Mohanlal Sukhadia University, Udaipur

M.Sc. Physics (CBCS) Programme

(valid from session 2017-18 onwards)

COURSE STRUCTURE

CORE PAPERS

Paper code	Paper Name
M1PHY01-CT01	Mathematical Methods in Physics
M1PHY02-CT02	Classical Mechanics
M1PHY03-CT03	Quantum Mechanics-I
M1PHY04-CT04	Electronics
M2PHY01-CT05	Computational Methods in Physics
M2PHY02-CT06	Quantum Mechanics-II
M2PHY03-CT07	Statistical Mechanics
M2PHY04-CT08	Electrodynamics
M3PHY01-CT09	Atomic and Molecular Physics
M3PHY02-CT10	Solid State Physics
M4PHY01-CT11	Nuclear and Particle Physics
M4PHY02-CT12	Experimental Techniques in Physics
M1PHY05-CP01	General Physics Laboratory
M1PHY06-CP02	Electronics Laboratory
M2PHY05-CP03	Electronics and Microprocessor Projects
M2PHY06-CP04	Computational Physics Laboratory
M3PHY05-CP05	Data Analysis Techniques in Experimental Physics
M4PHY05-CP06	Modern Physics Laboratory

Discipline Specific Electives

Paper code	Paper Name
M3PHY03-ET01A	Radiation Physics
M3PHY03-ET01B	Plasma Physics
M3PHY03-ET01C	Theoretical Methods in Condensed Matter Physics
M3PHY04-ET02A	Industrial Electronics
M3PHY04-ET02B	Data and Computer Communications
M3PHY04-ET02C	Programming Using Java
M3PHY04-ET02D	Semiconductor Physics and Devices
M4PHY03-ET03A	Fundamentals of Nanoscience
M4PHY03-ET03B	Atmospheric Physics
M4PHY03-ET03C	Microwave Electronics

M4PHY04-ET04A	Materials Science
M4PHY04-ET04B	Ionosphere Physics
M4PHY04-ET04C	Astronomy & Astrophysics
M3PHY06-EP01X	Practical-I
M3PHY06-EP01P	Project Work
M4PHY04-EP0XX	Practical-II
M4PHY04-EP02P	Project work

NOTE : A candidate selecting EP01P cannot select elective EP02P and vice versa

SKILL ENHANCEMENT PAPERS

(Note : The student should opt for different skill enhancement paper in different semesters, X stands for the number of the skill paper. For example, if communication skills in English is the first skill enhancement paper opted by a student, the code would be SP01E and if Programming in C is the second paper opted by the same student in another semester, the code would be SP02F)

Paper code	**Paper Name**
SP0XA	Laboratory Instrumentation
SP0XB	Computer Hardware Maintenance
SP0XC	Vacuum Techniques
SP0XD	Materials Preparation
SP0XE	Communication Skills in English
SP0XF	Programming in C

SEMESTER WISE DETAILS OF COURSES OFFERED

Paper No.	Course	Course Name	No. of Credits	Max. Marks		
				Ext.	Int.	Total
SEMESTER-I						
M1PHY01-CT01	I	Mathematical Methods in Physics	4	80	20	100
M1PHY02-CT02	II	Classical Mechanics	4	80	20	100
M1PHY03-CT03	III	Quantum Mechanics-I	4	80	20	100
M1PHY04-CT04	IV	Electronics	4	80	20	100
M1PHY05-CP01	V	General Physics Laboratory	4	80	20	100
M1PHY06-CP02	VI	Electronics Laboratory	4	80	20	100
Total			**24**	**480**	**120**	**600**
SEMESTER-II						
M2PHY01-CT05	I	Computational Methods in Physics	4	80	20	100
M2PHY02-CT06	II	Quantum Mechanics-II	4	80	20	100
M2PHY03-CT07	III	Statistical Mechanics	4	80	20	100
M2PHY04-CT08	IV	Electrodynamics	4	80	20	100
M2PHY05-CP03	V	Electronics and Microprocessor Projects	4	80	20	100
M2PHY06-CP04	VI	Computational Physics Laboratory	4	80	20	100
M2PHY07-SP01X	VII-X	Skill Enhancement Course-I	2	80	20	100
Total			**26**	**560**	**140**	**700**
SEMESTER-III						
M3PHY01-CT09	I	Atomic and Molecular Physics	4	80	20	100
M3PHY02-CT10	II	Solid State Physics	4	80	20	100
M3PHY03-ET01X	III-X	Discipline Specific Elective-I	4	80	20	100
M3PHY04-ET02X	IV-X	Discipline Specific Elective-II	4	80	20	100
M3PHY05-CP05	V	Data Analysis Techniques in Experimental Physics	4	80	20	100
M3PHY06-EP01X OR M3PHY06-EP01P	VI-X	Elective Practical-I OR PROJECT WORK	4	80	20	100

Total			**24**	**480**	**120**	**600**
SEMESTER IV						
M4PHY01-CT11	I	Nuclear and Particle Physics	4	80	20	100
M4PHY02-CT12	II	Experimental Techniques in Physics	4	80	20	100
M4PHY03-ET03X	III-X	Discipline Specific Elective-III	4	80	20	100
M4PHY04-ET04X	IV-X	Discipline Specific Elective-IV	4	80	20	100
M4PHY05-CP06	V	Modern Physics Laboratory	4	80	20	100
M4PHY06-EP0XX OR M4PHY06-EP02P	VI-X	Elective Practical-II OR PROJECT WORK	4	80	20	100
M4PHY07-SP02X	VII-X	Skill Course-II	2	80	20	100
Total			**26**	**560**	**140**	**700**
Grand Total			**100**	**1960**	**640**	**2600**

<u>SYLLABUS</u>

<u>SEMESTER I</u>

M1PHY01-CT01: Mathematical 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

<u>UNIT – I</u>

Coordinate Systems: (4hrs)

Curvilinear coordinates, differential vector operations, special coordinate systems - rectangular Cartesian, spherical polar and circular cylindrical coordinates, and expressions of gradient, divergence, curl and Laplacian

Tensors: (4hrs)

Coordinate transformations, scalars, contravariant and covariant vectors, definition of contravarient, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors, quotient rule

<u>UNIT –II</u>

Matrices: (4hrs)

Orthogonal matrices, Orthognality conditions- two and three dimensional cases, Hermitian and unitary matrices, Pauli matrices, Dirac matrices, Diagonalization of matrices - Eigen value and Eigen vectors

Elementary Group Theory: (4hrs)

Definition of group, Isomorphism and Homomorphism, Matrix representation- reducible and irreducible groups, subgroup-invariant subgroup, Discrete groups-two objects two-fold symmetry axis, three objects-three-fold symmetry axis, Continuous Groups- orthogonal group O_3^+, special unitary group SU(2)

UNIT – III

Second Order Differential Equations: (4hrs)

Separation of variables-ordinary differential equations, singular points, series solutions – Frobenius method and its limitations, Wronskian-linear independence and linear dependence

Special Functions: (4hrs)

Bessel functions of the first kind, integral representation, Legendre functions-generating function, recurrence relations and orthogonality, Associative Legendre functions, spherical harmonics, Hermite functions. Laguerre functions.

UNIT –IV

Complex Variables: (8hrs)

Functions of complex variable, Cauchy- Rieman conditions, Cauchy Integral theorem, Cauchy integral formula, Laurent expansion, Calculus of residues –poles, Essential singularities and branch points, Residue theorem, Jordan's lemma, Singularities on contours of integration, Evaluation of definite integrals.

UNIT –V

Fourier Series and Fourier Transforms: (4hrs)

Fourier series- General properties and uses, Differentiation and integration of Fourier series, Fourier transforms, Fourier integral-exponential form, Fourier transform-inversion theorem

Laplace Transform: (4hrs)

Elementary Laplace transforms, Laplace transform of derivatives**,** substitution properties of Laplace transform

Tutorials: (10hrs)

Applications of topics covered in each unit in Physics (based on problems given in the reference books) as given in the detailed lecture schedule will be covered in the tutorial classes.

