SYLLABUS FOR M.Sc. IN PHYSICS

UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

(To be effective from 2018 -19)

MPHYCC4 Lab-I

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' ln€)dulus Elliptical fringe method
3. Youne 1110dulus — 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 l l . 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 lane.
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 — (_iuoy and Quincke•s noeth0kls
20. Hydrogen spectrum and solar spectrum — Rydbere -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.

SEMESTER 11

MPHY CC-5 Modelin and simulation	5 Credits

(5 Credits)

Inter disciplinary in nature. Recommended to be selected by students ofother programme as DSE l/ 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 Pghon (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 PDE:

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,lsing model, Molecular dynamic.

(5 Credits)

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 analyse 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 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, Planc 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 EM W, Fresnel formulae, Brewster's law and degree of polarization, total internal reflection and critical angle, reflection froln a metallic surface, Propagation of EM W 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:

(5 Credits)

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

MPHYCC-7 Electronics 1

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, flipflops - 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.

(5 Credits)

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

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, [iouville's theorem.

Unit 2: Ideal classical gas: Partition function of a classical ideal gas, thermodynamical potentials in terms of partition function for an ideal monoatomic gas in microcanonical and grand canonical ensembles, entropy of mixing and Gibbs paradox, Maxwell-Boltzmann distribution law, entropy of monoatomic gas.

Unit 3: Quantum statistics and Applications I: Density matrix, quantum ensembles, ideal Bose gas, Bose condensation, liquid He Il, superfluidity and I .anclau-s theory.

Unit 4: Quantum statistics and Applications Il: 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: Noneqlibrium 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 EditionRichard E. Sonntag (Univ. of Michigan), Gordon J. van wylen (Hope College) ISBN: 978-0-471-61427-2, 1997
2. Pathria R.R., Statistical Mechanics, 2nd Edition, Elsevier, 1996.

(5 Credits)

3. Thermodynamics and Statistical mechanics , author by John m. seddon and Julian d. gale, 3rd edition, RSC publication, 2001, UK

(5 Credits).

Course

MPHYCC-9 Lab-Il

Objectives:

l . 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):

l . To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. Successive approximation (Method of Iteration), Newton Raphson method
3. The Bisection method
4. Gauss Elimination method
5. Matrix Inversion, Lagrange •s Interpolation ibrnu.lla
6. Trapezoidal Rule, Simpsolfs l;3-rule
7. Euler's nwthod, 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. l l . To simulate the random walk.

Course Outcome:

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

l . 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.

SEMESTER 111

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

Course Objectives:

l . 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