MOHANLAL SUKHADIA UNIVERSITY: UDAIPUR

MASTER OF SCIENCE IN PHYSICS (SEMESTER SCHEME)

(Effective from Session 2010-11)

1. **Duration of the Course**: The Master of Science (Physics) course will be of four semester duration to be conducted in two years. Each semester will be of approximately five months (90 working days) duration.

2. **Eligibility**: Candidates seeking admission to the first semester of Master of Science Physics must have a B.Sc.or equivalent degree with Physics as one of the optional subject/honours subject and studied Mathematics at their graduation level from a recognized university

3. **Admission**

   Admission will be made on the basis of the fifty percent weightage to the marks obtained in the entrance examination conducted by the University and fifty percent weightage to total theory marks obtained at the graduation level (Total marks of graduation excluding practical marks) Reservation as per university rules contained in the University Information Bulletin shall be followed.

4. Seats: 25 or As decided by the University and given in the information bulletin

5. **Course structure :**

Paper No.	Paper Code	Paper Name	No. of lecture /practical	Max. Marks Ext.	Int.	Total
SEMESTER-I						
I	S1161	Mathematical Methods in Physics	4	75	25	100
II	S1162	Classical Mechanics	4	75	25	100
III	S1163	Quantum Mechanics-I	4	75	25	100
IV	S1164	Electronics	4	75	25	100
V (Practical)	S1165P	General Physics Laboratory	10	75	25	100
VI(Practical)	S1166P	Electronics Laboratory	10	75	25	100
		Total	36	450	150	600
SEMESTER-II						
I	S2161	Computational Methods in Physics	4	75	25	100
II	S2162	Quantum Mechanics-II	4	75	25	100
III	S2163	Statistical Mechanics	4	75	25	100

IV	S2164	Electrodynamics	4	75	25	100
V(Pratical)	S2165P	Laboratory Project	10	75	25	100
VI(Pratical)	S2166P	Computational Physics Laboratory.	10	75	25	100
		Total	36	450	150	600
SEMESTER-III						
I	S3161	Atomic and Molecular Physics	4	75	25	100
II	S3162	Solid State Physics	4	75	25	100
III	S3163	Nuclear and Particle Physics	4	75	25	100
Elective Subject (Select one paper IVA, IVB,IVC as per note given below)						
IVA	S3164A	Plasma Physics	4	75	25	100
IVB	S3164B	Theoretical Methods in Condensed Matter Physics	4	75	25	100
IVC	S3164C	Radiation Physics	4	75	25	100
V	S3165	Modern Physics Laboratory	10	75	25	100
VI	S3166	Elective Lab	10	75	25	100
Total			36	450	150	600
SEMESTER IV						
I	S4161	Experimental Techniques in Physics	4	75	25	100
Special Paper-I (Select one paper out of IIA,IIB and IIC as per note given below)						
IIA	S4162A	Atmospheric Physics	4	75	25	100
IIB	S4162B	Condensed Matter Physics-I	4	75	25	100
IIC	S4162C	Microwave Electronics	4	75	25	100
Special Paper-II (Select one paper out of IIIA,IIIB,IIIC ,IIID) as per note given below						
IIIA	S4163A	Ionospheric Physics	4	75	25	100
IIIB	S4163B	Astronomy & Astrophysics	4	75	25	100
IIIC	S4163C	Condensed Matter Physics-II	4	75	25	100
IIID	S4163D	Materials Science	4	75	25	100
IV	S4164	Project	8	75	25	100
V(Pratical)	S4165P	Specialization Lab-I	8	75	25	100
VI(Pratical)	S4166P	Specialization Lab-II	8	75	25	100
Total			36	450	150	600
Grand Total			**144**	**1800**	**600**	**2400**

6 Scheme of instruction:

6.1Theory: Class room instructions as per lecture schedule announced at the beginning of the course.

6.2 Tutorials: A teacher will conduct tutorials in a paper which shall be conducted in the form of interactive class room teaching for following:

(i) To give class room instructions on topics already covered in lectures but students require detailed explanation/examples

(ii) Working out problems, program, demonstration etc. to make students understand the topics.

6.3 Practical: Students are required to work for the specified practical hours to carry out practical experiments, assignments, projects etc. Tutorials in the practical class can be conducted through seminars /workshops/demonstrations.

6.4 Seminar: Students are required to give one seminar in each semester (10 to 15 minutes) using Audio visual aids. They will be required to submit detailed written work on the seminar topic. Seminars can be conducted as a part of tutorials allotted to the practical. Each teacher giving instructions to the students will be giving atleast one lecture each in each semester to provide latest developments, techniques etc. Attendance in all the seminars of all other students is compulsory. Marks proportionate to their absence will be deducted from seminar component of the internal marks.

6.5 Assignments: Teachers will give regular assignments to the students to assess in the topics. Students will be required to complete the same within the stipulated period

7. ATTENDANCE:

Regular attendance of the student is an important factor in the semester system. University rules regarding implementation of attendance for semester courses will followed.

8**. Examination scheme:**

8.1 University shall conduct examinations only after completion of instructions as per course structure of each semester.

8.2 Each theory paper shall be of 100 marks (75 marks for written examination of 3-hrs duration and 25 marks for internal assessment

8.3 Each practical paper shall be of 100 or 200 marks depending the number of practical in a semester. (75 marks/150 marks for external examination and 25/50 marks for internal marks)

8.4 Syllabus of each paper shall be divided into five units.

8.5.The question paper shall consist total six questions. Part-A shall consist of one compulsory question of 10 marks with ten parts covering the entire syllabus for which answer must be provided within 20 words for each. Part-B will consist five long answer questions (which requires answers in about 500 words for each), one from each unit with internal choice. Each question in the part-B will carry 13 marks each.

8.6 The Internal marks will be awarded by the teacher concerned and will be put for consideration of a committee consisting of Head of the Department, Teacher concerned and Senior teacher of the Department. The committee will ensure that norms given for internal evaluations are followed in the award of internal marks for each theory & practical paper. Detailed breakup of the internal marks along with attendance of the candidate must be submitted to the university.