Recommended Books:

Mathematical methods for Physicists – George B. Arfken & Hans J. Weber

Applied Mathematics for Physicists and Engineers – L. A. Pipes

M1PHY02-CT02: Classical 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

Many particle systems; conservation laws, Constraints; their classification; degrees of freedom, D'Alembert's principle, generalized coordinates, Lagrange's equations from D'Alembert's principle, velocity dependent potentials and dissipative forces, Jacobi integral
(8 hours)

UNIT-II

Gauge invariance, generalized momenta, cyclic coordinates, integrals of motion, Symmetries of space and time with conservation laws (2L)

Rotating frames : transformation equations, pseudo (fictitious) forces, Rigid body dynamics: Angular momentum and Kinetic energy of motion about a point , Moment of intertia tensor,
(6 hours)

UNIT-III

Central force: definition and characteristics; properties, closure and stability of circular orbits, Two-body collisions, scattering in laboratory frame, scattering centre-of-mass frame (4 hours)

Variational principles: Techniques of the calculus of variations, Example of use of the variational principle to find the shortest distance between two points, Hamiltons principle: derivation of Lagrange's equations from Hamilton's principle, equations of motion. (4 hours)

UNIT-IV

Canonical transformation: generating functions, Hamilton-Jacobi equation; solution: Hamilton's principal function, Solution of harmonic oscillator problem by H-J method (4 hours)
Poisson brackets: fundamental PB, some properties, Poisson theorems, Angular momentum PBs, Invariance of PB under canonical transformations, relation of PB to quantum mechanics (4 hours)

UNIT-V

Types of equilibria, Periodic motion, small oscillations and normal modes, Free vibrations of a symmetric linear triatomic ,Special theory of relativity, Lorentz transformations, Velocity transformations, mass energy equivalence, Four vectors : velocity and acceleration 4 vectors. (8 hours)

TUTORIALS (10 T)

Principle of virtual work, problems related to conservation laws, Application of Lagrange eqns : Simple pendulum, two connected mass with string over pulley, rolling mass inside or outside a circular ring, Foucault's pendulum, examples of coriolis force on earth, Example of how energy can be conserved while H need not and vice versa

Infinitesimal contact transformation, Example of application of canonical transformation for a harmonic oscillator

In addition to the above problems, students are expected to solve examples and problems given in the text as assignments.

Reference Books:

Herbert Goldstein: Classical Mechanics

Rana and Joag, Classical Mechanics

M1PHY03-CT03: Quantum Mechanics-I

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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

Inadequacy of Classical Mechanics: 3L

Black body radiation, Planck' hypothesis, The photoelectric effect, Compton effect, Frank-Hertz experiment, Hamilton's principle. Schrödinger equation, Normalisation, probability interpretation of ψ, Admissible wave functions.

Linear Vectors Space: 5L

Vectors: Definition and properties, Examples of linear vector spaces, norm of a vector, orthonormality and linear independence, Basis and dimensions, Completeness (Closure property), Hilbert space, subspace, Inequalities and Ehrenfest theorem.

Operators: Equality, product, sum, power, function, inverse of operators, eigenvalues and eigenvectors of an operator, Positive definite, continuous and bounded operators, Linear operators, Hermitian operators, Unitary operators, Projection operators.

UNIT-II

Dirac Space and Representation Theory: 3L

Completeness of eigenfunctions, Bra and Ket notation for vectors, Dirac-Delta function, Matrix elements of change of basis, Unitary transformation. Representation theory, Coordinate and momentum representations.

Postulates of Quantum Mechanics & Uncertainty Relations: 5L

Postulates of Quantum mechanics, Uncertainty relations, States with minimum uncertainty product, Commutators, Theorem of simultaneous eigenfunctions,

UNIT –III

Quantum Dynamics: 5L

The equations of motion, Schrodinger picture, Heisenberg picture, Interaction Picture, Linear Harmonic Oscillator: Solutions from Schrodinger and Heisenberg Pictures, the method of second quantization

The Hydrogen Atom: 3L

Two body equation, Separation of variables for spherically symmetric potential, Radial wave equation, Radial wavefunctions and energy states.

UNIT –IV

Quantisation of Angular Momentum: **5L**

Definition, angular momentum of a system of particles, Matrix representation, Pauli matrices, the spin eigenvectors. Orbital angular momentum: Solutions, Spherical harmonics and properties, addition theorem (no proof).

Addition of angular momenta: **3L**

Clebsch-Gordan coefficients, the selection rules, properties of CG coefficients (without proof): symmetry, orthogonality and recursion relations.

UNIT –V

Perturbation Theory (Non-degenerate case): **5L**

Basic formulation of the method and applications: Anharmonic oscillator (x^4), linear harmonic oscillator, infinite square well.

Degenerate case: **3L**

Formulation and applications: Stark and Zeeman effects in H, Infinite cube well.

Textbook:

1. Quantum Mechanics, V.K. Thankappan, Wiley Eastern Ltd. (1986).**Reference books:**

1. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Education Inc. (2005).
2. Principles of Quantum Mechanics, R. Shankar, Plenum Press, New York (1994).
3. Modern Quantum Mechanics, J.J. Sakurai, Addison and Wesley (1994).

M1PHY04-CT04: Electronics

*(**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-1

Amplification: Operational Amplifiers-I (8L)

Differential amplifier: circuit configurations, dual input, balanced output differential amplifier, DC analysis and AC analysis, inverting and non inverting inputs, Block diagram of typical OP-Amplifier, Constant current-bias level translator. Open loop configuration, inverting and non-inverting amplifiers, and Frequency- response.

OP-Amp Parameters: input offset voltage, bias currents, input offset current, output offset voltage, CMRR, frequency response, Slew rate. OP-Amp with negative feedback, voltage series feedback, effect of feed-back on closed loop gain, input and output resistance, band width.

UNIT-II

Operational Amplifiers based Instrumentations and their applications (3L):

DC and AC amplifier, voltage follower, Adder, subtractor, multiplier, phase changer, Active filters, Active Integrator and active differentiator.

Oscillators and wave shaping Circuits (5L)

Oscillator Principle - Oscillator types, Frequency stability response, the phase shift oscillator, Wien bridge oscillator, LC tunable oscillators, Multivibrators: Monostable and Astable, Comparators, Square and triangle wave form generators.

UNIT-III

Voltage regulators (3L)

Block diagram of Power supply, fixed voltage regulators, adjustable voltage regulators, switching regulators. Clipping and clamping circuits.

Boolean algebra and logic gates (4L): Canonical and standard forms, IC logic families, Simplification of Boolean functions: Karnaugh map of up to 4 variables, don't care conditions, NAND and NOR implementation

Combinational logic (4L)

Adders, subtractors, binary parallel adder, magnitude comparator, decoders/Demultiplexers encoders/multiplexers.

UNIT-IV

Sequential Logic (5L): Basic flip-flop, clocked RS flip-flop, T flip-flop, D flip-flop, J-K flip flop, triggering of flip-flops, JK master slave flip-flops; Synchronous and asynchronous counters: Binary counters, Decade counters, Registers

Microprocessors (3L):

Organization of a Micro computer based system, Microprocessor architecture and its operations, Memory, memory map. The 8085 microprocessor unit; Functional block diagram.

UNIT-V

Assembly Language Programming of 8085 (8L): Instruction set of 8085: Data transfer operations, Arithmetic operations, Logic operations, Branch operations, Addressing modes of 8085 instructions, Assembly language programmes involving data transfer, arithmetic logic operations and looping, counting and indexing - counters and timing delays.

Tutorials (10T hrs)

Review of basic electronics: Currents in a transistor, Design of CE and CC Amplifier, Design of two stage amplifier. In addition to the above, problems from the reference books can be given as assignments to the students.

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, PHI, New Delhi – 110001
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.

M1PHY05-CP01 : General Physics Laboratory

NOTE:

1. Students are required to complete at least five experiments allotted to them.
2. Students are expected carry out the practical after understanding theoretical principle behind each experiment, design of experiments, working principle of the equipments/instruments, sources of errors in experiments etc.
3. Experimental errors must be estimated in all experiments.

