



MAGADH UNIVERSITY

BODH GAYA

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SYLLABUS FOR M.SC PHYSICS
UNDER
CHOICE BASED CREDIT SYSTEM
(CBCS)

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Overview on CBCS system

The total credit points allotted for M.Sc physics programme under Choice Based Credit System (CBCS) is 100. The detailed structure of the four-semester M.Sc. physics programme under CBCS is given as below:

Semester	No of course/papers	Credit per course/paper	Total Credit	Minimum No of learning hours	No of core course/paper	No. of elective course/paper	Code & nature of elective course/paper
I	05	05	25	250	4	1	AECC-1
SEMESTER BREAK							
II	06	05	30	300	5	1	AEC-I
SEMESTER BREAK							
III	06	05	30	300	5	1	AECC-II
SEMESTER BREAK							
IV	03	05	15	150	0	3	EC-1 EC-2 DSE-1 OR GE-1

DETAILS OF ELECTIVE COURSES PRESENTED IN THE TABLE:

1. AECC (Ability Enhancement Compulsory Courses):

- I. AECC-I: Environmental Sustainability (3 credit) & Swachhha Bharat Abhiyan activities (2 credit)
- II. AECC-II: Human values and professional ethics (3 credit) & Gender sensitization (2 credit)

2. AEC (Ability Enhancement Courses): Students can choose one of the following

- a. Computers and IT skills
- b. Web designing
- c. Financial risk management
- d. Solid management
- e. Mushroom culture

- f. Bio-fertilizer production
 - g. Environmental law
 - h. Tourism and hospitality management
 - i. Life-skill and skill development
 - j. Yoga studies
- 3. EC (Elective Course):**
- I. EC-I: Elective paper-I
 - II. EC-II: Elective paper-II
- 4. DSE (Discipline Specific Elective):** Core Course/paper-5 taught in the second semester will be opened to be selected as DSE paper. A student will be allowed to choose a paper from any subject other than his core course from the same faculty in the same University.
- 5. GE (Generic Elective Course):** Students can choose from one of the following
- a. Music
 - b. Dramatics
 - c. Fine arts
 - d. Graphic Design
 - e. Inclusive Policies
 - f. Human rights
 - g. Any course run by any department

Important points on CBCS systems:

- **The list of elective papers, syllabus and prerequisite of the elective courses (particularly AECC, AEC, DSE and GE) will be decided finally by the Board of Courses of Studies (BOCS) of the department.**
- **All elective courses listed may not be available in all semesters.**
- **Based on the availability of resource persons and infrastructure the department will assist the students to select elective courses of their choice.**
- **The final CGPA/class will be decided on the performance of the students in the 16 courses/ papers including the 14 core courses/papers and two EC/ papers.**
- **The one DSE or GE paper, two AECC papers and one AEC paper will be qualifying in nature and a student has to score at least 45% marks in these papers. Grade will be awarded separately for these courses, however, performance in these elective courses/papers will not be considered for awarding the final CGPA/class.**

Course structure

SEMESTER-I					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-1	Classical Mechanics	5	70	30	100
MPHYCC-2	Mathematical Physics	5	70	30	100
MPHYCC-3	Quantum Mechanics	5	70	30	100
MPHYCC-4	Lab-I	5	70	30	100
MPHYAECC-1	Environmental Sustainability (3 credits) and Swachchha Bharat Abhiyan Activities (2 credits)	5	50	50	100

SEMESTER-II					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-5	Modeling and simulation	5	70	30	100
MPHYCC-6	Electrodynamics and plasma physics	5	70	30	100
MPHYCC-7	Electronics-I	5	70	30	100
MPHYCC-8	Statistical Mechanics	5	70	30	100
MPHYCC-9	Lab-II	5	70	30	100
MPHYAEC-1	Any one of the followings: <ul style="list-style-type: none"> • Computers and IT skills • Web designing • Financial risk management • Solid management • Mushroom culture • Bio-fertilizer production • Environmental law • Tourism and hospitality management • Life-skill and skill development • Yoga studies 	5	50	50	100

SEMESTER-III					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-10	Atomic and Molecular Physics	5	70	30	100
MPHYCC-11	Condensed matter physics	5	70	30	100
MPHYCC-12	Electronics-II	5	70	30	100
MPHYCC-13	Nuclear and particle physics	5	70	30	100
MPHYCC-14	Lab-III	5	70	30	100
MPHYAECC-2	Human values and professional ethics (3 credits) and Gender sensitization (2 credits)	5	50	50	100

SEMESTER-IV					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYEC-1	Elective paper-I	5	70	30	100
MPHYEC-2	Elective paper-II Part-1: Practical-50 marks Part-2: Dissertation-50 marks	5	70	30	100
MPHYDSE-1 Or MPHYGE-1	Core Course/paper-5 taught in the second semester will be opened to be selected as DSE paper. A student will be allowed to choose a paper from any subject other than his core course from the same faculty in the same University.	5	70	30	100

For MPHYGE-1, students can choose any one of the topics presented at point 5 in page 4.

DETAILS OF ELECTIVE PAPERS

Elective-1					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYEC-1	(Any one from the following list)				
	1. Advanced Quantum Mechanics				
	2. Advanced Condensed matter physics				
	3. Atmospheric Physics				
	4. Biophysics				
	5. Lasers and Photonics				
	6. Measurement and Instrumentation	5	70	30	100
	7. Computational Methods				
	8. Nano Science				
	9. Plasma Physics				
	10. Crystal Physics and X-ray crystallography				
	11. Energy Science				
12. Environmental Physics					
Elective-2					
Part-1: Practical					
Part-2: Dissertation					
MPHYEC-2	Part-1: Any one from of the list of 12 in MPHYEC-1	2.5	35	15	50
	Part-2: Dissertation (On any topic on physics)	2.5	35	15	50

Note: The List for both MPHYEC-1 and MPHYEC-2 are purely provisional. Students will be offered choices based on the availability of proper infrastructure and teaching capabilities at the concerned department. Further, E.S.E and C.I.A. stand for End Semester Examination and Continuous Internal Assessment, respectively.

Exam Pattern

Each paper will be of 100 marks. End Semester Examination (ESE) will carry 70 marks. Continuous Internal Assessment (CIA) will carry 30 marks

Pass marks in every semester paper is 45%.

Aggregate mark in a semester must be at least 45% for clearing the subject papers of each semester.

Total credit 100

Semester I- 25 credit

Semester III- 30 credit

Semester II-30 credit

Semester IV-15 credit

1 credit is equivalent to 10 theory hours or 20 laboratory hours.

Theory Paper		Credit-05	Total Marks-100		
Type of Examination	Duration	Question papers and details of evaluation	No. of questions to be set	Distribution of marks	Total
End Semester Examination (ESE) [Written] 70 marks	3 Hours	Group-A: Multiple Choice Questions	10	2x10	20
		Group-B: Short answer type questions	05 (5 questions, one from each unit. 4 questions to be answered.)	5x4	20
		Group-C: Long answer type questions	05 (5 questions, one from each unit. 3 are to be answered.)	10x3	30
Continuous Internal Assessment (CIA) (30 marks)	1 Hour	Mid semester test No of Tests: 02 [Written] Each test should carry 7.5 marks			
		Group-A: Multiple Choice Questions	03	0.5x3=1.5	7.5x2=15
		Group-B: Short answer type questions	02	1.5x2=3	
		Group-C: Long answer type questions	01	3x1=3	
		Assignment		05	05
		Seminar/Quiz		05	05
		Attendance, punctuality and conduct		05	05

Practical paper		Credit-05	Total Marks: 100	
End Semester Examination (ESE)	6 Hours	1 experiment to be performed	70	This marks distribution is for practical in semesters-I, II, III and IV. In the IV th semester we have elective papers.
Continuous Internal Evaluation(CIA)			30	
Elective practical and presentation of dissertation	6 Hours	1 experiment to be performed plus dissertation presentation	35+35=70	
CIA of practical and dissertation			15+15=30	

Syllabus

SEMESTER 1

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 on 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 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 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 equation and its applications, Jacobi 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 equations 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 identity, Angular momentum-Poisson bracket relations. The Hamilton-Jacobi equation for Hamilton's principal 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 Laws-laws of gravitation form 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, the 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. Know 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

References:

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.