8.7 To ensure that questions are put within the scope of the course, following materials must be sent to examiners to set question papers

(a) Prescribed syllabus of the paper

(b) Detailed lecture schedule (Minimum 40 Lectures) giving the chapter/section of the text books & Reference book.

(c) Model Question paper

9.**Internal evaluation scheme to award internal marks**

9.1 Assignments: 40% of the internal assessment marks for each theory paper will be awarded on the basis of the performance in the assignments regularly given to the students.

9.2 Internal examination: 40% of the total internal assessment marks for each theory paper will be awarded on the basis of the performance in the written examination conducted by the faculty, one at the end of the two months and another at the end of the semester.

9.3 Viva /Oral examination: 20% of the total internal assessment marks for each paper will be awarded on the basis of the performance in the Internal viva examination. At least one Internal Viva Voce examination per paper will be conducted by a committee consisting of local examiners preferably during internal examination.

9.4 Students are required to keep record of the assignments, Seminars and answer books of the internal examinations and present them at the end of the semester to the advisory board of the course. The attendance / Lab log book and performance sheet of the student can be examined by the board .The internal marks awarded by the teacher will be moderated by the advisory board if necessary.

9.5 If a student has undertaken project work but failed to submit Project report before the prescribed date for submission, he/she shall be declared failed in IV semester. However he/she will be allowed to submit the same whenever next Semester examination is conducted and internal marks will be carried over.

10. Minimum passing marks and criteria for promotion to next higher semester

10.1 The minimum marks for passing a semester shall be 36% in each paper and 40% marks in the aggregate.

10.2 A candidate may be promoted to the next semester if he or she has secured at least 36% marks in each papers but has failed to secure 40% marks in aggregate. He/she shall be required appear in one or more of the papers of the papers as and when these papers are offered again by the university so as to satisfy the passing criteria laid in 10.1. However, candidate will not be allowed to reappear in the practical papers to improve the percentage.

10.3 A candidate may be promoted to the next semester if he/she has secured at least 36% marks in four papers prescribed in the first semester, provided that aggregate of marks in all papers together is at least 40%. Such candidate shall be required to appear in papers in which he/she has secured less than 36% marks when these courses are offered again so as to satisfy the passing criteria laid in 10.1

10.4 A candidate fails to satisfy the criteria 10.1, 10.2, and 10.3 for promotion to next higher semester shall be required to rejoin the semester in which he/she has failed to satisfy the above criteria, if otherwise eligible in accordance with the university regulations laid in this regard.

10.5 In case result of a semester is not declared by the university, before the starting of the next higher semester, the students who have appeared in all the papers in the semester will be allowed to attend the class of the next higher semester at their own risk. Candidates who are not eligible to be promoted to the next higher semester will have to leave that semester.

10. RESULT

At the end of final examination the candidate's eligible for the award of M.Sc. Degree (Semester Scheme) in the subject concerned. Degree shall be classified on the basis of the marks obtained in the first, second, third and fourth semester examination taken together, as follows:

(a)First Division

60% or more of aggregate marks of all semesters

(b) Second Division

48% or more but less than 60% of aggregate of all semesters

(c) Third Division

40% or more but less than 48% of aggregate marks of all semesters

A candidate must pass the M Sc examination within four years of the initial admission to the first semester of the course

M.Sc. PHYSICS (Semester Scheme)

(Effective from session 2010-11)

Semester-I

S1161: Paper-I: 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: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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

UNIT – I

Coordinate Systems (4L)

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: (4L)

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

UNIT –II

Matrices: (4L)

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: (4L)

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: (4L)

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

Special Functions: (4L)

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

UNIT –IV

Complex Variables: (8L)

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: (4L)

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

Laplace transform (4L)

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

Tutorials(10T)

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

S1162:Paper-II: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: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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 (8L)

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, (6L)

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 (4L)

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. (4L)

UNIT-IV

Canonical transformation: generating functions, Hamilton-Jacobi equation; solution: Hamilton's principal function, Solution of harmonic oscillator problem by H-J method (4L)

Poisson brackets: fundamental PB, some properties, Poisson theorems, Angular momentum PBs, Invariance of PB under canonical transformations, relation of PB to quantum mechanics (4L)

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. (8L)

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

S1163: Paper-III: Quantum Mechanics

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External: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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

Linear Vector Space(5L)
Vectors; examples of linear vector spaces, norm of a vector, orthonormality and linear independence, Basis and dimensions, Completeness (Closure property), Hilbert space, subspaces, Operators; Equality, product, sum, power, function, inverse of operators, eigenvalues and eigenvectors of an operator, Positive definite, continuous and bounded operators

UNIT-II

Hermitian operators, Unitary operators, Projection operators Completeness of eigenfunctions, Bra and Ket notation for vectors, Dirac-Delta function, Representation theory, Matrix elements of change of basis, Unitary transformation. Coordinate and momentum representations (3L)

Uncertainty and the Commutation relations (3L): Uncertainty relation of **x** and **p**, states with minimum uncertainty product, Commutators, simultaneous eigenfunctions

UNIT-III

Quantum Dynamics(8L): The equations of motion, Schrodinger picture, Heisenberg picture, Interaction Picture, Solution of problem of Linear Harmonic Oscillator (Schrodinger and Heisenberg Picture), the method of second quantization, and hydrogen atom.

UNIT –IV

Theory of Angular momentum:(10L) The definition, angular momentum of a system of particles, Matrix representation, Pauli matrices, the spin eigen vector, orbital angular momentum, Spherical Harmonics, addition theorem (no proof), addition of angular momenta; Clebsch-Gordan coefficients, the selection rules, symmetry, orthogonality and recursion relations.

UNIT –V

Perturbation theory(8L)*:* Basic formulation and principle of the method, Non-degenerate case; applications to Anharmonic oscillator (x^4) and linear harmonic oscillator, degenerate case; applications to linear Stark effect and the Zeeman effect in the Hydrogen atom

Tutorials: (10 T hrs)

Solving problems based on topics covered in each unit from reference books including following (Details will be listed in the lecture schedule by the teacher):

Reference Books

1. V.K.Thankappan, Quantum Mechanics
2. L.I.Schiff, Quantum Mechanics
3. B.Craseman and J.D.Powel, Quantum Mechanics
4. A textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan. (Tata McGraw-Hill).