LIST OF EXPERIMENTS

1. Measurement of arc spectra by constant deviation spectrometer.
2. Determination of elastic constants of glass by method of Cornu's fringes.
3. Determination of coefficient of thermal conductivity of metal by Angstrom's method.
4. To study variation in internal resistance of a material with temperature.
5. To study the Hall effect in a given semiconductor probe and to find the Hall Voltage and Hall Coefficient, Charge Carriers, Hall angle and Mobility.
6. To study the characteristic of given Solar Cell Panel.
7. Determination of λ, $d\lambda$, and thickness using Michelson's interferometer.
8. Determination of wavelength of light emitted by He-Ne laser and to verify the law governing Interference from a Young's double slit experiment.
9. (a) Measurement of wavelength of He-Ne laser light using ruler. (b) Measurements of thickness of thin wire with laser.
10. Investigation of Faraday's effect and to determine Verdt's constant.
11. To plot the polar curve of a filament lamp and to determine its mean spherical intensity.
12. To study the dissociation limit of iodine.
13. Jamin's Interferometer's method for refractive index of air using He-Ne Laser.
14. Beam characteristics of a He-Ne laser beam.
15. Any other experiments designed and setup by the teacher.

M1PHY06-CP02: Electronics Laboratory

Internal Assessment: ***20 %***

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

NOTE:

1 Students are required to complete at all experiments allotted to them from Section-A and section-B.

2. Students are expected carry out the practical after understanding theoretical principle behind each experiment, design of experiments, working principle of the equipments/instruments, sources of errors in experiments etc.

3. Experimental errors must be estimated in all experiments.

LIST OF EXPERIMENTS

SECTION-A: Analog Electronics

1. Measurement of operational amplifier parameters.
2. Study of Clipping and clamping circuits.
3. Study of active filter circuits
4. Study of active integrator and differentiator circuits
5. Study of Wien Bridge Oscillator
6. Study of wave form generators: (a) Square wave generator (astable multivibrator), (b) Pulse generator (monostable multivibrator) and triangular wave generator.
7. Study of Schmitt Trigger and comparators
8. Study of UJT parameters and Relaxation Oscillator
9. Design of a Regulated power supply: (a) Study of series voltage regulated power supply and (b) study of IC regulated power supply

SECTION-B: Digital Electronics

1. Study of Combinational circuits:
   (i) Two bit and four bit adder
   (ii) Subtractor
   (iii) Decoder and 7- segment display
   (iv) Multiplexer and
   (v) Demultiplexer

2. Study of Sequential circuits:
   (i) Flips Flops : RS, JK, JKMS, D &T flip-slops

3. Study of Shift Registers

4. Study of Counters :
   (i) 4-bit Ripple counter
   (ii) 4-bit Synchronous Counter
   (iii) BCD Counter

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, PHI, 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.

7. Lab manuals

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)*

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Lectures: 40hrs Tutorials : 10 hrs
Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

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(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

*(**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.)

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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)*

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

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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

*(**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

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

(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
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.)

SEMESTER III

M3PHY01-CT09: Atomic and Molecular 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

UNIT-I (8L)

General introduction – Atomic orbital, Electromagnetic spectrum, Hydrogen Atom spectrum-I Hydrogen Atom spectrum-II, Pauli's Principle, Spectra of alkali atoms- I, Spectra of alkali atoms- II, Spin orbit interaction, Fine structure in alkali Spectra, Equivalent and non equivalent electrons

UNIT-II (8L)

Normal Zeeman Effect, Anomalous Zeeman Effect, Paschen back effect, Stark Effect, Two electron systems , LS and JJ coupling, determination of nuclear spin and nuclear g factors, transition probabilities and line width, Doppler, natural collision and stark broadening

UNIT-III (8L)

Rotation spectra of diatomic molecules, Rotation spectra of Polyatomic molecules, Techniques and instrumentation, Chemical analysis by Microwave spectroscopy, Diatomic vibrating rotator, The interaction of rotation and vibration, Vibration of poly atomic Molecules, I-R- Spectrometer

UNIT-IV (8L)

Pure rotational Raman Spectra, Vibrational Raman Spectra, Polarization of light and Raman Effect, Structure determination from Raman effect, Structure determination from IR, spectroscopy, Raman Spectrometer, Near I R Raman Spectroscopy, F T Raman Spectroscopy

UNIT-V (8L)

Electronic Spectra of Diatomic molecules, Electronic Spectra of poly atomic molecules, Molecular Photoelectron Spectroscopy, General Introduction – Resonance Spectroscopy, NMR Spectroscopy- I, NMR Spectroscopy- II, ESR Spectroscopy- I, ESR spectroscopy- II

Tutorials (10hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:

1. G.K. Woodgate, Elementray Atomic Structure, Second Edition Clarendon Press, Oxford.
2. Colin N. Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy
3. T.A. Littlefield - Atomic and Molecular Physics.
4. Eistaberg and Rasmic- Quantum Physics of Atoms. Molecules Solids and Nuclear Particles.
5. Ashok Das and A.C. Melfessions. quantum Mechanics ; A Modem Approach (Gordon and Breach Science Publishers).
6. White - Atomic Spectra.
7. Herzberg- Molecular spectra.
8. Charles Kittle- Spectroscopy
9. Gupta & Kumar- Spectroscopy

M3PHY02-CT10: Solid State 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

UNIT-I

Crystallinity and Forms of Solids (8hrs):
Crystal classes and systems, periodic array of atoms, fundamental types of lattices, 2d and 3d lattices, index system for crystal planes, simple crystal structures, non ideal crystal structures, elementary ideas of point defects: line defects, planar faults, surface and volume defects, lattice vacancies, interstitials, colour centers, F-centers.
Reciprocal lattice, diffraction of waves by crystals, scattered wave amplitude, structure factor, Brillouin zones.

UNIT-II

Lattice Dynamics(8hrs)
Lattice vibrations, phonons, vibrations of crystals with monoatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonons. Specific heat of solids, phonon heat capacity, anharmonic crystal interactions, thermal conductivity.

UNIT-III

Electrons in Solids (8hrs):
Free electron theory- Fermi statistics, effect of temperature on the Fermi- Dirac distribution, free electron gas in three dimensions, heat capacity of the electron gas, electron motion in magnetic fields.
Number of orbitals in a band, energy bands in metals, insulators and semiconductors, tight binding approximations.

UNIT-IV

Idea of reduced and periodic zones, construction of Fermi surfaces, electron orbits, hole orbits, open orbits, de Haas van Alfen effect for Fermi surface (no derivation). **(4hrs)**
Superconductivity, Meissner effect, type-I and type-II superconductors, BCS theory of superconductors, Josephson junctions. **(4hrs)**

UNIT-V

Magnetic Phenomena in Solids (8hrs):

Langevin diamagnetism equation, quantum theory of diamagnetism of mononuclear systems, paramagnetism, quantum theory of paramagnetism, Hund's rules.

Ferromagnetic order, magnons, neutron magnetic scattering, Antiferromagnetic order, Ferromagnetic domains, single domain particle.

Tutorials (10 T hrs)

Examples and problems from Reference books will be covered during Tutorials and assignments.

Recommended Book:

1. Introduction to Solid State Physics by Charles Kittel (Seventh or higher Edition).
2. Solid State Physics by A.J. Dekker

M3PHY03-ET01A: Radiation 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

UNIT-I

Sources of Radiation (6hrs): Cosmic rays, radioactive sources, accelerators (Brief study of principle of operation & characteristics of radiations of Cockroft Walton, Van de Graff, cyclotron, electron linac, electron synchrotron) Synchrotron radiation: Polarization, coherence and emittance. Neutron Source: Reactors, Neutrons from charged particle and photon induced reactions.
Radiation Protection (2hrs): Units and special parameters, background levels, radiation carcinogesis

UNIT-II

Interaction of Charged Particle with Matter (3hrs): Definition of range, types of charged particle interaction, energy transfer in elastic collisions, Bethe formula, scattering of heavy and light charged particles

Interaction of Photons (5hrs): Attenuation coefficients, classical scattering from single electrons, coherent scattering, Klein –Nishina cross section for Compton scattering (No derivation), Compton scattering from atomic electrons: Effect of electron binding, electron recoil energy, electron momentum distributions from Compton profiles. Photoelectric absorption, characteristic X-rays, Auger electrons, pair production

UNIT-III

Interaction with Neutrons (8hrs): Neutron interactions, Neutron fields in non-multiplying media: Definition of flux, current density, collision dynamics, distribution of energy and angle of scatter, Mean scatter angle and energy loss in single collision, extension to multiple collision, slowing down in hydrogen, neutron diffusion, moderation and diffusion.

