SYLLABUS FOR M.Sc. IN PHYSICS

UNDER

CHOICE BASED CREDIT SYSTEM
(CBCS)

(To be effective from 2018-19)

Head
University Department of Physics
B.R.A. BIHAR UNIVERSITY
Muzaffarpur-842001

Babasaheb Bhim Rao Ambedkar Bihar University, Muzaffarpur

Ist SEMESTER

			Assignment		10
			Seminar/Quiz		10
			Attendance, Punctuality & Conduct		05
Practical Paper		Credit 04		Total Marks: 100	
Oral/Semester Examination (ESE)	4 Hours		1 Experiment to be performed		80
Internal Assessment (CIA)					20
Elective Practical and presentation of Dissertation	4 Hours	1 Experiment to be performed plus Dissertation presentation		80+20	80
III Of Practical and Dissertation					20

Program Outcomes:

The recent developments in Physics, has been included in the enriched M.Sc. (Physics) Syllabus to meet the present day needs of Academic and Research Institutions and Industries. An important objective of the course is to develop an understanding of 'core physics' at deeper levels, each stage revealing new phenomena and greater insight into the behavior of matter and radiation. The various courses in the first two semesters, are designed to bridge the gap between college and university level physics and to bring all students to a common point. These courses also aim to consolidate the college level knowledge of physics by providing much more logical and analytical framework which will be essential for the specialization courses in the third and fourth semesters. After the completion of their M.Sc. Students will have :

1. Strong analytical abilities.

2. Qualities needs for teaching of Science and doing research.

3. Knowledge of theoretical as well as experimental areas of Physics.

4. Capabilities to generate self-employment.

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5. Computational Skill and ICT development.

SEMESTER I

MPHYCC-1 : Classical Mechanics (5 Credits)

Course Objectives:

1. To give students a solid foundation in classical mechanics.

2. To introduce general methods of studying the dynamics of particle systems.

3. To give experience in using mathematical techniques for solving practical problems.

4. To apprise the students of Lagrangian and Hamiltonian formulations and their applications.

5. To apprise the students regarding the concepts of electrodynamics and its use in various situations.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The question paper will be divided into three parts A, B and C. Part A will have two compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit [10 x 2 = 20]. Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 =20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Lagrangian Dynamics and Hamiltonian formulation Constraints, Principal of Virtual Work, D' Alembert's principle and its applications Lagrange's question and its applications factor integral and energy conservation. Concept of symmetry, velocity dependent potential. Variational calculus and least action principle. Hamilton's Principle Lagrange's equation from Hamilton's principle, Legendre transformation. Hamilton's function and Hamilton's equation of motion configuration space and phase space. Hamilton's equation from variational principle.

Unit 2 : Canonical transformations and Hamilton Jacobi theory : Generating function, Canonical transformation and its examples, Group property, Lagrange and Poisson brackets and other canonical invariants, equation of motions. Infinitesimal canonical theorem in Poisson bracket formalism, Jacobi principle and characteristic functions with example, the harmonic oscillator, Separation of variable in Hamilton-Jacobi equation; Action-angle variables and its examples – the Kepler problem in action-angle variables.

Unit 3 : Central Force Motion and Rigid Body : Reduction to one-body problem. General Properties of central force, Effective potential, Motion in a central force field-general solution, Inverse Square Law force. Kepler's Law – laws of gravitation from Kepler's laws, Virial theorem. Scattering in a central force field and in Laboratory Co-ordinates. The rigid bodies, Kinematics of rigid body motion, Orthogonal transformations, Euler's theorem and its applications. Finite and infinitesimal rotations, rate of change of a vector, the rigid body equation of motion. Coriolis effect, angular momentum and kinetic energy of motion about a point, the inertia tensor and the moment of inertia, the principal axis transformation, the Euler equations of motion.

Unit 4 : Small Oscillation : Formulation of the problem, Eigenvalue equation and the principal axis transformation, frequencies of free vibrations and normal coordinates, forced vibrations and the effect of dissipative forces. Resonance and beats.

Unit 5 : Relativity : Review of special theory of relativity –Lorentz transformations, 4-vectors, 4-dimensional velocity and acceleration, 4-momentum and 4-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle. General theory of relativity; Curved space-time; Eotvos experiment and the equivalence principle.

Course Outcomes:

1. Knew the difference between Newtonian mechanics and Analytic mechanics.

2. Solve the mechanics problems using Lagrangian formalism, a different method from Newtonian mechanics.

3. Understand the connection between classical mechanics and quantum mechanics from Hamiltonian formalism.

4. Understanding of basic concepts of special and general theory of relativity.

Reference

1. N.C. Rana & P S Joag, Classical Mechanics, McGraw Hill, First Edition 2011

2. Herbert Goldstein, Charles P. Poole, and John L. Safko, Classical Mechanics, Pearson, Third Edition 2011.

3. John R. Taylor, Classical Mechanics, University Science Books, First Edition 2005.

4. David Morin, Introduction to Classical Mechanics, Cambridge University Press, First Edition 2008.

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MPHYCC-2 MATHEMATICAL PHYSICS (5 CREDITS)

Course Objectives:

1. To develop knowledge of mathematical Physics and its application.
2. To develop expertise in mathematical techniques those are required in Physics.
3. To enhance problem solving skills.
4. To give the ability to formulate, interpret and draw inferences from mathematical solutions.

The End Semester Question will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts, A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with four questions from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have two long answer questions with question from each unit. The student is required to answer any three (out of five) (3 x 10 = 30).

Unit 1 : Linear Differential Equations and Special Functions:

Linear Differential Equations, Power series solution, Special Functions: Hermite, Legendre, Bessel, Lauguerre Polynomials, Fourier and Laplace Transforms.

Unit 2 : Elements of Complex analysis:

Analytic functions, Taylor and Laurent series, calculus of residues, nature of singularities, Evaluation of definite integrals, Jordan's Lemma.

Unit 3: Group Theory:

Groups, subgroups, cosets, invariant subgroups, factor groups, homomorphism and isomorphism, orthogonality theorems, Continuous groups with Special reference to O(3), SU(2), SU(3).

Unit 4 : Elementary Tensor Analysis:

Coordinate Transformations, Contravariant and covariant vectors, Contravariant, covariant and mixed tensors, tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, metric tensor, conjugate tensors and associated tensors.

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Unit 5 : Geodesic Christoffel's symbol, Parallel displacement vector, Riemann-Christoffel tensor, Epsilon tensor, Christoffel's 3 index symbol.

Course Outcomes:

1. Master the basic elements of complex mathematical analysis.
2. Solve differential equations that are common in physical sciences.
3. Apply group theory and integral transforms to solve mathematical problems of interest in physics.
4. Understanding how to use special functions in various physics problems.
5. Properties of covariance and principle of equivalence.

Reference :

1. Jerfkovk & Weber, Mathematical Methods for Physicist, Elsevier, Sixth Edition 2012.
2. Murray R. Spiegel, Schaum's Outline of Advanced Mathematics for Engineer and Scientists, McGraw Hill, First Edition 2009.
3. Mary L. Boas, Mathematical Methods in the Physical Sciences, John Wiley, Third Edition 2005.
4. Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, and Dennis Spellman, Schaum's Outline of Complex Variables, McGraw Hill, Second Edition 2009.

MPHYSC 3 QUANTUM MECHANICS (5 CREDITS)

Course Objectives:

1. To illustrate the inadequacy of classical theories and the need for a quantitative theory.
2. To explain the basic principles of quantum mechanics.
3. To develop valid and systematic mathematical methods for quantum mechanics.
4. To apply quantum mechanics to simple systems occurring in atomic and solid state physics.

That End Semester Examination will be of 3 hour duration and will carry 70 marks. The questions paper will be divided into three parts A, B and C. Part A will have two compulsory questions (multiple choice type) covering the whole syllabus with atleast one from each unit (10 x 2=20). Part B will have six short answer questions, with one question from each unit. The student is required to answer any

four out of them (4 × 5 = 20), Part C will have six long answer questions with one question from each unit. The student is required to answer any three out of them (3 × 10 = 30).

