NEP and Learning Outcome-based Curriculum Framework (LOCF)

For

B.Sc. (Honours) Physics Programme

Academic Session (w.e.f. 2024-2025)

I & II SEMESTERS

DEPARTMENT OF PHYSICS

MAHARAJA SURAJMAL BRIJ UNIVERSITY BHARATPUR

Dr. Divyanshu Bhatnagar

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Scheme of Examination

The examination pattern comprises 20% internal assessment and 80% external assessment.

External Assessment

Theory Papers:

1. Each theory paper in the end-of-semester examination (EoSE) carries 80% marks.
2. The EoSE will be of 3 hours duration.
3. The questions will be designed in alignment with Bloom's Taxonomy.

Part A of the question paper shall contain 10 very short answer type questions covering the entire syllabus. Each question carries equal marks.

Part B of the question paper shall contain 04 descriptive type questions one from each unit with internal choice. Each question carries equal marks.

Value-Added Papers

1. Each theory paper in the end-of-semester examination (EoSE) carries 80% marks.
2. The EoSE will be of 2 hours duration.
3. Question paper shall contain 40 multiple choice questions covering the entire syllabus. Students have to attempt any 35 questions. Each question carries 1 mark.
4. If a student attempts more than 35 questions, only the first 35 attempted questions will be considered.

Practical:

Internal: continuous evaluation (20%).

External: end term practical record (20%), written exam (40%) and viva-voce (20%).

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SEMESTER-I

Course Title	Course Code	L	T	P	L	T	P	Total Credits	MARKS				
		(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)													
Mathematical Physics-I	UPSC-01	3	0	0	3	0	0	3	15	60	0	0	75
Mechanics	UPSC-02	3	0	0	3	0	0	3	15	60	0	0	75
Waves and Oscillations	UPSC-03	3	0	0	3	0	0	3	15	60	0	0	75
Physics Lab-1	UPLAB-01	0	0	6	0	0	3	3	0	0	15	60	75
Elective Course(s)													
Chemistry-I (Conductance and Electrochemistry)	UCGE-01	2	0	0	2	0	0	2	10	40	0	0	50
Statistical Methods and Data Analysis-I	UCGE-02	2	0	0	2	0	0	2	10	40	0	0	50
Basics of Drone Technology	UPGE-01	2	0	0	2	0	0	2	10	40	0	0	50
Introductory Astronomy-1	UPGE-02	2	0	0	2	0	0	2	10	40	0	0	50
Skill Enhancement Course(s)													
Electric Circuits and Networks	UPSEC-01	2	0	0	2	0	0	2	10	40	0	0	50
Ability Enhancement Course(s)													
Environmental Science and Sustainable Development-1	UAEC-01	2	0	0	2	0	0	2	10	40	0	0	50
Value-added Course(s)													
Science and Society	UVAC-01	2	0	0	2	0	0	2	10	40	0	0	50

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UPSC-01: MATHEMATICAL PHYSICS-I

Course Outcomes:

After completing this course, student will be able to,

- Draw and interpret graphs of various elementary functions and their combinations.
- Understand the vector quantities as entities with Cartesian components which satisfy appropriate rules of transformation under rotation of the axes.
- Use index notation to write the product of vectors in compact form easily applicable in computational work.
- Solve first and second order differential equations and apply these to physics problems.
- Understand the functions of more than one variable and concept of partial derivatives.
- Understand the concept of scalar field, vector field and gradient of scalar fields.
- Understand the properties of discrete and continuous distribution functions.

Unit I

Functions: Plotting elementary functions and their combinations, Interpreting graphs of functions using the concepts of calculus, Taylor's series expansion for elementary functions.

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Introduction to index notation and summation convention, Product of vectors – scalar and vector product of two, three and four vectors in index notation using δij and $sijk$ (as symbols only – no rigorous proof of properties), Invariance of scalar product under rotation transformation.

Unit II

Ordinary Differential Equations: First order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor, Applications to physics problems.

Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complimentary function, particular integral and general solution, Determination of particular integral using method of undetermined coefficients and method of variation of parameters, Cauchy-Euler equation, Initial value problems. Applications to physics problems.

Unit III

Multi-Variable Functions: Functions of more than one variable, Partial derivatives, chain rule for partial derivatives. Scalar and vector fields, concept of directional derivative, the vector differential operator, gradient of a scalar field and its geometrical interpretation.

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Unit IV

Probability Distributions: Discrete and continuous random variables, Probability distribution functions, Binomial, Poisson and Gaussian distributions, Mean and variance of these distributions.

References/Books:

1. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
2. Differential Equations, George F. Simmons, 2007, McGraw Hill.
3. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
4. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
5. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
6. Probability and Statistics, Murray R Spiegel, John J Schiller and R Alu Srinivasan, 2018, McGraw Hill Education Private Limited.
7. Essential Mathematical Methods, K.F.Riley and M.P.Hobson, 2011, Cambridge Univ. Press.
8. Vector Analysis and Cartesian Tensors, D.E. Bourne and P.C. Kendall, 3 Ed. , 2017, CRC Press.
9. Vector Analysis, Murray Spiegel, 2 Ed., 2017, Schaum's outlines series.
10. John E. Freund's Mathematical Statistics with Applications, I. Miller and M. Miller, 7th Ed., 2003, Pearson Education, Asia.

