems with reference to petrogenesis; magmas, their generation in the crust and mantle, their emplacement and their relation to plate tectonics; magmatic crystallization, differentiation and assimilation; classification of igneous rocks; major and trace elements and isotopic composition of igneous rocks in the context of petrogenesis; petrogenesis of important types of igneous rocks; volatile components in petrogenesis. Physical and rheological properties of silicate melts-Bingham liquid; partial melting and fractional crystallization in closed and open system models. Role of T.P. and fluids in metamorphism; metamorphic facies; mineral assemblages and important reactions in different facies; types of metamorphism and metamorphic-belts; relationship among metamorphism, anatexis and grantization. Petrogenetic aspects of important rocks of India such as the Deccan Trap. The Layered intrusions, charnockites, khondalities and 'gondites'.

(ix) **Ore Geology:** Physico-chemical controls of deposition and of post-depositional changes in ores; geological processes of formation of economic mineral deposits; global metallogeny as related to crustal evolution; metallogenesis in space and time. Elements of ore petrology; mineral assemblages and fluid inclusions as 'sensors' of ore-forming environments; Live ore forming systems. Geological setting, characteristics features and genesis of ferrous and nonferrous ore deposits of India. Metallogenic history of India.

(x) **Marine Geology:** Morphological and tectonic domains of the ocean floor; midocean ridge systems; seawater-basalt interaction and hydrothermal vents; models and rates of ocean circulation and of sedimentation in the oceans; digenetic changes in oxic and anoxic environments; mobility of redox metals; major components of marine sediments and processes regulating sediment composition; geochronology of marine sediments from radioactivity measurements; sedimentary markers of palaeoenvironmental conditions; mineral resources of the oceans and factors controlling their distribution. Ocean margins; nature of deep sea sediments, their chronology and correlation; tectonic history of the oceans.

(xi) **Petroleum Geology:** Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combinations traps. Techniques of exploration. Petroliferous basins of India.Well logging and other methods.

(xii) **Precambrian Geology and Crustal Evolution:** Evolution of the early crust, early Precambrian life, lithological, geochemical and stratigraphic characteristics of granite greenstone and granulite belts. Stratigraphy and geochronology of the Precambrian terrains of India.

(xiii) **Applied Geology:**

(a) **Photo geology and Remote Sensing:** Elements of photogrammetry; elements of photo interpretation; electromagnetic spectrum emission range, film and imagery; multispectral sensors; geological interpretation of air-photos and imagery.

(b) **Engineering Geology:** Mechanical properties of rocks; geological investigations for the construction of dams, bridges, highways and tunnels.

(c) **Mineral Exploration:** Geological and geophysical methods of surface and subsurface exploration on different scales, sampling, assaying and evaluation of mineral deposits; geochemical and Geobotanical surveys in exploration.

(d) **Hydrogeology:** Ground water, Darcy's law; hydrological characteristics of aquifers; Hydrological cycle; precipitation, evapotranspiration and infiltration processes; hydrological Classification of water-bearing formations; fresh and salt water relationship in coastal and inland areas; ground water exploration and management, water pollution, ground water regimes in India.

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Environmental Sciences

1. Environmental Science and Environmental Issues:

Definition. Principles and scope of environmental science. Earth, man and environment. Ecosystems and pathways in ecosystem. Physico-chemical and biological factors in the environment. Human population growth, Urbanization, Industrialization, Effects of agriculture on environment.

Structure and composition of atmosphere: hydrosphere, lithosphere and biosphere. Mass and energy transfer across the various interfaces. Material balance, First and second laws of thermodynamics, Heat transfer processes.

Conventional and Non-conventional Energy Sources: Thermal power plants, Hydropower projects, Nuclear power projects, Biogas, Wind energy, Solar energy, Geothermal energy and Tidal power. Advantages, limitations and scope for above types of energies in India.

Global environmental problems: Deforestation, desertification, ozone layer depletion, greenhouse effect and global warming.

Global environmental awareness and action plans: Stockholm conference, Montreal protocol, Rio-de-Janeiro summit, Kyoto protocol, Copenhagen summit, World Wide Fund for nature (WWF), Carbon credit.

Environmental policies and legislations: Environmental policy resolutions, legislation, Public policy strategies in pollution control. Introduction acts and legal provisions pertaining to Environmental protection. Natural resources conservation and sustainable development.

2. Environment and Ecology:

Definition, principles and scope of ecology. Human ecology and human settlement. Evolution, origin of life and speciation.

Abiotic factors like temperature, light, rainfall, humidity, atmospheric gases and wind. Wind factor and fire factor. Topographic factors like height and direction of mountains. Steepness of slopes, edaphic factors like formation of soil, composition of soil, soil erosion and conservation. Ecological adaptions in plants like hydrophytes, mesophytes, xerophytes and halophytes. Ecological adoptions in animals.

Ecosystems. Structure and functions, biotic and abiotic components, energy flows, food chain, food web, ecological pyramids, biomass and numbers, types and diversity, ecological succession, Population. Community ecology and parasitism. Prey-predator relationships.

Major types of ecosystems. Pond, grassland, forest, desert, cropland and terrestrial ecosystems. Primary and secondary productivity.

System ecology and ecosystem modeling. Development of environmental modeling. Scope, types and state of art.

Biodiversity: Concept of biodiversity. Types of biodiversity. Importance of biodiversity. Major biomes distribution. Biodiversity hotspots. Endangered species. Conservation of biodiversity in national parks, sanctuaries and biosphere reserves. Biodiversity in India.

Ecological succession: Mechanism of succession. Course of succession. Types and trends of succession. Climax concept in succession. Succession and biogeo-chemical cycling of Carbon, Sulphur, Nitrogen and phosphorous.

3. Environmental Chemistry:

Fundamentals of environmental chemistry: Concept and scope. Stoichiometry. Gibbs free energy. Redox potential, chemical potential and chemical equillibria. Acid-base reactions, solubility products and solubility of gases in water. The carbonate system. Saturated and unsaturated hydrocarbons. Radionuclides in air.

Air chemistry: Structure and composition of atmosphere. Chemical composition of air and heat balance. Classification of elements. Chemical speciation. Particles, ions and radicals in atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry of air pollutants. Photochemical smog.

Water chemistry: Chemistry of water. Concept of DO, BOD and COD. Sedimentation, coagulation, filteration and redox potential. Hydrosphere-characteristics and structure. Oceans, ice and fresh water systems.

Properties of water bodies: Alkalinity, acidity, calcium and other metals in water, organic pollutants, soaps, oil, detergents and pesticides in water. Radionucleides.