MPHYCC-2 Mathematical Physics (5 Credits)**Course Objectives:**

1. To develop knowledge in mathematical physics and its applications.
2. To develop expertise in mathematical techniques that 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 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 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: Linear Differential equations and special functions:

Linear Differential Equations, Power series solutions; Special Functions: Hermite, Legendre, Bessel, Laguerre 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 integral, Jordan's lemma

Unit 3: Green's Function

Green's Function, Dirac Delta Function, Properties and applications

Unit 4: 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 5: 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

Course Outcome:

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

References:

1. Arfken & Weber, Mathematical Methods for Physicists, Elsevier, Sixth Edition 2012.
2. Murray R. Spiegel, Schaum's Outline of Advanced Mathematics for Engineers 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.

MPHYCC— 3 Quantum Mechanics (5 Credits)

Course Objectives:

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

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 at least one from each unit ($10 \times 2 = 20$). 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 ($4 \times 5 = 20$). 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 ($3 \times 10 = 30$).

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 Hermitian operators, unitary and similarity transformation; Operators, Fourier Transform, Wave function as a 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, Heisenberg 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.G. 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.

Unit 6: Relativistic quantum mechanics: The Klein-Gordon (KG) equation — Charged particle in an electromagnetic field, Interpretation of the KG equation,

Dirac equation, free particle solution, equation of continuity, Plane wave solutions of the Dirac equation, Non-relativistic limit of the Dirac equation, Fine structure of Hydrogen.

Course Outcome:

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

References:

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, Elyahu Zaarur, 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-I (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 (minimum12):

1. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration
2. Young –modulus-- Elliptical fringe method
3. Young-modulus, - Hyperbolic fringe method
4. Four Probe Method - Determination of resistivity of semiconductor at different temperatures
5. Determination of Ultrasonic velocity in given 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
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 coefficient and verify inverse square law.
15. Determination of operating voltage of a GM tube and verify inverse - square law
16. Direct reading of Zeeman Effect (e/m of an electron) with a laser source
17. Compact microwave training system Experiment
18. Stefan's constant.
19. Susceptibility –Guoy and Quincke's methods
20. Hydrogen spectrum and solar spectrum - Rydberg's 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.

MPHYAECC-1

A- Environmental Sustainability (3 Credit)

B- Swachha Bharat Abhiyan Activities (2 Credits)

Each credit requires 10 hours of teaching- learning for theory and 20 hours for practical assignment field work.

A-Unit -1 Environmental ethics & ecosystem: Concept of sustainable development with reference to human values in western and Indian perspective, sustainable development & conservation of natural resources (Nature, factors, structure, development and people participation) development, environment- rural and urban, concept of Ecosystem.

A-Unit -2 Development and its effect on environment: Environment Pollution -water, air, noise etc. due to Urbanisation, Industrial civilization, Concept of Global Warming, Climatic Change, Green House Effect, Acid rain, Ozone layer depletion. Menace of encroachment of exotic plants particularly parthenium and trees with special reference to impact on habit & habitat on indigenous flora & fauna.

A-Unit -3 Concept of Bio-diversity and its conservation: Environmental Degradation and conservation. Govt. Policies, Social effects and role of social reforms in this direction. Role of science in conservation of environment concept of Three 'R.' (reduce, reuse, recycle). Need of environmental education and awareness programme and ecological economics.

B-Unit -4 Swachha Bharat Abhiyan: The concept of Swachhata as personal, Gandhian approach towards social and environmental moral values & concept of swachhata and its relation to moral upgradation of society and freedom struggle. Awareness Programme related to Swachhata. Role of 'Swachhagrahis' in Swachha Bharat Abhiyan.

Sanitation and hygiene, why sanitation is needed, sanitation and human rights, plantation, value of nature, concept of community participation and role of state agencies. Case study of Sanitation, effects of cleanliness, diseases - infectious and vector — Born Idea of spread of diseases through body and other biological fluids and excreta.

B-Unit-5 Assignment/Practical/field work based on unit-4

Or

Alternative to unit-4 and 5, a student can also enroll for Swachha Bharat Internship programme of MHRD.

SEMESTER II

MPHYCC-5 Modeling and simulation (5 Credits)

Inter disciplinary in nature. Recommended to be selected by students of other programme as DSE 1/ GE

Course Objectives:

1. To encourage students to "discover" physics 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 basic in C++/Python/ Java 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.

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 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: Object oriented Programming language

Object oriented paradigm with reference to C++: Objects and classes, Encapsulation and data abstraction, Delegation; Inheritance, Polymorphism: function and operator overloading, dynamic binding; message communication; Elementary idea about Fortran, Java and Python (Basic features only).

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, Numpy, Scipy, Matplotlib, Use of Scilab and R for scientific programming.

Unit 3: ODE and POE:

ODE: RK method, Leap Frog method; Application to electron motion in electric and magnetic fields; Non-linear equations; PDE: Elliptic equations: Poisson equation; Hyperbolic equations: wave equation; Parabolic equation: Diffusion equation for Lagrangian fluids.

Unit 4: Matrix Problems

Jacobi method for matrix inversion; Techniques for solving eigenvalue problems

Unit 5: Monte Carlo method and simulation

Random number generators, Monte Carlo integration, Metropolis algorithm, Ising model. Molecular dynamic.

Course Outcome:

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

1. Learn how to interpret and analyze 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 analyze the data.

References:

1. Rubin H. Landau, Manuel J. Paez, Computational physics-Problem solving with computers, John Wiley & sons, New York (1997).
2. P.L. DeVries, 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

MPHYCC-6 Electrodynamics and Plasma Physics (5 Credits)

Course Objectives:

1. 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 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 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: Electromagnetic wave equation and field vectors: Maxwell's equations in free space.

Plane wave in free space. Dispersion of electromagnetic waves, 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 waves and its Interaction with matter on macroscopic scale:

Electromagnetic waves(EMW) in free space, 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

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 equation 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 equations, hydromagnetic waves: magnetosonic waves, Alfven waves, wave propagation parallel and perpendicular to magnetic field.

Course Outcomes:

Students will have understanding of:

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

References:

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

Publication, 2004).

MPHYCC-7 Electronics 1 (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
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 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: 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, first order active filters.

Unit 4: Digital Electronics: Number systems and codes, binary arithmetic, logic gates: AND, OR, NAND, NOR, NOT, XOR. Boolean algebra theorems, De-Morgan's theorems, Minterm 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 microcontroller: Microcomputer Block Diagram, System Buses, 8085 Microprocessors, architecture and operation, Assembly language Instructions (classification only). 8051 Microcontroller Architecture, Ports and elementary idea of

interfacing.

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 characteristic study.
5. How to construct electronic circuit

References:

1. J. Millman, and H. Taub, Pulse Digital and Switching Wave forms, Tata McGraw Hill, (1991).
2. R. L. Boylestad, and L. 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, Printice Hall, Englewood cliffs, NJ (1999).
5. R.A. Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd. (1999).

