SEMESTER II

M2PHY01-CT05: Computational Methods in Physics

*(**Note**: At the beginning of the semester, students must be provided: Detailed Lecture schedule of topics to be covered in each lecture, tutorial topics, clearly defining chapters/sections of reference books followed, link to web resources etc. Examiners are expected to take into consideration the lecture schedule while setting the question papers to ensure questions are set within scope of the syllabus)*

External: 80 Marks Internal: 20 marks

Lectures: 40hrs Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

(Topics must be taught through Algorithmic approach. Detailed derivations of the equations are not required.)

UNIT-I:

Computers and Numerical Analysis(3L): IEEE 64 bit Floating point number representation, arithmetic operations, consequences of floating Point representation, computing errors, Error propagation, Introduction to parallel and distributed computing, Measuring efficiencies of Numerical procedures

System of Linear Equations(6L): Solving a system of Linear equations using Gauss Elimination, Gauss Jordan methods, Inverse of a matrix, Iterative methods to solve Equations: Gauss Seidel iterations, comparison of Iterative and Direct Methods.

UNIT-II

Non-linear equations(4L): Bisection and Newton Raphson method, Solution of Polynomial Equations, Newton methods for a system of nonlinear equation,

Interpolation(3L): Lagrange Interpolation, Difference tables, Truncation error, Spline Interpolation

Curve fitting (3L): Straight line fit, fitting using polynomial function of higher degree, Exponential Curve Fit, cubic spline fitting

UNIT-III

Fourier Transform(3L): Fourier analysis and orthogonal functions, Discrte Fourier Transform, Power Spectrum of driven pendulum

Numerical Integration(2L): Simpson and Guass quadrature method.

Numerical Differentiation (1L): Difference approximation of first derivative

UNIT-IV

Differential equations(5L): Euler and Taylor Series methods, Runge-Kutta Methods, Predictor-corrector Method, Comparison of different methods .

Elementary ideas of solutions of Partial Differential Equations (1L)

Monte-Carlo simulations (3L) :Sampling and Integration, Metropolis Algorithm, Applications in Statistical physics

UNIT-V

Matrices and Eigen values (6L): Eigen values and Eigen vectors, Similarity transformation and Diagonalization, power method to find eigen values, physical meaning of Eigen values and eigen vectors

Reference Books:

1. V. Rajaraman, Computer Oriented Numerical methods , Third Edition, PHI, 2013
2. Curtis F Gerald and Patrick Wheatley :Applied Numerical Analysis ,Seventh Edition, Pearson Education Inc. 2004
3. Won Young Yang, Wenwu Cao, Tae-Sang Chung and John Morris: Applied Numerical Methods Using MATLAB, Wiley 2005
4. Tao Pang: An Introduction to Computational Physics, Cambridge Press

M2PHY02-CT06: Quantum Mechanics-II

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External: 80 Marks Internal: 20 marks
Lectures: 40hrs Tutorials : 10 hrs
Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

UNIT-I

Approximation methods: **5L**

The WKB approximation: Introduction of the method, The Classical region, Tunneling, The WKB wavefunction and connection formulae, Criterion for validity of approximation, Applications to potential well with a vertical wall and no vertical walls, Energy of one dimensional bound system.

The Variational method: **3L**

Basic formulation and principle of the method, bound state (Ritz method), Applications to linear harmonic oscillator, Ground state energy under delta potential, Helium atom

UNIT-II

Theory of scattering: **5L**

The scattering experiment, Classical and quantum mechanical scattering, Relationship of scattering cross-section to the wavefunction, Scattering amplitude, Method of partial waves, Expansion of a plane wave into partial waves.

Scattering by a central potential V(**r**)**:** **3L**

Dependence of phase shift on V(**r**), angular momentum and energy, Zero energy scattering, Scattering length, Scattering by a square well potential, effective range

UNIT-III

Born approximation and Integral equation of scattering: **5L**

Born approximation, Green Function, The integral equation for scattering, The Born series, Criterion for the validity of the Born approximation, Low energy soft-sphere scattering, Yukawa Scattering, Scattering of electrons by atoms, Rutherford scattering

Identical particles: **3L**

The identity of particles, the indistinguishability principle, symmetry of wave functions, spin and statistics, Pauli exclusion principle, Illustrative example: scattering of identical particles, case of spin half and spin zero particles.