Soil chemistry: Lithosphere-formation of the earth, structure and composition of the earth. Differentiation of elements. Soil and agriculture. Nature and composition of soil. Acid-base and ion exchange reactions in soil. NPK in soil. macronutrients in soil. Nitrogen pathways.

Principles, working and applications of analytical techniques: Titrimetry, gravimetry, colorimetry, spectrophotometry nephalometry, turbidimetry, flame photometry, polarography, paper chromatography, thin layer chromatography, ion exchange chromatography, gas chromatography (GC), atomic absorption spectroscopy (AAS), HPLC, X-ray florescence, X-ray diffraction, neutron activation analysis and isotope dilution analysis.

4. Environmental Pollution and Its Control:

Air Pollution: Definition. Natural and anthropogenic sources of air pollution. Primary and secondary air pollutants. Transport and diffusion of pollutants. Gas laws governing effects of pollutants in atmosphere. Methods of monitoring and control of air pollution. Study of air pollutants-SO2, NOx, CO and SPM. Effects of pollutants on human beings, plants, animals, materials and climate. Acid rain. Air quality standards. Air monitoring instruments- Orsat apparatus, high volume sampler and source monitors.

Air pollution meteorology: Wind speed, direction and their vertical profiles. Turbulence, atmospheric stability characteristics and classes. Plume behavior. Effects of micrometeorology on point source emission. Wind valley effect, land/sea breeze effect and heat island effect. Mixing height boundary. Temperature inversion. Factors affecting dispersion of air pollutants. Micrometeorological instruments.

Water pollution: Types, sources and consequences of water pollution. Physical, chemical and biological characteristics of water and wastewater. Physico-chemical and bacteriological sampling and analysis of water. Water quality. Water quality standards (WHO, BIS and CPCB). Water quality indices. Pollution potential of industrial effluents of industries-textile & dye, paper & pulp, sugar, chemical, food processing, petroleum, tannery and electroplating industry. Effects of water pollution on human beings, plants, animals and materials. Biological uptake of pollutants. Bioaccumulation and biomagnification. Eutrophication. Water borne diseases. Bio-indicators. Wastewater treatment: Introduction. Flow diagram of wastewater treatment. Preliminary treatments -Flow measurement, screening, gritting, skimming. Primary treatments- primary and secondary sedimentation. Secondary treatments-trickling filter, activated sludge process and bio-towers. Tertiary treatments-precipitation, ion exchange, membrane filtration, reverse osmosis, electro-dialysis and effluent disinfection. Sludge treatments-thickening, conditioning, dewatering, digestion, drying and disposal. Common effluent treatment plant (CETP).

Terrestrial pollution: Physico-chemical and bacteriological sampling and analysis of soil. Soil quality. Sources of solid wastes. Composition of solid wastes. Collection, transportation and characterization of solid wastes. Effects of solid wastes on environment and health of human beings. Management of solid wastes by methods-sanitary landfill, incineration, pyrolysis, composting and vermicomposting. Modern trends- reduce, reuse, recycle strategy. integrated waste management for energy recovery. Hazardous wastes and its management. Generation and management of solid wastes in industries-textile & dye, paper & pulp, sugar, fertilizers, petroleum, chemical and food processing industry.

Noise Pollution: Sources of noise pollution. Measurement of noise. Noise exposure levels and standards. Impact of noise pollution on human health. Noise control and abatement measures.

Marine pollution: Sources of marine pollution and control. Criteria for disposal of pollutants in marine system. Coastal management. Radioactive and thermal pollution.

5. Environmental Impact Assessment and Auditing:

Introduction: Definition of EIA & EIS. Environmental inventory. Concept, scope and Objectives of EIA. National Environmental Policy Act (NEPA-1969). EIA Guidelines-1994 of Government of India. Procedure to review report of EIA.

Impact Assessment Methodologies: Definition and concept of impacts. Types of impacts (negative & positive, primary &secondary, reversible & irreversible, tangible & intangible). Impact identification. Methods for impact identification- matrices, networks and checklists. Advantages and disadvantages of EIA methodologies.

Components of EIA: Environmental setting. Baseline data. Prediction and evaluation of impacts. Environmental management plan and monitoring. Baseline information. Prediction, Evaluation and mitigation of impacts on socio-economic, air, water, soil and noise environments.

Preparation and writing of EIA: For water resources. Dams and irrigation projects. Mining and infrastructural projects.

Environmental auditing: Notification and guidelines for environmental audit.

6. Environmental Geoscience and Remote Sensing:

The Earth system and biosphere: Conservation of matter in various geospheres-lithosphere, hydrosphere, atmosphere and biosphere. Energy budget of the Earth. Earth's thermal environment and seasons. Ecosystems flow of energy and matter. Co-existence in communities and food web. Earth's major ecosystems-terrestrial and aquatic. General relation between landscape, biomass and climate. Indian monsoon-EL Nino, droughts, tropical cyclones and western disturbances.

Mineral resources and environment: Resources and reserves. Minerals and population. Oceans as new areas for mineral exploration. Processing and smelting of minerals. Environmental impacts of mineral exploration.

Landuse planning: The landuse plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation.

Introduction to remote sensing: Definition. Historical perspective. Electromagnetic radiation (EMR). EMR spectrum. Radiation laws. Blackbody and real body radiations. Hemispheric reflectance, transmittance and absorption. Applications of remote sensing in environmental studies.

Applications of remote sensing in environmental studies: Land use/land cover, wastelands, forests, forest fires, water resources, disasters, wildlife habitats, vegetations.

Geographical Information System (GIS): Definition. Capabilities and advantages. History, objectives and elements of GIS. Data models- Raster and vector data model. Data structures- relational, hierarchical and network data structures. Overview of GIS softwares. Use of GIS in environmental management.

7. Industrial Safety, Hygiene and Toxicology:

Concept, need and application of industrial safety effective implementation of safety. Safety policy in the industries. Risk assessment and management: Checklist procedure. Preliminary hazard analysis. What if analysis. Failure mode effect analysis. Hazard and operability (HAZOP) studies. Hazard analysis techniques- fault tree analysis and event tree analysis. General outline of DOW index. Risk estimation and management. Major hazard control. On-site and off-site emergency preparedness.

Industrial hygiene: Environmental stresses- physical, chemical, biological and ergonomic stresses. Principles of industrial hygiene.

Elementary industrial toxicology: Introduction and Definition. Major toxic substances. Environmental agents causing public concern. Factors affecting toxicity of toxicant. Acute and chronic toxicity studies. Morphological, functional and biochemical changes. LD_{50} and LC_{50}. Dose response curve. Probit factor. Extrapolation of animal studies results to human. Carcinogenesis- initiation, promotion and progression of cancer. Threshold limit value (TLV) and criteria used in arriving at TLV.