Unit 1: Basics of Quantum mechanics :

Origin of quantum mechanics, particle aspects of radiation, wave aspect of radiation, particle versus waves, intermediate nature of microphysical world quantization rules and wave packets.

Unit 2: Mathematical Foundations :

Linear vector spaces, dimensionality, basis, eigenvalue equations, orthogonality and completeness conditions; Observables, Dirac's Bra and Ket notation, Properties of Hermition operators, unitary and similarity transformation, Operators, Fourier Transform. Wave function as fa vector in Hilbert space, Superposition principle; Representations. Relation between ket and wave function. Eigenvalue spectrum of linear momentum and its wave functions; Transformation between coordinate and momentum representations, Ehrenfest Theorem.

Unit 3 : Quantum Dynamics:

Schrodinger, Heisenberger and Interaction pictures, Linear Harmonic Oscillator solution using Schrodinger picture and Heisenberg picture (Matrix Mechanics). Angular Momentum, Spin and parity operators: symmetry and conservation principle definition of angular momentum, ladder operators, allowed values, construction of angular momentum matrices, Spin and Pauli spin matrices; Coupling of angular momentum, C.S. Coefficients.

Unit 4 : Perturbation theory:

Time independent perturbation theory for discrete levels – non-degenerate and degenerate cases, removal of degeneracy. Spin-Orbit coupling, Fine Structure of Hydrogen, Variation method, Time dependent perturbation theory, - constant and periodic perturbations. Fermi Golden rule, WKB approximation, sudden and adiabatic approximations.

Unit 5 : Scattering theory:

Quantum Scattering theory Differential and total cross sections scattering amplitude, Formal expression for scattering amplitude – Green's functions. Born approximation – Application to spherically symmetric potentials.

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Course Outcomes:

1. To have a working knowledge of the foundations, techniques and key results of quantum mechanics.
2. To comprehend basic quantum mechanical applications at the research level
3. Gain an ability to competently explain/teach quantum physics to others.

Reference :

1. B.H. Bransden and C.J. Joachain, Quantum Mechanics, Pearson, Second Edition 2007.
2. David J. Griffiths, Introduction to Quantum Mechanics, Pearson, Second Edition 2009.
3. Yoav Peleg, Reuven Pnini, ElyahuZaarur, and Eugene Hecht. Schaum's Outline of Quantum Mechanics, McGraw Hill, Second Edition 2010.
4. P.M. Mathews and K. Venkatesan, Quantum Mechanics, McGraw Hill, Second Edition 2010

MPHYCC-4 LAB-1 [5 CREDITS]

Course Objectives:

1. To make the student familiarize with the basics of experimental physics.
2. To enable the student to explore the concepts involved in the thermodynamics and heat.
3. To make the student understand the basic concepts in modern optics.
4. To allow the student to understand the fundamentals of instruments involved.

List of experiments (minimum 12) :

1. Measurement of Hall Coefficient of given semiconductor: Identification of type of semiconductor and estimation of charge carrier concentration.
2. Young's Modulus-Elliptical fringe method
3. Young's Modulus- Hyperbolic fringe method.
4. Four probe Method- Determination of resistivity of semiconductor at different temperatures.
5. Determination of Ultrasonic velocity in gm liquid for a fixed frequency.
6. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne Laser.
7. Measurement of laser parameters using He-Ne laser/diode laser.
8. Refractive Index of liquids/Using He-Ne laser/Diode laser.

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9. Determination of wavelength of a laser by Michelson Interferometer method

10. Determination of semiconductor band gap

11. Thermistor -Determination of energy gap

12. Determination of numerical aperture of an optical fiber

13. Determination of wavelength of a laser source using diffraction grating.

14. Determination of operating voltage of a GM tube and determine the linear absorption

15. Determination of operating voltage of a GM tube and verify inverse- square law

16. Direct reading of Zeeman effect (a/m of an electron) with a laser source

17. Compact microwave training system Experiment

18. Stefan's constant

19. Susceptibility – Guoy and Quneke's methods.

20. Hydrogen spectrum and solar spectrum – Rydberg constant.
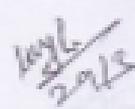
Course Outcome

At the end of the course.

1. The student should have knowledge of the different experimental techniques.

2. The student should have understood the basics of physics involved in experiments.

3. The student should be able to apply the concepts of physics and do the interpretation and acquire the result.
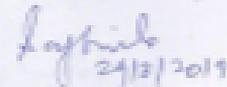
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MPHYCC-5 MODELING AND SIMULATION (5 CREDITS)

Inter disciplinary in nature. Recommended

To be selected by students of other programme as DSE I/II

Course Objectives :

1. To encourage students to "discover" in a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational technique with programming in Fortran/C++/Python/Java to face the world of problems solving high performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in traditional curriculums.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The questions paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 × 2=20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Programming in Fortran

FORTRAN Programming, Flow chart, integer and floating point arithmetic built in functions array and Subroutine File I/O.

Unit 2 : Programming with Python:

Program development, Variables Expressions and statements, Functions, Conditionals and Recursion, Iteration, Strings, Lists, Dictionaries, Tuples, Files, Types of errors and Debugging, Function Libraries, loop and control structure, some simple application.

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Unit 3 : ODE and PDE:

ODE: RK method, Leap Frog method: Application to electron motion in electric and magnetic fields, Non-linear equations: PDE Laplace and equations, Poisson equation; 1D-diffusion.

Unit 4 : Matrix Problems:

Jacobi method for matrix inversion techniques for solving eigenvalue problems, Simultaneous orthogonality, Diagonalization, Hermitian.

Unit 5 : Numerical method and simulation:

Methods of finding roots of equation, Bisection method, Newton Raphson method, Interpolation, Taylor series, Numerical differentiation, Numerical Integration, Curve filling: Least Square fitting, Cubic spline fitting, Random number generators, Monte Carlo integration Metropolis algorithm, Ising Model.

Course Outcomes:

1. Learn how to interpret and analyse data visually, both during and after computation.
2. Gain an ability to apply physical principles to real-world problems.
3. Acquire a working knowledge of basic research methodologies, data analysis and interpretation.
4. Understand various simulation techniques which can be used in future by students to analyse the data.

Reference :

1. Rabin H. Landau Manuel J. Paez: Computational physics-Problem solving with computers, John Willey & Sons, New York (1997).
2. P. L. Delvries, A First Course in Computational Physics, John Wiley & sons, New York (1994).
3. G. Golub and J.M. Ortega Scientific Computing: An Introduction with Parallel Computing, Academic Press, San Diego (1993).
4. J.M. Thijssen, Computational Physics, Cambridge University Press, Cambridge, 1999.

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M.PHY.CC 6 ELECTRODYNAMICS AND PLASMA PHYSICS (5 CREDITS)

Course Objectives :

1. To apprise the students regarding the concepts of electrodynamics and its use in various situation.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 x 2=20). Part B will have five short answer questions with one from each unit (30 x 2=20). Part B will have five short answer questions (30 x 2=20). Part B student is required to answer one out of three questions of Part B (4 x 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Electromagnetic wave equation and field vectors:

Maxwell's equations in free space. Plane wave in free space. Dispersion of electromagnetic wave. Poynting vector in free space. Polarization of electromagnetic waves; electric field vector in terms of scalar and vector potential, Wave equation in terms of scalar and vector potential.

Unit 2 : Electromagnetic wave equation and its interaction with matter on macroscopic scale:

Electromagnetic waves (EMW), nature, propagation of EMW in isotropic, anisotropic dielectrics, in conducting media; Boundary conditions, reflection and refraction of EMW, Fresnel formulae, Brewster's law and degree of polarization total internal reflection and critical angle, reflection from a metallic surface, Propagation of EMW between conducting planes, Wave guides; TE and TM mode, Transmission lines, Rectangular and cylindrical wave guides, cavity resonator.

Unit 3 : Fields of moving charges and Radiating System:

Retarded Potentials, Lienard Wiechert potentials, field of a point charge in uniform rectilinear motion, in arbitrary motion, Radiation from an accelerated charged particle at low and high velocity, Radiating System; Oscillating electric dipole, radiation from an oscillating dipole from a small current element, from a linear antenna, Antenna arrays.