UNIT-IV

Time dependent perturbation theory: **5L**

Basic principle and formulation of time dependent perturbation theory, constant perturbation, Continuum, Transition to continuum, Fermi's golden rule, scattering cross section in the Born approximation, Harmonic perturbation

Radiative transitions in atoms: **3L**

Theory of radiative transitions in atoms, The dipole transitions, Selection rules involving m and ℓ.

UNIT-V

Relativistic wave equations:

The Klein Gordan equation: **2L**

Introduction, The Klein-Gordan equation, Interpretation of probability and the equation of continuity.

Dirac equation: **6L**

The first order wave equations, Weyl equation, The Dirac equation, Properties of Dirac matrices, Covariant form of Dirac equation, Existence of intrinsic angular momentum of Dirac particle, Solutions of Dirac equation, The non-relativistic limit of Dirac equation, spin-orbit coupling, Hole theory.

Textbooks:

2. Quantum Mechanics, V.K. Thankappan, Wiley Eastern Ltd. (1986).
3. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Education Inc. (2005).

Reference books:

1. Principles of Quantum Mechanics, R. Shankar, Plenum Press, New York (1994).
2. Modern Quantum Mechanics, J.J. Sakurai, Addison and Wesley (1994).

M2PHY03-CT07: Statistical Mechanics

*(**Note**: At the beginning of the semester, students must be provided: Detailed Lecture schedule of topics to be covered in each lecture, tutorial topics, clearly defining chapters/sections of reference books followed, link to web resources etc. Examiners are expected to take into consideration the lecture schedule while setting the question papers to ensure questions are set within scope of the syllabus)*

External: 80 Marks Internal: 20 marks
Lectures: 40hrs Tutorials : 10 hrs
Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

UNIT-I (8L)

Classical Statistical Mechanics: The Postulate of Classical Statistical Mechanics, Microcanonical Ensemble,, Derivation of Thermodynamics, Equipartition theorem, classical ideal gas, Gibbs Paradox

Canonical Ensemble and Grand canonical Ensemble: Canonical Ensemble, Energy fluctuations, Grand Canonical ensemble, Density fluctuations in the Grand Canonical Ensemble, The Chemical potential, Equivalence of the canonical ensemble and grand canonical ensemble

UNIT-II (8L)

Quantum Statistical Mechanics: The postulates of Quantum Statistical mechanics, Density Matrix, Ensembles, Third law of Thermodynamics, The Ideal Gases: Micro canonical and Grand Canonical Ensemble, Foundations of Statistical Mechanics

UNIT-III (8L)

The General Properties of Partition function, Classical Limit of Partition functions, Singularities and Phase transitions

Classical cluster expansion, quantum cluster expansion, Virial coefficient, variational Principles, imperfect gases at Low temperatures

Identical particles and symmetry requirement, difficulties with Maxwell-Boltzmann statistics, quantum distribution functions, Bose Einstein and Fermi-Dirac statistics and Planck's formula

UNIT-IV (8L)

Bose Einstein condensation, liquid He4 as a Boson system, quantization of harmonic oscillator and creation and annihilation of phonon operators, quantization of fermion operators.

The Ising Model: Definition of Ising model, Spontaneous Magnetization, The Bragg-Williams Approximation, The One dimensional Ising Model

UNIT-V (8L)

Landau theory of Phase transition, critical indices, scale transformation and dimensional analysis. Correlation of space-time dependent fluctuations, fluctuations and transport phenomena

Tutorials (10T Hrs)

1. Calculation of number of states and density of states 1D free particles in a Box
2. Linear harmonuic and harmonic s\oscillators
3. Statistics of Occupation number calculation of thermodynamic quantities
4. Black body radiation and photon statistics
5. Evaluation of second virial coefficient
6. Fluctuations in thermodynamic variables

In addition to the above, examples and problems from Reference books will be listed in the Lecture schedule as Tutorials

Reference Books :

1. Huag : Statistical Mechanics
2. Reif : Fundamentals of Statistical and Thermodynamical Physics.
3. Rice : Statistical mechanics and Thermal Physics.
4. Kubo: Statistical Mechanics
5. Landau and Lifshitz: Statistical mechanics
6. S. N. Biswas- Statistical mechanics

M2PHY04-CT08: Electrodynamics

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External: 80 Marks Internal: 20 marks
Lectures: 40hrs Tutorials : 10 hrs
Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

UNIT-I

Coordinate systems and transformation (2L).
Electrostatics: Field lines, flux and Gauss law and applications, Laplace and Poisson equations, electrostatic boundary conditions (4L).
Magnetostatics: Biot-Savart law, Ampere's theorem, electromagnetic induction (2L).