Occupational health: Concept of health and occupational health. Spectrum of health, Occupational and work related diseases. History of occupational diseases. Characteristics of occupational diseases. Level of prevention. Essentials of occupational health services. personal protective equipments (respiratory and non-respiratory).

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Geography

UNIT NO 1: CLIMATOLOGY :

Introduction: Definition, Nature and Scope, Aims and Objectives, Subdivisions, Development of modern climatology. Composition and structure of atmosphere.

Isolation and Heat Budget: Definition, factors affecting the distribution of isolation, effects of atmosphere, Heat budget of the earth and atmosphere.

Temperature, Humidity and Precipitation: Horizontal and vertical distribution of temperature. Factors affecting the distribution of temperature, inversion of temperature, Humidity types, Forms of precipitation, Types of rainfall.

Fronts and air masses: Classification, modification of airmasses and types of fronts Atmospheric disturbances, Climatic Classification and Recent trends in climatology

Cartographic Techniques: Climatograph, Climograph, Hyther graph, Wind rose. Isothermal lines. Interpretation of satellite imageries showing daily weather forecast.

UNIT NO 2: GEOMORPHOLOGY:

Introduction: Definition, Nature, scope and fundamental concepts of geomorphology

Origin and Evolution of the earth: Continental Drift Theory, Palaemagnetism, Seafloor Spreading Theory, Plate Tectonic Theory. Davisian Cycle of Erosion.

Landforms: Fluvial Landforms, Karst Landforms, Glacial Landforms, Aeolian Landforms.

Techniques: Average slope analysis, Relative and absolute relief, Dissection Index, Millor's Isotan maps, drainage Density, drainage frequency, Drainage network hierarchy- Hartshon's and Strahlers methods.

UNIT NO 3: ECONOMIC GEOGRAPHY:

Introduction: Definition, Nature and Scope, Approaches, Bran chases and recent trends in Economic Geography.

Theories and Models: Von Thunen's Theory of Agricultural Location, Weber's Theory of Industrial Location, Rostow's model, Myrdal's Model, Friedman's Core Periphery Model.

Economies of scale: Agglomeration and Growth Poles. External and Internal Economies of scale.

Statistical Techniques: Crop combination, Crop concentration, Crop diversification, Intensity of crops, Network analysis, Dispersion of settlements, Growth of Urban Population, Degree of Urbanization, Functional classification of towns.

UNIT NO 4: POPULATION AND SETTLEMENT GEOGRAPHY:

Introduction: Nature and scope, Approaches, Sources of Population data, Factors influencing distribution of population, Types of population density.

Fertility and Mortality: Measures of Fertility and Mortality, Factors influencing fertility and Mortality, Composition of Population- Age, Sex, Religion and Economic Compositions of Population.

Population Theories: Demographic Transition, Optimum Population Theory and Karl Marks Theory.

Statistical and Cartographic Techniques used in the study of Population and settlement Geography

UNIT NO 5: GEO-STTISTICAL METHODS:

Techniques: Central Tendencies, correlation of co-efficient, Regression, residual from regression, least square and semi average method.

Sampling techniques: Significance of Sampling, Types of sampling,

UNIT NO 6: GEOINFORMATICS:

Application of computer in geographic data analysis: Application of Excel worksheet, If condition command, Advance filter, conditional formatting,

Remote sensing; Definition, History, electromagnetic spectrum, Aerial Photographs, Scale of aerial Photographs, Camera calibration, types of platforms, types of sensors, satellite imageries, annotation of satellite imageries, calculation of scale, Types of satellites, Recent development of Remote sensing, Major centers of remote sensing.

GPS; Introduction to GPS, functions, applications and advance development in GPS

GIS: What is GIS? Views of a GIS, What you Can Do With GIS? Objectives and tasks of GIS, Coordinate System, Geographic Coordinate System, Projected Coordinate Systems, Vector And Raster Data Models, Definition Of Attributes, Types Of Attribute, DEM, GIS software.

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|| अंतरी पेटवू ज्ञानज्योत ||

NORTH MAHARASHSTRA UNIVERSITY

SYLLABUS FOR Ph. D.
ENTRANCE TEST

PAPER – II

FACULTY : ENGINEERING & TECHNOLOGY

Mechanical Engineering

1. Mathematics:

1.1 Differential Equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

1.2 Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations, Solution of ordinary differential equation, Iterative methods, Finite Difference Method.

1.3 Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

2. Mechanical Engineering Group:

A) Heat Power:

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

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: *Power Engineering*: Steam Tables, Rankine, Brayton cycles with regeneration and reheat. *I.C. Engines*: air-standard Otto, Diesel cycles. *Refrigeration and air-conditioning*: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes. *Turbomachinery:* Pelton-wheel, Francis and Kaplan turbines - impulse and reaction principles, velocity diagrams.

B) Production Engineering:

Machining and Machine Tool Operations: Basic machine tools; machining processes-turning, drilling, boring, milling, shaping, planing, gear cutting, thread production, broaching, grinding, lapping, honing, super finishing; mechanics of machining - geometry of cutting tools, chip formation, cutting forces and power requirements, Merchant's analysis; selection of machining parameters; tool materials, tool wear and tool life, economics of machining, thermal aspects of machining, cutting fluids, machinability.

Product Design and Development: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering.

Production Planning and Inventory Control: Forecasting techniques - causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory - functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation - manufacturing applications; PERT and CPM, time-cost trade-off, resource leveling.

Quality Management: Quality - concept and costs, quality circles, quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000; design of experiments - Taguchi method.

C) Design Engineering:

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

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, 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; strain energy methods; thermal stresses.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

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

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, spur gears, rolling and sliding contact bearings, brakes and clutches.

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Civil

Operations Research Techniques:

Importance of Operations Research (OR), Applications of OR techniques in decision making, systematic approach in problem solving, optimization of processes.

Numerical methods:

Importance of numerical methods, linear curve fitting techniques, polynomial curve fitting techniques, numerical differentiation, numerical integration, numerical solution of polynomial equations, interpolation and extrapolation, numerical solution of ordinary differential equations, numerical solution of partial differential equations, stability and convergence.

Computer fundamentals:

Fundamentals of computer operations, common languages, languages for scientific applications, types of variables, ability to write simple programs with IF, GOTO conditions and LOOPS, matrix operations, familiarity with software Microsoft word, Microsoft excel and Microsoft power point.

Project management techniques:

Elements of project management, role of a leader, event and activity, bar charts, Critical Path Methods (CPM) and Project Evaluation and Research Techniques (PERT) methods.

Statistics:

Concept of average, mean, mode, median, standard deviation, weight of observation, size of sample, grab and composite samples, representative samples.