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UPSC-02: MECHANICS

Course Outcomes:

Upon completion of this course, students will be able to,

- Learn the Galilean invariance of Newton's laws of motion.
- Understand translational and rotational dynamics of a system of particles.
- Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
- Understand Einstein's postulates of special relativity.
- Apply Lorentz transformations to describe simultaneity, time dilation and length contraction.
- Use various instruments for measurements and perform experiments related to rotational dynamics, elastic properties, fluid dynamics, acceleration due to gravity, collisions, etc.
- Use propagation of errors to estimate uncertainty in the outcome of an experiment and perform the statistical analysis of the random errors in the observations.

Unit I

Fundamentals of Dynamics: Inertial and Non-inertial frames, Newton's Laws of Motion and their invariance under Galilean transformations. Momentum of variable mass system: motion of rocket. Dynamics of a system of particles, principle of conservation of momentum. Impulse. Determination of centre of mass of discrete and continuous objects having cylindrical and spherical symmetry, Differential Analysis of a static vertically hanging massive rope.

Work and Energy: Work and Kinetic Energy Theorem. Conservative forces and examples (Gravitational and electrostatic), non-conservative forces and examples (velocity dependent forces e.g. frictional force, magnetic force). Potential Energy. Energy diagram. Stable, unstable and neutral equilibrium. Force as gradient of the potential energy. Work done by non-conservative forces.

Collisions: Elastic and inelastic collisions. Kinematics of $2 \rightarrow 2$ scattering in centre of mass and laboratory frames.

Unit II

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical) using parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force and its applications.

Unit III

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Central Force Motion: Central forces, Law of conservation of angular momentum for central forces, Two-body problem and its reduction to equivalent one-body problem and its solution. Concept of effective potential energy and stability of orbits for central potentials of the form kr^n for n = 2 and -1 using energy diagram, discussion on trajectories for $n = -2$. Solution of Kepler's problem, Kepler's laws for planetary motion, orbit for artificial satellites.

Unit IV

Relativity: Postulates of special theory of relativity, Lorentz transformations, simultaneity, length contraction, time dilation, proper length and proper time, Life time of a relativistic particle (for example muon decay time and decay length). Space-like, time-like and light-like separated events. Relativistic transformation of velocity and acceleration. Variation of mass with velocity, Mass-energy Equivalence. Transformation of Energy and Momentum.

References/Books:

1. An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
2. Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education
3. Theory and Problems of Theoretical Mechanics, Murray R. Spiegel, 1977, McGraw Hill Education.
4. Classical Mechanics by Peter Dourmashkin, 2013, John Wiley and Sons.
5. https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dour mashkin)/
6. Introduction to Classical Mechanics With Problems and Solutions, David Morin, 2008, Cambridge University Press.
7. Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
8. Introduction to Special Relativity, Robert Resnick, 2007, Wiley.

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UPSC-03: WAVES AND OSCILLATIONS

Course Outcomes:

On successful completion of this course, the students will have the skill and knowledge to,

- Understand travelling and standing waves, stretched strings
- Understand simple harmonic motion
- Understand superposition of N collinear harmonic oscillations
- Understand superposition of two perpendicular harmonic oscillations
- Understand free, damped and forced oscillations
- Understand coupled oscillators and normal modes of oscillations

Unit I

Wave Motion: One dimensional plane wave, classical wave equation, standing wave on a stretched string (both ends fixed), normal modes. Travelling wave solution.

Unit II

Simple Harmonic Motion: Differential equation of simple harmonic oscillator, its solution and characteristics, energy in simple harmonic motion, linearity and superposition principle, rotating vector representation of simple harmonic oscillation, motion of simple and compound pendulum (Bar and Kater's pendulum), loaded spring.

Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences, Beats

Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies, effect of variation of phase

Unit III

Damped Oscillations: Equation of motion, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor

Forced Oscillations: Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation, quality factor

Unit IV

Coupled Oscillations: Coupled oscillators, normal coordinates and normal modes, energy relation and energy transfer, di-atomic molecules, representation of a general solution as a linear sum of normal modes, normal modes of N coupled oscillators.

References/Books:

1. Vibrations and Waves by A. P. French. (CBS Pub. and Dist., 1987)
2. The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988)

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3. Fundamentals of Waves and Oscillations By K. Uno Ingard (Cambridge University Press, 1988)
4. An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
5. Waves: BERKELEY PHYSICS COURSE by Franks Crawford (Tata McGrawHill, 2007).
6. Classical Mechanics by Peter Dourmashkin, John Wiley and Sons
7. https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dour mashkin)

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UPLAB-01: PHYSICS LAB-I

Course Outcomes:

After successful completion of the course on Physics lab, a student will be able to:

• Develop skills in precision measurements and error analysis using mechanical systems.

• Demonstrate understanding of mechanical properties like moment of inertia, friction, viscosity, and elasticity through practical experiments.

• Apply principles of simple harmonic motion, damping, and resonance to analyze oscillatory systems.

• Use electronic instruments such as CRO to investigate waveforms and study superposition, Lissajous figures, and tuning fork vibrations.

Every student must perform at least 8 experiments (4 from each section) from the following sections:

Section A: List of Practical's (Mechanics)

1) To study the random errors in observations. It is advisable to keep observables of the order of least count of the instruments.
2) To determine the moment of inertia of a symmetric as well as asymmetric flywheel
3) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
4) To determine g and velocity for a freely falling body using Digital Timing Technique.
5) To determine the Young's Modulus of a Wire by Optical Lever Method.
6) To determine the vertical distance between two given points using sextant.
7) To determine the coefficients of sliding and rolling friction experienced by a trolley on an inclined plane.
8) To verify the law of conservation of linear momentum in collisions on air track.