UNIT-II

Maxwell's equations in free space and linear isotropic media, boundary conditions on fields at interfaces (3L).

Scalar and vector potentials, Gauge invariance (2L).

Electromagnetic waves in free space, dielectrics and conductors, reflection and refraction (3L).

UNIT-III

Electromagnetic waves in dielectrics and conductors: polarization, Fresnel’s law, coherence, interference and diffraction (2L).
Dispersion relations in plasma, Lorentz invariance of Maxwell’s equations, classification of waves (TEM, TE, TM), Transmission lines: lossless line, terminated transmission line and general lossy line (4L).
Rectangular wave guide, Electromagnetic cavities: time average electric and magnetic energies (2L).

UNIT-IV

Electromagnetic cavities: damping constant, quality factor (no derivation), Dipole radiation: Retarded potential (2L).
Liénard-Wiechert potential, dynamics of charged particle in static and electromagnetic field, electric and magnetic fields due to a uniformly moving charge and an accelerated charge (4L).
Radiation from moving charges, Qualitative discussion of Bremsstrahlung, synchrotron radiation (no derivations), Radiation reaction: The Abraham-Lorentz formula, radiation damping (2L)

UNIT-V

Basic properties and occurrence: definition of plasma, natural occurence of plasma, Astrophysical plasmas (2L).

Criteria for plasma behaviour, plasma oscillation, quasineutrality and Debye shielding, plasma parameter and plasma production, thermal ionization, Saha equation (No derivation) (4L).

Brief discussion of methods of laboratory plasma production, steady stage glow discharge, microwave breakdown and induction discharge (2L).

Tutorials: 10 hrs Additional Contact Hours : 10 (Problems based upon coordinate systems and transformation, electrostatic and magnetostatic boundary conditions, Maxwell's equations, rectangular waveguide and electromagnetic cavities)

Recommended books:

DJG – David J. Griffiths, Introduction to Electrodynamics, 2nd Edition

JDJ – J.D. Jackson, Classical Electrodynamics, 3rd Edition

MS- M. Sadiku – Elements of Electromagnetics, 3rd Edition

Chen: Plasma Physics, 2nd Edition

P & C – Robert Plonsey and R.E Collins : Principles and applications of electromagnetic fields

M2PHY05-CP03: Electronics and Microprocessor Projects

Internal Assessment: ***20 %***

External Assessment: ***Section-A: 30%, Section-B: 30 %, Viva-Voce: 20%***

External Assessment: In section A: students are required to submit a project report and working model of the project for evaluation. In section B students will write and execute one program based on microprocessor. External Assessment will involve presentation and viva –voce.

Section A

Design and fabrication of one Experimental Kit

Students will be required to carry out laboratory project either individually or in groups in the physics Laboratory under guidance of a teacher which involves design & construction of equipments, circuits etc. which involves about 20 hrs of practical work per student that can be used to demonstrate physical principles or to carry out laboratory experiments.

Section B

Microprocessor Assembly Language Programming

Assembly Language Programming of 8085 Microprocessor. At least ten exercises of arithmetical, logical, data transfer, sorting and time delay problems.

Note: Any other experiments suggested by teacher

Reference Books:

1.“Integrated Electronics”, by J. Millman and C.C. Halkias, TMH, New Delhi

2."OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PHI, New Delhi

3."Electronic Devices and Circuit Theory" by Robert Boylestead and Louis Nashelsky, PH1, New Delhi - 110001, 1991.

4.“Digital Logic and Computer design” by Electronics by Morris Mano

5."Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, TMH, New Delhi.

6."Microprocessors Architecture, Programming and Applications with 8085/8086"
Ramesh S Gaonkar, Wiley - Eastern Ltd., 1987.