MPHYCC-8 Statistical Mechanics (5 Credits)

Course Objectives:

1. The course is to understand the basics of Thermodynamics and Statistical systems.
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 ten compulsory questions (multiple choice type) covering the whole syllabus (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: 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 monatomic 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 Applications I: Density matrix, quantum ensembles, ideal Bose gas, Bose condensation, liquid He II, super fluidity 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 Chandrasekhar limit. Ising model, Random walk and Brownian motion;

Unit 5: Non-equilibrium processes: Features of Equilibrium and Non Equilibrium Thermodynamics, Linear theory of Non Equilibrium Thermodynamics, Current and Affinity, Onsager relation, Fluctuations, Microsystems

Course Outcome:

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 applications of statistical laws

References:

1. Introduction to Thermodynamics. Classical and Statistical, 3rd Edition Richard E. Sonntag (Univ. 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. seddon and Julian d. gale, 3rd edition, RSC publication, 2001, UK

MPHYCC-9 Lab-II (5 Credits)

Course Objectives:

1. To encourage students to "discover" physics 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 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 C 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 and Lagrange's Interpolation formula
6. Trapezoidal Rule, Simpson's 1/3-rule
7. Euler's method and 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 Monte 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.

MPHYAEC-1

Any one of the followings***:

- Computers and IT skill
- Web designing
- Financial risk management
- Solid waste management
- Mushroom culture
- Bio-fertilizer production
- Environmental law
- Tourism and Hospitality management
- Life-skill and skill development
- Yoga Studies

*****Note: It is important to note here that all these choices may not be available at the concerned department. Depending on the infrastructure and availability of topic expertise, MPHYAEC-1 will be decided at the BOCS.**

Computers and IT skill

Unit-1: Basics of 'Computer System': What is a computer? Computer System components — Hardware and Software. Introduction to the terms - Motherboard, SMPS, Processor, RAM, ROM, Ports and Cards. Broad overview of different makers of these components, their availability in the market and their prices.

Unit-2: Basics of 'Operating Systems': Introduction to Unix/Linux Operating System. Introduction to Windows Operating System. Basic operations on Unix/Linux and Windows Operating Systems.

Unit-3: Information Management: Document Processing and e-Documentation using Word processor like open office. Statistical and Graphical data analysis using spread sheet and statistical packages. Data / Information communication and presentation using PowerPoint.

Unit-4: SSD (Special Skill Development):Detailed study on any one of the following three using Spoken Tutorial:

- a. Latex
- b. Accounting software
- c. Spread sheet using Spoken tutorial
- d. Matlab/Sci lab

Unit-5:Networking Basic: Network topologies, LAN, MAN, WAN, TCP/IP, Knowledge of Networking hardware, Service/Client, Interface. Internet Connectivity

Unit-6:Assignment / Field Work based and Unit 1, 2, 3 and 4.

Web Designing

Course description: This paper is designed to enable student to learn basic components required to design and manage a website. The emphasis is given on hands-on training so as to enable students to design their own website.

Course objectives: To expose students to the technology of web site design and to introduce various tools and languages required for dynamic and creative design of state-of-the-art web sites.

Unit-1: HTML5 and CSS3:General Introduction to Internet and WWW, Text tags, Graphics, Video and Sound Tags, Link and Anchor Tags, Table Tags, Form Tags, Miscellaneous tags (layers, image maps etc), Events, Web sockets, CSS3, API, Example Applications, etc.

Unit-2: PHP Programming and My SQL: Programming constructs, Variable/Constants, GET & POST, Files, User defined Functions, Built-in Functions, Cookies, Sessions, Error Handling, MySQL tools and its integration, AJAX, XML, Object Orientation, Form, Facebook and Paypal Integration, Example Applications.

Unit-3: Java script and jQuery: Java script — Basic data types, control structures, functions, arrays and objects, events, html DOM. cookies, error handling, multimedia, animation, Example Applications, jQuery — Basics, Selectors, Attributes, DOM, Events, AJAX, CSS, UI, Plug-ins.

Unit-4: Content Management and SEO: Word Press — Installation, Settings, Categories, Posts, Media, Pages, Tags, Links, Comments, Plug-in, theme. SEO — Introduction, thumb rules, methods, keyword & title optimization.

Unit-5: Lab/Assignment/hand-on training based on Unit 1, 2, 3 and 4.

Learning outcomes:

On completion of this course, the students would:

1. Have a strong foundation to undertake specialized courses in the field of web designing.
2. Develop their own website and manage it.

The Laboratory work will consist of 9-15 Experiments:

1. Practicing basic HTML tags, text tags, text styles, paragraph styles, headings, lists, forms, Tables, link and Anchor tags etc.
2. Including graphics, video and sound in Web pages, Layers and Image maps
3. Creating animated Gifs, simple flash animations
4. Cascading style sheets
5. Creating and browsing XML database
6. Installing web server, setting PHP, Creating client and back end script with GET and POST methods (connecting HTML)
7. MySQL commands/tools and this integration with PHP
8. Exercises covering Java script and jQuery
9. Development of a website using word press involving a variety of tools practiced above

Financial Risk Management

Course description: Every investment activity entails an element of risk, even bank fixed deposits once to be free from risk are subject to risk like interest rate, inflation and default risk. Therefore, managing risk is one of the Prime Concern for every investor. At the same time, Speculators feel the requirement of such a financial instrument that can help in having gain at a low cost. The answer to all these is understanding and practicing DERIVATIVES.

The derivatives are most modern financial instruments in hedging risks. The individuals and firms who wish to avoid or reduce risk can deal with the others who are willing to accept the risk for a price. A common place where such transactions take place is called the “derivative market”.

Course objectives:

1. To develop skills among the students who are planning to pursue their career in Finance and Banking Sector.
2. To develop knowledge among the students to enable them to take decision under the most difficult situation led by uncertainties in the competitive business world.

Unit-1:Introduction:-Risk as an investment Strategy- managing risk in the corporate world- credit Risk V/s Market Risk- Default Risk-Foreign Exchange Risk- Interest rate Risk- Systematic Risk and Non-Systematic Risk-Hedging Scheme-Delta-Theta-Gama-Vegas-Rho

Unit-2: Risk and Derivatives based Hedging Strategies:

Risk Associated with Investment

- Systematic Risk
- Non Systematic Risk Hedging- Risk Management
- Strategy of Diversification of portfolio
- Strategy of Active Portfolio Management
- Hedging/Risk Management Through Derivatives:
- Short Hedge
- Long Hedge

Unit-3: Financial Markets and Derivatives:

Financial Markets:

- Money Market
- Capital Market

Order-Driven Market and Types of Orders Traders in Derivatives Market-

- Hedger
- Spectator
- Arbitrageur

Unit-4: Derivatives: A Birds eye view Introduction

Different derivative transactions: option contract Pay offs from option contract

Futures transaction-

- Features of Futures transaction
- Margin Deposit-initial margin and mark-to-market margin

Forward transaction-

- Features of forward transaction
- Difference of between options, futures and forward contracts

Unit-5: SWAP

- Foreign Exchange Swap
- Interest Rate Swap (Plain Vanilla SWAP)
- Cross Currency SWAP(Total Loan SWAP)
- Derivatives trading at NSE-commodity derivatives trading in India Case studies.

Learning Outcomes: By the end of the course students should be able to understand the mechanism of managing and handling risk which explicitly addresses the uncertainties of the competitive corporate world of 21st century.