S1164: Paper-IV: 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: 75 Marks   Internal: 25 marks
Lectures: 40hrs   Tutorials: 10hrs

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

UNIT-1

Operational Amplifiers-I (8L):
Differential amplifier - circuit configurations - dual input, balanced output differential amplifier, DC analysis - AC analysis,inverting and non inverting inputs, CMRR - constant current bias level translator.
Block diagram of typical OP-Amp analysis. Open loop configuration, inverting and noninverting amplifiers, Op-Amp with negative feedback, voltage series feedback, effect of feed back on closed loop gain, input resistance, bandwith and output offset voltage - voltage follower..

UNIT-II

Operational Amplifiers-II (2L)

Practical Op-Amp input offset voltage-input bias current-input offset current, total output offset voltage, CMRR frequency response. DC and AC amplifier. integrator and differentiator

Oscillators and wave shaping Circuits (6L)
Oscillator Principle - Oscillator types, Frequency stability response, the phase shift oscillator, Wein bridge oscillator, LC tunable oscillators, Multivibrators-Monostable and Astable, Comparators, Square wave and triangle wave generation, clamping and clipping.

UNIT-III

Voltage regulators(3L)

Fixed voltage regulators, adjustable voltage regulators, switching regulators.

Combinational logic (5L)

The transistor as a switching, circuit realisation of OR, AND, OR, NOR, NAND gates, Exclusive OR gate, Boolean algebra - De-morgan Theorems, Adder, subtractor, comparator, decoder/Demultiplexer Data selector/multiplexer, encoder.

UNIT-IV

Sequential Logic(5L): Flip-Flops: one - bit memory, the RS flip-flop, J flip flop, JK master slave flip-flops, T flip-flop, D flipflop, shift resisters - synchronous and asynchronous counters, cascade counters, Binary counter, Decade counter. Basic concepts about fabrication and characteristics of integrated circuits.

Microprocessors(3L):
Introduction to microcomputers: memory - input/output - interfacing device 8085, CPU - Architecture - BUS timings - Demultiplexing the address bus generating control signals ,

UNIT-V

Assembly Language Programming of 8085(8L): Assemblers, cross assemblers. Instruction set of 8085- addressing modes - Illustrative programmes - writing Assembly language programmes looping, counting and indexing - counters and timing delays - stack and subroutine.

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. "Electronic Devices and Circuit Theory" by Robert Boylested and Louis Nashdsky, PH1, New Delhi - 110001, 1991.
2. "OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PH1, Second Edition 1991.
3. "Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, Tata McGraw Hill Company, New Delhi, 1993.
4. "Microprocessors Architecture, Programming and Applications with 8085/8086" Ramesh S Gaonkar, Wiley - Eastern Ltd., 1987.

S1165:Paper-V: General Physics Laboratory

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: Section-A: 60 Marks, Section-B: 15 Marks

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

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. Following topics must be taught before allotment of experiments: Design of experiments, Errors in measurements: Random error, systematic errors, propagation of errors, significant figures.
4. Experimental errors must be estimated in all experiments.
5. Students are required to go through workshop practice.

LIST OF EXPERIMENTS

Section-A

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. Determination of λ, dλ, and thickness using Michelson's interferometer.
5. Determination of wavelength of light emitted by He-Ne laser and to verify the law governing Interference from a Young's double slit experiment.
6. (a) Measurement of wavelength of He-Ne laser light using ruler. (b) Measurements of thickness of thin wire with laser.
7. Study of study Faraday effects using He-Ne laser.
8. Investigation of Faraday's effect and to determine Verdt's constant.

9. To plot the polar curve of a filament lamp and to determine its mean spherical intensity.
10. To study the dissociation limit of Iodine.

11.Jamin's □nterferometer's method for □$_{air}$ (refractive index of air using He-Ne Laser.

12. Quinke's method for the susceptibility of a liquid.
13. Beam characteristics of a He-Ne laser beam.
14. Refractive index of film emulsion using diffraction-interference profile.
15. Any other experiments designed and setup by the teacher

Section-B

Workshop Practice

Students are required to undergo workshop practice for a period of 3 hrs/week

1. Getting acquainted with a mechanical Workshop
2. Machine Drawing
3. Operation of Lathe, Drilling, cutting machines etc.for mechanical fabrication work
4. Glass Blowing methods

S1166:Paper-VI: Electronics Laboratory

Total Laboratory Hrs: 100 hrs   Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: Section-A: 50 Marks, Section-B: 25 Marks

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

NOTE:

1 Students are required to complete at least five experiments allotted to them from Section-A and Two experiments from 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

(All experiments must be designed and fabricated by the students. At least 5 hrs/week must be devoted for experiments under this section).

1. Measurement of operational amplifier parameters.
2. Design and study of difference and Logarithmic amplifier.
3. Design and study of active filter, active integrator and differentiator circuits
4. Design and study of wave form generators: (a) Square wave generator (astable multivibrator), (b) Pulse generator (monostable multivibrator) and triangular wave generator.
5. Design and study of Combinational circuits: four bit adder, decoder, multiplexer and demultiplexer
6. Design and Study of Sequential circuits: Flips Flops (RS,JK,D &T flip-slops
7. Design and study of Registers & Counters
8. Study of (a) ADC (b) DAC
9. Design of a Regulated power supply: (a) Study of series voltage regulated power supply and (b) study of IC regulated power supply
10. Any other experiments suggested by teacher

SECTION-B

(3 hrs/week must be devoted for experiments under this section)

1. Assembly Language Programming 8085 using cross Assembler (At least 10 selected examples from "Microprocessors Architecture, Programming and Applications with 8085/8086" Ramesh S Gaonkar