Theory of probability:

Elements of probability theory, addition and subtraction of probability.

Theory of errors:

Significant figures, accuracy and precision, error definition, truncation error, round off error, total numerical error, human error, instrumental error, systematic error, cumulative error, compensating error, blunders, formulation error, data uncertainty.

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Electronics Engineering

Basic Electronics

Energy band diagram, Fermi level. Carrier concentration under thermal equilibrium, and their temperature dependence. Extrinsic and Intrinsic Semiconductors.
Carrier Transport, Drift, Diffusion, Excess carriers, Recombination, continuity equation, Poission's equation.
P-n junction, current-voltage, small signal capacitance, switching.
BJT, carrier profile, dc and ac characteristics.
Schottky diodes, ohmic contact.
MOS capacitor C-V characteristics, MOSFET threshold voltage and I-V characteristics
Basic bipolar and MOSFET process step technology.
Diode and its applications.
Basic FET and Bipolar Transistor amplifier circuits and parameters of amplifiers. Operational amplifier and its applications. Negative feedback and frequency compensation. Positive feedback and oscillators.
Filters, AGC, AVC and amplitude stabilization of oscillators.
Voltage regulators and power amplifiers, modulators, demodulators and mixers.

Networks & Control Systems

Network topology , Node-pair and loop analysis of networks containing independent and dependent sources, Sinusoidal steady state analysis of single-phase and 3-phase circuits, Resonance, Symmetrical components , Magnetically coupled circuits,. Fourier series and transform, Laplace transform, Analysis of RLC networks using Laplace transform, network functions for one-port and two-port networks , Impulse response and superposition integral, Network theorems , State variables , Formulation of state equations of RLC-networks and solutions , Discrete systems.

Open-loop and Closed-loop systems; Servomechanisms and regulator problems ; Transfer function; Block diagram algebra ; Signal flow graphs; Mathematical Models for Physical Systems : Mechanical translational and rotational systems; Gear trains; dc generator and motors; Transportation lag systems; Analogs: Components like potentiometers as error sensing devices; Synchros; as servomotor; tachometers; Concept of stability; necessary and sufficient conditions for stability; Routh-Hurwitz criterion; Transient Response; Typical inputs; Time-domain specifications; Steady state errors; error series; system error and Non-unity feedback systems; Frequency response; Bode plots: both semilog coordinates and, log-log coordinates; Frequency domain specifications: Gain Margin and phase Margin; Nyquist stability criterion; M and N circles; Nichols chart; Root locus and Root Contours;

State-variable representation of systems; Phase variables: Solution of state equations, controllability and observability.

Power Electronics & Power Systems

Semiconductor Devices in switched mode - Diode, SCR, BJT, IGBT, MOSFET - drivers, protection, thermal aspects - ratings

Figures of merit - ripple factor, average value, Harmonic factor, Distortion factor, THD, Power factor, Crest factor

Power in switching circuits -

2-pulse Midpoint converter - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap - use in DC drives.

3-pulse converter - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap - use in DC drives.

Bridge converters - three phase and single phase - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap - use in DC drives.

Buck, Boost, Buck-Boost Converters - circuit steady state analysis - current and voltage ripple estimation - discontinuous and continuous modes of operation. Use of SCR in buck converters - commutation circuit.

Inverters - 120 deg. and 180 deg. conduction operation - selective harmonic elimination - McMurray inverter - SPWM, unipolar and bipolar switching

Single phase AC Voltage Controller - analysis and operation

Snubbers - turn on, turn off, snubbers - RCD snubber

Modeling of transmission lines, synchronous machines and transformers, one-line diagram per unit (p.u) computation; Symmetrical and Unsymmetrical fault analysis; Power System Protection , Design of relays; Zone of protection; primary and backup protection; protection of transmission lines and transformers.

Communication Theory

Review of Fourier Techniques: Fourier transform properties, spectral density, Hilbert transforms, bandpass signals and complex envelopes,

Probability Theory and Random Process: Random variables, distribution and density functions, expected values, transformations Specification of a random process, stationary, ensemble averages, correlation functions, power spectra, filtering of random signals, Gaussian processes, noise, matched filtering

Basic Digital Communication: Vector space representation of digitally modulated signals, optimal receiver for additive white Gaussian noise, performance of binary and M-ary modulation schemes- PSK and QAM, power spectra of linearly modulated signals

Review on fundaments of optical Communication Fiber Cable characterization and testing splicing, connectors, design of Local area network installation-link consideration-power budget and rise-time budget, local area network, cabling of local area networks, testing troubleshooting and measurement.

Components of fiber optic networks, fiber optic networks-an overview, transceivers for fiber optic networks, semi conductor optical fibers. Erdium-doped fiber amplifiers.Passive components, switches and functional modules of fiber-optic networks-couplers/splitters, wavelength division multiplexers and demultiplexers, filters, isolators, circulators and attenuators. Optical switches and functional modules.

Review on satellite fundaments. Satellite link design: Design of down links, uplink design, design of satellite links for specified (C/N) Interference effects in complete link design, Satellite Transponders : Function and implementation of transponder, transmission impairments Spread spectrum technique direct sequence spread spectrum techniques, DS-CDMA, FM-SS FH-SS CDMA, Synchronization and applications.

Encoding and forward error correction for digital satellite links, Error detection and correction, channel capacity, error detection coding, implementation of error detection on satellite links, echo controlling Earth station : transmissions, receivers, antennas, tracking system, terrestrial interface primary power test methods

Digital Signal Processing

The Discrete Fourier Transform :

Representation of periodic sequences – the Discrete Fourier series – properties of the Discrete Fourier series – Fourier representation of finite duration sequences – The Discrete Fourier Transform properties of the Discrete Fourier Transform – Linear Convolution using the Discrete Fourier Transform – Two dimensional DFT.

Computation of the Discrete Fourier Transform:

Efficient computation of the DFT – FFT Algorithms -Direct computation of the DFTc - Radix – 2 FFT algorithm- Radix – 4 FFT algorithm - Implementation of FFT algorithm A linear Filtering approach to computation of the DFT - The Geortzel algorithm The chirp – Z – Transformation algorithm- Quantization errors in the direct computation of the DFT and FFT algorithms.

Digital Filters Design:

FIR – Filters-Magnitude response and Phase response of Digital Filters - Frequency response of linear phase FIR filters - Design techniques for FIR Filters - Design of optimal Linear phase FIR Filters IIR – Filters - IIR Filter Design by Impulse Invariant method-IIR Filter Design by the Bilinear Transformation-Butterworth Filters – Chebyshev Filters – Inverse Chebyshev filters – Elliptic Filters – Frequency transformation

Discrete Hilbert Transforms :

Real and Imaginary part sufficiency for causal sequences – minimum-phase condition – Hilbert Transform Relations for the DFT – Hilbert Transform Relations for complex sequences.