A few topics for case studies: Risk Management as Decision-making Process in the Banking Sector-Risk and Uncertain business world-managing risk under the conditions of uncertainty- investment strategy and Risk- Impact of Systematic risk in project-management-importance of the knowledge of various types of risk associated with the investment Hedging Strategy for Portfolio-delta Hedging-static delta Hedging and Dynamic delta Hedging-theta-gamma-Vegas and Rho hedging.

Assignments: Each student has to prepare a dissertation on any topic related to any of the unit. The dissertation should include the following heads:

1. Preface
2. Definition
3. Review of literature
4. Methodology
5. Observations/Case study
6. Relevance
7. Decisions
8. Conclusions
9. Reference

List of Books:

1. **Derivatives and Risk Management** by Dhanesh Kumar Khatri-Macmillian Publishers India Limited, Delhi.
2. **The Essentials of Risk Management** by Michel Crouhy, Dan Galai ISBN: 0071818510/978- 0071818513
3. **Credit Risk management for Indian Banks** by K. Vaidyanthan-Sage Publishing.
4. **Risk Management** by Indian institute of Banking
5. **Risk Management and Financial Institutions** by John C. Hull-Published by John Wiley and Sons, New Jersey.
6. **Risk Management** by Paul Hopkin-Published on Amazon.com
7. **Fundamentals of Risk Management: Understanding Evaluating an implementing effective Risk Management** by Paul Hopkin-Published on Amazon.Com.Uk. Publisher Kogan Page.
8. **Essentials of Risk Management** by Michel Crouhy-Publisher McGraw Hill Education.
9. **Essentials of Financial Risk Management** by Horcher-Publisher Wiley Bartlett-Publisher Rutledge.

Solid waste Management

Course description: The course would cover-general introduction including definition of solid wastes—**municipal waste, biomedical waste, hazardous waste, e-waste**; legal issues and requirements for solid waste management; sampling and characterization of solid waste.

Course objectives:

1. Understanding of problems of municipal waste, biomedical waste, hazardous waste, e-waste, Industrial waste etc.
2. Become aware of Environment and health impacts of solid waste mismanagement

Unit-1:General introduction including definitions of solid waste including municipal, hospital and industrial solid waste; E-wastes; legal issues and requirements for solid waste management; Solid waste management rules, 2016.

Unit-2: Health and environmental issues related to solid waste management

Unit-3: Methods of waste collection, collection techniques, waste container compatibility, waste storage requirements, transportation of solid wastes

Unit-4: Treatment and disposal techniques for solid wastes—composting: Composting, Vermicomposting, Autoclaving, Microwaving, Incineration, Non-incineration thermal techniques, Land filling.

Unit-5:Source Reduction, Product Recovery and Recycling Recovery of Biological Conversion Products: Composts and Biogas

Incineration and Energy Recovery

Integrated Waste Management (I WM)

Learning outcomes:

After completion of the course students should be able to characterize solid waste; analysis of hazardous waste constituents; understand health and environmental issues related to solid waste management; apply steps in solid waste management-waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques.

Practical:

1. Awareness about disposal of different wastes in waste-bin (Concept of disposal of Biodegradable, Non-biodegradable and bio hazardous wastes in different colored bins)
2. Method of composting
3. Method of vermicomposting
4. Autoclaving
5. Bio-gas production

Assignments:

1. Global and Indian issues related to Solid wastes
2. Health issues related to solid waste management
3. Environmental issues related to solid waste management
4. Disposal methods for biodegradable wastes
5. Disposal methods for Non-biodegradable wastes
6. Disposal methods for Recyclable wastes
7. Biomedical wastes and their disposal methods
8. E-wastes and their disposal
9. Land filling method of solid waste disposal
10. Vermicomposting methods of solids waste disposal etc.

Mushroom Culture

Course description: The course would cover-general introduction about fungi including a general life cycle of Mushroom, Edible and Poisonous mushroom, Different aspects of mushroom cultivation in relation to environment, Nutritional value of mushrooms, Economic importance and health benefits of mushroom. Identification of mushroom by spore print method. Production method of edible mushrooms — Button and oyster mushroom; Preservation method for mushroom fruiting body- drying. Diseases of mushroom caused by bacteria, fungi and viruses and its control.

Course objectives:

1. Cultivation methods for edible varieties of mushroom.
2. Preservation method for mushroom fruiting body as well as its spore and mycelium.
3. Awareness of health benefits of mushroom consumption.

Unit-1: General introduction about fungi including a general life cycle of Mushroom; Edible and Poisonous mushroom; Different aspects of mushroom cultivation in relation to environment; Economic importance and health benefits of mushroom.

Unit-2: Production method of some edible mushroom — Button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus sajorcaju*).

Unit-3: Preservation method for mushroom fruiting body-drying; Diseases on mushroom caused by bacteria, fungi and viruses and its control.

Unit-4: Isolation and culture of spores, culture media preparation. Production of mother culture, mother spawn, commercial spawn.

Unit-5: Different methods of maintenance of mushroom culture and its strain preservation

Learning outcomes:

After completion of the course students should be able to understand the cultivation methods for the production of mushrooms viz. Button, Oyster; diseases on mushroom and its remedial measure; preservation method for mushroom fruiting body and its spore as well as mycelium; social, economical, environmental and health benefits of mushroom consumption.

Practical:

1. Production of mother culture by spore culture.
2. Cultivation of Oyster mushroom.
3. Spore print and microscopic examination of mushroom spore and mycelium.
4. Preservation of mushroom by drying

Assignments:

1. Edible mushroom cultivated in India
2. Poisonous mushroom.
3. Cultivation method for Button and Oyster mushrooms.
4. Nutritional and other health benefits of mushrooms.
5. Mushroom spawn production methods etc.

Bio-fertilizer production:

Course description: The course would cover-general introduction about different types of biofertilizers. Edible and Different aspects of biofertilizers production in relation to environment protection, soil enrichment and other benefits. Production methods of different types of biofertilizers.

Course objectives:

1. Structure and characteristic features of different microorganisms used as biofertilizers.
2. Cultivation methods for different types of biofertilizers.
3. Awareness of environmental and agricultural benefits of biofertilizers.

Unit-1: Introduction to biofertilizers-Structure and characteristic features of the following biofertilizer organisms: Bacteria: *Azotobacter*, *Rhizobium*. *Cyanobacteria*. *Nostoc*.

Unit-2: Nitrogenous Biofertilizers: Bacteria - Isolation and purification of *Azotobacter*, mass multiplication *Azotobacter*, formulation of inoculum of *Azotobacter*. Methods of application of *Azotobacter* inoculants. Isolation and purification of *Rhizobium*, mass multiplication and inoculum production of *Rhizobium*, Methods of application of *Rhizobium* inoculants.

Unit-3: Isolation and purification of *Cyanobacteria*- Mass multiplication of cyanobacterial bioinoculants -Trough or Tank method, Pit method, Field method; Methods of application of cyanobacterial inoculum. *Azolla* - mass cultivation and application in rice fields.

Unit-4: Biofertilization processes-Decomposition of organic matter and soil fertility and vermicomposting.

Unit-5: Biofertilizers - Storage, shelf life, quality control and marketing.

Learning outcomes: After completion of the course students should be able to understand the cultivation methods for the production of different types of biofertilizers and their benefits.

Practical:

1. Isolation and identification different types of microorganisms used as bio-fertilizers.
2. Mass Cultivation of *Azotobacter*.
3. Mass cultivation of *Nostoc*.