Section B: List of Practical's (Waves and Oscillations)

1) Experiments using bar pendulum:
   a) Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM.
   b) Determine the value of g using bar pendulum.
   c) To study damped oscillations using bar pendulum
   d) Study the effect of area of the damper on damped oscillations. Plot amplitude as a function of time and determine the damping coefficient and Q factor for different dampers.
2) To determine the value of acceleration due to gravity using Kater's pendulum for both the cases (a) $T\_1 \approx T\_2$ and (b) $T\_1 \neq T\_2$ and discuss the relative merits of both cases by estimation of error in the two cases.

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3) Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO
4) Study the superposition of two simple harmonic oscillations using CRO: Study of Lissajous figures
5) Experiments with spring and mass system
   a) To calculate g, spring constant and mass of a spring using static and dynamic methods.
   b) To calculate spring constant of series and parallel combination of two springs.
6) To study normal modes and beats in coupled pendulums or coupled springs.
7) To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify $\lambda^2 - T$ Law.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments.

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UCGE-01: CHEMISTRY-I

(CONDUCTANCE AND ELECTROCHEMISTRY)

Course Outcomes:

By the end of the course, the students will be able to:

- Understand factors influencing conductance and ionic mobility.
- Apply conductance measurements to determine physical and chemical properties.
- Explain electrochemical cells, electrode potentials, and EMF.
- Use EMF and potentiometric methods for titrations and pH determination.

Unit I

Fundamentals of Conductance: Quantitative aspects of Faraday's laws of electrolysis. Arrhenius theory of electrolytic dissociation. Conductivity: equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions. Wein Effect and Debye–Falkanhegan Effect.

Unit II

Applications of Conductance: Transference number and its experimental determination using Hittorf and moving boundary methods, Ionic mobility, applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid base).

Unit III

Basics of Electrochemistry: Reversible and irreversible cells with Examples, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, standard electrode potential (reduction Potential) and its application to Gas–ion half-cell. Electrochemical series.

Unit IV

Applications of Electrochemistry: Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference, liquid junction potential; determination of activity coefficients and salt bridge, pH determination using hydrogen electrode. Potentiometric titrations qualitative treatment (acid-base and oxidation-reduction only).

References/Books:

1. Castellan, G.W. (2004), Physical Chemistry, Narosa.

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2. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.

3. Kapoor, K.L. (2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.

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UCGE-02: STATISTICAL METHODS AND DATA ANALYSIS-I

Course Outcomes:

By the end of the course, the students will be able to:

- Familiar with interpretation and use of analytical data collected by different techniques.
- Significance of different analytical techniques and their applications.
- Reliability and presentation of data for reporting to different forum.

Unit I: Basics of Chemical Analysis

Analytical Chemistry, Qualitative and quantitative analysis, Analytical methodology. Calibration of glass wares, recording laboratory data.

Unit II: Different Methods of Chemical Analysis

Titrimetric method: volumetric titremetry, standard solution, titrimetric curve, calculation;

Gravimetric method: precipitation gravimetry, calculation and applications of gravimetry; and

Spectrometric methods: introduction, principle and instrument, working quantitative aspects

absorbance, applications in chemical analysis

Unit III: Accuracy and Precision

Comparison of precision, Errors, Distribution of random errors, propagation of errors, measurement of errors, significant figure, inter laboratory error.

Unit IV: Statistical Method of Chemical Analysis

Methods of least square analysis of variance, Q test, Z test, T test, statistical treatment of finite sample, recommendations for treating outliers. Minimising errors in analytical procedure.

References/Books:

1. Dey, R. A. and Underwood, A. L., Quantitative Analysis, 6th Edition, Pearson.

2. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Fundamental analytical chemistry, Thomson Asia Ltd.

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UPGE-01: BASICS OF DRONE TECHNOLOGY

Course Outcomes:

After completing this course, students will be able to:

• Explain the fundamentals, types, and key applications of drones.

• Describe the system architecture of drones, including mechanical, hardware, and software components.

• Analyze the physical structure, components, and integration methods used in drone systems.

• Interpret the role of sensors, computing systems, and control mechanisms in drone operations.

Unit I

Introduction to Drone Technology: Definition and history of drones, Types and classification: by structure, by autonomy, by altitude, by application, by wing type, Drone mission types: Combat, Logistics, Civil, Reconnaissance, Target & decoy, Research & development (R&D), Overview of drone parts: Airframe, Motors, Propellers, Payloads, Applications of drones: Military, Industrial (agriculture, inspection), Commercial.

Unit II

Drone System Architecture: design approach-Mechanical design elements: Industrial Design (ID) structure, Frame, Enclosure, Hardware components: PCBA (Printed Circuit Board Assembly), System-on-Chip (SOC) types, Subsystems: input, output, storage, and communication, Software architecture: Firmware, OS and drivers, Sensing, navigation, and control systems, Application-specific components.

Unit III

Physical and Functional Integration: Physical structure of drones and mechanical stack-up, Actuators: Types and roles in drones, Propeller types: Carbon fiber vs. plastic propellers, Motors and heat management in drone design, UAV Sensors and Degrees of Freedom (DOF).

Unit IV

Drone Computing Systems and Integration: UAV computing systems: Flight controllers, Inertial Measurement Units (IMUs), Single-Board Computers (SBCs), Autopilot systems, Functional block diagram of a drone, System integration techniques.

References/Books:

1. "Getting Started with Drones" by Terry Kilby & Belinda Kilby.
2. "The Drone Book: How Unmanned Aircraft Changed the World" by Jack Symes

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UPGE-02: INTRODUCTORY ASTRONOMY

Course Outcomes:

After completing this course, students will be able to:

• Different types of telescopes, diurnal and yearly motion of astronomical objects, astronomical coordinate systems and their transformations

• Brightness scale for stars, types of stars, their structure and evolution on HR diagram.