Power Spectrum Estimation :

Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – parametric method for power spectrum Estimation.

Electromagnetic Field Theory

Vector fields. Divergence and Stokes theorems. Overview of Electrostatics and Magnetostatics.

Poissons Equation: Derivation, applications, existence and uniqueness. Dielectrics, Displacement vector. Capacitance matrix, Energy in the field.

Amperes Law: B Field calculations. Vector potential. The magnetic dipole. Magnetization of materials.

Faraday Law: Induced emf in stationary and moving coils. Inductance. Inductance matrix. Energy in the magnetic field.

Maxwell Equation: The wave equation. Poynting theorem. Poynting theorem for phasors.

Transmission Lines: The high-frequency circuit. LCR ladder model. The transmission line equation. Solution for loss-less lines. Wave velocity and wave impedence. Reflection and Transmission coefficients at junctions. VSWR.

Plane Waves: Solution of the wave equation in vacuum. Wave velocity and impedence. Normal and Oblique incidence at interfaces. Penetration into conducting surfaces â€“ skin effect. Reflection off dielectric layers.

Introduction to waveguides: Guided waves. Modes and their cutoffs. The TEM wave and the transmission line limit.

Antennas: The half-wave dipole antenna. Radiation patterns. Antenna gain and directivity.

Digital Systems

Combinational circuits: Karnaugh maps; Design of single and multiple output circuits using gates, MSI Ics, ROMs and PLAs.

Sequential circuits: Analysis and design of synchronous circuits; Analysis of asynchronous circuits.

Design of practical digital systems using state diagram/ASM chart techniques.

Instrumentation and Measurements

Analog indicating instruments; Q-meter; Hall effect instruments; rms, average and peak reading electronic instruments; Galvanometers; CRO and its applications; Errors in measurement, Systematic and Random errors, error analysis; DC and AC potentiometers, DC and AC bridges; Interference and noise: Screening and earthing: Instrument transformers; Digital instruments; Counters, A/D and D/A converters; Active and passive transducers; Instrumentation system for non electrical quantities, Thermo couples, Piezo electric type transducers.

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|| अंतरी पेटवू ज्ञानज्योत ||

NORTH MAHARASHSTRA UNIVERSITY

SYLLABUS FOR Ph. D.
ENTRANCE TEST

PAPER – II

FACULTY : MENTAL, MORAL & SOCIAL SCIENCES

Sociology

Module 1:- Basic Concept in Sociology :

1) Culture
2) Norms & Values
3) Social Institutions
   (Family, Marriage & Religion)
4) Social Stratification
   (Caste, Class, Gender & Ethnic)

Module 2:-Sociological Theories :

1) Liberal
2) Radical
3) Socialist

Module 3:- Sociological Thinkers :

1) Karl Marx
2) Emile Durkheim
3) Max – Weber
4) Talcott Parsons
5) Gramci
6) Giddens

Module 4:- Indian Social Thinkers :

1) G.S. Ghurye
2) M.N. Shriniwas
3) Radhakamal Mukherji
4) Leela Dubey
5) Mahatma Jyotiba Phule
6) Dr. B. R. Ambedkar

Module 5:- Sociology of Women :

1) Theories of gender relation
2) Social Movements of women
3) Women's Legislations
4) Women empowerment

Module 6:- Sociology of Education :

1) Basic Concepts
2) Social Components of Education
3) Education & Society
4) Education Policy in India

Module 7:- Development & Globalization :

1) Poverty
2) Health Education
3) Ecology
4) Tradition & Modernity in India

Module 8:- Methodology :

1) Nature of Social Research
2) Hypothesis
3) Research Design
4) Use of Sources & Aggregate data
5) Survey, Questionnaire & Structural Interview
6) Case Study & Unstructural Interview

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Social Work

Module 1:- Introduction to Social Work :

1) Introduction
2) Beginning of Social Work Education
3) Professionalization of Social Work, Values, Knowledge & Professional Associations.
4) Goals, Functions/Roles of Social Work.
5) Process of Social Work.

Module 2:- Methods of Social Works :

1) Case work
2) Group Work
3) Community Organization

Module 3:- Fields of Social Work – I :

1) Community Development
2) Urban, Rural & Tribal
3) Family & Child Welfare

Module 4:- Fields of Social Work – II :

1) Human Resource Management
2) Personnel Management & Industrial relations
3) Criminology & Correctional Administration

Module 5:- Social Reformers :

1) Rajaram Mohan Roy
2) Mahatma Phule
3) Shahu Maharaj
4) Mahatma Gandhi
5) Dr. Babasaheb Ambedkar

Module 6:- Social Policy & Programmes :

1) Govt. & non-Govt. Organizations
2) Social Development
3) Social & Human Development - Issues and approaches

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Psychology

Unit 1 : SENSATION, ATTENTION AND PERCEPTION :

1.1] **Sensation** - Introduction to Psychophysics : Basic concept and methods.
1.2] **Attention** - (a) Function of attention : Divided attention, Selective attention, (b) Theories of attention process, (c) signal detection theory and vigilance.
1.3] **Perception approaches** - Gestalt – Up (Feature analysis, Template matching, prototypes) Top – Down – and Pandemonium.
1.4] **Perception** - Cross cultural studies.
1.5] **Application** - Subliminal perception, perceptual defence, and extra sensory perception.

Unit 2 : PROBLEM SOLVING CREATIVITY AND DECISION MAKING:

2.1] **Problem** - Definition, problem solving cycle, types, obstacles and aids.
2.2] **Problem solving approaches** - Algorithm : heuristics ; means – end analysis, computer simulation and analogy.
2.3] Definition of creativity, measurment creativity.
2.4] **Reasoning and decision making** : Types of reasoning – syllogistic and conditional ; factors influencing decision making.
2.5] **Application** : Artificial intelligence.

Unit 3 : RELIABILITY VALIDITY :

3.1] Definition and types of Reliability and validity.
3.2] Correlation co-efficient : meaning, statistical significance, reliability co efficient.
3.3] Reliability of speeded tests and sample tested.
3.4] Content discription, validation, criterian prediction, construct identification, procedures.
3.5] Using reliability information and test validity and decision theory.

Unit 4 : CORRELATION AND REGRESSION :

4.1] Concept and Meaning of correlation.
4.2] Pearson's product – moment correlation.
4.3] Point – Biserial correlation and phi co-efficient.
4.4] Bi – serial and tetra choric correlation.
4.5] Partial and multiple correlation.
4.6] Simple linear Regression : concept and uses

Unit 5 : INFERENTIAL STATISTICS :

5.1] Inferences - Standard error of mean and other statistics.
5.2] Significance of difference for means variances and correlation co-efficients.
5.3] Assumptions of Analysis of variance, and one way ANOVA – Independent, Concept of repeated measures.
5.4] Two – way ANOVA – Independent, Concept of repeated measures
5.5] Analysis of Covariance : Concept.

