A.C. 10/2/2012

Item No. 4.25

University of Mumbai

Syllabus for **M.Sc. Semesters - I & II**

Program : M. Sc.

Course : Physics

(Credit Based Semester and Grading System with effect from the academic year 2012-13)

1 Course Structure & Distribution of Credits.

M. Sc. in Physics Program consists of total 16 theory courses, total 6 practical lab courses and 2 projects spread over four semesters. Twelve theory courses and four practical lab courses will be common and compulsory to all the students. Remaining four theory courses can be chosen from the elective courses offered by the institute. Two Lab courses can be chosen from the elective lab courses offered by the institute. Each theory course will be of 4 (four) credits, a practical lab course will be of 4 (four) credits and a project will be of 4 (four) credits. A project can be on theoretical physics, experimental physics, applied physics, development physics, computational physics or industrial product development. A student earns 24 (twenty four) credits per semester and total 96 (ninety six) credits in four semesters. Students can earn additional 2 (two) credits during the four semester period, by giving seminars. The course structure is as follows,

Theory Courses

	Course -1	Course-2	Course-3	Course-4
Semester-I	Mathematical Methods	Classical Mechanics	Quantum Mechanics-I	Solid State Devices
Semester-II	Advanced Electronics	Electrodynamics	Quantum Mechanics-II	Solid State Physics
Semester-III	Thermodynamics and Statistical Mechanics	Nuclear Physics	Elective-1	Elective-2
Semester-IV	Experimental Physics	Atomic and Molecular Physics	Elective-3	Elective-4

Practical Lab courses

	Course	Course
Semester-I	Lab-1	Lab-2
Semester-II	Lab-3	Lab-4
Semester-III	Project-1	Elective Lab-1
Semester-IV	Project-1	Elective Lab-2

The elective courses will be from topics ranging from, Nuclear Physics, Solid State Physics, Solid State Device Physics, Electronics & Communications, Electronics (Microprocessor, Microcomputers, Embedded systems), Astronomy, Space Physics, Materials Science, Laser Physics, Plasma Physics and other advanced specialized topics. Only some electives will be offered by each PG centre. Every year different electives may be offered depending on the availability of experts in PG centres.

Semester I

M.Sc. in Physics Program for Semester-I consists of four theory courses and two practical courses. The details are as follows:

Theory Courses (4): 16 hours per week (One lecture of one hour duration)

Theory Courses	Title of Subject	Lectures (Hrs)/sem.	Credits
PSPH101	Mathematical Methods	60	04
PSPH102	Classical Mechanics	60	04
PSPH103	Quantum Mechanics I	60	04
PSPH104	Solid State Devices	60	04
	Total	**240**	**16**

Practical lab courses (2): 16 hours per week

Practical Lab Course	Practical Lab Sessions (Hrs)/sem.	Credits
PSPHP101	120	04
PSPHP102	120	04
Total	**240**	**08**

Semester II

M.Sc. in Physics Program for Semester-II consists of four theory courses and two practical courses. The details are as follows:

Theory Courses (4): 16 hours per week (One lecture of one hour duration)

Theory Paper	Subjects	Lectures (Hrs)/sem.	Credits
PSPH201	Advanced Electronics	60	04
PSPH202	Electrodynamics	60	04
PSPH203	Quantum Mechanics II	60	04
PSPH204	Solid State Physics	60	04
	Total	**240**	**16**

Practical lab courses (2): 16 hours per week

Practical Lab Course	Practical Lab Sessions (Hrs)/sem.	Credits
PSPHP201	120	04
PSPHP202	120	04

Total	**240**	**08**

2. Scheme of Examination and Passing:

1. This course will have 40% Term Work (TW) / Internal Assessment (IA) and 60% external (University written examination of Two Hours duration for each course paper and practical examination of Three Hours duration for each practical course). All examinations will be held at the end of each semester and will be conducted by the University as per the existing norms.
2. Term Work / Internal Assessment - IA (40%) and University examination (60%)- shall have separate heads of passing.
3. To pass, a student has to obtain minimum grade point E, and above separately in the IA and University examination.
4. The University examination for Theory and Practical shall be conducted at the end of each Semester and the evaluation of Project work i.e. Dissertation if any, at the end of the each Semester.
5. The candidates shall appear for examination of 4 theory courses each carrying 60 marks of 2 hours duration and 2 practical courses each carrying 100 marks at the end of each semester.
6. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course carried out under the guidance of a faculty member with minimum number of experiments as specified in the syllabus for each group.

3. Standard of Passing for University Examinations:

As per ordinances and regulations prescribed by the University for semester based credit and grading system.