UNIT-IV

Nuclear Detectors (4hrs): Gas detectors, Scintillation detector, Semiconductor detectors

Microdosimetry and Radiation Effects (4hrs): Experimental determinations of microdosimetric spectra, practical considerations, primary radiation effects, track structure, radiation effects in condensed systems, radiolysis of water, dosimeter

UNIT-V

Dosimetry (4hrs): Charged particle equilibrium, photon interaction coefficients, relation between exposure, kerma and absorbed spectra, measurement of exposure, practical aspects of ionization chamber dosimetry, calorimetry, standardization for low and medium energy X-rays, high energy photons, electrons, chemical dosimeters, TLD, solid state and film dosimeters

Brief discussion of radiotherapy using photons, electrons and heavy particles **(2hrs)**
Brief introduction to radiation imaging techniques (Diagnostic radiology, tomography, MRI, Nuclear Medicine) **(2hrs)**

In addition to the above 10 hrs tutorials, assignments will be given by the teacher concerned.

Reference books:

1. A Primer in Applied Radiation Physics by F.A. Smith (World Scientific).
2. Nuclear Radiation Physics by R.E. Lapp and H.L. Andrews (Prentice-Hall, New Jersey, 1972).

Course M3PHY03-ET01B : Plasma 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: 10hrs

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

UNIT-I

Charged particle motion and drifts, Guiding centre motion of a charges particle. Motion in (i) uniform electric and magnetic field (i) gravitational and magnetic fields. Motion in non-uniform magnetic field (i) grad B perpendicular to B, grad B drift and curvature drift (ii) grade B parallel to B and principle of magnetic mirror. Motion in non-uniform electric field for small Larmour radius.(8L)

UNIT-II

Time varying electric field and polarization drift. Time varying magnetic field adiabatic invariance of magnetic moment(2L)

Plasma fluid equations fluid equations; Conventive, Two fluid and single fluid equations. Fluid drifts perpendicular to B diamagnetic drift. Diffusion and Resistivity : Collision and diffusion parameters. Decay of a plasma by diffusion, ambipolar diffusion

UNIT-III

Diffusion across magnetic field. Collision in fully ionized plasma. Plasma resistivity Diffusion in fully ionized plasmas. Solution of Diffusion equation.(3L)

Hydromagnetic equilibrium. Concept of magnetic pressure. Equilibrium of a cylindrical pinch. The Benner pinch. Diffusion of magnetic field into a plasma (5L)

UNIT-IV

Classification instabilities. Two stream instability. The gravitational instability Resistive drift waves.(3L)

Understanding the Sun: Solar plasma magneto hydrodynamics, solar magnetism, Chromospheres and corona, Solar wind and heliosphere, solar eruptions. Solar vibrations (GONG) sunspots and sunspots cycle.

UNIT-V

Solar plasma electrodynamics for solar luminosity, opacity, temperature, pressure, mass, radius and gases. The Sun's continuous and absorption line spectrum, solar energy transport, photosphere, chromospheres corona and solar winds. Solar interior, nucleus transformation and fusion reactions, solar neutrino experiments. (6L)

Basic of nebular models and the formation of the planets, Asteroid, Comets, Meteors. (2L)

Tutorials (10 hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

References :

1. F.F. Chen : An Introduction to Plasma Physics (Plenum Press) 1977.
2. R.C. Davidson : Methods in Non-linear Plasma Theory (Academy Press) 1972.
3. W.B. Kunkel : Plasma Physics in Theory and Application (Mc Graw Hill)1966.
4. J.A. Bittencoms : Fundamentals of Plasma Physics (Pergamons Press. 1986.

Course M3PHY03-ET01C: Theoretical Methods in Condensed Matter 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: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs
Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

UNIT-I

Electronic Structure: Single electron Model: Basic Hamlitonian, Densities of States, Statistical mechanics of non interacting electrons, sommerfield expansion :specific heat of non interacting electrons at low temperatures

Schrodinger equation and Symmetry: Translation Symmetry-Bloch's theorem, vanhove singularities, Fourier analysis of Bloch's theorem, Kronney penney model

UNIT-II

Rotational Symmetry: classes and characters, consequences of point group symmetries for Schrodingers equation.

Nearly free and tight bound electrons: Nearly free electrons- Degenerate perturbation theory, Brillouine zones-Nearly free electron Fermi surfaces.

UNIT-III

Tight bound electrons:Wannier functions and tight binding model.

Electron Electron Interaction: Hartree and Hartree-Fock equations : Hartree –fock equations, numerical implementation.

UNIT-IV

Density fuctional theory: Thomas Fermi theory and Kohn-shyam equations.

Calculations of Band Structure: Numerical methods: Psuedopotentials and orthogonal Plane wave

UNIT-V

,LCAO, Plane waves, LAPW, LMTO, Brief survey of Periodic table

Tutorials (10 Hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Book:

1. Condensed Matter Physics, Michael P Marder, Wiley Interscience, 2000
1. Solid State Phyics, Ashcroft & Mermin

M3PHY04-ET02A : INDUSTRIAL ELECTRONICS

UNIT I

POWER DEVICES

Power diode – Power transistor – Power MOSFET – SCR – TRIAC – GTO – IGBT – MCT –Protection of power devices.

UNIT II

CONVERTERS

Introduction to half wave, full wave and bridge rectifiers – Single phase and three phase – Half controlled and fully controlled converters – Dual converters – Introduction to cyclo converters and ac controllers.

UNIT III

INVERTER AND CHOPPER

Voltage, current and load commutation – Voltage Source Inverter (VSI) – Series and Parallel inverter – Bridge inverters – Single and three phase – Voltage control using PWM – Current Source Inverter (CSI) – Choppers – Step up and step down choppers – Chopper classification – Class A,B, C, D, E – AC choppers.

UNIT IV

DC AND AC DRIVES

Steady state characteristic of dc motors – Control of DC motor using converters and choppers –Regenerative and dynamic braking – Closed loop control scheme – Speed-torque characteristic of induction motor – Static stator voltage control – V/f control – Static rotor resistance control – Slip power recovery scheme – Self control of synchronous motor.

UNIT V

OTHER APPLICATIONS

Electronic timers – Digital counters – Voltage regulators – Online and offline ups – Switched mode power supply – Principle and application of induction and dielectric heating.

TEXT BOOK:

1. G. K. Mithal, “Industrial Electronics”, Khanna Publishers, Delhi, 2000.

REFERENCES

1. M. H. Rashid, “power Electronics Circuits, Devices and Application”, PHI, 3rd edition, 2004.
2. G. M. Chute and R. D. Chute, “Electronics in Industry”, McGraw Hill Ltd, Tokyo, 1995.
3. F. D. Petruzulla, “Industrial Electronics”, McGraw Hill, Singapore, 1996.

Course M3PHY04-ET02B : Data and Computer Communications

UNIT-I

Protocol Architecture : Overview: Communication model, Communication Tasks, Data Communication Networking: WAN, LAN,Wireless Networks. Basics of Network Software: Protocol and protocol architecture, Protocol functions, Design Issues for the layers, interfaces &Services, Connection oriented and connectionless services, service primitives, relationship of services to protocols , ISO REF Models, TCP/IP Model.

Data Communications: Data Transmission: Concepts of Frequency,Spectrum, bandwidth, Electromagnetic spectrum and frequencies for data communication, Fourier analysis , Data and signal, Transmission impairments, channel capacity, Nyquist bandwidth, Shannon capacity formula ,decibels and signal strength, Transmission media:Coaxial, twisted pair, Comparative study of Categories of cables, Coaxial, Optical Fibers, Wireless transmission: TerrestialMicrowave, satellite,Broadcast Radio,Infrared,.