Unit 6 : TYPES OF MEMORY AND NEUROLOGI CAL BASIS OF LEARNING AND MEMORY :

6.1] Sensory memory, Iconic memory, echoic STM, LTM, With types and determinants of memory.
6.2] Brain area associated with learning and memory.
6.3] Types of Amnesia after concussion (Anterograde, Retrograde) Korsakoff, Alzheimer's disease. Studies on role of brain in learning and conditioning.
6.4] Synaptic mechanisms and synaptic plasticity of learning and memory.
6.5] Application : Neuro – lignguistic programming.

Unit 7 : EXPERIMENTAL QUST EXPERIMENTAL DESIGNS :

7.1] Experimental designs : Definition, principles and functions.
7.2] Between group designs : Randomized group designs, Block group designs, Blockdesigns (a) Two group designs, (b) Randomized block designs with more than two groups.
7.3] Factorial designs : Simple factorial designs, Factorial designs with covariate, randomized block factorial designs.
7.4] Characteristics of and Types of Quasi experimental designs, Non equivalent control group designs, discontinuity, aromotion designs time series designs, cohort designs, Pre test – Post test design.
7.5] Scaling, purpose, Psychophysical scaling psychological scaling, Thurston type scale - and Likert types scale.

Unit 8 : SOCIAL PSYCHOLOGICAL APPROACH :

8.1] Definition Method and problems of social psychology.
8.2] Social perception, self perception, social cognition, Attribution process.
8.3] Attitude measurement, change, components, prejudices and discrimination.
8.4] Interpersonal attraction and communication, Need for social attraction, factors underline inter personal attraction. Altruism, Types of Communication.
8.5] Group dynamics and leadership, Group structure influence, leadership functions theories and types, function and types of group.

Unit 9 : PERSONALITY :

9.1] Approaches and methods.
9.2] Dispositional and psychoanalytical perspective.
9.3] Social and cognitive learning perspective.
9.4] Biological perspective and Neo psychoanalytical perspective.
9.5] Phenomenological and exintential perspective.

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Political Science

Module - I :- Political Theory

1) Liberalism
2) Marxism
3) Democracy
4) Nationalism

Module - II :- Political Thinkers

A . Western Political Thinkers

1) Plato
2) Aristotle
3) Machiavelli
4) Rousseau
5) Karl Marx
6) J.S. Mill

B. Indian Political Thinkers

1) B. G. Tilak
2) M.K. Gandhi
3) V. D. Sawarkar
4) Dr. B. R. Ambedkar
5) Jawaharlal Nehru
6) Abul Kalam Azad

Module - III :- Public Administration

1) Basic Concepts of Public Administration
2) Theories of Organization
3) Personnel Administration
4) Financial Administration
5) Development Administration
6) Bureaucracy
7) Good Governance
8) Public Policy- Models
9) Public Policy in India

Module IV: – International Relations :

1) Approaches to Study of International Relations
2) Power, Interest and Ideology in International Relations
3) Arms and Wars – Arms Control and Disarmament
4) Peaceful Settlement of Disputes
5) United Nations
6) Regional Organizations
7) Political Economy of International Relations
8) Globalization and non State actors

Module – V :- Comparative Politics :

1) Approaches to the Study of Comparative Politics
2) Constitutionalism
3) Forms of Government
4) Organs of Government
5) Electoral Systems and Party Systems
6) Bureaucracy
7) Dependency - Development and Underdevelopment

Module - VI :- Political Sociology :

1) Intellectual Foundations – Karl Marx, Max Weber
2) Political Culture, Political Socialization
3) Political Communication and Political Participation
4) Power, Authority and Legitimacy
5) Ideology and Hegemony
6) Political Elite
7) State and Welfare State
8) Social Movements
9) Bureaucracy

Module – VII :- Politics in India :

1) Nature of Indian Constitution
2) Fundamental Rights and Directive Principles
3) Federalism
4) Organs of Government
5) Electoral System and party system
6) Regionalism and National Integration
7) Panchayat Raj Institutions

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Defence and Strategic Studies

1. Strategic Studies :

a. Strategic Studies : Assumptions and Approaches.
b. Theories & Causes of War - Nature of Contemporary Warfare.
c. Deterrence : Concept, Nuclear Deterrence and Current Referance.
d. Nuclear Strategy : Historical Background - US - Nuclear Strategy - Soviet Nuclear Strategy - Russian Nuclear policy making - Chinese Nuclear Strategy - Indian Nuclear Strategy - Pakistan's Nuclear Strategy
e. Strategic Studies in the post cold war era.

2. Global and National Security :

a. Key concept of National Security : (i) Balance of power ,(ii) Collective Security (iii) United Nations ,(iv) Non alignment , (v) equal security , (vi) Common security.
b. Approaches to peace :(i) Diplomacy, (ii) International law, (iii) United Nations, (iv) Arms control and Disarmaments, (v) Track II diplomacy.
c. Human Rights : child, woman, sustainable communities and war.
d. Environmental issues : Global warming, Desertification, land sliding, acid rain, Transportation.
e. Organized Crimes : Money laundering, Narco trafficing and arms Trading.
f. International Terrorism : Impact and controlling measures.
g. Problems of India's Internal Security and the Role of the state political, economic, socio-cultural and other Dimensions, Terrorism, insurgency, Naxalist.

h. Defence Organization of India.

i) Higher Defence organization in India.
ii) Ministry of Defence.
iii) Paramilitary Forces.
iv) Intelligence Agencies.
v) Kargil Review Committee Recommendations.

j. India's External Security :

i) India and the United States (Post 1990-91).
ii) India and Russia (Post 1990-91)
iii) India and the Asia pacific (Post 1990-91)
iv) India and Europe (Post 1990-91)
v) India and West Asia (Post 1990-91)
vi) SAARC.

3. International Relations :

a. Theories and Approaches.
b. Cold war - Defence-New cold war-1989 changes in East Europe, Soviet disintegration.
c. Developments in the Third world : Regionalism, and Nonalignment.
d. Evaluation of International economic issues. Breton woods system; NIEO; North-South : GATT and WTO.
e. New world order and Globalization.