Assignments:

1. Biofertilizers cultivated in India
2. Environmental benefits of biofertilizers.
3. Agricultural benefits of biofertilizers.
4. *Azotobacter* as biofertilizer
5. *Rhizobium* as biofertilizer
6. *Cyanobacteria* as biofertilizers
7. *Azolla* as biofertilizers etc.

Environmental law

Course description: Law and policy plays a major role in the conservation and management of natural resources as well as pollution control. This course intends to introduce the students to the vast field of Environmental Law and Policy. The course would be divided into three broad areas. The first part would cover the basic concepts and principles of Environmental Law. This would include judicial precedents, which now forms an essential part of environmental jurisprudence. The second part would be divided into specific introductory modules on forests and wild life including bio-diversity related laws; Air and Water related laws including mega projects and marine laws; and laws relating to hazardous substances. The third part would discuss the role of judiciary including the National Green Tribunal in protecting the environment.

Course objectives:

1. To provide an overview of the law and policies relating to environment both at the national and international level.
2. To critically analyze the implementation of these laws and the role of adjudicatory bodies in the field of environment.

Unit-1: Introduction: Environment: meaning and components, Environment vs. Development debates, trigger events, business and environmental law, a brief introduction to SDGs.

Introduction to environmental laws in India; Constitutional provisions, an overview of the laws General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development; Public trust doctrine.

Unit-2: Forest, Wildlife and Biodiversity related laws: Evolution and Jurisprudence of Forest and Wildlife laws; Colonial forest policies; Forest policies after independence.

Statutory framework on Forests, Wildlife and Biodiversity: IFA, 1927; WLPA, 1972; FCA, 1980; Biological Diversity Act, 2002; Forest Rights Act, 2006. Strategies for conservation— Dolphin, Tiger, Elephant, Rhino

Unit-3: Air and Water Laws National Water Policy Laws relating to prevention of pollution, access and management of water and institutional mechanism: Water Act, 1974; Water Cess Act, 1977, EPA, 1986.

Pollution Control Boards
Ground water and law

Legal framework on Air pollution: Air Act, 1981; EPA, 1986 as amended to date including rules and notifications issued under it.

Unit-4: Environment protection laws and large Projects:

Legal framework on environment protection-Environment Protection Act as the framework legislation—strength and weaknesses; EIA.

Marine laws of India; Coastal zone regulations, Wetland conservation.

Unit-5: Judicial remedies and the role of National Green Tribunal: Role of Judiciary in environmental protection; Infrastructure projects and Indian judiciary

Learning outcomes:

On completion of this course, the students would:

1. Have a strong foundation to undertake specialized courses in the field of environmental laws and policy
2. Develop an inter-disciplinary approach to the issues relating to environment.

Assignments:

1. Environmental laws in India
2. Evolution and Jurisprudence of Forest and Wildlife laws
3. Legal framework on Air pollution
4. Biological Diversity law
5. Role of judiciary in environmental protection
6. Air Laws
7. Water Laws
8. Wetland Conservation etc.

Tourism and Hospitality Management

Course description: The course is designed to enable students to learn various components of tourism and hospitality industry like tour arrangements, transportation, hospitality and travel circuits. This course will enable students to earn required skills needed for self-employment and employment for others.

Course objectives: The aim of the course is to provide elementary knowledge of tourism industry including transportation, hotel, destination and future scopes.

Unit-1: Introduction:

Overview of tourism industry. Concept of tourism. Why it is important to study tourism? Scope of tourism and its economic importance. Impact of Tourism.

Unit-2: Elements of Tourism:

Attraction, accessibility, accommodation, tourism product, characteristics of tourism products, types of products and tourism. Hotel Industry, Hotel Chains, Departments of Hotel. Tourist Guide and Escort. Public Relation.

Unit-3: Tour operation:

Travel Agency and Tour Operator, Travel related documents, Passport, Visa, currency regulations, custom, health regulations, baggage regulations etc.

Unit-4: Transportation:

Role of transportation industry in tourism, Indian railways and its special trains (Palace on Wheels, Royal orient), airlines operating in India and international. Kind of Taxi and bus/coach services available.

Unit-5: Travel circuits:

Some popular and important tourism circuits in India (golden triangle, desert circuit, Buddhist circuit, sun and sand, back waters etc) and International circuits.

Learning outcomes:

On completion of this course, the students would:

1. Have a strong foundation to undertake specialized courses in the field of tourism and hospitality Management
2. Gain training for self employment and generate employment for others.

Assignments: Assignment will be based on Unit 1, 2, 3, 4 and 5

Life-skill and skill development

Course description: Acquisition of life skills will empower students to cope with the transitive interactions in personal and professional lives while in an age of communication the curriculum will equip students to develop expertise in the utilities of ICT in the transmission of knowledge.

Course objectives:

1. To develop communication skill of students.
2. To develop writing skill of students.
3. To develop expertise in the utilities of ICT in the transmission of knowledge.

Unit-1: Life Skills: Critical thinking, Aristotle's Law of Logic, Problem solving, Creative thinking

Unit-2: Inter personal Skills: Childhood Ethics, Coping with emotions and stress, Trustworthiness and empathy, Negotiating difference of opinions

Unit-3: Communication skills: What is Communication? Listening Skills, Speaking Skills, Reading Skills, Writing Skills, Group Discussion and Personal interview, Barriers to Communication

Unit-4: Specialized Writing Skills: Official letters, Business letters, Personal letters, Writing agendas, Minutes, Reports, Writing CVs, Resume, Statement of Purpose, Sending applications through mail with attachments, Rapporteurship, Documentation

Unit-5: Information and Communication Technology (ICT) Literacy: Word processor, Excel, PageMaker, Pdf conversion, Preparing PowerPoint Presentation

Learning outcomes:

After completion of the course students should be able to cope with the transitive interactions in personal and professional lives. The course will equip students to develop expertise in the utilities of ICT in the transmission of knowledge.

Assignments: Assignment will be based on Unit 1, 2, 3, 4 and 5

Yoga studies

Unit — 1*

BASIC CONCEPT OF YOGA

- 1. Introduction to Yoga:** Definitions of Yoga, Thinkers on yoga and their views - Patanjali, Gherand and; Goraksh; Karma Yoga, Bhakti Yoga and Gyan Yoga: Concept and Characteristics.
- 2. Raja Yoga** Eight steps of Yoga; Description and significance of Yamas and Niyamas.
- 3. Asanas and Pranayams: Methods,** advantages and limitations; Concept of Prana and Nadis; The subtle body, Chakras.
- 4. Pratyahara and Dharana :** Significance and techniques; Pratyahara and Dharana — Yoga Nidra, AntarMouna, Ajapa Jap:
- 5. Hath Yoga :** Shatkarmas- their methods, benefits and limitations
- 6. Body and Mind:** Body-mind relation; the conscious, subconscious and unconscious; Psychosomatic disorders.

UNIT - 2

APPLICATIONS OF YOGA

- 1. Yogic Lifestyle and Health:** Medical concept and definition of health, Causes of disease according to medical science and yoga; Basic instincts and their management through yoga;
- 2. Diet and Nutrition:** Medical and Yogic concept of diet; the three Gunas in relation to diet.
- 3. Effect of Yoga on body systems:** The Bones and Joints, Cardiovascular, Respiratory, Digestive, Nervous, Endocrinal and Excretory systems. Preventive, Promotive and curative effects of yoga.
- 4. Stress management:** Concept and types of stress, Effects of stress on body and mind, Yogic management techniques.
- 5. Social Health management:** Causes and effects of crime and substance abuse on society, Role of yoga as supporting and transforming agent.