2. Interfacing Experiments Microprocessor/Microcontroller to read, process and output data)

3. Use of SPICE for electronic circuit simulations.

4. Interfacing experiments using Pheonix kit(microcontroller Kit for Physics Experiments)

SEMESTER-II

S2161: Paper-I: Computational Methods in Physics

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

External: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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

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

UNIT-I:

Computational Errors (2L): IEEE 64 bit Floating point number representation, various kinds of computing errors, error propagation

System of Linear Equations(6L): Solving a system of Linear equations using Gauss Elimination, Gauss Jordan methods, Inverse of a matrix, Decomposition :Traingularization, Iterative methods to solve Equations: Gauss Seidel iterations

UNIT-II

Non-linear equations(3L): Bisection and Newton Raphson method, Newton methods for a system of nonlinear equations

Interpolation(2L): Interpolation with evenly and unevenly spaced points

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

UNIT-III

Fourier Transform(3L): FFT Versus DFT,Physical Meaning of DFT, Interpolation by Using DFS

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

Numerical Differentiation (3L): Difference approximation of first derivative, second and higher derivatives

UNIT-IV

Differential equations(3L): Runge-Kutta Method, Predictor-corrector Method, Comparison of different methods .

Elementary ideas of solutions of Partial Differential Equations.(2L)

Random Variate, Montecarlo evaluation of integrals, Methods of importance sampling, Random walk and Metropolis method (3L)

UNIT-IV

Matrices and Eigen values(8L): Eigen values and Eigen vectors, Similarity transformation and Diagonalization, power method to find eigen values, physical meaning of eigen values and eigen vec tors, eigne value equations

Tutorials:

Tutorials and assignments must be conducted using Computers, MATLAB/Mathematica Software)

1 Usage of Matlab commands (I/O, 2d and 3d Graphic output)
2 Examples of various types of computing errors
3 Factorization of a symmetric positive definite Matrix
4 Cubic Spline interpolation
5 Polynomial curve fit polynomials of degree 1,3,5,7 by Least squares
6 DFT spectra of a two tone analog signal
7 The BER curve of communication with multidimensional signaling
8 Surface area of a revolutionary 3d Cubic object

In addition to the above tutorials and assignments will be given by teacher from the reference books

Reference Books:

1. Applied Numerical methods using MATLAB, Won Y.T,Yang et.al, Wiley 2005

2. Applied Numerical Analysis, Gerald /Wheatley, Pearson Education, 2002

3. Computer Oriented Numerical Methods, Rajaraman, PHI

S2162:Paper-II: 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: 75 Marks　　　　Internal: 25 marks
Lectures: 40hrs　　　　Tutorials: 10hrs

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

UNIT-I

Approximation methods(5L) The WKB approximation**:** Principle of the method, The WKB wavefunction, Criterion for validity of approximation, Connection formulae, Applications to one dimensional bound system, Penetration of a potential barrier
The Variational method (3L): Basic formulation and principle of the method, bound state (Ritz method), Applications to linear harmonic oscillator, Helium atom

UNIT-II

Theory of scattering(4L): The scattering experiment, relationship of the scattering cross-section to the wave function, the scattering amplitude, method of partial waves, expansion of a plane wave in terms of partial waves.
Scattering by a central potential V(r**)(4L):** zero energy scattering, the scattering length, scattering by a square well potential, effective range, resonance scattering (No derivation).

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UNIT-III

The Born approximation(4L): Born approximation and Green Function, the integral equation for scattering, Criterion for the validity of the Born approximation, scattering of electrons by atoms
Identical particles(4L): 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(8L): Basic principle and formulation of time dependent perturbation theory, constant perturbation, transition to continuum, Fermi’s golden rule, scattering cross section in the Born approximation, Harmonic perturbation, radiative transitions in atoms, dipole transitions, selection rules.

UNIT-IV

Relativistic wave equations(8L): Introduction, The Klein-Gordan equation, the first order wave equations, The Dirac equation, Properties of Dirac matrices, the free Dirac particles, equation of continuity, non-relativistic limit, spin-orbit coupling, Hole theory.

Tutorials (10L)

The complicated steps involved in deriving formulae for selected topics shall be considered in this part. Also the illustrative examples will be elaborated in tutorials. (Details will be listed in the lecture schedule by the teacher):

Text and reference books:

1. Quantum Mechanics, V.K. Thankappan, (Wiley Eastern Limited).
2. A textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan. (Tata McGraw-Hill).
3. Quantum Mechanics, J.L. Powell and B. Crasemann, (Addison-Wesley).
4. Quantum Mechanics, L.I. Schiff (McGraw-Hill).

S2163:Paper-III: Statistical Mechanics

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

External: 75 Marks	Internal: 25 marks
Lectures: 40hrs	Tutorials: 10hrs

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

UNIT-I (8L)

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

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

UNIT-II(8L)

Quantum Statistical Mechanics: The postulates of Quantum Statistical mechanics, Density Matrix, Ensembles, Third law of Thermodynamics, The Ideal Gases: Microcanonical 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

S2164: Paper-IV: 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: 75 Marks — Internal: 25 marks
Lectures: 40hrs — Tutorials: 10hrs

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

UNIT-I

Electrostatics: Field lines, flux and Gauss Law, Gauss' Law applications, Laplace and Poisson equations, Electrostatic boundary conditions. (4L)
Magnetostatics: Biot-Savart law, Ampere's theorem, electromagnetic induction, Maxwell's equations in free space (4L)

UNIT-II

Maxwell's equations in linear isotropic media,Boundary conditions on fields at interfaces Scalar and vector potentials, Gauge invariance, Electromagnetic waves in free space, Electromagnetic waves in dielectrics, and conductors. (8L)

UNIT-III

Reflection and refraction, polarization, Fresnel's law, Coherence, interference, diffraction (2L)

Dispersion relations in plasma, Lorentz invariance of Maxwell's equations, Classification of waves (TEM, TE, TM), Transmission lines: Lossless line and general lossy line, Rectangular wave guide, Electromagnetic cavities : Time average electric and magnetic energies (6L)