4. Standard point scale for grading:

Grade	Marks	Grade Points
O	70 & above	7
A	60 to 69.99	6
B	55 to 59.99	5
C	50 to 54.99	4
D	45 to 49.99	3
E	40 to 44 .99	2

F (Fail)	39.99 & below	1

5. Grade Point Average (GPA) calculation:

1. GPA is calculated at the end of each semester after grades have been processed and after any grade have been updated or changed. Individual assignments / quizzes / surprise tests / unit tests / tutorials / practicals / project / seminars etc. as prescribed by University are all based on the same criteria as given above. The teacher should convert his marking into the Quality-Points and Letter-Grade.
2. Performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). It is the weighted average of the grade points obtained in all the subjects registered by the students during the semester

$$\text{SGPA} = \frac{\sum_{i=1} C_i p_i}{\sum_{i=1} C_i}$$

C_i = The number of credits earned in the i^{th} course of a semester.

p_i = Grade point earned in the i^{th} course

i = 1,2,….n represents number of courses for which the student is registered.

3 The Final remark will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade point obtained in all the semesters registered by the learner.

$$\text{CGPA} = \frac{\sum_{j=1} C_j p_j}{\sum_{j=1} C_j}$$

C_j = The number of credits earned in the j^{th} course upto the semester.for whic h the CGPA is calculated

p_j = Grade point earned in the j^{th} course*

j = 1,2,….n represents number of courses for which the student is registered upto the semester for which the CGPA is calculated.

* : A letter Grade lower than E in a subject shall not be taken into consideration for the calculation of CGPA

The CGPA is rounded upto the two decimal places.

M.Sc. (Physics) Theory Courses

Semester –I

Semester-I : Course no.: PSPH101: Mathematical Methods (60 lectures, 4 credits)

Unit-1

Properties of Fourier series, integral transforms, development of Fourier integrals, Fourier transform of derivatives, convolution theorem. Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem.

Unit-2

Matrices, Eigenvalues and Eigen vectors, Diagonalization of Matrices, Application to Physics problems, Applications to differential equations. Introduction to Tensor Analysis, Addition and Subtraction of Tensors, summation convention, Contraction, Direct Product, Levi-Civita Symbol

Unit-3

Complex Variables, Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order m, Contour Integrals, Evaluation of improper real integrals, improper integral involving Sines and Cosines, Definite integrals involving sine and cosine functions.

Unit-4

Differential Equations: Frobenius method, series solutions, Legendre, Hermite and Laguerre polynomials, Bessel equations, Partial differential equations, separation of variables, wave equation and heat conduction equation. Green's functions in one dimension.

Main references:

S.D.Joglekar, Mathematical Physics: The Basics, Universities Press 2005

S. D.Joglekar, Mathematical Physics: Advanced Topics, CRC Press 2007

M.L. Boas, Mathematical methods in the Physical Sciences, Wiley India 2006

Additional references.

1. G. Arfken: Mathematical Methods for Physicists, Academic Press
2. A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, McMillan
3. A.C. Bajpai, L.R. Mustoe and D. Walker, Advanced Engineering Mathematics, John Wiley
4. E. Butkov, Mathematical Methods, Addison-Wesley
5. J. Mathews and R.L. Walker, Mathematical Methods of physics
6. P. Dennery and A. Krzywicki , Mathematics for physicists

7. T. Das and S.K. Sharma, Mathematical methods in Classical and Quantum Mechanics
8. R. V. Churchill and J.W. Brown, Complex variables and applications, V Ed. Mc Graw. Hill, 1990
9. A. W.Joshi, Matrices and Tensors in Physics, Wiley India

Semester-I : Course no.: PSPH102: Classical Mechanics (60 lectures, 4 credits)

Unit-1

Review of Newton's laws, Mechanics of a particle, Mechanics of a system of particles, Frames of references, rotating frames, Centrifugal and Coriolis force, Constraints, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and the dissipation function, Simple applications of the Lagrangian formulation. Hamilton's principle, Calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, Lagrange Multipliers and constraint exterimization Problems, Extension of Hamilton's principle to nonholonomic systems, Advantages of a variational principle formulation,

Unit-2

Conservation theorems and symmetry properties, Energy Function and the conservation of energy. The Two-Body Central Force Problem**:** Reduction to the equivalent one body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The virial theorem, The differential equation for the orbit and integrable power-law potentials, The Kepler problem : Inverse square law of force, The motion in time in the Kepler problem, Scattering in a central force field, Transformation of the scattering problem to laboratory coordinates.

Unit-3

Small Oscillations: Formulation of the problem, The eigenvalue equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Forced and damped oscillations, Resonance and beats.

Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle.

Unit-4

Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, Poisson brackets and other canonical invariants, Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum Poisson bracket relations.