UNIT-II

Data Encoding: BCA (NRZ,Bipolar AMI, B8ZS, HDB3,ASK,FSK,PSK,PCM,AM,FM,PM), Spread Spectrum. Asynchrous and Synchronous transmission, Full and Half duplex, Interfacing, Functional and Procedural aspects of V.24,

Data Link Control: Flow control: Stop and Wait, Sliding window, Error detection: Parity Check,CRC. Error control: Stop and Wait ARQ, Go back-N ARQ, Selective-Reject ARQ, Brief idea of HDLC and other Data Link control protocols

UNIT-III

Circuit Switching: Simple switching Network, Circuit Switching Networks, Circuit Switching Concepts: Space Division switching, Time Division Multiplexing, Routing in circuit switching Networks, Contrl Signalling, Inchannel & common channel signaling, Brief idea of SS7. Packet Switching: Packet switching principles, Routing,X.25

UNIT-IV

LAN Technology: LAN architecture, IEEE 802 standards, Ethernet (CSMA/CD): Medium Access Control, 10, 100, Gigabit Ethernet. Brief survey of other LAN systems (Token ring,FDDI,ATM, Fiber channel). Wireless LANS, Bridges, Latest trends in LAN technologies

LAN Devices: Study of specifications of L2 and L3 switches, Structured cabling, Passive components.

UNIT-V

Principles of Internetworking, connection less Internetworking, IP, IPv6, IP multicasting. Routing protocols, TCP, UDP, SNMP,SMTP and MIME, HTTP.

Recommended Books :

1. William Stallings: Data & Communications,Sixth Edition
2. A. S. Tanenbaum : Computer Networks

Course M3PHY04-ET02C : Programming using JAVA

UNIT-I

Introduction to Java: Bytecode, features of Java, data types, variables and arrays, operators, control statements.

Objects & Classes: Object Oriented Programming, defining classes, static fields and methods, object construction

UNIT-II

Inheritance: Basics, using super, method overriding, using abstract classes, using final with inheritance.

Packages and Interfaces: Defining a package, importing package, defining an interface, implementing and applying interfaces.

UNIT-III

Exception Handling: Fundamentals, exception types, using try and cache.

Multithreaded Programming: Creating a single and multiple threads, thread priorities, synchronization.

UNIT-IV

Applets: Applets basics, applets architecture, applets skeleton, the html applet tag, passing parameters in applets.

Event Handling: Event classes and event listener interfaces.

UNIT-V:

Graphic Programming Introduction to swings.

Recommended Books :

1. P. Naughton and H. Schildt: The complete reference to Java, Tata Mc-Graw Hill.
2. Deitel and Dietel: How to program in Java

M3PHY04-ET02D: Semiconductor Physics and Devices

(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/ section 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 the scope of the syllabus)

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

UNIT-I: Semiconductor in Equilibrium and Carrier Transport Phenomena

Chemical equilibrium and mass-action law, allowed and forbidden bands, electrical conduction in solids, density of state function and its extension to semiconductors, Statistical mechanics, charge carriers in semiconductors, dopant and energy levels, extrinsic semiconductors, statistics of donors and acceptors, charge neutrality and position of Fermi levels, carrier drift, carrier diffusion and graded impurity distribution.

UNIT-II: Excess Carriers in Semiconductors and the p-n Junction

Carrier generation and recombination; characteristics of excess carriers, Ambipolar transport and quasi-Fermi energy levels, Excess carrier lifetime: Shockley-Read-Hall theory of recombination

Surface effects, basic structure of p-n junction and p-n junction under zero bias; Built-in potential barrier, electric field and space charge width, p-n junction under forward and reverse bias, junction capacitance, one-sided p-n junction and non-uniformity doped junction, p-n junction current, small-signal model of the p-n junction, diode carrier equation and junction breakdown, charge storage and diode transients, the Schottky barrier diode: metal-semiconductor junction, semiconductor-semiconductor junction, metal-semiconductor ohmic contacts and hetero-junctions, electrochemical junction, junction in organic materials.

UNIT-III: Physics of Semiconductor Devices

The Physics of Bipolar junction transistor (BJT), Field effect transistor (FET), Photo-detectors, Light emitting diodes (LEDs), Laser diodes, Power semiconductors devices, Integrated circuits, High-frequency, high-power and nano-electronic devices, Semiconductor process technology, MBE and MOCVD.

UNIT-IV: Physics of Solar Cells

Photovoltaic cells and power generation, characteristics of photovoltaic cells, detailed balance, photo-current, device current, limiting efficiency, effect of band gap and spectrum on efficiency; depletion approximation and calculation of carrier and carrier densities, general solution for J (V), p-n junction in dark and under illumination, effects of parasitic resistance, irradiation, temperature on p-n junction characteristics, lattice matching in epitaxial growth, Epitaxial growth, vapor phase epitaxy; growth of single-crystal ingots, wafer and doping.

UNIT-V: Solar Cell Devices

Monocrystalline solar cells: principle and cell design, materials and design issues, Silicon material properties and Silicon solar cell designs; III-V semiconductor material properties and GaAs solar cell design, thin film solar cells: thin film photovoltaic materials; amorphous Silicon and amorphous Silicon solar cell design, defects in polycrystalline thin film materials, $CuInSe_2$, CdTe and Silicon thin film solar cells, organic, dye sensitized and perovskite solar cells, Managing light: Photon flux, concentration, effect of concentration on device physics, light confinement, photon recycling, Strategies for high-efficiency.

Reference books:

1. Donald A. Neamen and Dhrubes Biswas; Semiconductor Physics and Devices, 4th edition, McGraw Hill, 2003.
2. S.M. Sze, Semiconductor device Physics and Technology, John Wiley and Sons, 2002.
3. Ben. G. Streetman and Sanjay K. Banerjee, Solid Sate Electronics Devices, 7th edition, PHI, 2014.
4. Jenny Nelson; The Physics of Solar Cells, 1st edition, Imperial College press, 2003.
5. L. Fraas and L. Partain, Solar Cells and their applications, John Wiley and Sons, 2010.
6. T. Markvart and L. Castaner, Solar Cells: Materials, Manufacture and Operations, Elsevier, 2005.
7. N.D. Gupta and A.D. Gupta, Semiconductor Devices Modeling and Technology, PHI, 2013.

M3PHY05-CP05: Data Analysis Techniques in Experimental Physics

Computer based data analysis Techniques will be offered. Details will be available on course web site

M3PHY06-EP0XX : Practical-I (Elective)

M3PHY06-EP01A : Radiation Physics Lab

Experiments based on Monte Carlo simulations for multiple scattering of photons in in-vivo tissues, skeleton bones, water, etc., Computation of photon cross-sections and mass attenuation coefficients of various biological tissues and tissue-equivalent materials using XCOM program of J.H. Hubbel, Use of HPGe detector in analysis of γ-ray spectra.

References:

1. Radiation Detection and Measurement by G.F. Knoll (John Wiley & Sons, New York).
2. J. Felsteiner et al. Philos. Mag. **30**, 537 (1974).
3. XCOM code by J. H. Hubbel, University of California, USA.

M3PHY06-EP01B : Plasma Physics

M3PHY06-EP01C:Theoretical methods in Condensed Matter Physics

M3PHY06-EP02C: Programming using JAVA

M3PHY06-EP02D: Semiconductor Physics and Devices

M3PHY06-EP01P: Project Work

Students are allowed to offer a Project work under supervision of a faculty member. The project will be evaluated centrally at the University Department.

SEMESTER IV

M4PHY01-CT11: Nuclear and Particle 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: 10hrs
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

Properties of stable nuclei (4L)
Nuclear Size: Different type of radii and brief discussion of methods to determine radii., spin and magnetic moment of nuclei, Quadrupole moment of nuclei.

Nuclear Force and Two body problem (4L)
Ground state of deuteron: Ground state wave function, Nucleon-Nucleon scattering: Qualitative discussion of n-p and p-p scattering cross section

UNIT-II

Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces, isospin, exchange nature of nuclear force. (3L)

Nuclear Model (5L): Liquid Drop Model, Evidence of shell structure, single- particle shell model, its validity and limitations; Brief discussion of Nuclear Collective model

UNIT-III

Nuclear Reactions (5L): Nuclear Reactions: Energy considerations, Cross section for nuclear reactions : statistical considerations. Compound Nucleus & Direct reactions, Nuclear fission and fusion (brief discussion), Neutron scattering cross section (brief discussion)

Alpha Decay (3L)
Range and disintegration energy, Geiger Nuttal law, Fine structure of alpha spectrum

UNIT-IV

Beta Decay (4L): Beta particles: experimental information, neutrino hypothesis, Fermi theory of beta decay, Fermi Kurie plot, Brief survey of *ft* values : allowed and forbidden transitions, Non-conservation of parity in beta decay, Helicity of Neutrino.