Unit I

Introduction to Astronomy and Astronomical Scales: History of astronomy, wonders of the Universe, overview of the night sky, diurnal and yearly motions of the Sun, size, mass, density and temperature of astronomical objects, basic concepts of positional astronomy: Celestial sphere, Astronomical coordinate systems, Horizon system and Equatorial system

Unit II

Basic Parameters of Stars: Stellar energy sources, determination of distance by parallax method, aberration, proper motion, brightness, radiant flux and luminosity, apparent and absolute magnitude scales, distance modulus, determination of stellar temperature and radius, basic results of Saha ionization formula and its applications for stellar astrophysics, stellar spectra, dependence of spectral types on temperature, luminosity classification, stellar evolutionary track on Hertzsprung-Russell diagram

Unit III

Astronomical Instruments: Observing through the atmosphere (Scintillation, Seeing, Atmospheric Windows and Extinction). Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical telescopes, radio telescopes, Hubble space telescope, James Web space telescope, Fermi Gamma ray space telescope.

Unit IV

Astronomy in the Internet Age: Overview of Aladin Sky Atlas, Astrometrica, Sloan Digital Sky Survey, Stellarium, virtual telescope

Citizen Science Initiatives: Galaxy Zoo, SETI@Home, RAD@Home India

References/Books:

1. Seven Wonders of the Cosmos, Jayant V Narlikar, Cambridge University Press
2. Fundamental of Astronomy, H. Karttunen et al. Springer
3. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley Publishing Co.
4. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College Publishing.

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UPSEC-01: ELECTRIC CIRCUIT ANALYSIS

Course Outcomes:

At the end of the course the student will be able to,

- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and their difference
- Solve complex electric circuits using network theorems.
- Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
- Evaluate the performance of two port networks.

Unit-I

Circuit Analysis: Ideal voltage source, real voltage source, current source, Kirchhoff's current law, Kirchhoff's voltage law, node analysis, mesh analysis, Star and Delta conversion.

Unit-II

DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RL circuit with initial current, time constant, RL and RC Circuits with source

Unit-III

AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak to peak, root mean square and average values, form factor and peak factor (for half-rectified and full-rectified sinusoidal wave, rectangular wave and triangular wave).

Unit-IV

Voltage-current relationship in resistor, inductor and capacitor, phasor, complex impedance, power in AC circuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits

References/Books:

1. Electric Circuits, S. A. Nasar, Schaum's outline series, Tata McGraw Hill (2004)
2. Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education (2004)
3. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
4. Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)

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UAEC-01: ENVIRONMENTAL SCIENCE AND SUSTAINABLE DEVELOPMENT-I

Course Outcomes:

After completing this course, students will be able to:

- Understand key natural systems and processes essential for sustaining life.
- Identify human impacts on the environment and global sustainability.
- Evaluate strategies for environmental protection and sustainable development.
- Adopt responsible attitudes and practices towards environmental conservation.

Unit I

Fundamentals of Environmental Studies: Multidisciplinary nature of environmental studies, Components of the environment: atmosphere, hydrosphere, lithosphere, biosphere; Scope and importance of environmental studies, Concept of sustainability and sustainable development, Brief history and evolution of environmentalism.

Unit II

Ecosystem Basics: Definition and concept of ecosystems, Structure: biotic and abiotic components, Functions of ecosystems: Physical (energy flow), Biological (food chains, food webs. ecological succession), Biogeochemical (nutrient cycling) processes, Concepts of productivity, ecological pyramids, and homeostasis.

Unit III

Types of Ecosystems: Overview of major ecosystem types: Terrestrial: Tundra, Forest, Grassland, Desert; Aquatic: Ponds, Streams, Lakes, Rivers, Oceans, Estuaries; Importance and threats to these ecosystems, with examples from India.

Unit IV:

Ecosystem Services and Conservation: Provisioning, Regulating, Cultural, and Supporting; Strategies for ecosystem preservation and conservation, Basics of ecosystem restoration

References/ Books:

1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). Environment, 8th Edition. Wiley Publishing, USA.

2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

3. Odum, E.P., Odum, H.T., and Andrews, J. (1971). Fundamentals of Ecology. Saunders, Philadelphia, USA.

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4. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg , L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA.

5. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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UVAC-01: SCIENCE AND SOCIETY

Course Outcomes:

After successful completion of the course, a student will be able to:

- Understand the philosophy of science and the scientific method.
- Recognize the interrelation of science, technology, and traditional practices.
- Identify key developments in modern science and their societal impacts.
- Appreciate the contributions of Indian scientists and women in science.

Unit I

Philosophy and Method of Science: Philosophy of science, Scientific method, Role of observation, rational thinking, questioning, and experimental design, Myths vs. facts in scientific inquiry.

Unit II

Traditional Practices and Indigenous Knowledge: Water harvesting structures and sustainable practices, Traditional architecture and eco-friendly materials, Indigenous agricultural practices and domestication, Contributions of ancient Indian scientists and women in science.

Unit III

Science and Public Welfare: Public health: nutrition, hygiene, physical and mental health; Vaccines, antibiotics, and antimicrobial resistance; Food security: Green and White Revolutions.

Unit IV

Modern Science and Technology: IT revolution and e-governance, Clean and renewable energy technologies, Space science and exploration, Ecology, evolution, and environmental sustainability

References/Books:

1. Basu and Khan (2001). Marching Ahead with Science. National Book Trust
2. Gopalakrishnan (2006). Inventors who Revolutionised our Lives. National Book Trust
3. Yash Pal and Rahul Pal (2013) Random Curiosity. National Book Trust
4. Hakob Barseghyan, Nicholas Overgaard, and Gregory Rupik. Introduction to History and Philosophy of Science
5. John Avery {2005). Science and Society, 2nd Edition, H.C. 0rsted Institute, Copenhagen.
6. Dharampal (2000). Indian Science and Technology in the Eighteenth Century, OIP.