UNIT-IV

Electromagnetic cavities (8L) : damping constant, quality factor (no derivation), Retarded potential : Liénard-Wiechert potential, Electric and magnetic fields due to a uniformly moving charge , Electric and magnetic fields due to an accelerated charge, Radiation from moving charges, Qualitative discussion of Bremsstrahlung, synchrotron radiation (no derivations), reaction force of radiation

UNIT-V

Basic properties and occurrence(8L). Definition of plasma. Criterla for plasma behaviour, Plasma oscillation. quasineutrality and Debye Shielding. The plasma parameter. natural occurence of plasma. Astrophysical plasmas. Plasma production Thermal ionization. saha equation(No derivation). Brief discussion of methods of laboratory plasma production. Steady stage glow discharge, microwave breakdown and induction discharge,

TUTORIALS (10 T hrs)

Magnetostatic boundary conditions
Energy and momentum in EM waves : Poynting vector
Concept of phase and group velocity
Plasma in Magnetiosphere and ionosphere.

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

Reference Books:

David J. Griffiths, Introduction to Electrodynamics
Robert Plonsey and R.E Collins : Principles and applications of electromagnetic fields
Sadiku – Elements of Electromagnetics
Chen: Plasma Physics

S2165:Paper-V: Laboratory Project

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: 75 marks . Required to submit a project report and working model of the project for evaluation. External Assessment will involve presentation and viva –voce.

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

Students will be required to carry out laboratory project either individually or in groups in the physics Laboratory under guidance of teachers which involves design & construction of equipments, circuits etc. which involves about 100hrs of practical work per student that can be used to demonstrate physical principles or to carry out laboratory experiments.

S 2166:Paper-VI: Computational Physics Laboratory

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: Section-A : 25 marks . Section B: 50 Marks

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

Section A (This section must be first completed through lab work of 30 hrs) Programming using Fortran 77/90 for proficiency in programming and implementing simple algorithms.

Section B: Computational Physics problems using MATLAB.(70 hrs of Computational Lab work). Problems can be taken from following reference books

1. Applied Numerical methods using MATLAB, Won Y.T,Yang et.al, Wiley 2005

2. Computational Physics: An Introduction by R.C. Verma, P.K.Ahluwalia and K.C.Sharma, New Age International,New Delhi

SEMESTER-III

S3161:Paper-I: 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: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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

UNIT-I (8 L)

Quantum States of one electron atoms-Atomic Orbitals- Hydrogen Atom spectrum, Pauli's Principle-Spectra of alkali elements, Spin orbit Interaction and fine structure in alkali Spectra, equivalent and non-equivalent electrons

UNIT-II(8L)

Normal and anomalous Zeeman Effect, Paschen back effect, Stark Effect Two electron systems, Interaction energy in LS and JJ coupling, Hyperfine structure and determination of nuclear spin and nuclear g factors, radiative transition probabilities, line width, Doppler broadening, natural broadening, collision broadening and stark broadening.

UNIT-III (8 L)

The rotation of Molecules, rotational spectra, diatomic molecules, poly atomic molecules,Techniques and instrumentation, chemical analysis by Microwave spectroscopy.

IR Spectrsocopy: The vibrating diatomic molecule, the diatomic vibrating rotator,The interactions of rotations and vibrations, the vibrartion of polyatomic Molecules, Analysis by IR techniques, IR spectrometer

UNIT-IV (8L)

Raman Spectrocopy : Pure rotational Raman Spectra, Vibrational Raman Spectra, polarization of light and Raman Effect, Structure determination from Raman and IR spectroscopy, Raman Spectrometer, Near Infra Red FT Raman Spectrsocopy

UNIT-V(8L)

Electronic Spectrsocopy of Molecules: Electronic Spectra of Diatomic molecules, Electronic Structure of Diatomic Molecules, Electronic spectra of polyatomic molecules, Molecular Photoelectron Spectroscopy

Spin Resonance Spectroscopy: NMR Spectroscopy: Hydrogen Nuclei, ESR spectroscopy

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.

S3162: Paper-II: 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: 75 Marks — Internal: 25 marks
Lectures: 40hrs — Tutorials: 10hrs

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

UNIT-I

Crystallinity and Forms of Solids (8L):
Crystal classes and systems, periodic array of atoms, fundamental types of lattices, 2d and 3d lattices, index system for crystal planes, simple crystal structures, nonideal crystal structures, and 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(8L)
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 (8L):
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). (4L)
Superconductivity, Meissner effect, type-I and type-II superconductors, BCS theory of superconductors, Josephson junctions. (4L)

UNIT-V

Magnetic Phenomena in Solids (8L):
Langevin diamagnetism equation, quantum theory of diamagnetism of mononuclear systems, paramagnetism, quantum theory of paramagnetism, Hund's rules.
Ferromagnetic order, magnons, neutron magnetic scattering, ferromagnetic order, Antiferromagnetic order, Ferromagnetic domains, single domain particle.

Tutorials (10 T hrs)

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

Recommended Book:

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

S3163: Paper-III: 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: 75 Marks — Internal: 25 marks
Lectures: 40hrs — Tutorials: 10hrs

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 reaction: statistical consideration. 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 structureof alpha spectrum

UNIT-IV

Beta Decay (4L): Beta particles:experimental information, Fermi theory of beta decay, Fermi kurie plot, allowed and forbidden transitions, Brief survey of ft values, Brief discussion of electron capture, 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, Nuclear resonance & Mossbauer Effect.

UNIT-V

Introduction to Particle Physics (8L)

Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction; Relativistic kinematics

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. H.A. Enge, Introduction to Nuclear Physics, Addison-Wesley, 1975

3. I.S. Huges, Elementary particle Physics, Penguin

S3164A Paper-IVA : 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: 75 Marks   Internal: 25 marks
Lectures: 40hrs   Tutorials: 10hrs

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

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.

S3164B Paper-IVB : 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

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

UNIT-I (8)

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 (8)

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 (8)

Tight bound electrons:Wannier functions and tight binding model.