Gamma Decay (4L): Electromagnetic transitions in nuclei, Gamma ray transition probability: (qualitative study only), Internal conversion of gamma rays (qualitative study only), Brief discussion of Angular correlation of gamma rays

UNIT-V

Introduction to Particle Physics (8L) : Classification of Elementary Particles, Particle interactions. Brief survey of different types of elementary particles (Electrons, protons, neutrons, mesons, hyperons and their anti-particles). Conservation laws. Spin and parity assignments, isospin, strangeness. C, P, and T invariance and applications of symmetry arguments to particle reactions. Parity non-conservation in weak interactions

Tutorials (10 T hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:

1. Fundamentals of Nuclear Physics, Varma, Bhandari and Somayajulu, CBS, New Delhi 2005
2. Nuclear Physics, D. C. Tayal, Himalaya Publishing House

M4PHY02-CT12: Experimental Techniques 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

UNIT-I

Sensors & transducers (8L): Mechanical and Electromechanical sensors: Strain Gauge, inductive and capacitative sensors. Thermal Sensors and measurement of temperature: Resistance change, thermo-emf, junction semiconductor, thermal radiation. Magnetic Sensors: Magnetic resistive, Hall effect, inductive and eddy current based sensors. Opto- electronic devices: Solar cells, LED, Photo detectors. Radiation detectors: GM detector, Scintillation, Semiconductor pin detector.

UNIT-II

Analog Signal Processing (8L): Signal classifications, functions in analog signal processing, Errors in signal processing, Signal conditioning, Recovery & Conversion, Sample and hold circuits, Impedance matching, filtering and noise reduction, shielding and grounding, Analog to Digital Conversion, Digital to Analog Conversion, Box-car integrator, modulation techniques, Phased locked Loop, lock-in detector, Lock in Amplifier,

UNIT-III

Vacuum Techniques and Thin Films (8L): Introductory vacuum concepts: System volume, leak rates, pumping speed, conductance and measurement of system pressure. Vacuum Pumps: Rotary, Diffusion pumps, UHV pumps and materials for UHV, measurement of vacuum, surface preparation and cleaning procedure. Thin film preparation techniques: Thermal evaporation, sputtering, ion-beam, molecular epitaxial and chemical vapor methods.

UNIT-IV

Digital Imaging and Basics of Imaging techniques (8L): Field effect Transistors, homo and hetro-junction devices: device structure, characteristics, frequency dependence and applications, Charge coupled Devices and its applications, Microscopic techniques in Physics (Field Ion Microscopy, Scanning Tunneling Microscopy, Electron Microscopy: Principle, typical experimental setup and measurement).

UNIT-V

Mass spectroscopy (2L): Principle, spectrometer, and its operation, resolution, Mass spectrum, applications.

Physical Property Measurements of Solids (6L): Experimental techniques for measurement of Heat capacity, Electrical resistance of metals, thermal conductivity and magnetic susceptibility (Principle, typical experimental setup and measurement).

Tutorials (10 T)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:

1. Sensors &Transducers by D. Patranabis, PHI, New Delhi
2. Analog Signal Processing by Ramón Pallás-Areny, John G. Webster, Wiley
3. Vacuum Science and Technology by VV Rao, TB Ghosh and KL Chopra, APL, New Delhi
4. Advanced Experimental techniques in Modern Physics by KM Varier, A Jodrph and PP Pradyumnan, PP, New Delhi
5. Microscopy Techniques for Material Science by Ashley Clarke, Colin Nigel Eberhardt, CRC press
6. Experimental techniques in low-temperature physics, by Guy Kendall White, Philip J. Meeson, Oxford University Press
7. Lecture Notes by the Eminent Teachers and Instrument Manuals available on www.google.com

M4PHY03-ET03A : FUNDAMENTALS OF NANOSCIENCE

UNIT I INTRODUCTION

Nanoscale Science and Technology - Implications for Physics, Chemistry, Biology and Engineering - Classifications of nanostructured materials - nano particles - quantum dots, Nanowires – ultra – thinfilms - multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II PREPARATION METHODS

Bottom-up Synthesis -Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES

Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography

UNIT IV PREPARATION ENVIRONMENTS Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological contamination, Safety issues, flammable and toxic hazards, biohazards.

UNIT V CHARACTERISATION TECHNIQUES

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques - AFM, SPM, STM, SNOM, ESCA, SIMS - Nanoindentation.

TEXT BOOKS: 1. A.S. Edelstein and R.C. Cammearata, eds., Nanomaterials: Synthesis, Properties and Applications, (Institute of Physics Publishing, Bristol and Philadelphia, 1996)

2. N John Dinardo, Nanoscale charecterisation of surfaces & Interfaces, Second edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES: 1. G Timp (Editor), Nanotechnology, AIP press/Springer, 1999

2. Akhlesh Lakhtakia (Editor) The Hand Book of Nano Technology, “Nanometer Structure”, Theory, Modeling and Simulations. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

Course M4PHY03-ET03B Atmospheric 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: 10hrs

UNIT-I

Radiative transfer in the atmosphere(8L):

Temperature of the sun and spectral distribution of solar radiation, blackbody radiation budget of radiation energy, Passage of solar radiation through the atmosphere, atmospheric windows, emissivity, absorption spectra of atmospheric gases, optically thick and thin approximation, aerosol, scattering, calculation of radiative heating and cooling, terrestrial radiation and its passage through the atmosphere.

UNIT-II

Atmospheric thermodynamics(8L):

Laws of thermodynamics, Lapse rate, thermodynamic equations entropy change water-air mixture, moisture variables, potential temperature, virtual temperature, thermodynamic diagram, dry and moist static energy, static stability, convective instability.

UNIT-III

Basic equations of atmospheric dynamics(8L):

Equations of motion in spherical coordinates, rotating frame, coriolis force, quasistatic approximation, scale analysis, Rossby number, balanced flow, natural coordinate system, equations of continuity in spherical and Cartesian coordinates. Thermodynamic energy equations, pressure as vertical coordinate.

UNIT-IV

Cloud microphysics(6L):

Cloud forms and characteristics, formation and growth of precipitation particles, terminal velocity, thunderstorms, artificial rain making.

UNIT-V

Atmospheric Circulation(8L):

Circulation, Vorticity, divergence and deformation Circulation theorems and applications, Barotropic and baroclinic fluids, dynamic instabilities.

Tutorials (10 T hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:

Physical meteorology, H.G. Houghton, 1985
Atmospheric Sciences : an introductory survey, J.M. Vallace and P.V. Hobbs, Acad. Press, 1977.
A short course on cloud Physics, R.R. Rogers, 1979.
An introduction to dynamic meteology, J.R. Holton, Acad. Press, 1979.
Introduction to Theoretical Meteorology, S.L. Hess, 1959.
Atmospheric Waves, T. Beer, Wiley, 1974.
Atmospheric Tides, Chapman and Lindzen, Riedel, 1969.

M4PHY03-ET03C: Microwave Electronics

*(**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

Introduction (1hr): Introduction to microwaves and its frequencies spectrum, Necessity of microwaves and their applications

Wave Guides:
(a) **Rectangular wave guides (3hrs):** Wave equation & its solutions, TE and TM modes. Dominant mode and choice of wave guide dimensions, Methods of excitation of wave guide, Power transmission and power losses.
(b) **Circular wave guides (4hrs):** Wave equation and its solutions, TE, TM and TEM modes, Power transmission and power losses.

UNIT-II

Resonators (3hrs): Resonant modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Frequency meter, Dielectric resonators
Striplines (3hrs): Introduction to mircostrip lines, Characteristic impedance of microstrip lines, Losses in microstrip lines, Quality factor of microstrip lines, Basics of parallel and coplanar strip lines.
Transferred electron devices (2hrs): Gunn effect, Differential negative resistance, Two-valley model theory (No derivation), Microwave generation using Gunn diode.