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SEMESTER-II

Course Title	Course Code	L (Hrs)	T (Hrs)	P (Hrs)	L (Credits)	T (Credits)	P (Credits)	Total Credits	MARKS TI	TE	PI	PE	Total
Core Course(s)													
Mathematical Physics-II	UPSC-04	3	0	0	3	0	0	3	15	60	0	0	75
Electricity and Magnetism	UPSC-05	3	0	0	3	0	0	3	15	60	0	0	75
Modern Physics	UPSC-06	3	0	0	3	0	0	3	15	60	0	0	75
Physics Lab-2	UPLAB-02	0	0	6	0	0	3	3	0	0	15	60	75
Elective Course(s)													
Chemistry-II (Coordination and Organometallic Compounds)	UCGE-02	2	0	0	2	0	0	2	10	40	0	0	50
Statistical Methods and Data Analysis-II	UCGE-04	2	0	0	2	0	0	2	10	40	0	0	50
Engineering Materials	UPGE-02	2	0	0	2	0	0	2	10	40	0	0	50
Introductory Astronomy-2	UPGE-04	2	0	0	2	0	0	2	10	40	0	0	50
Skill Enhancement Course(s)													
Programming using Python	UPSEC-02	2	0	0	2	0	0	2	10	40	0	0	50
Ability Enhancement Course(s)													
Environmental Science and Sustainable Development-2	UAEC-01	2	0	0	2	0	0	2	10	40	0	0	50
Value-added Course(s)													
Indian Knowledge System	UVAC-02	2	0	0	2	0	0	2	10	40	0	0	50

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UPSC-04: MATHEMATICAL PHYSICS-II

Course Outcomes:

After successful completion of the course on mathematical physics-II, a student will be able to:

- Understand the concept of divergence and curl of vector fields.
- Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's theorems to compute these integrals. The students will be also enabled to apply these to physics problems.
- Use curvilinear coordinates to problems with spherical and cylindrical symmetries.
- Represent a periodic function by a sum of harmonics using Fourier series

Unit – I

Vector Calculus: Divergence and curl of a vector field and their physical interpretation. Laplacian operator. Vector identities, Integrals of vector-valued functions of single scalar variable. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields. Flux of a vector field. Gauss divergence theorem, Green's and Stokes' Theorems (no proofs) and their applications.

Unit – II

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Scale factors, element of area and volume in spherical and cylindrical coordinate Systems. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems.

Unit – III

Some Special Integrals: Beta and Gamma Functions and relation between them, expression of integrals in terms of Gamma and Beta Functions.

Unit – IV

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series). Parseval's Identity.

References/Books:

1. Mathematical methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.
2. Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
3. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

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4. Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge Univ. Press.
5. Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3 Ed., 2017, CRC Press.
6. Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's outlines series.
7. Fourier analysis: With Applications to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.

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UPSC-02: ELECTRICITY AND MAGNETISM

Course Outcomes:

After successful completion of the course Electricity and Magnetism, a student will be able to:

• Apply Coulomb's law to line, surface, and volume distributions of charges.

• Apply Gauss's law of electrostatics to distribution of charges

• Solve boundary value problems using method of images

• Comprehend the genesis of multipole effects in arbitrary distribution of charges

• Understand the effects of electric polarization and concepts of bound charges in dielectric materials

• Understand and calculate the vector potential and magnetic field of arbitrary current distribution

• Understand the concept of bound currents and ferromagnetism in magnetic materials

UNIT-I

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge. Divergence of electric field using Dirac Delta function, Curl of electric field, electric field vector as negative gradient of scalar potential, Ambiguities of Electric potential, Differential and integral forms of Gauss's Law, Applications of Gauss's Law to various charge distributions with spherical, cylindrical and planar symmetries.

UNIT-II

Boundary Value Problems in Electrostatics: Formulation of Laplace's and Poisson equations. The first and second uniqueness theorems. Solutions of Laplace's and Poisson equations in one dimension using spherical and cylindrical coordinate systems and solutions in three-dimensional using Cartesian coordinates applying separable variable technique. Electrostatic boundary conditions for conductors and capacitors.

Special techniques for the calculation of Potential and Field: The Method of Images is applied to a system of a point charge and finite continuous charge distribution (line charge and surface charge) in the presence of (i) a Plane infinite sheet maintained at constant potential, and (ii) a Sphere maintained at constant potential.

UNIT-III

Multipole Expansion: Monopole, dipole and quadrupole potentials at large distances due to an arbitrary charge distribution expressed in terms of Legendre polynomials, negative Gradient of Dipole potential in spherical coordinates.

Electric Field in Matter: Polarization in matter, Bound charges and their physical interpretation. Field inside a dielectric, Displacement vector D, Gauss' Law in the presence of dielectrics

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Boundary conditions for D, Linear dielectrics, Electric Susceptibility and Dielectric Constant, idea of complex dielectric constant due to varying electric field. Boundary value problems with linear dielectrics.

UNIT-IV

Magnetic Field: Divergence and curl of magnetic field B, Magnetic field due to arbitrary current distribution using Biot-Savart law, Ampere's law, Integral and differential forms of Ampere's Law, Vector potential and its ambiguities, Coulomb gauge and possibility of making vector potential divergenceless, Vector potential due to line, surface and volume currents using Poisson equations for components of vector potential.