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Unit 4 : Relativistic Electrodynamics:

Transformation equation for current density and charge density, vector potential and scalar potentials, the electromagnetic field tensor, transformation equation for electric and magnetic field, Covariance of Maxwell in four tensor form, covariance of Maxwell and transformation law of Lorentz force.

Unit 5 : Plasma Physics:

Elementary concepts of plasma, derivation of moment equations from Boltzmann equation. Plasma oscillation, Debye shielding, plasma confinement, magneto plasma. Fundamental equation hydromagnetic waves magnetosonic waves. Alfven waves, wave propagation parallel and perpendicular to magnetic field.

Course Outcome:

Students will have understanding of:

1. Time-varying fields and Maxwell equation.
2. Various concepts of electromagnetic waves.
3. Radiation from localized time varying sources and the charged particle dynamics.

Reference :

1. Introduction to Electrodynamics, David J. Griffiths, Prentice-hall of India, Third Edition, 2009.
2. Classical Electrodynamics, J.D. Jackson, Wiley Publishing, Newyork 3rd Edition, Eight Print, 2002.
3. J.A. Bittencourt, Fundamentals of Plasma Physics. Third edition (Springer Publication, 2004.

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MPMKCC 7 ELECTRONICS 1 (5 CREDITS)

Course Objectives :

1. To make the student familiarise with the basics of electronics.
2. To enable the student to explore the concepts involved in the oscillators.
3. To make the student understand the basic concepts in IC and digital devices.
4. To allow the student to understand the fundamentals of multivibrators.
5. To provide in-depth theoretical base of Digital Electronics.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 x 2=20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 =20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Semiconductor devices:

BJT, JFET, MOSFET (Enhancement and depletion types), UJT, SCR, TUNNEL Diode, Zener Diode.
Structure, working and characteristics.

Unit 2 : Amplifiers and feedback

BJT biasing, design of a CE transistor amplifier, small signal model, emitter follower, Negative feedback and its properties (effect of feedback on different parameters), types of feedback, Oscillators. Principles, Barkhausen criterion, frequency stability, phase shift oscillator, Wien bridge oscillator.

Unit 3 : Operational Amplifiers:

Operational amplifier block diagram, ideal and practical op-amp characteristics. Op-amp circuits, inverting and non-inverting amplifier, adder, subtractor, differentiator, integrator, current to voltage converter.

Unit 4 : Digital Electronics

Number system and codes, binary arithmetic, logic gates: AND, OR, NAND, NOR, NOT, XOR. Boolean algebra theorems, De-morgan's theorems, Mintems and Maxterm representation, simplification using

Boolean algebra theorems and K-maps, half and full adders, flip-flops-RS and JK Elementary ideas of Registers, counters, comparators.

Unit 5 : Microprocessor and small microcontroller :

Microcomputer block diagram, system law 8085 Microprocessors, architecture and operation, Assembly language instructions (classification only).

Course Outcomes:

Students will have understanding of,

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.

2. Designing of different types of the Digital circuits and to give the computational details for Digital circuits.

3. Characteristics of devices like PNP and NPN junction diode and truth tablets of different logic gates.

4. Basic elements and to measure values with multimeter and their characteristic study.

5. How to construct electronic circuit.

Reference :

1. J. Millman, and H. Taub, Pulse Digital and Switching Wave forms, Tata McGraw Hill, (1991).

2. R.L. Boylestad and J. Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, (2007).

3. D.A. Bell, Electronics Devices and Circuits, Oxford University, (2008).

4. Ben G. Streetman, Solid state electronic devices, Prentice Hall, Englewood cliffs, NJ (1995).

5. R.A. Gayakwad, Op-Amps & Linear integrated circuits Prentice Hall India Pvt. Ltd. (1999).

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MPHYCC-8 STATISTICAL MECHANICS (5 CREDITS)

Course Objectives:

1. The course is to understand the basics of Thermodynamics and Statistical system.
2. Understand the various laws of thermodynamics.
3. Acquire the knowledge of various statistical distributions.
4. To comprehend the concepts of Enthalpy, phase transitions and thermodynamic functions.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have two compulsory question (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2=20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1 : The statistical basis of thermodynamics:

Postulates of classical statistical mechanics, macroscopic and microscopic states, Phase space, Ensemble-microcanonical, canonical and grand canonical, Statistical equilibrium, density distribution of phase point, Liouville's theorem.

Unit 2 : Ideal classical gas:

Partition function of a classical ideal gas, thermodynamical potentials in terms of partition function for an ideal monoatomic gas in microcanonical and grand canonical ensembles, entropy of mixing and Gibbs paradox, Maxwell-Boltzmann distribution law, entropy of monoatomic gas.

Unit 3 : Quantum statistics and Application I:

Density matrix, quantum ensembles, ideal Bose gas, Bose condensation, liquid He II, superfluidity and Landau's Theory.

Unit 4 : Quantum statistics and Applications II:

Ideal Fermi gas, specific heat and Pauli paramagnetism, Principle of detailed balance, Landau diamagnetism, white dwarfs and Chandrashekhar limit, Ising model, Random walk and Brownian motion;

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Unit 5 : Nonequilibrium processes :

Features of Equilibrium and Non Equilibrium Thermodynamics, Linear theory of Non Equilibrium Thermodynamics, Current and Affinity, Onsager relation, Fluctuations, Microsystems.

Course Outcomes:

At the end of this course, students will be able to:

1. Basic knowledge of thermodynamic systems.
2. Understand the basic idea about statistical distributions.
3. Impart the knowledge about the phase transitions and potentials.
4. Understand the application of statistical laws.

Reference :

1. Introduction to Thermodynamics, Classical and Statistical, 3rd Edition. Richard E. Sonntag (University of Michigan), Gordon J Van Wylen (Hope College) ISBN 978-0-471-61427-2, 1997.

2. Pathria R.K. Statistical Mechanics, 2nd Edition, Elsevier, 1996.

3. Thermodynamics and Statistical mechanics author by John m. seddare and Julian d. gale 3rd edition, R.S.C. publication, 2001, U.K.

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MPHYCC -8 Lab-II (5 CREDITS)

Course Objectives:

1. To encourage students to "discover" physics is a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance are various computational technique with programming basic in C to face the world of problems using high performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in traditional curriculum.

PROGRAMMING NUMERICAL METHODS USING FORTRAN LANGUAGE (ANY 8):

1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. Successive Approximation (method of iteration), Newton Raphson method.
3. The Bisection method
4. Gauss Elimination method.
5. Matrix Inversion, Lagrange's Interpolation Formula.
6. Trapezoidal Rule, Simpson's rule.
7. Euler's method, Runge-Kutta method (Fourth Order).
8. Predictor corrector methods.
9. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
10. To find the area of a unit circle by Carlo Integration.
11. To simulate the random walk.

Course Outcome:

At the end of this course, students will be able to:

1. Understand the basic idea about finding solutions using computational methods basics.
2. Learn how to interpret and analyze data visually, both during and after computation.
3. Gain an ability to apply physical principles to real world problems.
4. Acquire a working knowledge of basic research methodologies, data analysis and interpretation.
5. Realize the impact of physics in the global/societal context.

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Reference :

4. Introduction to Thermodynamics, Classical and Statistical, 3rd Edition Richard E. Sonntag (University of Michigan), Gordon J Van Wylen (Hope College) ISBN 978-0-471-60427-2, 1997.

5. Pathria R.K. Statistical Mechanics, 2nd Edition, Elsevier, 1996.

6. Thermodynamics and Statistical mechanics author by John m. seddare and Julian d. gale 3rd edition, R.S.C. publication, 2001, U.K.