UNIT - 3 (Practical)

- i. Pawanmuktasana - Part I, II and III
- ii. Relaxation asanas Shawasana, Adwasana, Makarasana, Matsyakridasana.
- iii. Meditative Asanas Padmasana, Siddhasana, Siddhayoniasana, Sukhasana.
- iv. Standing Asanas Tadasana, Tiryaktadasana, Katichakrasana, Dwikonasana, Trikonasana.
- v. Vajrasana series — Vajrasana, Suptavajrasana, Singhasana, Shashankasana, Ustrasana, Vyaghrasana.
- vi. Forward Bending Asanas - Pashchirnottanasana, Janushirasana.
- vii. Backward Bending Asanas — Bhujangasana, Tiryakbhujangasana, halabhasana, Dhanurasana, Chakrasana, Gomukhasana, Kandhrasana

UNIT - 4 (Practical)

- (i) Gatyatmak Asanas — Suryanamaskar, Shankhprakhshalana Asanas.
- (ii) Inverted Asanas — Bhumipadmastasana, Sarwanganasana, Halasana.
- (iii) Pranayama - Prepranayama Practices, Yogic Breathing, Nadishodhanuptostage III, Kapalbhati, Bhastrika, Bhramari
- (iv) Mudras and Kriyas - Gyan, Chin, Shambhawi, Nasikagra, Ashwini, Khechari, Agnisar
- (v) Bandhas - Jalandhar, Moola, Uddiyana, Mahabandha
- (vi) Shatkarmas- Kunjal, Jalneti, Laghooshankhprakhshalana, Trataka.
- (vii) Pratyahara -Yoganidra, Antarmauna, Ajapa.

Unit-5: Assignment/Vocational Training

(*1 unit --- 1 credit)

Unit 1+2 = 2x10 = 20 hrs

Units 3+4 (Practicals) = 2x20 = 40 hrs

Unit 5 (Vocational Training) = 10x2= 20 hours Total Programme = 20+40+20= 80 hours

SEMESTER III

MPHYCC-10 Atomic and Molecular Physics, Lasers (5 Credits)

Course Objectives:

1. Objective 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 transitions 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 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: Atomic Physics: Vector Atom 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: Electronic and Molecular Spectra: Molecule as non-rigid rotator, Anharmonic Oscillator (vibration-rotation system), Frank Condon Principle, NMR and ESR. Spectra/Vibration of Polyatomic molecule, Electronic spectra of polyatomic molecules, Chemical analysis by electronic spectroscopy, 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, Laser Resonators, Laser rate equations for three and four level Laser systems, Liquid (Dye) Lasers, Gas (CO₂, Nitrogen and Eximer) lasers, Laser applications in industry, Nuclear science, Spectroscopy. Light detection and Ranging

(LIDAR), scanning laser beam devices, Laser communication, (injection photodiode and Avalanche Photodiode), optical computing, and medical applications.

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, vibrational, electronic and Raman spectra of molecules.
4. Electron spin and nuclear magnetic resonance spectroscopy.
5. Principle, working and applications of laser

References:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).
2. C. N. Banwell, and E. M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).
3. G. Aruldas, Molecular structure and Spectroscopy, Prentice Hall of India, New Delhi, 2001

MPHYCC-11 Condensed Matter Physics (5 Credits)

Course Objectives:

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 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 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: 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 semiconductors, Fermi Surface, Cyclotron resonance and de Haas--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, colour centres

Unit 5: Dielectric Properties: Microscopic concept of Dielectric polarization, Langevin theory of polarization, Claussius-Mossotti equation, Dielectrics in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectricity, optical properties of crystals.

Course Outcomes:

Students will have understanding of:

1. 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, Wil G. D. Mahan, Princeton 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

MPHYCC-12 Electronics II (Analog and Digital Electronics) (5 Credits)

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 (Pass Marks 28). 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 X 2 = 20). Part B will have five short answer questions, with at least 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 at least one question from each unit. The student is required to answer any three out of them (3X 10= 30).

Unit-1: Operational Amplifiers construction and other linear devices: Building

blocks of an OP-AMP: Differential amplifier — dual input, balanced and unbalanced output amplifiers, current sources, current mirror, level translator, complementary symmetry output. 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 4: Sequential Circuits: Master-slave JK flip-flop, 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 characteristic 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. I. Floyd, Electronic Devices, "Pearson Education"- New York (2004)
3. Dennis Le Crissitte, Transistors, Prentice Hall India Pvt. Ltd (1963)
4. J.Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972)
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int Pub
6. M. Goodge, Semiconductor Device Technology McMillan (1983)
7. S.M.Sze, Physics of Semiconductor Devices, Wiley-Eastern Ltd.,
8. Milman and Taub, Pulse, digital and switching Waveforms, McGrew Hill (1965)
9. Ben.G. Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999)
10. R.A.Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd. (1999)

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 (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: Nuclear forces: Exchange forces and tensor forces. Low energy nucleon-nucleon scattering, Effective range theory; Deuteron problem, high energy nucleon-nucleon scattering (Qualitative 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 numbers, 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, Mossbauer Effect

Unit 5: Elementary Particle Physics: Conservation Laws and Symmetry, Strangeness, hypercharge, 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 chromodynamics.

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 (1980).

MPHYCC-14 Lab-111 (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. Construction of a single stage RC coupled amplifier using transistor and study its frequency response.
3. Construction of a two stage RC coupled amplifier using transistor and study its frequency response.
4. Study of Silicon Controlled Rectifier
5. Study the characteristics of UJT
6. Experiment on FET and MOSFET characterization and application as an amplifier
7. Construction of an Astable multivibrator circuit using OP AMP & 555 IC's
8. Characteristics of Tunnel diode and Gunn diode
9. Construction of a bistable multivibrator circuit using IC555 and study its performance.
10. Construction of adder, subtractor, differentiator and integrator circuits using the given OP — Amp
11. Construction of an A/D converter circuit and study its performance
12. Construction of a D/A converter circuit and study its performance
13. Construction of half-adder and full-adder circuit using NAND gates and study their performance.
14. Construction of half-subtractor and full-subtractor circuit using NAND gates.
15. Design of Schmitt's Trigger using ICs 741 and 555 timer — study of frequency divides.
16. Flip flops — RS, JK and D flip flops
17. Shift register and Photo diode characteristics
18. Study of counters: Ripple, Mode 3, Mod 5 counters
19. Photo — diode characteristics
20. Photo — transistor characteristics
21. Analog computer circuit design -- solving the simultaneous equations.
22. Multiplexer and Demultiplexer

23. Decoders and Encoders

Course Outcome:

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 circuits.
3. The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

MPHYAECC-2 (5 credits)

Human values and professional ethics (3 credits)

Gender sensitization (2 credits)

Unit — 1: Variety of Moral Issues, Principals of Ethics and Morality:-

Understanding the Harmony in the Society (society being an extension of family), Integrity, Work Ethic, Courage, Empathy, Self Confidence, Professional Ideas and Virtues. Ethics as a Subset of Morality, Ethics and Organizations, Duties and Rights of employees and employers.

Unit — 2: Holistic approach to corporate ethics:-

Vedantic Ethics -- Tagore, Vivekanand, Gandhi and Aurobindo on Ethics, Ethics in Finance, Business and Environment. Professional Rights, Intellectual Property Rights, Corporate Responsibility. Social Audit and Ethical Investing, Computer and Ethics.

Unit—3: Professional Ethics:-

Augmenting Universal Human Order, Characteristics of people-friendly and eco-friendly production, Strategy for Transition from the Present State to Universal Human Order, At the Level of Individual- as Socially and Ecologically Responsible Technologists and Managers, At the Level of

Society- as Mutually Enriching Institutions and Organizations. Case studies of typical holistic technologies and management patterns.