7. Lab manuals

M2PHY06-CP04 : Computational Physics Laboratory

Internal Assessment: 20 marks External Assessment : 80 marks

External Assessment: Section-A: 30 marks, Section-B: 30 marks, Viva-Voce: 10 marks, Practical Record : 10 marks

Note : Students are required to perform atleast 10 experiments from each section

SECTION A: PROGRAMMING IN FORTRAN

1. Gauss elimination Method
2. Gauss Seidel Method
3. Bisection Method
4. False Position Method
5. Newton Raphson Method
6. Roots of Quadratic equation
7. Matrix Addition, Matrix Subtraction and Matrix Multiplication
8. Matrix Inverse
9. Change a square matrix into a upper and lower triangular matrix
10. Area and volume of any given geometric shape
11. Temperature Conversion
12. Fibonacci series
13. Determination of maximum and minimum from a set of given numbers
14. Determine the factorial of a given number
15. Determine whether a given number is a prime number or not

SECTION B: INTRODUCTION TO MATLAB

1. Find minima and maxima of curve
2. Plotting bisection and regula falsi
3. Solving Differential and Integral equation
4. Curve Plotting
5. Fast Fourier transform and Discrete Fourier Transform (DFT)
6. Linear Interpolation
7. Multiple interpolation
8. Sample three different parabolic functions at the points defined in x
9. Vectors and Matrices operation
10. Curve Fitting
11. Interpolation and Extrapolation
12. Least Squares fitting

13. Cubic spline interpolation
14. Spline Interpolation

Reference Books :

1. Computer Oriented Numerical Methods
   V. Rajaraman

2. Computer Programming in Fortran 77
   V. Rajaraman

3. Matlab: An Introduction With Applications:
   Amos Gilat

4. Matlab: A Practical Introduction to Programming and Problem Solving:-
   Stormy Attaway

M2PHY07-SP01E: Skill Enhancement Course : English Communication and Presentation Skills

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External: 80 Marks Internal: 20 marks
Contact hours: 40hrs

Note:

a. Of the 40 contact hours, atleast 30 hours must be devoted to practical exercises
b. Five assignments and five internal assessments, one from each unit are to be carried out
c. Use of audio/visual aids must be made

UNIT – I

Introduction: Theory of Communication, Types and modes of Communication.

UNIT – II

Language of Communication: Verbal and non-verbal (Spoken and Written) Personal, Social and Business, Barriers and Strategies, Intra-personal, Inter-personal and Group Communication.

UNIT – III

Speaking Skills: Monologue, Dialogue, Group Discussion, Effective Communication/ Miscommunication, Interview, Public Speech.

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UNIT – IV

Reading and Understanding: Close Reading, Comprehensive Summary, Paraphrasing, Analysis and Interpretation Translation (from Indian language to English and vice-versa), Literary/Knowledge Texts.

UNIT – V

Writing Skills: Documenting, Report Writing, Making notes, Letter writing.

SWOC Analysis

Reference Books:

1. Bansal, R. K. & Harrison, J.B. (2013). *Spoken English: A Manual of Speech and Phonetics*, 4th ed. New Delhi: Orient Black Swan.
2. Sharma, N. (2010*). Communication Skills.* Satya Prakashan, New Delhi
3. Lesikar R. V, Flatley M E, Rentz K & Pandey. (2009). *Business Communication: Making Connections in a Digital World*. New Delhi, Tata McGraw Hill
4. *Vibrant English*. (2013). Hyderabad: Orient Black Swan
5. Raymond Murphy, *Essential English Grammar*, 2nd Ed, Canbridge University Press, Cambridge, 2007
6. Any other related Reading may be recommended

List of sample practical exercises: (Spoken and Written),

1. Greeting and Self Introduction
2. Introducing people
3. Talking about favorite things
4. Making offers
5. Expressing shock and disbelief
6. Making appointments
7. Talking about preferences
8. Inviting, advising, giving suggestions
9. Expressing thanks and gratitude
10. Responding to thanks
11. Giving opinion, complaints
12. Talking about hope, expressing regret
13. Agreement, disagreement, apologizing, requesting
14. Talking about fear, making predictions, expressing certainty and uncertainty
15. Lack of understanding and asking for clarifications
16. Asking for and giving directions
17. Shopping, phone conversations
18. Giving and responding to bad and good news
19. Interrupting people, expressing feelings (good and bad), congratulating
20. Narration of an incident, storytelling
21. Writing a resume
22. Letters to various authorities/offices (eg. Electricity, banks, etc.)