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SEMESTER III

MPHYCC-10 ATOMIC AND MOLECULAR PHYSICS LASERS (5 CREDITS)

COURSE OBJECTS :

1. Objectives of this course is to learn atomic, molecular and spin resonance spectroscopy.
2. To understand mechanism and working of lasers.
3. To be able to understand atomic and molecular transmissions and selection rules.
4. To understand the Raman Effect and its applications.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit, the student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1: Atomic physics:

Vector Atomic Model (LS, JJ coupling), Fine Structure and Hyperfine Structure, Zeeman Effect, Paschen-Back and Stark Effect, Intensity, Shape and width of spectral lines, Independent particle model; He atom as an approximation for many electron atomic systems, Slater determinants to write possible multiplets.

Unit 2: Electronics and Molecular Spectra:

Molecule as non-rigid rotator, Anharmonic Oscillator (vibration-rotation system), Frank-Canton Principle, NMR and ESR, Spectra/Vibration of Polyatomic molecule, Electronic spectra of polyatomic molecules, Chemical analysis by electronic spectroscope, Spectra of Hydrogen Molecule.

Unit 3: Molecular Potential:

Concept of Molecular Potential, Separation of electronic and nuclear wave function, Born-Oppenheimer approximation and its breakdown, Analysis by infrared techniques, Molecular orbital theory, LCAO approximation theories.

Unit 4: Raman and Spin Resonance Spectroscopy:

Vibrational and pure rotational Raman Spectra, Structure determination, Raman and infrared spectroscopic Technique and instrumentation.

Unit 5: Laser:

Significance of Einstein's A and B coefficients, pumping schemes, Characteristics of Laser Beams, Principles of Fiber Communication, Numerical Aperture, Laser Operation: Oscillator versus Amplifier, Threshold Condition, Laser Rate equations for three and four level laser systems, Ruby Laser, He-Ne Laser, Laser, Resonators, Laser rate equations for three and four level laser systems, He-Ne Laser.

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Semi conductor Lasers, Liquid (Dye) Lasers, Gas (CO_2) Lasers, Laser applications in industry, Spectroscopy, Light detection and Ranging (LIDAR), scanning laser beam devices. Laser communication, (injection photodiode and Avalanche Photodiode), and medical applications.

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MPHYCC-11 Condensed Matter Physics (5 CREDITS)

COURSE OBJECTS:

1. To study some of the basic properties of the condensed phase of materials especially solids.
2. To study electrical and magnetic properties of solids.
3. To understand superconductivity and various properties of semiconductors.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have two compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 × 2 = 20). Part B will have five short answer questions, one question from each unit. The student is required to answer any four out of them (4 × 5 = 20). Part C will have five long answer questions- one question from each unit. The student is required to answer any three out of them (3 × 10 = 30).

Unit 1 : Crystal structure:

Reciprocal lattice and applications, Brillouin Zones, Laue equations and Bragg's law, Laue and powder diffraction; Structure factor, atomic form factor, Intensity of diffraction maxima, extinctions due to Lattice centering.

Unit 2 : Electronic Properties:

Motion of electron in periodic lattice, Bloch theorem nearly free electron model, tight binding and cellular methods, effective mass, intrinsic and extrinsic semi- conductors, Fermi Surfaces, Cyclotron resonance and de Hass-van Alphen effect.

Unit 3: Magnetic Properties:

Heisenberg model, molecular field theory, Spin waves and magnons, Curie-Weiss law for susceptibility. Theories of ferromagnetism, anti-ferromagnetism and ferrimagnetism.

Unit 4: Superconductivity:

Meissner effect, London equation, flux quantization, Josephson effect, Crystal Defects: Point defects, line defects, planar faults, role of dislocations in Plastic deformation and crystal growth, colourcentres.

Unit 5: Dielectric Properties:

Microscopic concept of Dielectric polarisation, Langevin theory of polarisation, Clausius-Mossotti equation, Dielectric in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectric, optical properties of crystals.

Course Outcomes:

Students will have understanding of

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2. Structures in solids and their determination using XRD.
2. Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.
3. Electrical, thermal, magnetic and dielectric properties of solids.

References:

1. Introduction to Solid State Physics, 3rd & 6th Editions. C. Kittel, Wiley Publishing
2. Condensed Matter in a Nutshell, Will G.D. Mahan, Princeton Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin Holt-Rinehar-Winston 1976.
4. Elementary Solid State Physics, Principles and Applications, Ali Omar, M. Addison Wesley Publishing, 2011.

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Course Outcomes:

Students will have understanding of:

1. Atomic spectroscopy of one and two valance electron atoms.
2. The change in behavior of atoms in external applied electric and magnetic field.
3. Rotational, vibration, electronic and Raman spectra of molecules.
4. Electron spin and nuclear magnetic resonance spectroscopy.
5. Principle working and application of laser.

References:

1. H.E. White, Introduction to Atomic Spectra, McGraw Hill, (1984).
2. C.N. Banewell and E. M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).
3. G. Aruldhas, Molecular structure and Spectroscopy, Prentice Hall of India, New Delhi, 2001.

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COURSE OBJECTIVES:

1. To understand the working of advanced semiconductor devices and digital circuits and the utility of OP-AMP.
2. To learn the basics of integrated circuit fabrication, applications of timer IC-555 and building block of digital systems.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit [10 x 2 = 20]. Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them [4 x 5 = 20]. Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them [3 x 10 = 30].

Unit 1 : Operational Amplifiers construction and other basic devices:

Building blocks of an OP-AMP: Differential amplifier dual input, balanced and unbalanced output amplifiers, current sources, 555 IC timer and its applications, Schmitt trigger, VCO and phase locked loops and their important applications.

Unit 2 : OP-AMP applications:

Instrumentation amplifier, logarithmic and exponential amplifiers, analog multiplication, comparators, astable and monostable multivibrators, half wave and full wave precision rectifiers, Active filters-Second order Butterworth filters-LPF, HPF, narrow band and wide band, band-pass and band reject filters.

Unit 3: Digital Circuits and Combinatorial logic I:

Logic Families TTL and CMOS, construction of basic gates characteristics, Combinatorial Circuits-2's complement adder and subtractor.

Unit 4: Combinatorial Logic II:

Decoder, encoder, multiplexer, demultiplexer, D/A and A/D convertors.

Unit 5: Dielectric Properties:

Master-slave JK flip-flops, D and T flip-flops, edge triggered Flip-flops, Registers and Counters-Shift registers, Bidirectional registers, ripple counter, synchronous counter, up-down counter, decade counter, Johnson and Ring counter.

Course Outcomes:

Students will have understanding of:

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. Designing of different types of the Digital circuits and to give the computational details for Digital Circuits.
3. Characteristics of devices like PNP and NPN junction diode and truth tables of different logic gates.
4. Basic elements and to measure their values with multimeter and their characteristics study.
5. Working of Flip-Flops registers and counters.

References:

1. T.F. Schubert and E.M. Kim, Active and Nonlinear Electronics, John Wiley Sons, New York (1996).
2. J Floyd, Electronic Devices, Pearson Education New York (2004).
3. Dennis Le Croix the, Transistors, Prentice Hall India Pvt. Ltd (1963).
4. J. Millman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972).
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int. Pub.
6. M. Goxedge, Semiconductor Device Technology W. Millan (1563)
7. S.M. Sze, Physics of semiconductor Devices, Wiley –Eastern Ltd.
8. Millman and Taub, Pulse, digital and switching Waveforms, McGraw Hill (1965).
9. Ben G. Streetman, Solid state electronic devices, Prentice Hall, Englewood cliffs, NJ (1999).
10. R.A. Gayakwad, Op-Amps and Linear integrated circuits, Prentice Hall India Pvt. Ltd. (1999).
11. Digital Electronics by R.P. Jain.

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MPHYCC-13 Nuclear and Particle Physics (5 CREDITS)

COURSE OBJECTIVES:

1. To study the general properties of nucleus.
2. To study the nuclear forces and nuclear reactions.
3. To introduce the concept of elementary particles.
4. To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1 : Nuclear forces:

Exchange forces and tensor forces. Low energy nucleon-nucleon scattering, Effective range theory. Deuteron Problem, high energy nucleon-nucleon scattering Discussion, Charge independence, spin dependence and charge symmetry of nuclear forces, Isospin formalism. Yukawa interactions.