Magnetic Properties of Matter: Magnetization vector. Bound currents, Magnetic intensity. Differential and integral form of Ampere's Law in the presence of magnetised materials. Magnetic susceptibility and permeability. Ferromagnetism (Hund's rule).

Electrodynamics: Faraday's Law, Lenz's Law, inductance, electromotive force, Ohm's law ($\vec{J} = \sigma\vec{E}$), energy stored in a magnetic Field.

References/Books:

1. Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

2. Schaum's Outlines of Electromagnetics by J. A. Edminister and M. Nahvi.

3. Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.

4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.

5. Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.

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UPSC-06: MODERN PHYSICS

Course Outcomes:

After successful completion of the course on modern physics, a student will be able to:

• Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics, laying the foundation of modern physics.

• Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.

• The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Basic lasing action.

• The properties of nuclei like density, size, binding energy, nuclear force and structure of atomic nucleus, liquid drop model and mass formula.

• Radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.

• Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.

UNIT-I

Origin of Modern Physics Blackbody Radiation: Failure of explanation from classical theory; Planck's idea of a quantum; Quantum theory of Light: Photo-electric effect and Compton scattering. de Broglie wavelength and matter waves; Davisson-Germer experiment; Wave description of particles by wave packets. Group and Phase velocities and relation between them.

Problems with Rutherford model: Instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen-like atoms and their spectra.

UNIT-II

Uncertainty principle: Gamma ray microscope thought experiment; Wave-particle duality leading to Heisenberg uncertainty principle; Impossibility of an electron being in the nucleus. Energy-time uncertainty principle; origin of natural width of emission lines.

Basics of quantum Mechanics: Two-slit interference experiment with photons and electrons; Concept of wave functions, linearity and superposition. Time independent Schrodinger wave equation for non-relativistic particles; Momentum and Energy operators; physical interpretation of a wave function, probabilities, normalization and probability current densities in one dimension. Problem: One dimensional infinitely rigid box. An application: Quantum dot.

UNIT-III

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X-rays: Ionizing Power, X-ray Diffraction, Bragg's Law. Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley's Law.

LASERs: Properties and applications of Lasers. Emission (spontaneous and stimulated emissions) and absorption processes, Metastable states, components of a laser and lasing action.

UNIT-IV

Nuclear Physics: Size and structure of atomic nucleus and its relation with atomic weight; Nature of nuclear force, Stability of the nucleus; N-Z graph, Drip line nuclei, Binding Energy, Liquid Drop model: semi-empirical mass formula.

Radioactivity: Different equilibrium, Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: Fission and fusion: Mass deficit and generation of energy; Fission: nature of fragments and emission of neutrons. Fusion and thermonuclear reactions driving stellar evolution (brief qualitative discussions only).

References/Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

2. Modern Physics by R A Serway, C J Moses and C A Moyer, 3rd edition, Thomson Brooks Cole, 2012.

3. Modern Physics for Scientists and Engineers by S T Thornton and A Rex, 4th edition, Cengage Learning, 2013.

4. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication, 1974.

5. Quantum Mechanics: Theory and Applications, (2019), Ajoy Ghatak and S. Lokanathan, Laxmi Publications, New Delhi.

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UPLAB-02: PHYSICS LAB-2

Course Outcomes:

After successful completion of the course on Physics lab, a student will be able to:

• Demonstrate the ability to measure electrical parameters such as current sensitivity, charge sensitivity, and high resistance using ballistic galvanometer techniques.

• Apply bridge methods like Carey Foster's, Anderson's, and Owen's to accurately determine unknown resistances, self-inductance, and mutual inductance in electrical circuits.

• Analyse the behaviour of RC, RL, LC, and LCR circuits in series and parallel configurations, including resonance phenomena.

• Measure and interpret magnetic fields and induction effects using solenoids, Helmholtz coils, and electromagnetic braking setups to validate laws of electromagnetism.

• Perform experiments to determine fundamental constants such as Planck's constant, charge of an electron, and e/m ratio.

• Demonstrate quantum phenomena such as photoelectric effect, thermionic emission, and quantum tunnelling through experimental methods.

• Analyse atomic spectra and optical diffraction patterns to validate theoretical models of atomic structure and wave behaviour.

• Apply experimental techniques using lasers, LEDs, and spectrometers to understand the wave-particle duality and quantum mechanical principles.

Every student must perform at least 8 experiments (4 from each section) from the following sections:

Section A: List of Practical's (Electricity and Magnetism)

1) Ballistic Galvanometer Experiments

   a. Measurement of current and charge sensitivity of a ballistic galvanometer

   b. Measurement of critical damping resistance of a ballistic galvanometer

   c. Determination of high resistance by the leakage method using a ballistic galvanometer

2) Measurement of Resistance Using Bridge Methods

   a. Determination of an unknown low resistance by Carey Foster's Bridge

   b. Calibration of bridge apparatus for precision measurements

3) RC, LC, RL and LCR Circuits

   a. Series and Parallel RC, LC, RL and LCR circuits

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b. Resonance in Series and Parallel RC, LC, RL and LCR circuits

4) Measurement of Self-Inductance

   a. Measurement of self-inductance of a coil using Anderson's Bridge

   b. Measurement of self-inductance of a coil using Owen's Bridge

5) Measurement of Mutual Inductance

   a. Determination of mutual inductance between two coils using the Absolute method

   b. Verification of coupling effect and dependence on coil separation

6) Field Mapping and Magnetic Measurements

   a. Measurement of magnetic field strength (B) and its variation along the axis of a solenoid (determine dB/dx)

   b. Verification of linear variation and estimation of solenoid parameters from field distribution

7) The Magnetic Field from the Helmholtz Coil

   a. Variation of the magnetic field due to a circular current-carrying coil on an axial point

   b. Determination of Helmholtz Coil radius

   c. Verification of Superposition principle using Helmholtz coil

8) Experiments on Electromagnetic Induction and Electromagnetic Braking

   a. Study of the electromotive force (EMF) induced as a function of the velocity of the magnet

   b. Study of the charge delivered due to induction

   c. Study of electromagnetic (EM) damping

Section B: List of Practical's (Modern Physics)

1) Measurement of Planck's constant using black body radiation and photo-detector

   a. Study the spectral distribution of black body radiation.

   b. Determine Planck's constant from the radiation curve using a photo-detector.

