SYLLABUS FOR M.Sc. IN PHYSICS

UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

(To be effective from 2018 -19)

MPHYCC-14 Lab-Ill 5 Credits

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 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 tnultivibrator circuit using AIVIP & 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, subtracter, differentiator and integrator circuits using the given OP — Amp
11. Construction of an A/D converter circuit and study its performance
12. Construction of an 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— subtracter and full — subtracter circuit using NAND gates.
15. l)esizn of sehimitt•s -crigget- using ICs 74 1 and 555 tituer — 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 a 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.

SEMESTER IV

MPHYEC-I Elective Pa er l 5 Credits

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Course Objectives:

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
H	Nano Science
I	Plasma Physics
J	Crystal Physics and X – Ray Crystallography
K	Energy Science
L	Environmental Physics

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MPHYEC-IA Advanced Quantum Mechanics (5 Credits)

Course Objectives:

l. 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 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: 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 chiralitxz Properties of matrices; Charge conjugation; Normalization and completeness of spinors.

Unit 3: Quantum Field Theory: Second quantization — Lagrangian field theory, Hamiltonian formulation. (Qllantization of scalar field. Quantization of complex scalar and "Schrodinger" tield. Bosons and Fermions

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

Unit 5: Quantum Chromodynamics Il: 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 McGrawHill (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-1BAdvanced Condensed Matter Ph sics 5 Credits

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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, Ginzsburg —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, Princetyon 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 , 201 1

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MPHYEC— ICAtmospheric Physics

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 1: 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

L 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 Laerning, USA, 2010

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2. Murry L. Salby, Fundamentals of Atmospheric Physics, Academic Press, Elsevier, USA, 1996

3. David. G. Andrews, An Introduction to Atmospheric Physics, Cambridge University Press, United Kingdom, 2000.

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MPHYEC- ID Bi0Dhysics

Course Objectives:

1 . The course is to understand the basic knowledge on biomolecular
2. Understand the various theoretical modeling techniques involved in biomolecular systems
3. Acquire the knowledge of Structure and function of Proteins, Carbohydrates & 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-I: 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: UVVis 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 Biomolecular of chemistry and functions.
2. Understand the basic idea about the Structure and Function of Nucleic Acids.
3. Impart the knowledge about the Function of Carbohydrates and Proteins.
4. Understand the applications of Biomolecules.

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., Newyork 1997.

(5 Credits)

3. Biophysics by VasanthaPattabhi and N. Gautham, NarosaPublishmg House, New Delhi, 2002.

MPHYEC- IE Lasers and Photonics (5 Credits)

Course Objectives:

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

l. 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, ISpe.s of 1• iber and solution of Max ell •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:

l . 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, witha good understanding of its capabilities and limitations.

References:

1. Saleh B E A and M CTeich"Fundarnentals of Photonics", John Wilev.New York. 1 99 1 .

2. Pal B P(Ed. "(iuided Wave()ptical Cotuponent.s and l)evices", Acadelllic Press. 2()()6.

3. S,nlith F G and 'I" A king "Optics andPhotonicss".John Wiley,Chicester,2000.

4. Thyagaraian K and A Ghatak. "N onlinear Optics,in Encyclopedia of Modern Optics (Editors:Bob Guenther*etal*)",Elsevier Ltd..2005.

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MPHYEC — IF Measurement and Instrumentation

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 EngineeringMichael Sayer and Abhai Mansingh, Prentice Hall of India 2005
2. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington and

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(5 Credits)

K.D Robinson, McGraw Hill, 2003

3. Electronic Instrumentation- H.S. Kalsi, TMH Publishing Co. Ltd. 1997
4. Instrumentation Devices and Systems-C.S. Rangan, G.R. Sharma, V.S.V. Mani, 2nd Edition, Tata McGraw Hill, New

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MPHYEC-I G Computational Methods

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-I: 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: El •rape;oidal rule. Sillipson'.s rule. Numerical of Di tferential 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 I ,aplace's llquation, Use of spreadsheets for calculations and graphs. Simulation of simple Physics problems, introduction to MATLAB/SCILAB/MATHEMATICA

Course Outcome:

At the end ofthis 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:

(5 Credits)

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

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MPHYEC- IH Nano Science

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-I: 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; T EM, 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

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(5 Credits)

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 &yingwang, 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, Publised by Insitute of physics publishing Bristol and Philadelphia, printed in 2000 UK.

Credits)

MPHYEC— 11Plasma Physics(5

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 forth state of matter, Concept of electron and ion temperature, Debye Length, Cyclotron Frequency, Larmor radius, Drift velocity of guiding center, Magnetic moment Magnetic mirror systems and their relation to the plasma confinement, Adiabatic Invariants..

Unit 2: Magneto Hydro Dynamics (Fluid Approach): Introduction to ideal MHD systems, Fundamental equations of magneto hydrodynamic systems, Diffusion and mobility of charged particles in plasma, Plasma as fluid and MHD equations, Approximations and linearization of MHD from dimensional considerations, Single fluid MHD equation, MHD Generator.

Unit 3: Waves and instabilities in plasma: Waves in unmagnetised plasma, Energy transport, Ion acoustic waves and MHD waves, Issue of plasma stability and the use of normal mode to 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, Choudhaj•i. I he Physics of tluid.s and plasnnas•• (C 'ambridue UP 1998)

2. ('hen Francis, ,.Plasnva Physics", Il (Plenum Press, 1984)

3. Bitten Court J A, ..l'undamentals of Plasma Phy (Pergamon Press. 1988)

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4. Paul Bellan. •undamentals of Plastna Phy (CUP 2006)

MPHYEC— IJ 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 analyse the crystal structure using x-ray diffraction

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (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: Diffractions Brag(ecs 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, steoreographic projection, Point defects, line defects, planar faults, role of dislocations in Plastic deformation and crystal growth, colorcenters.

Course Outcomes:

Student would have understood

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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 difTraction 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).

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MPHYEC-IK 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 ITquired 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 hotovoltaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconduct ors, 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, Ele mentary 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 thro ugh Photoelectrolysis, Physics of material characteristics for production of Solar Hydrogen. Brief discu ssion 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.

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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, McGrew 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.

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MPHYEC-IL 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 (KirchofTk iavv. Planck •s 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 see 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, Environmentæ John Wiley
2. J. T. Hougtion, The physics of atmosphere, Cambridge Uruversity 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.

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