Unit 2 : Nuclear reactions:

Kinematics and conservation laws, Nuclear Reactions and Cross sections, Theory of Compound nucleus, Breit-Wigner single level formula, Mechanism of nuclear fission and fusion, Nuclear reactors.

Unit 3: Nuclear models:

(a) Single particle Shell model: Magic moments, spin, parity, magnetic dipole moment, electric dipole moment. (b) The Nilsson unified model. (c) Collective model: Vibrational and rotational states, β and γ bands.

Unit 4: Nuclear decay:

(a) Fermi theory of β decay, allowed and forbidden transitions Parity violation in β decay and helicity of neutrino. (b) Radiative transitions in nuclei (γ -decay). Spontaneous decay, internal conversion, Mössbauer Effect.

Unit 5: Elementary Particle Physics:

Conservation Laws and Symmetry. Strangeness, Isospins, Charge, CPT Invariance, Classification of elementary particles, SU(2) symmetry and its application to decay and scattering processes, SU(3) symmetry and the Quark model, Elementary idea of charm dynamics.

Course Outcomes:

At the end of the course, the students can able to:

1. Acquire basic knowledge about nuclear and particle physics.
2. Develop the nuclear reactions and neutron physics.
3. Understand the nuclear fission and fusion reactions.
4. Impart the knowledge about the nuclear forces and elementary particles.

References:

1. Kenneth S. Krane, Introductory nuclear physics, Wiley India New Delhi [2008].
2. J. Basdevant, J. Rich, M. Spiro, Fundamentals in nuclear physics, Springer, New York [2005].
3. D. Griffiths, Introduction to elementary particles, Wiley VCH, Weinheim [2008].
4. D.C. Tayal, Nuclear Physics, 4th edition Himalaya House, Bombay [2980].

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MPHYCC-14 Lab-III [5 CREDITS]

COURSE OBJECTIVES:

1. To make the student familiarize with the basics of electronics.
2. To enable the student to explore the concepts involved in the oscillators.
3. To make the student understand the basic concepts in IC and digital devices.
4. To allow the student to understand the fundamentals of multivibrators.

LIST OF EXPERIMENTS (MINIMUM 12)

1. Study of Transistor Bias Stability.
2. Study of single stage RC coupled amplifier using transistor and its frequency response.
3. Study of two stage RC coupled amplifier using transistor and its frequency response.
4. Study of Silicon Controlled Rectifier.
5. Study the characteristics of UJT.
6. Experiment of FET and MOSFET characterization and application as an amplifier.
7. Study of an Astable multivibrator circuit using OP-AMP.
8. Study of adder, subtracter, differentiator and integrator circuits using the given OP-AMP.
9. Study of an AC converter circuit and its performance.
10. Study of an D/A converter circuit and its performance.
11. Construction of half -adder and full- adder circuit using NAND gates and study their performance.
12. FLIP flops-RS, JK and D flip flops.
13. Study of NPN transistor characteristics.
14. Photo-diode characteristics.
15. Photo-transistor characteristics.
16. Multiplexer and Demultiplexer.

Course Outcomes:

At the end of the course,

1. The student will have knowledge on the different experimental techniques involved in electronics.
2. The student should be able to independently construct the circuit.
3. The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

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IV SEMESTER

MPHYEC-IA Advanced Quantum Mechanics (5 CREDITS)

COURSE OBJECTIVES:

1. To impart knowledge of advanced quantum mechanics for solving relevant physical problems.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts. A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1: Theory of Scattering:

Laboratory and centre of mass reference frames, Differential and total cross sections, scattering amplitudes using green's function, scattering by symmetric potential, Partial wave analysis, Phase shift, scattering amplitudes in terms of phase shift, optical theorem, scattering by square well potential and perfectly rigid sphere; Born approximation, its validity, application to square well potential and Yukawa potential.

Unit 2: Relativistic Quantum Mechanics:

Postulates of Quantum Mechanics, Space time description of Schrödinger Wave Equation, Klein Gordon equation, Dirac equation, covariant form; Plane wave solutions, Dirac interpretation of negative energy states and concept of antiparticles; Spin and magnetic moment of the electron. Non relativistic reduction, Helicity and chirality; Properties of γ matrices charge conjugation; Normalization and completeness of spinors.

Unit 3: Quantum Field Theory:

Second Quantization-Lagrangian Field theory, Hamiltonian formulation. Quantization of scalar field Quantization complex scalar and "Schrodinger" field, Bosons and Fermions.

Unit 4: Quantum Chromodynamics: is introduction to quantum dynamics, Quark model.

Unit 5: Quantum Chromodynamics in Standard model, Grand Unified Theories.

Course Outcomes:

Students will have understanding of:

1. Importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics.
2. Various tools to understand field quantization and related concepts.
3. Exposure to quantum field theory and several interactions.

References:

1. Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics Tata McGraw Hill (2004).

2. Thankappan, V.K. Quantum Mechanics, New-Age International (2004).

3. Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).

4. Bethe, H.A. and Jackiew R., Intermediate Quantum Mechanics, Perseus Book Group (1997).

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MPHYEC-08 Advanced Condensed Matter Physics (3 CREDITS)

COURSE OBJECTS:

5. The course is to understand the basic knowledge on crystal structures and systems.
6. Understand the various process techniques available of X-Ray Crystallography
7. Acquire the knowledge of Lattice waves and functions.
8. To comprehend the concepts of superconductivity and magnetic properties of solids.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into two parts, A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1: Electron States:

Hartree and Hartree-Fock approximations, correlation energy, Screening plasma oscillations, Dielectric function of an electron gas in random phase approximation, limiting laws & Friedel oscillation.

Unit 2: Electron-electron interaction:

Lindhard's expression for wave length and frequency dependent dielectric constant, Static screening, Kohn effect.

Unit 3: Superconductivity:

Energy gap, Cooper pair, BCS theory, Ginzburg-Landau theory, Josephson junction and its application, Microscopic quantum interference, High temperature superconductivity.

Unit 4: Magnetism:

The band model for ferromagnetism and its temperature dependence, Ferrimagnetism, Antiferromagnetism, magnetise effects in nanomaterials.

Unit 5: Dielectric Properties:

Theory of Dielectric, Piezoelectricity, Ferroelectricity, Antiferroelectricity and their applications, Nano-structured Ferroelectric materials, Synthesis and Characterization principles of Ferroelectric nanomaterials, Multiferroic and Smart materials.

Course Outcome:

At the end of this course students will be able to:

1. Basic knowledge of crystal structures and systems.

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2. Understand the basic idea about the Electronic Properties of Solids.
3. Impart the knowledge about the properties magnetic Properties of Solids.
4. Understand the application of superconductivity.

References:

1. C. Donald Ahrens, Essentials of Meteorology, Brooks Cole Cengage Learning, USA, 2010.
2. Murry L. Salby, Fundamentals of Atmospheric Physics, Academic Press, Elsevier, USA, 1996.
3. David G. Andrews, An Introduction to Atmospheric Physics, Cambridge University Press, United Kingdom, 2000.

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MPHYEC-1C Atmospheric (Physics) (5 CREDITS)

COURSE OBJECTIVES:

1. To provide a keen knowledge on atmospheric behavior, description of air, stratification of mass, trace constituents, radiative equilibrium of the planet, global energy budget, and general circulation.
2. To provide a deep insight on physics of atmosphere, aerosols and clouds.
3. To understand the Short wave and long wave radiation, radiometric lamberts equation, radioactive heating, thermal relaxation and greenhouse effect.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Introduction and Atmospheric Chemistry:

General descriptive and basic facts; Regions of the Atmosphere Atmospheric chemistry: Composition, Minor constituents, cycles of main elements, chemistry of sulphur, carbon, nitrogen compounds, photochemical pollution, aerosols.

Unit 2 : Atmospheric Photo chemistry

Radiates, absorption of radiant energy in the atmospheres, solar radiation, Chapman profile, photochemistry of ionosphere, stratospheric ozone, ozone hole; Greenhouse effect and its consequences, effective temperature.