Unit—4: Gender — an Overview:-

Gender: Definition, nature and evolution, culture, tradition, historicity;
Gender spectrum: biological, sociological, psychological conditioning; Gender based division of labor -- domestic work and use value.

Unit—5: Gender — Contemporary perspectives

Gender justice and human rights: international perspectives, Gender: constitutional and legal perspectives, media & gender, Gender: emerging issues and challenges.

SEMESTER-IV
MPHYEC-1 ELECTIVE PAPER 1(5 CREDITS)

One to be chosen from the following options**

- A. Advanced Quantum Mechanics
- B. Advanced Condensed matter physics
- C. Atmospheric Physics
- D. Biophysics
- E. Lasers and Photonics
- F. Measurement and Instrumentation
- G. Computational Methods
- H. Nano Science
- I. Plasma Physics
- J. Crystal Physics and X-ray crystallography
- K. Energy Science
- L. Environmental Physics

****Note: It is important to note here that all these choices may not be available at the concerned department. Depending on the infrastructure and availability of subject expertise, elective papers will be decided at the BOCS.**

MPHYEC-1A 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 X 2 = 20). Part B will have live 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: 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

Units 2: Relativistic Quantum Mechanics: Postulates of Quantum Mechanics, Space time description of Schrodinger Wave Equation, Klein Gordon equation, Dirac equation, covariant form; Plane wave solution; 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 of complex scalar and "Schrodinger" field, Bosons and Fermions

Unit 4: Quantum Chromodynamics I: Introduction to quantum chromodynamics, Quark model

Unit 5: Quantum Chromodynamics II: 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 universal 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).

MPHYEC-1B Advanced Condensed Matter Physics (5 Credits)

Course Objectives:

1. The course is to understand the basic knowledge on crystal structures and systems
2. Understand the various process techniques available of X-Ray Crystallography
3. Acquire the knowledge of Lattice waves and Polaritons
4. 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 three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (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: 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, magnetism effects in Nanomaterials.

Unit 5: Dielectric Properties: Theory of Dielectrics, 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
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 applications of superconductivity.

References:

1. Introduction to Solid State Physics, 3rd & 6th Editions. C. Kittel, Wiley Publishing
2. Condensed Matter in a Nutshell, WilG.D. Mahan, Princeton 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

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 (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 I: Introduction and Atmospheric Chemistry:

General description 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: Radiation, absorption of radiant energy in the atmosphere, 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 on 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. 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.

MPHYEC — 1D Biophysics (5 Credits)

Course Objectives:

1. The course is to understand the basic knowledge on biomolecular systems
2. Understand the various theoretical modeling techniques involved in biomolecular systems
3. Acquire the knowledge of Structure and function of Proteins, Carbohydrates & Nuclei 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 (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: 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 dichorism 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: Principles and types [Polyacrylamide gel electrophoresis (PAGE), SDSPAGE, agarose gel electrophoresis, 2D electrophoresis and their applications.

Unit-5: Theoretical techniques and their application to Biomolecules: Hard sphere Approximation, Ramchandran plot, Potential energy surfaces, Outline of Molecular Mechanics Method, Brief ideas about semi-empirical and ab-initio quantum theoretical methods, molecular charge distribution, molecular electrostatic potential and field and their uses.

Course Outcome:

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

1. Basic knowledge of Bimolecular 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.

References:

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., New York 1997.
3. Biophysics by VasanthaPattabhi and N. Gautham, NarosaPublishing House, New Delhi, 2002.

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 ten compulsory questions (multiple choice type) covering the whole syllabus (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: Basic Principles: Laser rate equation for three level and four level systems, 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: Applications of Laser: Fabrication of electronic components, Material processing; Laser Communication, Holography, Military applications, 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 solution of Maxwell's equation inside Fiber. Signal degradation and attenuation in Optical Fibers,

Unit 5: Optical Fiber systems: Optical sources (ILD and PIN Diode) and Optical Detectors (APD); Analog and Digital optical fiber Transmission System (PDH, SDH and WDM Technology)

Course Outcome:

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

References:

1. Balch B F A and M C Teich, "Fundamentals of Photonics". John Wiley, New York., 1991.
2. Pal B P (F.d.). "Guided Wave Optical Components and Devices" Academic Press, 2006.
3. Smith F G and T A King. "Optics and Photonics" John Wiley, Chichester, 2000.
4. Thyagarajan K and A Ghatak. "Nonlinear Optics, in Encyclopedia of Modern Optics (Editors: Bob Guenther et al)". Elsevier IA1_2005.

MPHYEC 1F Measurement and Instrumentation (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 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 ten compulsory questions (multiple choice type) covering the whole syllabus (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: Basic Principles: Measuring Instruments: Accuracy, precision, sensitivity and resolution; Scale, standards and calibration; Uncertainties of measurements and errors,

propagation of errors, 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, Lock-in amplifier.

Unit-4: Digital signal processing: A/D and D/A convertor, 7107 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,

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

MPHYEC-1G Computational Methods (5 Credits)

Course Objectives:

1. To encourage students to "discover" physics 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 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.

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 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: Introduction to C / C++/ Python/ Java programming: Algorithms, structured programming, Constants and variables, arithmetic expressions, input and output statements, logical expressions and conditional statements, iteration, functions, Arrays, Strings, Pointers, 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 finding roots of equations: Bisection method, Newton-Raphson method, Successive Approximation method; Solution of simultaneous algebraic equations: Gauss Elimination method, Gauss-Siedel 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, 2-dimensional Laplace's

equation. Use of spreadsheets for calculations and graphs. Simulation of simple Physics problems, introduction to MATLAB/SCILAB/MATHEMATICA

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.

References:

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, Third Edition, Prentice - Hall of India, 2003
4. Programming in ANSI- C. E. Balaguruswamy, Second Edition, Tata McGraw Hill, 1992

MPHYEC— 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 (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: 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, RF 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 applications, Nano-structured Ferroelectric materials, Synthesis and Characterization, techniques of Ferroelectric nano-materials, Multiferroic and smart materials

Course Outcome:

At the end of this 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.

References:

1. Nanostructure and Nanomaterials, synthesis properties and application, 2nd Edition, Author by Guozhong Cao & Ying Wang, Published by world scientific published, printed in 2004 Singapore.
2. Hand book of Nanotechnology, 3rd edition Author by Bhusha, Published in springer, printed 2004 German.
3. Nanostructure materials, processing, properties and potential applications, 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 UK.

MPHYEC— 1I Plasma Physics (5 Credits)

Course Objective:

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 (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: Basics (Single Particle Approach): Charged particles in uniform and non-uniform electromagnetic field, Plasma - the fourth 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 un-magnetized plasma, Energy transport, Ion acoustic waves and MHD waves, Issue of plasma stability and the use of normal mode to analyze 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 $f(v)$, 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, Dynamo action.

Course Outcomes:

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.

References:

1. A.R. Choudhari, "The Physics of fluids and plasmas" (Cambridge UP 1998)
2. Chen Francis, "Plasma Physics". II Edn,(Plenum Press, 1984)
3. Bitten Court J A, "Fundamentals of Plasma Physics" (Pergamon Press. 1988)
4. Paul Bellan, "Fundamentals of Plasma Physics" (CUP 2006)

MPHYEC— 1J Crystal Physics and X — Ray Crystallography (5 Credits)

Course Objectives:

Structural analysis is the first step in the characterization 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 analyze 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 (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: 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: CRYSTAL SYMMETRY: Bravais lattices, space groups and crystal structures, 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, proofs 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 and crystal growth, color centers.