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

UNIT-IV (8)

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

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

UNIT-V(8L)

,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

S3164C Paper-IVC : 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: 75 Marks — Internal: 25 marks

Lectures: 40hrs — Tutorials: 10hrs

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

UNIT-I

Sources of Radiation (6L): Cosmic rays, radioactive sources, accelerators (Brief study of principle of operation & characteristics of radiations of Cockroft Walton,Vande 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(2L):units and special parameters, background levels, radiation carcinogesis

UNIT-II

Interaction of Charged particle with matter (5L): Definition of range, types of charged particle interaction, energy transfer in elastic collisions,Bethe formula, scattering of heavy and light charged particles, Radiation loss:corrections for Born approximations and Bremstrahlung

Interaction of Photons(5L): Attenuation coefficients, classical scattering from single electrons, coherent scattering, Compton scattering: The Klein –Nishina cross section (No derivation), 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(6L): 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(4L) : Gas detectors, Scintillation detector,semiconductor detectors

Mircodosimetry & Radiation effects(4L): Experimental determinations of microdosimetric spectra,practical considerations, primary radiation effects, track structure, radiation effects in condensed systems, radiolysis of water, dosimeter

UNIT-V

Dosimetry(4L): 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 (2L)

Brief introduction to radiation imaging techniques(Diagonistic radiology, tomography, MRI,nuclear Medicine)) (2L)

Tutorials (10Hrs)

Study of decay characteristics of Standard Radioactive sources
Compton profile
Calculation of thickness of shielding materials for radiations
Nuclear detectors: Resolution, efficiency, calibration
Radiation effects in polymers,glasses,graphites and silicon
calculation of specific air kerma

In addition to the above tutorials and assignments will be given by teacher concerned

Reference:

A primer in Applied Radiation Physics, F.A. Smith, World Scientifc
Nuclear Radiation Physics ,R.E. Lapp and H.L.Andrews

S3165 Paper-V : Modern Physics Laboratory

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: Section-A: 40 Marks, Section-B: 35 Marks

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

Section-A

(Three Experiments from following)

1. Study of G.M counter and random events
2 Determination of end point energyof alpha particles
3. Determination of end point energy of beta rays
4. Study of absorption coefficient for gamma-rays
5. To determine the beta ray spectrum of Cs-137 source and to calculate the binding energy of K -shell electron of Cs-137.

Section-B

(Three Experiments from following)

1. ESR Studies
2. Zeeman Effect
3. Hall effect
4. Hysterises of Ferro Electric sample
5. Curie temperature of a ferromagnetic Sample
6. Measurement of Electrical conductivity
7. Study of X-ray Debye Scherer Powder spectra of cubic materials.

S3166A Paper-VI : Elective Lab.

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: 75 Marks

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

Laboratory/Computer simulation experiments on Elective Paper. (Detailed list of experiments will be given by the teacher)

Semester-IV

S4161: Paper-I: 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)*

UNIT-I

Sensors & transducers (8L) Mechanical and Electromechanical sensors:Strain Gauge, inductive and capacitative sensors. Thermal Sensors:Resistance change, thermoemf,junction semiconductor, thermal radiation.. Magnetic Sensors: Magnetic resistive, Hall effect, inductive and eddy current. Optical Sensors. Radiation detectors: GMdetector, Scintillation, Semiconductor

UNIT-II

Analog Signal Processing(5L): Signal classifications, functions in analog signal processing, Errors in signal processing, Signal conditioning: Recovery & Conversion:Lock in Amplifier, Phased locked Loop, sample and hold, Analog to Digital

Conversion, Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding; Fourier transforms; lock-in detector, box-car integrator, modulation techniques.

Measurements and Control(3L): Introduction to process control, process control loop, measurement of temperature and pressure, resistance measurement, analytical measurement and control

UNIT-III

Vacuum Techniques and 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 proedure. Thin film preparation techniques: Thermal evaporation, sputtering, ionbeam,molecular epitaxy and chemical vapor methods Brief study of methods for surface studies.

UNIT-IV

Basics of Imaging techniques(8L): Charge coupled Devices, Digital images, Storage and Retrieval of images, image enhancement, errors and sterology. Microscopic techniques in physics (Field Ion Microscopy, Scanning Tunneling Mircoscopy, Electron Microscopy)

UNIT-V

Mass spectroscopy : Principle, spectrometer, and its operation, resolution, Mass spectrum, applications (3L)

Physical Property Measurements of Solids : Experimental techniques for measurement of Heat capacity, Electrical resistance of metals, thermal conductivity and magnetic susceptibility (Principle, typical experimental setup and measurement) (5L)

Tutorials (10 T hrs)

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

Reference Books :

Sensors &Transduccers: Patranabis,PHI
Analog Signal Processing: Ramón Pallás-Areny, John G. Webster
Introduction to measurements and Instrumentation by Ghosh
Measurement and Control Basic, Thomas Hughes
Microscopy Techniques,Ashley Clarke, Colin Nigel Eberhardt
Experimental techniques in low-temperature physics
By Guy Kendall White, Philip J. Meeson, oxford University Press

S4162A: Paper-IIA: 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: 75 Marks Internal: 25 marks
Lectures: 40hrs Tutorials: 10hrs

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

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 coling, 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.

S4162B Paper-IIB : Condensed Matter Physics-I

*(**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

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

Unit-I

Structure Factor : Static structure factor and its relation with the pair correlation function. Determinationof structure factor by X-ray and neutron scattering. Inelastic neutron scattering and dynamic structure factor, space time correlation function and its relation with dynamic structure factor, properties of space time correlation function. Langevin's equation for Browninan Motion and its modifications. Velocity autocorelatiion function, mean square displacement, Relation between velocity autocorelation function and diffusion coefficient.

Unit-II

Liquid Metals : Metallic interactions-Kinetic energy, electrostatic exchange and correlation, Pseudopotential formalism, diffraction model, structure factor, form factor for local and nonlocal potentials, energy eigen states, dielectric screening. Energy wave number characteristics, calculation of phonon dispersion of liquid metals. Band structure energy in momentum and direct space. Ziman's resistivity formula, Green function method for energy bands in liquid metals.