Unit 3 Atmospheric thermodynamics and Cloud Physics:

Atmospheric system, Application of first law of thermodynamics to air and clouds, main processes in the atmosphere, cooling, potential temperature, adiabatic expansion with condensation, vertical stability, convective instability.

Unit 4: Cloud physics and Atmospheric Electricity:

Classification of clouds, growth of drops by condensation, growth by collision and coalescence, warm rain, ice formation, snow, hail and rain by ice process, ice precipitation Electric field and space charge, Fundamental problem of atmospheric electricity, Thunderstorm electricity, Lightning.

Unit 5: Atmospheric Dynamics:

Principle forces acting as a parcel of air, acceleration of air parcel, equation of motion, continuity equation, scales of motion, important features of large scale atmospheric motion, Large scale mid latitude circulation system, thermal circulation global, circulation pattern, mid latitude cyclones.

Course Outcome:

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

1. Acquire knowledge on earth atmosphere governing by physical laws.
2. Achieve basic inputs for the global circulation of atmosphere.
3. Create a scope to identify new areas of research in the field of atmospheric science.

References:

1. Introduction to Solid State Physics, 3rd & 6th Editions, C. Kittel, Wiley Publishing.
2. Condensed Matter in a Nutshell, M.G.D. Mahan, Princetpon Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin Holt-Rinehart-Winston 1976.
4. Elementary Solid State Physics, Principles and Applications; Ali Omar, M Addison Wesley Publishing, 2011.

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MPHYEC-1D Biophysics (5 CREDITS)

COURSE OBJECTIVES:

1. The course is to understand the basic knowledge on biomolecular.
2. Understand the various theoretical modeling techniques involved in biomolecular systems.
3. Acquire the knowledge of Structure and function of Proteins, Carbohydrates " Nucleic acid.
4. To comprehend the concepts of Biochemistry and system biology.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer question with one question from each unit. The student is required to answer any three ones out of them ($3 \times 10 = 30$).

Unit 1: Bioenergetics:

Principles of Thermodynamics, redox potential and free energy change of the reactions, Biological energy transducers.

Unit 2: Physical techniques in protein, nucleic acids and polysaccharide structural analysis:

UV Vis spectroscopy, infrared spectroscopy, Fluorescence spectroscopy, Atomic absorption spectroscopy, Raman spectroscopy, NMR, Mass spectroscopy, Circular dischroism spectroscopy, X Ray Diffraction technique, TEM and SEM.

Unit 3: Centrifugation:

Principles, types, Differential and density gradient centrifugation and their applications; Chromatography: Principles, types (Paper TLC, Affinity, Ion exchange, Gel filtration, GLC, HPLC) and their applications.

Unit 4: Electrophoresis:

[Polyacrylamide gel electrophoresis (PAGE), SDS PAGE, agarose gel electrophoresis, 2D electrophoresis and their application.

Unit 5: Theoretical techniques and their application to Biomolecules:

Hard sphere Approximation, Reenchandram plot, Potential energy surfaces, Outline of Molecular Mechanics Method, Brief ideas about semi empirical and ab-initer quantum theoretical methods, molecular charge distribution molecular electrostatic potential and field and their uses.

Course Outcome:

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

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1. Basic knowledge of Biomolecular of chemistry and functions.
2. Understand the basic idea about the Structure and Function of Nucleic Acids.
3. Impart the knowledge about the Function of Carbohydrates and Proteins.
4. Understand the applications of Biomolecules.

Reference:

1. Principles of Biochemistry by A.L. Lehninger, D.L. Nelson and M.M. Cox, CBS Publishers New Delhi, 1993.
2. Biochemistry by L. Stryer, W.H. Freeman and Co, Newyork, 1997.
3. Biophysics by Nasenthapattabhi and N. Gautham, Narosa Publishing House, New Delhi, 2002.
4. Elementary Solid State Physics, Principles and Applications, Ali Omar, M Addison Wesley Publishing, 2011.

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MPHYEC-1E Lasers and Photonics (5 CREDITS)

COURSE OBJECTIVES:

On successful completion of this course, students will be able to

1. Describe and explain the principles involved in the interactions between light and matter, including the effects of anisotropy and non-linearity comprehend the modification and control of optical properties of materials by externally imposed electric, magnetic and acoustic fields.

2. Recall and recount the optical properties of semiconductor light sources and detectors expand the theory and applications of the confinement of light in waveguides and fibers.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have two compulsory question (multiple choice type) covering the whole syllabus with two from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1: Basic Principles:

Laser rate equation for three level and four level system, Dynamics of Laser Process: switching, Mode locking mode pulling, lamb dip, hole burning, Energy levels and radiating properties of molecules, liquids and solids, Laser amplifier, Laser resonators, Techniques of laser excitation.

Unit 2 : Non-linear optical effects:

Harmonic generation, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, parametric generation, Self-focusing of light, Two photon absorption, Doppler free two photon spectroscopy, Laser spectroscopy.

Unit 3: Application of Laser:

Fabrication of electronic components, Material processing, Laser communication, Holography, Military application, Medical applications, Star Wars, Laser hazards and Laser safety, Optical Amplifiers, Infrared optical devices, Laser cooling, Trapping.

Unit 4: Optical Fiber Communication:

Optical Fiber structure, Wave guiding and Fabrication of Fiber, Types of Fiber and Properties of Maxwell's equation inside Fiber, Signal degradation and attenuation in Optical Fibers.

Unit 5: Optical Fiber systems:

Optical sources (LD and PIN Diode) and Optical Detectors (APD): Analog and Digital optical fiber Transmission System (PDH, SDH and WDM Technology).

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Course Outcomes:

1. Knowledge of fundamental physics of photonics is developed to a high level.
2. The course prepares students to be able to use the sophisticated instrumentation intelligently, with a good understanding of its capabilities and Limitations.

Reference:

1. Saleh BEA and MC Tech " Fundamentals of Photonics" John Wiley New York, 1991.
2. Pal BP(Ed)" Guided Wave Optical Components and Devices, Academic press, 2006.
3. Smit F G and TA King Optics and Photonics" John Wiley Chiester, 2000.
4. Thygarajan K and A Ghatak, " Nonlinear Optics in Encyclopedia of Modern Optics (Editors Bob Guenther etal)" Flsevier Ltd. 2005.

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MPhYCE-1F Measurement and Instrumentation II (5 CREDITS)

COURSE OBJECTIVES:

1. To make the student familiarize with the basics of experimental physics.
2. To make the student familiarize with the basics of electronics.
3. To enable the student to explore the concepts involved in the oscillators.
4. To allow the student to understand the fundamentals of instruments of instruments involved.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts. A, B and C. Part A will have two compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer question with one question from each unit. The student is required to answer any three from them ($3 \times 10 = 30$).

Unit 1: Basic Principles:

Measuring Instruments: Accuracy, precision, sensitivity and resolution; Scale, standards and calibration; Uncertainties of measurements and errors, propagation of error, statistical treatment of random errors, Distribution functions their derivation and properties.

Unit 2: Transducers:

Temperature, pressure/vacuum, magnetic field, vibration, strain, displacement and force transducers; Principle, construction and working.

Unit 3: Signal conditioning and recovery:

Signal level and impedance matching, Operational amplifier modules for different signal conditioning: addition, subtraction, scaling, differentiation and integration; Log and antilog amplifiers, analog multiplier and applications, instrumentation amplifier; Signal-to-noise considerations, Filters, Phase Lock-Loop, Lockin amplifier.

Unit 4: Digital signal processing:

A/D and D/A converter, 7307 A/D convertor based DMM, Embedded systems: 8051 microcontroller (basic ideas only) Computer interfacing of Science experiments.

Unit 5: Computer Interfacing of Science Experiments:

Real time and Offline Data Processing, Data acquisition systems and Data Loggers: Principle and Design, Passive and Active instrumentation with examples.

Course Outcome:

At the end of the course,

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1. The student should have had knowledge on the different experimental techniques.
2. The student should have understood the basics of physics involved in experiments.
3. The student should be able to apply the concepts of physics and do the interpretation and acquire the result.