4. Geo-politics and Military Geography :

a. Scope and importance of Geo-politics.
b. Evaluation of Geo-political Thoughts. Since the 19th century-Geo-politics during the cold war period Geopolitics in the post cold war Era.
c. Role of Geography in Military Applications.
d. Man and Environment : (i) Determinism (ii) Positivism
f. Planning process and principles of strategic Geography.
g. Weather conditions of sea as factors in amphibious and Air borne operations.
i. Military Geography of India and Defence problems.

5. Defence economics & Production :

a. Contemporary economic Theories.
b. Determinants of Defence Expenditure.
c. India's Defence Budget.
d. Economic Instruments of policy.
e. An analysis of India's Defence expenditures since 1947.
f. Defence and Development.

(i) Future Technology and Defence Expenditure. (Nuclear, Space, Dual Technology).
(ii) Gun Butter problem.

6. Indian Art of War :

a. Art of war in Ancient period : (Vedic and Epic period).
b. Art of war in Medieval period of India.
c. Art of Maratha warfare.
d. The other regional Military traditions of Medieval period in India.
e. British period : The Making of the British Military forces - The command structure of British company's Army - The British Military - operations in the 19th century.
f. British Indian Army.
g. Indian National Army.

7. Science, Technology and National Security :

a. Introduction to Military Technology - It's relevance to National Security.
b. Introduction to emerging Technologies.

(i) Energy
(ii) Electronics, Computers, Nanotech, and Artificial Intelligence.
(iii) Material science.
(iv) Biotechnology.

c. Application of Technologies to :

(i) Armament and weapon systems.
(ii) Missile Technology
(iii) Communications and Radar Technology
(iv) Electronic warfare and Information warfare.
(v) RNBC warfare & Nuclear Energy.
(vi) Aircraft and ships.
(vii) Satellite and space Technology
(viii) Intelligance

(ix) Logistics (Transport, Supplies, Inventory, Medical, Repair, Clothing and equipment).
(x) Border Management.

d. Impact of Developing Technologies on Military Doctrine and Conduct of warfare.
e. Application of New Technologies for internal security, Disaster Management, Training and Administration.
f. Non-Military use of Modern Technologies and their impact on National security (Power and Energy, Trade, Economy, Banking, Media etc.)

8. Strategy for peace and conflict Resolution :

a. Conceptual Analysis of conflict and peace.
b. Conflict management and conflict Resolution.
c. UN system-pacific settlement of Disputes-peace keeping, peace making and Adjudication.
d. Disarmament and Arms Control.
e. Confidence Building measures.
f. Functional Approaches and Regionalism.
g. Gandhian Approach & its relevance today.
h. Comprehensive Security and Human Security
i. Peace Research and peace movements.

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Economics

Unit 1: Micro and Macro Economics :

- Demand Theory: Marshallian & Hicksian Approaches
- Theory of Production - Homogeneous, CES, Cobb Douglas
- Theory of Cost – Traditional Theory and Modern Theory of Cost including Engineering Cost
- Market Structure – Perfect Competition Monopoly, Monopolistic Competition and Oligopoly
- Output and Employment, Aggregate Demand and Supply
- Income, Consumption and Investment Demand Theory
- Inflation and Unemployment
- Theories of Business Cycles

Unit 2: International Trade, International Finance :

- Modern theory of trade and trade Policy
- Intra-Industry Trade, Free Trade versus Protection, Analysis of gains from free trade
- Theories of Balance of Payment and exchange rate determination
- Policy Conflicts and Adjustment under Fixed and Flexible Exchange Rates
- International Financial Institutions – Asian Development Bank, World Bank & WTO, IMF:

Unit 3: Money, Public Finance, Development and Growth Theory :

- Demand for Money -
  Overview of development of monetary theory and major issues
- Classical and Neo-classical theories of Money
- Money in Keynesian Framework: Liquidity Preference (L-P) Theory and Further Developments in L-P approach
- New Monetarism and its critique
- Theory of Money Supply, Money Multiplier Process, Exogeneity of Money Supply
- Reformulation of Quantity Theory-Chicago School
- Fiscal and Monetary Policy Approaches, Fiscal Federalism
- Tax reforms, Central Government Finances
- Public Expenditure, Structure and Growth
- Theories of under-development, Hirschman, Rostow, Lewis, Gunder Frank, Myrdal, Harris-Tadaro
- Growth Theories-- Classical, Neo-classical, Keynesian, Post-Keynesian and New Growth Theories, Sustainable Development

Unit 4: Indian Economic Policy :

- Indian Economy-An Overview
- Poverty, Income Distribution
- Migration and Demographic Transition
- Development Strategy Over the Plans,Economic Reforms, Plans after Reforms
- Financing of Infrastructure Development, Education Sector

- PSUs, Privatization and Disinvestment
- Patterns (structure) of lndia's Foreign Trade - Volume, Trends, composition, direction, etc., Export Performance and Export Competitiveness
- India's Trade Policy: Review of Pre- and Post-liberalization - Exim Policies, Export Promotion Policies, SEZs; Tariff Structure, RTAs and FTAs
- India and WTO: Uruguay Round, Highlights of Ministerial Meetings: Singapore to Hong Kong, Concerns of Advanced Countries (ACs) and Developing Countries (DCs), The Doha Development Agenda (DDA) and Concerns of India
- Land Reforms in India and their impact on Agrarian Structure
- Agricultural price policy in India
- Nature and Problems of Rural Development in India
- Rural industrialization and strategies
- Rural poverty and Rural employment programmes
- Indian Industry and Structural Changes
- Monetary Policy in India since Independence – Role and Functioning of the Reserve Bank of India

Unit 5: Statistical Techniques :

- Descriptive Statistics :
  Collection, Organization and presentation of Data, Measures of central tendency and dispersion- mean, median, mode, standard,
  Deviation, variance, covariance and correlation coefficients, Correlation and regression analysis, Measures of skewness and peaked ness.
- Sampling and sampling methods :
  Sample and Population, Parameters and Statistics, Variables and Attributes; sampling and non-sampling errors; Types of sampling
- Theory of Probability :
  Probability, distribution, Events spaces. Joint, Margianal and Conditional Probability under conditions of certainty and uncertainty. Random variable: Expectation and Distribution. Addition and Multiplication Theorems. Probability Distribution, discreet and continuous and Expected values.
- Probability Distribution Function :
  Binomial, Poisson, Normal t-test, chi-square, t-test
- Statistical Estimation and Testing of Hypothesis :
  Types of estimators and their properties. Sampling distribution for sample mean and Proportion. Point and Interval estimation. Null and Alternate Hypothesis. Level of significance and Level of confidence, Confidence limits and Critical, Region; Tests of significance- Type I and II errors
- Times series
  Nature and decomposition of a time series-trend. Cyclical, seasonal and random components. Fitting trend curves.
- Index numbers
  Laspeyer’s, Paasche’s andFisher’s Indices

History

Section I : Ancient Indian History (Pre history to 1206 A.D.)