Unit-III

Quantum Liquids : Distinction between classical and quantum liquids, critetria for freezing, phase diagram of He4, He I and He II Tisaza's two fluid model, entropy filter, Fountain effect, superfluid film vehicle, Viscosity and specific heat of He4, first sound, second sound, third sound and fourth sound, Landau theory: Rotons and Phonis, t-matrix theory of superfluid He. Basic differences in superfluidity in He3 and He4.

Unit-IV

Supercooling and the Glassy State : Macroscopic Characteristics of a Glass, Kinetics of Nucleation and Phase Changes, Homogeneous nucleation and crystal growth,The critical cooling rate for glass formation,Superheating and vapour condensation, The Structure of Amorphous Solids,Network and modified-network glasses, Molten and amorphous semiconductors, Thermodynamic Aspects and Free Energy Landscape, Atomic Motions in the Glassy State,Relaxation processes, Strong and fragile liquids, Annealing and aging , Anharmonicity and boson , Supercooled and Glassy Materials, Hard sphere statistics on the amorphous branch, Supercooled water, Metallic glasses, Superionic glasses,glassy polymers

UNIT-V

Exotic Solids : Structure and symmetries of liquids, liquid crystals and amorphous solids. Aperiodic solids and quasicrystals; Fibonanccy sequency, Penrose lattices and their extension to 3-dimensions, Special carbon solids. Fullerences and tubules; formation and characterization of fullerences and tubules. Single wall and multivwall carbon tubules. Electronic properties of tubules. Carbon nanotubule based electronic based devices Definition and properties of nanostrctured materials. Methodsof synthesis of nanostructured materials. Special experimental techniques for characterization of nanostrcutred materials. Quantum size effect and its applications.

Tutorials (10 T hrs)

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

References

1. Egelestaff : In Introduction to the Liquid State (Chapters 2, 3, 5, 6, 7 and 8.)

2. Hansen and McDonald : Theory of Simple Liquids, (Chapters 3, 5, 7, and 9).
3. Faber : Theory of Liquid Metals.
4. March : Liquid Metals.
5. D. Pines and P. Nozier : The Theory of Quantum Liquid.
6. W.A. Harison : Pseudopotentials in the Theory of Metals Benjamin.
7. March, yound and Saupenthe - Many Body Problems.
8. March and Tosi : Atomic Motions in Liquids.
9. March, Tosi and Street : Amorphous Solids and the Liquid State, Plenum, 1985.
10. Dugdale : Electrical Properties of Metals an Alloys.
11. M. Shimoji : Liquid Metals.
12. P.I. Taylor, A Quantum Approach to the Solid State, Prentice Hall.
13. Physics of quasi crfstals Ech. Steinhardt and Ostulond.
14. Hand Book of nanostractured Matcriets & Nanotechnology Ed. Hari Singh Nalwa (Vol. 1 to 4).

S3162C Paper-IIC : 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: 75 Marks — Internal: 25 marks
Lectures: 40hrs — Tutorials: 10hrs

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

Unit-I (8L)

Introduction to microwaves and its frequencys spectrum, Application of microwaves.
Wave Guides :
(a) Rectangular wave guides : Wave equation & its solutions, TE & TM modes. Dominant mode and choice of wave guide Dimensions Methods of excitation of wave guide.
(b) Circular wave guide-wave equation & it solutions, TE, TM & TEM modes.
(c) Attenuation - Cause of attenuation in wave guides, wall current. & derivation of attenuation constant, Q of the wave guide.

UNIT-II (8L)

Resonantors : Resonant Modes of rectangular and cylindrical cavity resonantors, Q of the cavity resonantors, Excitation techniques, Introduction to Mircostrip and Dielectric resonantors, Frequency meter.

UNIT-III(8L)

Ferrites : Microwave propagation in ferrites, Farady rotatiion, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators.

Microwave tubes : Space charge spreading of an electron beam, Beam focussings. Klystrons : Velocity Modulation, Two Cabvity Klystron, Reflex Klystron Efficiency of Klystrons.

UNIT-IV(8L)

Magnetrons : Types & description, Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics.
Traveling wave tubes : O & M type traveling wave tubes. Gyrotorons : Constructions of different Gyrotrons, Field - Particle Interaction in Gyrotron.

UNIT-V (8L)

Microwave Measurement

Microwave Detectors : Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, Coupling using direction coupler.
Complex permitivity of material & its measurement: definition of complex of solids, liquids and powders 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. Electromagnetic Waves & Radiating System-Jorden & Balmain.
2. Theory and Applications of Microwaves A.B. Brownwell & R.E. Beam (Mc Graw Hill).
3. Introduction to Microwave Theory by Atwater (McGraw Hill).
4. Principles of Microwave circuits by G.C. Montogmetry (McGraw Hill).
5. Microwave Circuits & Passive Devices by M.L. Sisodia adn G.S. Raghuvanshi (Willey Eastern, New Delhi).
6. Foundations of Microwave Engineering by R.E. Collin (McGraw Hill).
7. Microwave Semiconductor Devices and their Circuit applications by H.A. Watson.
8. Microwaves by M.L. Sisodia & Vijay Laxmi Gupta.
9. Antenna Theory, Part-I by R.E. Collin & F.J. Zucker (McGraw Hill, New York).

10. Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts).
11. Antenna Theory Analysis by E.A. Wolff (J.Willey & sons).
12. Antenna Theory Analysis by C.A. Balanis Harper & Row, Publ. & Inc. New York.
13. Antenna Theory & Design by R.C. Elliott (LPHI Ltd. New Delhi.).

S4163A: Paper-IIIA: 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: 75 Marks | Internal: 25 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.

S4163B: Paper-IIIB: 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: 75 Marks — Internal: 25 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.
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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,□.
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.