References:

1. Measurement, Instrumentation and Experimental design in Physics and Engineering; Michael Sayer and Abhai Mansingh, Prentice Hall of India 2005
2. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington and K.D. Robinson, McGraw Hill, 2003.
3. Electronic Instrumentation-H.S. Kalsi, TMH Publishing Co. Ltd. 1997.
4. Instrumentation Devices and Systems-C.S. Rangan, G.R. Sharma, V.S.V. Mani, 2nd Edition, Tata McGraw Hill, New.

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MPHYEC-16 Computational Methods (5 CREDITS)

COURSE OBJECTIVES:

1. To encourage students to "discover" Physics in a way physics learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational techniques with programming basic in C to face the world of problems using high performance iteration techniques.
4. To show how physics can be applied in a much border context than discussed in traditional curriculum.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of three (4 x 5 = 20). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of three (3 x 10 = 30).

Unit 1: Introduction to Fortran/Python:

Algorithms, structured programming, Constants and variables, arithmetic expressions, input and output statements, Logical expression and conditional statements, Iteration, functions, Arrays, Strings, I/O functions, Files.

Unit 2 : Data Interpretation and analysis:

Precision and accuracy, error analysis, propagation of errors, least square fitting: linear, polynomial and nonlinear regression, goodness of fit and chi square test. Elementary probability theory, random variables, binomial, poisson and normal distributions.

Unit 3: Finite difference methods:

Computer arithmetic, normalized floating point representation, its consequences and pitfalls. Methods of findings roots of equations: Bisection method, Newton-Raphson method, Successive Approximation method. Solution of simultaneous algebraic equations Gauss Elimination method, Gauss-Siedal iterative method.

Unit 4: Numerical Techniques:

Interpolation: Lagrange Interpolation, Difference tables, Spline Interpolation, Series approximation of functions: Taylor series, Numerical Differentiation, Numerical Integration: Trapezoidal rule, Simpson's Rule, Numerical solution of Differential Equations: Euler's method, Runge-Kutta methods.

Unit 5: Some application of Numerical methods in Physics:

Largest and smallest Eigenvalues, Diagonalisation of matrices, Initial value problems, Simulation of simple physics problems, Introduction to MATLAB/SCILAB/MATHEMATICA

Course Outcome:

At the end of the course,

1. Understand the basic idea about findings solutions using computational method basics.
2. Learn how to interpret and analyze data visually, both during and after computation.
3. Gain and ability to apply physical principal to real-world problems.
4. Acquire a working knowledge of basic research methodologies, data analysis and interpretation.
5. Realise the impact of physics in the global/societal context.

Reference:

1. Mathematical methods of physics- J. Mathews and R.L. Walker, Second Edition, Addison-Wesley.
2. Mathematical methods for Physicists - G.B. Arfken and H. Weber, Seventh Edition, Academic Press, 2012.
3. Introductory Methods of Numerical analysis S.S. Sastry, Thirtd Edition, Prentice-Hall of India, 2003.
4. Programming in ANSI-C.E. Balaguruswamy, Second Edition, Tata McGraw Hill, 1992.

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MPHYSC-1H Nano Science (5 CREDITS)

COURSE OBJECTIVES:

1. The course is to understand the basic knowledge on nanoscience and nanotechnology.
2. Understand the various process techniques available of nanostructure materials.
3. Acquire the knowledge of various nano particles process methods.
4. To enhance the various analytical technique to understand the nano properties and characteristics of nano materials.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 x 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer question with one question from each unit. The student is required to answer any three of them (3 x 10 = 30).

Unit 1: Introduction and Basic Principles:

Definition of Nanomaterials, Properties, Applications and Scope of Nano-Science, Quantum size effect, Electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of quantum well structure, Quantum wells, quantum wires and quantum Dots: Preparation and properties; conduction electrons and dimensionality, Properties dependent on density of states. Carbon nanostructures: Fullerenes, structure, Superconductivity in C60, Carbon nanotubes: synthesis and structure, Electrical and Mechanical properties, Graphene.

Unit 2: Synthesis:

Techniques for synthesis: Top down approach: Ball milling; Bottom-up approach; Chemical methods of synthesis, R.F. Plasma and Pulsed Laser techniques Biological methods: synthesis using microorganisms, and plant extracts.

Unit 3: Characterization Techniques:

Characterization tools for nanomaterials: Thermal analysis: DTA, DSC, TGA, dilatometry: Electrical measurements: LCR meter, electrometer amplifier; Optical UV-Visible spectroscopy, IR spectroscopy Ellipsometry, Raman Photoluminescence and spectroscopy, Atomic absorption spectroscopy, Structural characterization: X-ray Diffractometer, Magnetic characterization: vibrating sample magnetometer; TEM, SEM, STM, AFM.

Unit 4: Magnetic Nanomaterials:

Magnetic nanoparticle, multiferroic and smart materials, Elementary idea of NEMS and nanotransistors.

Unit 5: Dielectric and Multiferroic materials:

Theory of Dielectrics, Piezoelectricity, Ferroelectricity, Anti-Ferroelectricity and their application, Nano-structured Ferroelectric materials, Synthesis and Characterization, techniques of Ferroelectric nano-materials, multiferroic and smart materials.

Course Outcome:

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

1. Basic knowledge of Nanoscience and nanotechnology.
2. Under the basic idea about the nano structure.
3. Impart the knowledge about the properties and characteristics techniques of nano materials.
4. Understand the applications of nanomaterials.

Reference:

1. Nanoconstructure and Nanomaterials, synthesis properties and application, 2nd Edition, Author by Guozhong Cao & yingwang, Published by world scientific published, printed in 2004 Singapore.
2. Hand book of Nanotechnology, 3rd edition, Author by Bhushu, Published in springer, printed 2004 German.
3. Nanostucture materials, progressing, properties and potential application, 2nd Edition, Author by Carl C. Koch, Published by William Andrew publications, printed in 2007 US.
4. Nanomaterials, synthesis, properties and applications 2nd Edition, Author by A.S. Edelstein, Published by Institute of physics publishing Bristol and Philadelphia, printed in 2000 U.K.

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MPHYEC-11 Plasma Physics [5 CREDITS]

COURSE OBJECTIVES:

1. To expose the students to theory related to motion of charge particle in inhomogeneous field, production of plasma and usage of plasma.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts, A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (2 x 10 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1: Basics (Single Particle Approach)

Charged particles in uniform and non-uniform electromagnetic field, Plasma - the forth state of matter, Concept of electron and ion temperature, Debye Length, Cyclotron Frequency, Larmor radius, Drift velocity of guiding center, Magnetic moment Magnetic mirror systems and their relation to the plasma confinement. Adiabatic Invariants.

Unit 2: Magneto Hydro Dynamics (Fluid Approach)

Introduction to Ideal MHD systems, Fundamental equations of magneto hydrodynamic systems, Diffusion and mobility of charged particles in plasma, Plasma as fluid and MHD equations, Approximations and linearization of MHD from dimensional considerations, Single fluid MHD equation, MHD Generator.

Unit 3: Waves and instabilities in plasma

Waves in unmagnetised plasma, Energy transport, Ion acoustic waves and MHD waves, Issue of plasma stability and the use of normal mode to analyse stability, Interaction between plasma particles, Perturbation at two fluid interface, Rayleigh Taylor instability, Kelvin Helmholtz instability and Jeans instability.

Unit 4: Kinetic Theory:

Need for kinetic theory and MHD as approximation of kinetic theory, Meaning of f(x), Phase space for many particle motion, Velocity and space distribution function, Derivation of fluid equation and Electron-ion plasma oscillation frequency, Derivation of Landau damping Equations of Kinetic Theory and Vlasov equations for fluid dynamics.

Unit 5: Applications:

Saha's theory of thermal ionization, Application in Space Science, Controlled Thermonuclear Fusion, Magnetic reconnection, Dynamoaction.

Course Outcome:

Students will have understanding of:

1. Theoretical method to study the charge particle motion.
2. Process to generate plasma in the laboratory.
3. Mechanism plasma production is helpful to make fusion reactors.