2) Photo-electric effect

   a. Estimate Planck's constant using a graph of maximum energy of photo-electrons versus frequency of light.

   b. Study the stopping potential for different frequencies of incident light.

3) Work function determination using vacuum diode

   a. Study the thermionic emission from a directly heated filament.

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b. Determine the work function of the filament material.

4) Planck's constant using LEDs

    a. Measure threshold voltage for at least four different color LEDs.

    b. Plot energy vs. frequency graph and calculate Planck's constant.

5) Hydrogen spectrum experiment

    a. Observe the H-alpha emission line in Hydrogen using a spectrometer.

    b. Determine its wavelength using diffraction grating.

6) Determination of e/m

    a. Use magnetic focusing method to measure specific charge of the electron.

    b. Alternatively, use bar magnet setup for measurement.

7) Millikan oil drop experiment

    a. Measurement of the terminal velocity of the oil drop.

    b. Determine the charge of an electron using balance of electric and gravitational forces.

8) Tunnel diode experiment

    a. Obtain I–V characteristics of a tunnel diode.

    b. Demonstrate the quantum tunneling effect.

9) Laser single slit diffraction

    a. Observe and record diffraction pattern of laser through a single slit.

    b. Determine the wavelength of the laser source.

10) Laser double slit diffraction

    a. Record the interference pattern of laser through double slits.

    b. Determine the wavelength of the laser source.

11) He-Ne laser diffraction using plane grating

    a. Record diffraction pattern of He-Ne laser through a plane transmission grating.

    b. Determine wavelength and angular spread.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments.

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UPGE-03: ENGINEERING MATERIALS

Course Outcomes:

After successful completion of the course on Engineering Materials, a student will be able to:

- Identify and classify key engineering materials including metals, ceramics, polymers, composites, and carbon-based nanomaterials.
- Explain the principles and techniques of top-down and bottom-up nanomaterial synthesis methods.
- Demonstrate an understanding of thermal and chemical processing techniques such as annealing, sintering, and green synthesis.
- Illustrate the applications and processes involved in thin-film fabrication techniques including PVD, CVD, and photolithography.

Unit I:

Engineering Materials: Introduction to engineering materials, Properties and applications of Metals and Alloys, Ceramics: types, properties, and uses, Polymers and Composites, Carbon-based nanomaterials (graphene, CNTs, fullerenes).

Unit II:

Nanomaterials Synthesis Techniques: Top-down vs. Bottom-up approaches, Mechanical milling: Ball milling, Wet chemical methods: Co-precipitation, Sol-gel synthesis, Green synthesis of nanomaterials.

Unit III:

Advanced Synthesis and Processing Techniques, Hydrothermal and Solvothermal synthesis, Thermal treatments: Annealing and sintering, Process parameters and their impact on material properties.

Unit IV:

Thin Film Deposition and Fabrication: Vacuum deposition and Thermal evaporation, Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD), Photolithography: Principles and applications in micro/nanofabrication.

References/Books:

1. "Materials Science and Engineering: An Introduction" by William D. Callister Jr. and David G. Rethwisch
2. "Nanostructures and Nanomaterials: Synthesis, Properties and Applications" by Guozhong Cao and Ying Wang
3. "Introduction to Nanoscience and Nanotechnology" by Gabor L. Hornyak et al.
4. "Thin Film Technology Handbook" by Aicha Elshabini and Fred D. Barlow III

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UPGE-04: INTRODUCTORY ASTROPHYSICS-2

Course Outcomes:

After successful completion of the course, a student will be able to:

- Explain the structure and activity of the Sun, the origin of the solar system, and planetary dynamics.
- Describe methods of exoplanet detection and explain their significance in astronomy.
- Analyse galactic structures, rotation curves, dark matter evidence, and the fundamental aspects of cosmology and astrobiology.
- Outline the historical and contemporary development of astronomy in India, including major observatories and space missions.

UNIT-I

Sun and the solar system: Solar parameters, Sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, origin of the solar system, the nebular model, tidal forces and planetary rings.

UNIT-II

Exoplanets: Detection methods and characterization.

Physics of Galaxies: Basic structure and properties of different types of Galaxies, Nature of rotation of the Milky Way (Differential rotation of the Galaxy), Idea of dark matter.

UNIT-III

Cosmology and Astrobiology: Standard Candles (Cepheids and SNe Type1a), Cosmic distance ladder, Olber's paradox, Hubble's expansion, History of the Universe, Chemistry of life, Origin of life, Chances of life in the solar system.

UNIT-IV

Astronomy in India: Astronomy in ancient, medieval and early telescopic era of India, current Indian observatories (Hanle-Indian Astronomical Observatory, Devasthal Observatory, Vainu Bappu Observatory, Mount Abu Infrared Observatory, Gauribidanur Radio Observatory, Giant Metre-wave Radio Telescope, Udaipur Solar Observatory, LIGO- India) (qualitative discussion), Indian astronomy missions (Astrosat, Aditya).