S4163C: Paper-IIIC Condensed Matter Physics-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: 75 Marks | Internal: 25 marks
Lectures: 40hrs | Tutorials: 10hrs

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

UNIT-I

Phase Transformation and Alloys : Equilibrium transformation of first and second order. Equilibrium diagrams. Phase rule. Interpretation of phase diagrams. Substitutional solid solutions. Vegard's law, intermediate phases, Hume-Rothery rules. Interstitial phases (carbides, nitrides, hydrides, borides). Martensitic transitions. structure factor of liquid metal alloys, behaviour of s(q), radial distribution function g(r) and relationship between s(q) and g(r)

UNIT-II

Disordered Systems : Disorder in condensed Matter, Substitutional, positional and topographical disorder. Short and long range order. Spinning, sputtering and ion-implantation techniques, glass Transiton, glass formation ability, nucleation and growth processess. Anderson model for random system and electron localization, mobility edge, qualitative application of the idea of amorphous semicodnuctors and hopping conduction. Metglasses, Models for structure of metalglasses. Structure factor of binary metallic glasses and it relationship with the radial distribution functinos. Discussion of electric, magnetic and mechanical properties of glassy system.

UNIT-III

Structure determination/characterization : Basic theory of X-ray diffraction. Indexing of Debye-Scherer patterns powder samples, examples from some cubic and non-cubic symmetries. Neutron diffraction-basic interactions, corss section, scatterign lengthand structure factor. Mossbauer effect, hyperfine parameters-Isomer shift, quadrupole splittign and Zeeman splitting. Applications: Valence and co ordination, site symmetry magnetic behaviour. Discussion in context of Fe57.

UNIT-IV

Optical constants, dispersion relation of optical; constants from Maxwell's equations, Kramers-Kroning relations, optical absorption and emission in semiconductors, exciton absorption, impurity and interband transitions,luminescence, activators, Frank-condon prionciple,photoluminescence and thermoluminescence

Tutorials (10 T hrs)

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

Ref**erences**

1. Egelstaff : An introduction to the liquid state (Chapters 2,3,5,6,7 and 8).
2. Hansel and Mc Donald : Theory of Simple liquids (Chapters 3,5, 8 and 9).
3. Faber-Theory of liquid metals.
4. March-Liquid Metals.
5. D.Pines and P. Nozier- The theory of quantum liquids.
6. W.A. Harison : Pseudo potentials in the theory of metals.
7. March, Yound and Saupenthe : Many Body Problems.
8. March and Tosi : Atomic Motins in Liquids.
9. March, Tosi and Street : Amorphous solids and the Liquids State, Plenum, 1985.
10. Dugdale : Electrical Properties of Metals and Alloys.
11. M. Shimoji : Liquid Metals.
12. P.I. Taylor, A. Quantum Approach to the Solid State, Prentice Hall.
13. Introductiion to Solid State by L. Azaroff.
14. Physics of Engineerign Materials by Srinivasan.
15. Lecture Notes in Physics, No. 283, Electronic band structure and its applications (EdO M. Yussouf (1987) Springer - Vertag).

S4163D: Paper-IIID 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: 75 Marks Internal: 25 marks

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

UNIT-I

Phase diagrams (10L):

Definations 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 a eutectic alloys.Gibbs phase value the iron-carbon system. The Fe-Fe; C Phase diagram, Development of microstructures in iron-carbon alloys.

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

UNIT-II

Ceramics (5L):

Ceramic structure,ceramics density calculations, Sillicate Ceramics, imperfections in ceramics, ceramic phase diagram, Brittle fracture of ceramics, stress,strain behavious, meachnism of plastic deformation.

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. Polymer crystallinity-polymer crystal. Stress-strain behaviour. Deformation of semicrystalline, polymers mechanism. Thermoplastic and thermosetting polymers, viscoelasticity. Deformation of elastomers. Impact strength, fatigue, strength and hardness.

UNIT-IV

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

UNIT-V

Magnetic Materials(8L):

Soft magnetic materials- hard magnetic materials- thin films- ferrites- weakly ferrimagnetic crystals (canted antiferromagnetics)- reorientation transition layered

Magnetic nanoparticles, magnetic thin films- multilayer- DMS,GMR,CMR (Nano particle). Measurement of Particle size density- porosity- lattice constant using X-ray. Magnetic characterization using Mössbauer spectroscopy and Neutron diffraction, NMR, FMR, MOKE, MCD, - Hall Effect field measurement,VSM (Low and high field magnetic field and temperature).

Tutorials (10 T hrs)

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

Text Book:
Material Science and Engineering : An Introduction : William D. Callister Jr., John Wielly & Sons.

S4164: Paper-IV: PROJECT

Candidates are expected to undertake a major project work in the IV semester as per following specific guidelines.

1. Each candidate will be required to undertake a project work which involves laboratory work of approximately 100 hrs.
2. Project work must be carried out in a research laboratory or PG laboratory of the university or university approved institutions under a faculty member.
3. The project work is mainly aimed to motivate the students towards research by training them in the use of sophisticated Research equipments, acquainting them with various research programme as well as providing them to work with research students and faculty members.
4. If more than one student is allotted a project work, the work carried out by each student must be minimum 100 hrs of laboratory work.
5. Each student must submit the objective and work plan of the project work within one week of the starting of fourth semester failing which candidate shall not be registered for the project work.
6. Towards end of third semester, the candidate are expected to contact faculty members for project work. In case the candidate is not able to get a supervisor, head of the department will allot a supervisor.
7. Project work can be theoretical physics problem/computational/design, fabrication and testing of research level equipments/experimental setups.
8. In the case of joint project work, the contribution by each candidate must be specified in the project report
9. 75% attendance in the laboratory is compulsory. The candidate will be required to submit monthly attendance certificate from supervisor in the office of the department. If the attendance is less than 75%, candidate shall not be examined in the project work.

S4165: Paper-V: SPECIALIZATION LAB-I

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: 75 Marks

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

Laboratory/Computer simulation experiments on special Papers. (Detailed list of experiments will be given by the teacher)

S4166: Paper-VI: SPECIALIZATION LAB -II

Total Laboratory Hrs: 100 hrs Max. Marks: 100

Internal Assessment: 25 marks,

External Assessment: 75 Marks

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

Laboratory/Computer simulation experiments on special Papers. (Detailed list of experiments will be given by the teacher)