SEMESTER II

MPHYCC 5 MODELING AND SIMULATION (5 CREDITS)

Inter disciplinary in nature. Recommended

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

Course Objectives :

1. To encourage students to "discover" in a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational technique with programming in Fortran/C++/Python/Java to face the world of problems 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 questions paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with two from each unit (10 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 : Programming in Fortran:

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

Unit 2 : Programming with Python:

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

Unit 3 : ODE and PDE:

ODE: RK method, Leap Frog method: Application to electron motion in electric and magnetic fields, Non-linear equations: PDE Laplaes and equations, Poisson equation; (2-Dimass ion.

Unit 4 : Matrix Problems:

Jacobi method for matrix inversion techniques for solving eigenvalue problems, Simultaneous orthogonally, Diagonalization, Hermition.

Unit 5 : Numerical method and simulation:

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

Course Outcome:

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.

Reference :

1. Rubin H. Landau Manuel J. Paez. Computational physico-Problem solving with computers, John Willey & 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.

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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 situation.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 x 2=20). Part B will have five short answer questions, with one 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 wave equation and its Interaction with matter on macroscopic scale:

Electromagnetic waves (EMW) in free space, propagation of EMW in isotropic, anistropic 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 reasonator.

Unit 3 : Fields of moving charges and Radiating System:

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

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Unit 4 : Relativistic Electrodynamics:

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

Unit 5 : Plasma Physics:

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

Course Outcome:

Students will have understanding of:

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

Reference :

1. Introduction to Electrodynamics, David J. 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 (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 two from each unit (10 x 2=20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 x 5 = 20), Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Semiconductor devices:

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

Unit 2 : Amplifiers and feedback:

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

Unit 3 : Operational Amplifiers:

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

Unit 4 : Digital Electronics:

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

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

Unit 5 : Microprocessor and small microcontroller :

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

Course Outcome:

Students will have understanding of:

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. Designing of different types of the Digital circuits and to give the computational details for Digital circuits.
3. Characteristics of devices like PNP and NPN junction diode and truth tablets of different logic gates.
4. Basic elements and to measure values with multimeter and their characteristic study.
5. How to construct electronic circuit.

Reference :

1. J. Millman, and H. Taub, Pulse Digital and Switching Wave formš, Tata McGraw Hill, (1991).
2. R.L. Boylestad and 1. 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).

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MPHYCC -8 STATISTICAL MECHANIES (5 CREDITS)

Course Objectives :

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

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

Unit 1 : The statistical basis of thermodynamics:

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

Unit 2 : Ideal classical gas:

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

Unit 3 : Quantum statistics and Application I:

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

Unit 4 : Quantum statistics and Applications II:

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

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Unit 5 : 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 knowldge about the phase transitions and potentials.
4. Understand the application of statistical laws.

Reference :

1. Introduction to Thermodynamics, Classical and Statistical, 3rd Edition Richard E. Sonntag (University of Michigan), Gordon J Van Wylen (Hope College) ISBN 978-0-471-61427-2, 1997.
2. Pathria R.K. Statistical Mechanics, 2nd Edition, Elsevier, 1996.
3. Thermodynamics and Statistical mechanics author by John m. seddom and Julian d. gale 3rd edition, R.S.C. publication, 2001, U.K.

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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 are various computational technique with programming basic in C to face the world of problems using high performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in traditional curriculum.

PROGRAMMING NUMERICAL METHODS USING FORTRAN LANGUAGE (ANY 8):

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

Course Outcome:

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

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

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Reference :

4. Introduction to Thermodynamics, Classical and Statistical, 3rd Edition Richard E. Sonntag (University of Michigan), Gordon J Van Wylen (Hope College) ISBN 978-0-471-61427-2, 1997.
5. Pathria R.K. Statistical Mechanics, 2nd Edition, Elsevier, 1996.
6. Thermodynamics and Statistical mechanics author by John m. seddom and Julian d. gale 3rd edition, R.S.C. publication, 2001, U.K.

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