UNIT-III

Microwave linear beam tubes (8hrs): Space charge spreading of an electron beam, Beam focusings, Velocity modulation, Two cavity Klystron, Reflex Klystron and efficiency of Klystrons, Slow wave structure of helix TWT, Amplification process and working principle of TWT.

UNIT-IV

Microwave crossed field tube (4hrs): Types and description, Theoretical relations between electric and magnetic field of oscillations for magnetrons. Modes of oscillations and operating characteristics of magnetrons. Construction and working principle of Gyrotron.

Ferrites (4hrs): Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, gyrator, circulator). Introduction to single crystal ferromagnetic resonators.

UNIT-V

Microwave test equipment (5hrs): Measurement of power, frequency, attenuation, impedance and VSWR. Reflectometer, Antenna measurements and radiation pattern.

Complex permittivity of materials and its measurement (3hrs): Definition of complex permittivity of solids, Dielectric properties of materials using shift of minima method.

Tutorials (10 T hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:

1. Microwave devices and circuits by Samuel Y. Liao (Pearson).
2. Microwaves by M.L. Sisodia & Vijay Laxmi Gupta (New Age International).
3. Microwave Devices and Applications by Dinesh C. Dube (Narosa).
4. Foundations of Microwave Engineering by R.E. Collin (McGraw Hill).
5. Electromagnetic Waves & Radiating System-Jorden & Balmain (PHI Learning).
6. Theory and Applications of Microwaves A.B. Brownwell & R.E. Beam (Mc Graw Hill).
7. Introduction to Microwave Theory by Atwater (McGraw Hill).
8. Principles of Microwave circuits by G.C. Montogmetry (McGraw Hill).

M4PHY04-ET04A : Materials Science

*(**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

Phase diagrams (10L):

Definitions and basic concepts. Solubility limit. Phases, microstructure. Phase equilibria. Equilibrium phase diagram. Binary isomorphous systems. Interpretations of phase diagrams. Binary eutectic systems. Development of microstructures in eutectic alloys. The Fe-Fe; C phase diagram, Development of microstructures in iron-carbon alloys.

Phase transformations: Kinetics of phase transformation, metastable vs equilibrium states.

UNIT-II

Ceramics (5L):

Ceramic structure, ceramics density calculations, Silicate Ceramics, imperfections in ceramics, ceramic phase diagram of Al_2O_3-Cr_2O_3 system, Brittle fracture of ceramics, stress, strain behaviours (qualitative)

Glasses (5L)

Properties of glasses, glass forming. Heat treating glasses glass ceramic. Clay products. Characteristics of clay. Composition of clay products. Refractories. Abrasives, Cement.

UNIT-III

Polymers (8L):

Hydrocarbon molecules. Polymer molecules. The chemistry of polymer molecules. Molecular weight and shape. Molecular structure. Molecular configuration. Stress-strain behaviour. Thermoplastic and thermosetting polymers, viscoelasticity. Deformation of elastomers. Impact strength, fatigue, strength and hardness.

UNIT-IV

Composites: Particles Reinforced composites, large particles composites, dispersion strengthened composites, Fiber Reinforced Composites: Influence of fiber length, orientation and concentration. The Fiber phase, matrix phase, Polymer-matrix, Metal-Matrix, Ceramic-Matrix Composites, Carbon-Carbon composites, laminar composites, sandwich panels.

UNIT-V

Magnetic Materials (8L):

Soft magnetic materials, hard magnetic materials, qualitative discussion of magnetic thin films, multilayers - DMS, GMR, CMR (no derivations). Magnetic nanoparticles, Measurement of Particle size density- porosity- lattice constant using X-ray. Working principles of magnetic characterization using Mössbauer spectroscopy (qualitative discussion only), and VSM (Low and high field magnetic field and temperature) (qualitative discussion only).

Tutorials (10 hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Text Book:

1. Material Science and Engineering : An Introduction : William D. Callister Jr., John Wiley & Sons.
2. Introduction To Magnetic Materials 2nd Edition: Cullity and Graham
3. Jagdish Varma, Roop Chand Bhandari, D.R.S. Somayajulu : Fundamentals of Nuclear Physics

Course M4PHY04-ET04B : Ionospheric 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: 10hrs

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

UNIT-I

Ionosphere propagation and measurement techniques (8L)

Effect of Ionosphere on radiowave propagation, Refraction, Dispersion and polarization, Magnetoionic theory, critical frequency and virtual height, Oblique propagation and maximum usable frequency, Ground based techniques : ionosondes, radars, scintillation and TEC, ionospheric absorption, rocket and satellite borne techniques: Langmuir probe, electric field probe mass spectrometer.

UNIT-II

Ionospheric Plasma Dynamics (8L):

Basic Fluid equations, steady state ionospheric Plasma motions due to applied forces, generation of Electric field mapping, collision frequencies, Electrical conductivities, Plasma diffusion, Ionospheric dynamo, Sq current system, Equatorial Electrojet & EIA.

UNIT-III

Airglow and its measurement(8L)

Night glow, Dayglow, Twilight glow, Aurora, Photometers, Spectrometers and imagers for airglow measureent, applications of Airglow measurement for ionospheric dynamics and composition.

UNIT-IV

Ionospheric Plasma irregularities(8L):

E-region irregularities associated with electrojet, Sporadic-E, Auroral electrojet and associated irregularities, F-region irregularities, Equatorial Spread F and its various manifestations. Airglow depletions and plasma bubbles, Ground based, rocket borne and satellite based measurement techniques for these irregularities. Theories of ESF.

UNIT-V

Ionospheric modeling and models (8L):

IRI, SUPIM, TIGCM, PIM. Brief introduction to ionospheres of Mars, Venus and Jupiter.

Tutorials (10 T hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

Reference Books:-

1. Aeronomy of the Middle Atmosphere , Guy Brasseur and Susan Solomon.
2. Electromagnetic waves and Radiating System , Jordan
3. Antennas and Radio Wave Propagation , R.E. Collin.
4. Electronics Communication Systems, B.P.Lathi.
5. Electronics Communication , Kennedy.
6. Introduction of Ionospheric Physics, Risbeth and Garriot.

Course M4PHY04-ET04C : Astronomy and Astrophysics

*(**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: 10hrs

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

UNIT-I

Introductory Concepts (8L)

Basic parameters in Astronomical observations (Magnitude scales , Coordinate system), Stellar classification -H.R. Diagram , Saha's equation , Jean's criteria for stellar formation, Galaxy classification

Cosmology : Cosmological models , observations , cosmic violence (in nucleus of the Galaxy), Cosmic back-ground radiation, Elementary particles and cosmos, Big-Bang.

Model of inflationary Universe (flatness and horizontal problem), Relativistic and Cosmic geometry of space – time and universe.

UNIT-II

Optical and near IR studies of Stars and Galaxies (8L)

Optical Telescopes with CCD's -High angular Resolution Techniques (Speckle, Lunar Occultation adaptive optics). Interferometry with Telescopes.

Spectral Energy Distribution (in optical Bands) in Stars, Rotation of stars, Study of Binary Stars, Gaseous Nebulae.

Extinction curve of interstellar matter, dust-Rotation, Curve of galaxies, Spectral Energy Distribution, Colour studies (Imaging of galaxies in Different bands).

UNIT -III

High Energy astronomy (8L)

Atmospheric transmission, Detection Techniques for X-rays and Gamma-rays, X-ray-Telescopes with imaging and Spectroscopy -Radiation Processes in Accretion Disks around Black Holes and X-rays Binaries -Active Galactic Nuclei.

UNIT-IV (8L)

Dark Matter: Evidences of dark matter – Dark matter components in our galaxy, in Halos of the spiral galaxy, in clusters of candidates in dark matter. Baryonic and non-Baryonic candidates in dark matter.