Sources : Literary, Epigraphically, Coinage and Accounts of Foreign travelers.

Polity : Mauryan Administration.
Administration of Satvhanas
Administration of Guptas.
Administration of Vardhana dynasty.
Administration - Cholas, Pallvas, and Rastrakutas.
Administration of Yadavs.

Society : Social and cultural life in Vedic Age
Social, Cultural conditions during Maurya period
Socio – Cultural and Economic life during Gupta age.
Education in Ancient India.
Caste system in Ancient India.
Position of women in Ancient India.
Socio –Religious and economic conditions under the Yadavas.

Economy : Industries, Internal and foreign Trade in Ancient India.

Religion : Vedic Religion, Buddhism and Jainism
Art and Architecture in Ancient India,
Growth of cities and urbanization in Ancient India.
Recent trends and advances in Ancient Indian History.

Section 2 : Medieval Indian History (1206 A.D. to 1800 A.D.)

Section - 2A :

Sources : Literary, Epigraphically, Coinage, Accounts of foreign travelers etc.

Polity : System of Government during Sultanate period, Provincial Administration, Revenue System of Delhi Sultanate.

Central Administration under the Mughals.
Provincial and Revenue Administration under the Mughals.
Administration of Rajputs.
Central and provincial Administration of Muslim States in Deccan.
Judicial Administration under Delhi Sultanate.
Judiciary under the Mughals, and also under Vijayanagar kings.
Military Administration under Vijaynagar kings.

Society : Social conditions in India under the Delhi Sultanate.
Position of women under the Delhi Sultanate.
Education in India during Sultanate period.
Socio – Cultural life in India under the mughals.
Position of women and Education in India during Mughal period
Fairs and festivals.
Bhakti Movement in Medieval India,
Sufism in medieval India during Sultanate period and Mughal period.
Social structure in Medieval India during Mughal Period.
Education in India under Sultan of Delhi & the Mughals

Economy : Industries, trade and commerce in India during Sultanate period & Mughal period.
Architecture and Sculpture in Medieval India.
Growth of urbanization in Medieval India.
Recent trends and advances in research in medieval Indian History.

Section 2 B : History of the Marathas (1630 – 1818)
Sources of Maratha History :
Central -provincial Administration under Marathas,
Military administration of the Marathas,
Revenue system under the Marathas,
Social Structure and caste system in Maratha country,
System of Vatandari.
Position of Women in Maratha country.
Education system under the Marathas.
Industries, internal and foreign trade of the Marathas,
Banking system in Maratha Country,
Growth of religion in Medieval Maharashtra.
Judiciary under the Marathas.
Recent trends and advances in research in Maratha History.

Section 03 : India under East India Company -

Section 03A :

Administration of India under East India Company
Socio – Economic policies.
Growth of education in India under East India company.

Section 3B : Colonial Period -

Growth of Education in India up to Indian Independence.
Social awakening in India.
Social structure in India under British rule.
Rise and Growth of Nationalism in India.
Different Phases of Indian National Movement in India.
Factors leading to the Partition of India.
Growth of press in India under British rule,
Growth of Industries, trade and commerce in India under British rule.
Recent trends and advances in research in Modern Indian History.

Section 3C : Constitution of India –

Growth of Industries, trade, Road and transport system during post independence period.
Foreign Policies of India with Pakistan, China, Afganistan, Burma, Ceylon, Nepal, Bhutan.
Growth of Science and Technology in India.

Section 04 : Theories of History and Research Methodology -

Section 4A :Theories of History –

Nature and scope of History,
Philosophy and Theories of History,
Positivism in History,
Post Modernism and History.

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विषय - तत्वज्ञान

१. तत्वज्ञ

प्लेटो, ॲरिस्टॉटल, देकार्त, हयूम, कांट, मिल, हेगेल, मार्क्स, डयूई, विटगेन्सटाईन, रसेल, मूर हुसेर्ल, हायडेगर, सार्त्र, पॉपर,

२. भारतीय दर्शने

चार्वाक, बौध्द दर्शन, जैन दर्शन, न्याय, वैशेषिक, सांख्य, योग, पूर्वमीमांसा, अव्दैत वेदान्त.

३. तत्वज्ञान विषयातील क्षेत्रे :

अ) **नीतीशास्त्र (सैध्दान्तिक व अनुप्रयुक्त/उपयोजित)** :- स्वातंत्र्य आणि जबाबदारी, प्रयोजनवादी उपपत्ती, कर्तव्यवादी उपपत्ती, अधिनीतीशास्त्राची संकल्पना, वैद्यकीय नीतिशास्त्रातील प्रश्न, व्यावसायिक नीतिशास्त्रातील प्रश्न, पर्यावरणीस नीतिशास्त्रातील प्रश्न.

ब) **तर्कशास्त्र आणि ज्ञानमीमांसा** :- वाक्य आणि विधान, ज्ञानाची संकल्पना, सत्यता, समर्थन आणि वैधता. प्रमाणाचे प्रकार, ज्ञानविषयक उपपत्ती (वास्तववाद, कल्पनावाद, मानसघटनावाद), संशयवाद

क) **सत्ताशास्त्र :** 'स्व' विषयक संकल्पना, मोक्ष, संकल्प स्वातंत्र्य आणि नियतत्ववाद, ईश्वर, अशिवाची (दुरिताची) समस्या, वास्तवविषयक उपपत्ती (एकतत्ववाद, व्दितत्ववाद, वास्तववाद, अनेकतत्ववाद), परिवर्तन आणि तादात्म्य, कारणता विषयक उपपत्ती

ड) **धर्माचे तत्वज्ञान :** ईश्वराच्या अस्तित्वाच्या सिध्दतेसाठी देण्यात येणारे पुरावे (सत्ताशास्त्रीय, विश्वोत्पत्तिवादी, प्रयोजनवादी, कारणिक, अवलंबित्व विषयक युक्तिवाद), ख्रिस्ति, हिंदू, ईस्लाम धर्माचे प्रमुख सिध्दांत, धार्मिक अनुभव,

इ) **सामाजिक आणि राजकीय तत्वज्ञान :** वितरणात्मक न्याय, समतेची संकल्पना, स्वातंत्र्य, अधिकार आणि कर्तव्य, लोकशाही, स्त्रीवाद, आधुनिक भारतीय सामाजिक तत्वचिंतक,

फ) **सौंदर्यशास्त्र :** सौंदर्यशास्त्र व कलेच्या तत्वज्ञानाचे स्वरुप, कलाकृती बद्दलच्या विविध उपपत्ती, रस आणि ध्वनी, सौदर्यशास्त्रीय वृत्ती.

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