Reference:

1. A.R. Choudhary, The Physics of fluids and plasmas" (Cambridge), U.P. (1998).
2. Chery Francis Plasma Physics: II Film (Plenum Press, 1984.
3. Bitten Court J.A. Fundamentals of Plasma Physics, (Pergamon Press, 1988).
4. Paul Hellax, of Fundamentals of Plasma Physics (CUP 2005).

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MPHYEC-1J Crystal Physics and X-Ray Crystallography (5 CREDITS)

COURSE OBJECTIVES:

Structural analysis is the first step in the characterisation of any material. The atomic structure of a material depends on the method of synthesis and on various parameters involved in the technique.

This course will

1. Introduce the fundamental concepts of crystal structure.
2. To understand the diffraction principle and use of X-rays.
3. To understand the symmetry and space groups.
4. To know about lattice representation and reciprocal lattices.
5. To determine and analyse the crystal structure using x-ray diffraction.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of five ($5 \times 3 = 15$). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1: Geometry of Crystals

Introduction, lattice, crystal systems, symmetry, primitive and non-primitive cells, lattice directions and planes, unit cells of hcp and ccp structures constructing crystals, some simple ionic and covalent structures.

Unit 2: Symmetry of Crystals

Bravais lattices, space groups and crystal symmetry. Symmetry of the fourteen Bravais lattices, coordination of Bravais lattice points, space filling polyhedral, thirty two crystal classes, centres and inversion axes of symmetry, crystal symmetry and properties, translation symmetry elements, Quasiperiodic crystals or crystalloids.

Unit 3: Lattice Representations

Indexing lattice directions, lattice planes, miller indices, zones, zone axes, zone law, transforming miller indices and zone axes symbols, reciprocal lattice vectors, reciprocal lattice, unit cells, for cubic crystals, proof of some geometric relationships using reciprocal lattice vectors, Addition rule, Weiss zone law, d spacing of lattice planes.

Unit 4: X-Rays Diffraction

Diffraction Bragg's law diffraction methods, scattering by electrons, atoms, unit cell, introduction to X-rays, electromagnetic radiation continuous spectrum, characteristic spectrum, absorption filters,

production of X-rays, detection of X-rays, safety precautions, Contributions of Laue, Bragg and Ewald to X-ray diffraction Indexing of X-ray diffraction pattern.

Unit 5: Crystal Defects:

Representing crystals in projection, crystal planes, stacking faults and twins, stereographic projection. Point defects, line defects, planar faults, role of dislocations in Plastic deformation crystal growth, colorcenters.

Course Outcomes:

Student would have understood

1. The structure of various crystals.
2. Know the theoretical framework like symmetry and space groups.
3. Know to characterize the crystal using X-ray diffraction experiments and
4. Also would be able to analyse the collected experimental data

Reference:

1. C. Hammond, The basics of Crystallography and diffraction, Oxford university press, New York (2009).

2. B.D. Culity, elements of X-ray diffraction, Addison Wesley, Massachusetts (1956)

3. C. Suryanaryana, M.G. Norton, X-ray diffraction - A practical approach, Plenum press, New York (1998).

4. C. Kittel, Introduction to solid state physics, 7th Ed., Wiley India, New Delhi (2004).

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COURSE OBJECTIVES:

This Course will

1. Enable the students to appreciate the importance of solar energy and renewable energies.
2. Provide an understanding of essential components of renewable energy applications and limitations.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit [10 × 2 = 20]. Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 × 5 = 20). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them [3 × 10 = 30].

Unit 1 : Solar Energy : Fundamental and Material Aspects:

Fundamentals of photovoltaic Energy Conversion Physics and Material Properties, Basic to Photovoltaic Energy Conversion: Optical Properties of Solids, Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carries.

Unit 2 : Solar Energy: Different Types of Solar Cells:

Types of Solar Cells, junction solar cell, Transport Equation, Current Density, Open-circuit voltage and short circuit current, Brief description of single crystal silicon and organic Polymer Solar Cells, Elementary ideas of advanced Solar Cells, e.g. Tandem Solar cells, Solid Liquid Junction Liquid Solar Cell, Nature of Semiconductor, Principales of Photo electrochemical Solar Cells.

Unit 3: Hydrogen Energy: Fundamentals, Production and Storage:

Relevance in relation to depletion of fossil fuels and environmental consideration, Solar Hydrogen through Photoelectrolysis, Physics of material characteristics for production of Solar Hydrogen. Brief discussion of various storage techniques, special features of solid hydrogen brief discussion of various storage processes, special features of solid hydrogen storage materials. Structural and electronic characteristics of storage materials. New storage Modes.

Unit 4: Solar thermal application and utilisation:

Solar architecture, solar wafer heating, solar dryer, solar distillation, solar thermal-electric production, solarconcentrator.

Unit 5: Other Renewable clean energies.:

Elements of wind energy and Ocean Energy and Ocean Thermal Energy Conversion.

Course Outcome:

The students will be able to

1. Understand the importance of solar energy and renewable energies.
2. Understand essential components of renewable energy applications and limitations.
3. Design renewable energy systems as requirements.
4. Contribute towards reduction of our dependence on conventional energy sources.

Reference:

1. Kreith and Kreider , Principles of Solar Engineering, McGraw Hill Pub. .
2. A.B. Meinel and A.P. Meinal, Applied Solar Energy.
3. M.P. Agarwal, Solar Energy, S. Chand & Co.
4. S.P. Sukhatme, Solar energy, T.M.H.
5. G.D. Rai, Non-conventional Energy sources, Khanna Publication, Delhi.

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MPHPRE-31 Environmental Physics (5 CREDITS)

COURSE OBJECTIVES:

This course will

1. Enable the students to learn the concepts of sustainable development and coexistence with nature.
2. Enable the students to gain abilities to reduce environmental pollution.
3. Enable the students to understand the source of solar and terrestrial radiation.
4. Enable the students realise the hazards associated with depleting Ozone layer, and the factors responsible for the depletion of Ozone layer.
5. Enable the students to understand the importance of trees.
6. Enable the students to realise the importance of renewable energy sources like solar, wind and biogas.

The end Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit ($10 \times 2 = 20$). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them ($4 \times 5 = 20$). Part C will have five long answer question with one question from each unit. The student is required to answer any three out of them ($3 \times 10 = 30$).

Unit 1: Essentials of Environmental Physics:

Structure and thermodynamics of the atmosphere, composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Laws and motion, hydrostatic equilibrium, General circulation of the tropics. Elements of weather and climate of India.

Unit 2 : Solar and terrestrial Radiation:

Physics of radiation, Interaction of light with matter, Rayleigh and Mie scattering, Laws of radiation (Kirchoff's law, Plank's law, Beer's law, Wien's displacement law, etc.) Solar and terrestrial spectra, CFC radiation, Ozone depletion problem, IR absorption energy balance of earth atmosphere system.

Unit 3: Environmental pollution and degradation:

Elementary fluid dynamics, Diffusion, Turbulence and Turbulent diffusion, Factors governing air, water and noise pollution. Air and water quality standards. Waste disposal, Heat Island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.

Unit-4: Environmental Changes and Remote Sensing:

Energy sources and combustion, Renewable sources of energy, Solar energy, wind energy bioenergy, Hydropower, Fuel cells, nuclear energy, Forestry and bio-energy.

Unit 5: Global and Regional Climate:

Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Inertia forces, Reynolds number, Enhanced Greenhouse effect, Energy balance a zero-dimensional Greenhouse model.

Course Outcome:

The students will be able to

1. Understand the importance of environmental processes.
2. Get opportunities of working metrological stations and even establish metrological stations in remote places for better future.
3. Develop his/her understanding of global and regional climate change.

Reference:

1. Egbert Becker and Narek Van Groundelle, Environmental Physics John Wiley.
2. J.T. Houghton, The Physics of atmosphere, Cambridge University Press, 1977.
3. J. Twidell and J. Weir, Renewable energy resources, Else, 1988.
4. R.N. Keshavamurthy and M. Shankar Rao, The physics of monsoons, Allied publishers, 1992.
5. G.J. Haltiner and R.T. Williams, Numerical weather prediction, John Wiley, 1980.

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