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 analyze the collected experimental data

References:

1. C. Hammond, The basics of Crystallography and diffraction, Oxford University press, New York (2009).
2. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley, Massachusetts (1956).
3. C. Suryanarayana, 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).

MPHYEC-1K Energy Science (5 Credits)

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 (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: 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 carriers.

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 and Polymer Solar Cells, Elementary Ideas of advanced Solar Cells e.g. Tandem Solar cells, Solid Liquid Junction Solar Cells, Nature of Semiconductor, Principles 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 Photo-electrolysis, Physics of material characteristics for production of Solar 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: Hydrogen Energy: Safety and Utilization:

Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Various type of Fuel Cells, Applications of Fuel Cell, Elementary concepts of other Hydrogen Based devices such as Hydride Batteries.

Unit 5: Other Renewable Clean Energies:

Elements of Solar Thermal Energy, Wind 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.

References:

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, TMH.

5. G.D. Rai, Non-conventional Energy sources, Khanna Publications, Delhi.

MPHYEC-1L 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 realize 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 realize 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 (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: 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 of 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 (Kirchhoff's law, Planck's law, Beer's law, Wien's displacement law, etc.) Solar and terrestrial spectra, UV 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 processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, Hydropower, Fuel cells, nuclear energy, Forestry and bioenergy.

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 basics 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.

References:

1. Egbert Boeker and Rienk 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, Elbs, 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.

MPHYGE-1

Any one of the followings***:

- Music
- Dramatics
- Fine arts
- Graphic Design
- Inclusive Policies
- Human Rights
- Family Management
- Any course run by any department

*****Note: It is important to note here that all these choices may not be available at the concerned department. Depending on the infrastructure and availability of topic expertise, MPHYGE-1 will be decided at the BOCS. Syllabuses of some of these topics are given here.**

Generic Elective (GE) course (5 Credits)

Graphic Designing

Unit 1: HTML5 and CSS3: General Introduction to Internet and WWW, Text tags, Graphics, Video and Sound Tags, Link and Anchor Tags, Table Tags, Form Tags, Miscellaneous tags (layers, image maps etc), Events, Web sockets, CSS3, API, Example Applications, etc.

Unit 2: PHP Programming and MySQL: Programming constructs, Variable/Constants, GET & POST, Files, User defined Functions, Built In Functions, Cookies, Sessions, Error Handling, MySQL tools and its integration, AJAX, XML, Object Orientation, Form, Facebook and Paypal Integration, Example Applications.

Unit 3: Java script and jQuery: Java script — Basic data types, control structures, functions, arrays and objects, events, html DOM, cookies, error handling, multimedia, animation, Example Applications,

jQuery — Basics, Selectors, Attributes, DOM, Events, AJAX, CSS, UI, Plug-ins.

Unit 4: Content Management and SEO: Word Press — Installation, Settings, Categories, Posts, Media, Pages, Tags, Links, Comments, Plugins, theme.

SEO — Introduction, thumb rules, methods, keyword & title optimization.

Unit 5: Assignment / Field Work based and Unit 1, 2, 3 and 4.

Note: Students who enrolled for WEB DESIGNING as AEC in Semester II will not be allowed to take Graphic Design as a GE course in Semester IV

Generic Elective (GE) course (5 Credits)

Inclusive Policies

Unit 1: Concept of Inclusive Policy:

- a. Meaning and Nature of inclusive policy
- b. Exclusion and Inclusion Controversy, caste based Exclusion

Unit 2: Right of Individual and their Redressal

- a. State Policies and the Rights of Individual
- b. Obstacles in the fulfillment of Individual Rights, Poverty, Illiteracy, Under Development, Government Policies

Unit 3: Sources of Inclusive Policies

- a. Constitutional Provisions and Inclusive Policies
- b. Ideas of Amartya Sen.

Unit 4: Inclusive Policies and Human Rights

- a. Social, Economic, Political and Legal Structure of the Country.
- b. Bureaucratic corruption, police Atrocities and criminal judicial process.

Unit 5: Assignment / Field Work based and Unit 1, 2, 3 and 4.

Generic Elective (GE) course (5 Credits)

Human Rights

Unit 1: Conceptual Aspects of Human Rights

- a. Meaning and Concept of Human Rights
- b. Human Rights, Natural Rights, Civil Rights, Political Rights and Legal Rights.

Unit 2: Evolution of the Concept of Human Rights

- a. Magna Carta, The united state declaration of Independence: The French Declaration of the Rights of Man and the Citizen: United state Bill of Rights: Geneva Convention of 1864: Universal declaration of Human Rights, 1948.
- b. International Bill of Rights, Significance of Universal Declaration of Human Rights International Covenant on Civil and political Rights, International Covenant on Economic, Social and cultural Rights..

Unit 3: Diversity, Multiculturalism and Human Rights

- a. Value of Diversity: Collective Cultural Rights and the Idea of Universal Human Rights: Multiculturalism and Minority Rights: protection and promotion of Human Rights in Multicultural Societies.
- b. Beyond Universal Human Rights: Universalism of human Rights: Nation-State and the Right to national Self-Determination: state Sovereignty and the Politics of Universal Human rights.

Unit 4: Theoretical aspects of Human rights.

- a. Theories of Human rights-Liberal Perspective-Locke, Rousseau, J.S Mill, Marxian Perspective-Marx, Gramsci
- b. Feminist Perspective of Human Rights.

Unit 5: Assignment / Field Work based and Unit 1, 2, 3 and 4.

Generic Elective (GE) course (5 Credits)

Family Management

(One credit requires ten hours of theory and twenty hours of practical/assignment/field work)

Unit 1: Concept of typical Indian family:

Indian society and Indian family, importance of relationship within family, similarities and dissimilarities in between Indian and western family, definite role of family members.

Unit 2: Food production and cleanliness:

Cooking - art or science, personal grooming, hygiene & uniform, Do's and don'ts while working in the kitchen, Domestic Food Production, nutrition- Balanced Diet and its function, effect of heat on fat, carbohydrates, proteins, vitamins and minerals. Cholesterol and trans fats and related diseases. Disease producing microbes.

Unit 3: House keeping:

Equipment handling, care & cleaning & identification of cleaning equipments; Care, cleaning & polishing of surfaces — metals, glass, floor, carpets; Paints, daily cleaning of rooms and bath rooms.

Unit 4: Safety & health care:

Psychology child care and care of the elderly. Basic human anatomy and physiology (skeleton, respiratory, circulatory, excretory, nervous & reproductive systems). First aid care in different accidents (hemorrhage, asphyxia, shock & unconsciousness, cardiac arrest, burns, insect bite, snake bite, poisoning, injury etc.). Nursing, first aid box, importance of group practice of yoga and exercise.

Unit 5: Importance of communication and care in family:

Leadership in family, communication gap between generations, significance of soft-skill, Indian laws related to family problems, understanding and misunderstanding within the family members and among close relatives, in-laws etc. Necessity of small investments for family members.

Important points regarding syllabus:

- **Lab works from semester-I to IV will be decided based on the availability of instruments and infrastructure.**
- **The syllabus of MPHYEC-2 will be decided by BOCS at the appropriate time depending on the availability of infrastructure and relevant resources.**

*****DISCLAIMER:** *In case of any discrepancy in the matter related to syllabus of M.Sc. Physics, Magadh University, Bodh Gaya, the matter will be resolved either at the BOCS level or at the University level depending on the nature of difficulty.*

THE END