References/Books:

1. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College Publishing.
2. The Molecular Universe, A.G.G.M. Tielens (Sections I, II and III), Reviews of Modern Physics, Volume 85, July-September, 2013
3. Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer

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UCGE-03: COORDINATION AND ORGANOMETALLIC COMPOUNDS

Course Outcomes

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Apply standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Explain the meaning of the terms Δ_o, Δ_t, pairing energy, CFSE, high spin and low spin. Explain how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy and use it to explain behaviour of organometallics

Unit 1: Coordination Chemistry

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit-2 Bonding in Coordination compounds

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_o. Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Unit 3: Organometallic Compounds

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene.

Unit 4: Metal Carbonyls

18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

References:

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1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.

2. Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), Inorganic Chemistry, Pearson.

3. Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.

4. Pfennig, B. W. (2015), Principles of Inorganic Chemistry. John Wiley & Sons.

5. Cotton, F.A.; Wilkinson, G. (1999), Advanced Inorganic Chemistry Wiley-VCH.

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UCGE-04: STATISTICAL METHODS AND DATA ANALYSIS-II

Course Outcomes:

By the end of the course, the students will be able to:

• Understand key statistical tools such as confidence intervals and hypothesis testing for analytical data interpretation.

• Apply least square methods and evaluate figures of merit for data calibration and performance evaluation.

• Demonstrate proficiency in sampling techniques, sample handling, and laboratory data management.

• Analyse the role of standards, calibrations, and multivariate techniques in modern analytical methodologies.

Unit I: Statistical Foundations in Analytical Chemistry

Confidence interval, Testing of hypothesis, plotting of data, least square method.

Unit II: Analytical Performance Evaluation and Quality Control

Figures of merit: sensitivity, detection limit, linear dynamic range, control test, upper control limit and lower control limit, Validation, reporting analytical results and significant figures.

Unit III: Sampling Techniques and Sample Handling

Analytical samples, sample size, constituent sample, real samples, sample, sample handling, preparing laboratory samples, automated sample handling, lab on chip.

Unit IV: Laboratory Standards and Calibration Methods

General laboratory principles, recording laboratory data, standards, comparison of standards, internal standard, external standards calibration, least square method, and multivariant calibration.

References/Books:

1. Encyclopaedia of analytical chemistry: Applications, Theory, and Instrumentation, R A Meyor (Eds) Wiley and Sons (2000).

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UAEC-02: ENVIRONMENTAL SCIENCE AND SUSTAINABLE DEVELOPMENT-II

Course Outcomes:

After completing this course, students will be able to:

• Understand the causes and impacts of climate change on human health, biodiversity, and global economy.

• Analyse international environmental agreements and their relevance in addressing climate-related challenges.

• Assess the role of renewable energy sources in promoting sustainable development and environmental conservation.

• Evaluate the importance of environmental justice and movements in shaping national and global policies.

Unit I

Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture.

International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc.

Unit II

Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions.

Human population growth: Impacts on environment, human health, and welfare; Carbon foot-print.

Unit III

Resettlement and rehabilitation of developmental project affected persons and communities; relevant case studies.

Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc.

Unit IV

Environmental justice: National Green Tribunal and its importance.

Renewable Energy Sources: Solar Energy, Wind Energy, Hydropower, Biomass and Bioenergy, Tidal and Wave Energy, Hydrogen and Fuel Cells, Geothermal Energy.

References/ Books:

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1. Divan, S. and Rosencranz, A. Environmental Law and Policy in India: Cases, Material & Statutes.
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. Environment.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environmental Science and Conservation.

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UVAC-02: INDIAN KNOWLEDGE SYSTEM

Course Outcomes:

After successful completion of the course, a student will be able to:

- Understand the foundational concepts and scope of Indian Knowledge Systems (IKS).
- Examine the historical and cultural evolution of IKS from ancient to modern India.
- Explore the technological and scientific advancements of ancient India in fields such as aeronautics, metallurgy, and astronomy.
- Analyse archaeological and literary evidence supporting India's contributions to early science and engineering.

Unit I

Introduction to Indian Knowledge Systems (IKS): Definition, Concept and Scope of IKS, IKS-based approaches on Knowledge Paradigms, IKS in Ancient and Modern India, Genesis of the Land and Antiquity of Civilization, Traditional Knowledge System: Concept of Matter, Life and Universe.

Unit II

Scientific Thought and Technology in Ancient India: Sage Agastya's Model of Battery, Concept of Gravity and Velocity of Light, Vimāna: Aeronautics in Ancient Texts, Vedic Cosmology and Modern Concepts, Bhāratīya Kāla-gaṇanā (Indian Time Calculation).

Unit III

Astronomy and Cosmological Understanding: History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth's Sphericity and Rotation, Archeoastronomy in Ancient India.

Unit IV

Material Sciences and Archaeological Insights: Laboratory Tools and Apparatus in Ancient India, Traditional Juices, Dyes, Paints, and Cements, Glass and Pottery Production, Metallurgy and Engineering in the Vedic & Post-Vedic Age Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Bet–Dwārkā Marine Technology and the Sindhu Valley Civilization.

References/Books:

1. The Knowledge System of Bhārata by Bhag Chand Chauhan.
2. Pride of India: A Glimpse of India's Scientific Heritage, edited by Pradeep Kohle
3. History of Science in India, Volume I and Volume VIII, edited by Sibaji Raha
4. India's Glorious Scientific Tradition by Suresh Soni.
5. Science and Technology in Ancient India by Debiprasad Chattopadhyaya.

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