Radio Telescopes – Radio Interferometry. Very long Base Interferometry (VLBI) of Radio Pulsars, Radio galaxies – Distribution of HI gas in Galaxies – Radiation mechanism

UNIT-V (8L)

Black hole Observation, Gravitational lens, Schwarzschild radius, Singularity, X-rays and Gamma rays bursts through cosmic flux detection using photo-multiplier tubes.
Hubble's law and Hubble's constant (Red shift, distance, age of the Universe Measurements) – Galactic Structure – Rotation and spiral (Optical, radio, X-rays, Gamma radiation observation).

Tutorials (10 T hrs)

Examples and problems from Reference books will be listed in the Lecture schedule as Tutorials and assignments

REFERENCES:

1. Solar Astrophysics by Peter V. Foukal.
2. Galaxy Formation (second edition) by Malcolm S. Longair.
3. Fundamentals of solar Astronomy by Arvind Bhattnagar and William livingston.
4. The Fundamentals of Stellar Astrophysics by George W. Collins, II .
5. Stellar Astrophysics by R.Q. Haung , K. N. yu.
6. Advanced Stellar Astrophysics by William Kenneth Rose.
7. Introduction to Stellar Astrophysics by Erika Bohm- Vitense.
8. Quasars and Active Galactic Nuclei by Ajit K. Kembhavi and Jayant Vishnu Narlikar.
9. Astrophysics Stars and Galaxies by K.D. Abhyankar.

10 The Sun by Michael Stix.

10. Spectropolarimetry by Jean Stein Flow.

M4PHY05-CP06 : Modern Physics Laboratory

1. To study random events for a Co-60 source using a G.M. counter
2. To determine end point energy of beta-particles of the given radioactive source
3. To study absorption coefficient of lead for cobalt 60 gamma rays using G.M. counter
4. To calibrate the given scintillation counter and measure the energy emitted by an unknown radioactive source
5. To calibrate the given scintillation counter and calculate the resolution of the counter using Cesium-137 source
6. To determine the d value, Miller indices (h,k,l) and calculate the lattice constant ‘a’ for Silicon
7. To determine the d value, Miller indices (h,k,l) and calculate the lattice constant ‘a’ for and KCl
8. To determine the d value, Miller indices (h,k,l) and calculate the lattice constant ‘a’ for and NaCl
9. To determine the d value, Miller indices (h,k,l) and calculate the lattice constant ‘a’ for and Al

M4PHY06-EP0XX: Practical Based on Electives

M4PHY06-EP03A: Fundamentals of Nanoscience
M4PHY06-EP03B: Atmospheric Physics

M4PHY06-EP03C : Microwave Electronics Laboratory

1. Study the mode characteristics of reflex Klystron and to determine the mode number, transit time, ETR and ETS.
2. Determine the wavelength and frequency of microwaves produced by Klystron source.
3. Determine the wavelength and frequency of microwaves produced by Gunn diode source.
4. Study of the V-I characteristic of a Gunn diode and to measure its power.
5. Determine the dielectric constant of given dielectric material using reflex Klystron.
6. To study the radiation pattern of given antenna by plotting polar graph and find out 3 dB parameters.
7. To determine the low, medium and high voltage standing wave ratio using Klystron tube.
8. Bragg's diffraction based experiments using microwaves.
9. To study substitution method for the measurement of attenuation and to study variation in attenuation with the frequency.
10. To study square law behavior of a microwave crystal detector and hence to determine operating range and detection efficiency.

Reference books:

1. Basic Microwave Technique and Laboratory Manual by M.L. Sisodia and G.S. Raghuvanshi (Wiley Eastern Limited).
2. Microwave Engineering by D. M. Pozar (John Wiley & Sons Inc).
3. Microwave Engineering by A. Das and S. K. Das (Tata McGraw-Hill)

M4PHY06-EP04A : Materials Science Laboratory

1. To calculate the average particle size of the given sample from the given TEM micrograph

2. To index the XRD spectrum, calculate the lattice parameter (a_0) and determine the average size by the Scherrer method of the given sample

3. To measure the density and hence calculate the porosity of the given sample

4. To calibrate the given Mössbauer spectrum and hence determine the magnetic hyperfine field of Fe

5. To calibrate the given Mössbauer spectrum and hence determine the isomer shift and electric field gradient of the given sample

6. To determine the magnetic parameters (saturation magnetization, coercivity, retentivity) of the given ferromagnetic sample
7. Determination of g-value of electron using ESR
8. Measure resistivity of a semi-conductor at different temperatures by Four Probe method
9. Measurement of magnetic susceptibility of a paramagnetic solution by Quincke's method.
10. Determination of the Curie temperature of the given ferrite sample.
11. Study of the surface of the given sample using AFM

M4PHY06-EP04B: Ionospheric Physics
M4PHY06-EP04C: Astronomy and Astrophysics
M4PHY06-EP02P: Project Work

M4PHY07-SP02E: Skill Enhancement Course :

Programming in C

(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
Contact hours: 40hrs

Note:

a. The practical aspects of the course must be taught as laboratory instructions using computers.
b. Teacher is required to ensure that students carry out the computer implementation of the algorithm/program in the laboratory as a part of this course.
c. Five assignments and five internal assessments (practical), one from each unit are to be carried out

UNIT - I

Algorithm development: Steps in program design, Problem identification, algorithms, flow chart, top-down and bottom up design.

BASICS OF C: Structure of a C program, C tokens, identifiers, character set, keywords, basic I/O data types and sizes. Constants, variables, special symbols

UNIT – II

Operators: Arithmetic, relational and logical operators, increment and decrement operators, conditional operator, assignment operators, expressions, bit wise operators

Conditional statements: Two-way: if, if- else, null else, nested if, Multi-way : switch, else-if.

UNIT – III

Iterative: Loops - for, while and do-while, break, continue, initialization and accessing, nested loops, exit ( ), goto statements

UNIT – IV

Functions: built-in and user-defined functions function declaration, parameter passing- call by value & call by reference, recursive functions.

Storage classes - auto, extern, global and static.

UNIT – V

Array: one dimensional and multi-dimensional array, array handling, passing arrays to functions, arrays and strings, string-handling functions.

Recommended books :

- *Yashavant* P. *Kanetkar,Let us C*
- *E Balagurusamy, Programming In Ansi C*

LIST OF SAMPLE PRACTICAL PROGRAMS:
Note: Students are required to perform all the experiments.

Unit 1

1. C Program Print Hello Word
2. C Program Declaring Variable and Printing its Value
3. C Program to perform arithmetic operation.
4. C Program to Calculate Area and Circumference of Circle
5. C Program to Calculate Area of Rectangle
6. C Program to Calculate Area of Square
7. C Program to Convert temperature from degree centigrade to Fahrenheit
8. C Program to Swap of two no's without using third variable

Unit -2

1. C Program to check enter number is even or odd
2. C program to check enter year is Leap year or not
3. C Program to check enter character is vowel or consonant.
4. C Program to Find greatest in 3 numbers
5. C Program to Calculate sum of 5 subjects and Find percentage
6. C Program to Find the simple interest.
7. C Program to Solve Second Order Quadratic Equation.

Unit-3

1. C Program to Print First 10 Natural Numbers
2. C Program to Even number Series
3. C Program to Odd number Series
4. C Program to Find Factorial of Number
5. C Program to print Fibonacci series
6. C Program to Print table of n and square of n using pow()
7. Check Whether Given Number is Palindrome or Not
8. C Program to Check Whether Number is Prime or not
9. C Program to Check for Armstrong Number in C
10. C Program to Check Whether Number is Perfect Or Not

Unit-4

All programs of Units 1, 2 and 3 implemented by Function

Unit-5

1. C Program to delete duplicate elements in an array
2. C Program to calculate Addition of All Elements in Array
3. C program to find Smallest Element in Array in C Programming
4. C Program to find Largest Element in Array in C Programming
5. C Program to reversing an Array Elements in C Programming
6. C Program to Searching element in 1-D array
7. C program for addition of two matrices of 3*3
8. C Program to Addition of Diagonal Elements in Matrix
9. C Program to Addition of All Elements in Matrix
10. C Program to Multiply Two 3 X 3 Matrices
11. C Program to find transpose
12. C Program to find addition of Lower Triangular Elements
13. C program to calculate sum of Upper Triangular Elements in C
14. C Program to evaluate Subtraction of two matrices (matrix) in C