Main Text : Classical Mechanics, H. Goldstein, Poole and Safco, 3rd Edition, Narosa Publication (2001)

Additional References :

1. Classical Mechanics, N. C. Rana and P. S. Joag. Tata McGraw Hill Publication.
2. Classical Mechanics , S. N. Biswas, Allied Publishers (Calcutta).
3. Classical Mechanics, V. B. Bhatia, Narosa Publishing (1997).
4. Mechanics, Landau and Lifshitz, Butterworth, Heinemann.
5. The Action Principle in Physics, R. V. Kamat, New Age Intnl. (1995).
6. Classical Mechanics, Vol I and II, E. A. Deslougue, John Wiley (1982).
7. Theory and Problems of Lagrangian Dynamics, Schaum Series, McGraw (1967).
8. Classical Mechanics of Particles and Rigid Bodies, K. C. Gupta, Wiley Eastern (2001)

Semester-I :Course no.: PSPH103: Quantum Mechanics-I (60 lectures, 4 credits)

Unit-1: Theory:

Review of concepts: Analysis of the double-slit particle diffraction experiment; the de Broglie hypothesis; Heisenberg's uncertainty principle; probability waves. Postulates of QM: Observables and operators; measurements; the state function and expectation values; the time-dependent Schrodinger equation; time development of state functions; solution to the initial value problem. Superposition and Commutation: The superposition principle; commutator relations; their connection to the uncertainty principle; degeneracy; complete sets of commuting observables. Time development of state functions and expectation values; conservation of energy, linear momentum and angular momentum; parity.

Unit-2: Formalism:

Dirac notation; Hilbert space; Hermitian operators and their properties. Matrix mechanics: Basis and representations; matrix properties; unitary and similarity transformations; the energy representation. Schrodinger, Heisenberg and Interaction pictures.

Unit-3: Schrodinger equation solutions: One-dimensional Problems:

General properties of one-dimensional Schrodinger equation. Particle in a box. Harmonic oscillator. Unbound states; one-dimensional barrier problems. Finite potential well.

Unit-4: Schrodinger equation solutions: Three-dimensional Problems:

Orbital angular momentum operators in cartesian and spherical polar coordinates, commutation and uncertainty relations, spherical harmonics. Two-particle problem - coordinates relative to the centre of mass; radial equation for a spherically symmetric central potential. Hydrogen atom, eigenvalues and radial eigenfunctions, degeneracy, probability distribution.

Texts:

1. Richard Liboff, Introductory Quantum Mechanics, 4th ed., 2003. (RL)
2. DJ Griffiths, Introduction to Quantum Mechanics, 1995. (DG)
3. A Ghatak & S Lokanathan, Quantum Mechanics: Theory & Applications. 5thed., 2004. (GL)

Additional References:

1. W Greiner, Quantum Mechanics: An Introduction, 4th. ed., 2004.
2 R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
3 SN Biswas, Quantum Mechanics, 1998.

<u>Semester-I : Course no.: PSPH104: Solid State Devices (60 lectures, 4 credits)</u>

Note: Problems form an integral part of the course.

Unit-1: Semiconductor Physics:

Classification of Semiconductors; Crystal structure with examples of Si, Ge & GaAs semiconductors; Energy band structure of Si, Ge & GaAs; Extrinsic and compensated Semiconductors; Temperature dependence of Fermi-energy and carrier concentration. Drift, diffusion and injection of carriers; Carrier generation and recombination processes- Direct recombination, Indirect recombination, Surface recombination, Auger recombination; Applications of continuity equation-Steady state injection from one side, Minority carriers at surface, Haynes Shockley experiment, High field effects. Hall effect; Four – point probe resistivity measurement; Carrier life time measurement by light pulse technique. Introduction to amorphous semiconductors, Growth of semiconductor crystals.

Unit-2: Semiconductor Devices I:

p-n junction : Fabrication of p-n junction by diffusion and ion-implantation; Abrupt and linearly graded junctions; Thermal equilibrium conditions; Depletion regions; Depletion capacitance, Capacitance – voltage (C-V) characteristics, Evaluation of impurity distribution, Varactor; Ideal and Practical Current-voltage (I-V) characteristics; Tunneling and avalanche reverse junction break down mechanisms; Minority carrier storage, diffusion capacitance, transient behavior; Ideality factor and carrier concentration measurements; Carrier life time measurement by reverse recovery of junction diode;; p-i-n diode; Tunnel diode, Introduction to p-n junction solar cell and semiconductor laser diode.

Unit-3: Semiconductor Devices II:

Metal – Semiconductor Contacts: Schottky barrier – Energy band relation, Capacitance-voltage (C-V) characteristics, Current-voltage (I-V) characteristics; Ideality factor, Barrier height and carrier concentration measurements; Ohmic contacts. Bipolar Junction Transistor (BJT): Static Characteristics; Frequency Response and Switching. Semiconductor heterojunctions, Heterojunction bipolar transistors, Quantum well structures.

Unit-4: Semiconductor Devices III:

Metal-semiconductor field effect transistor (MESFET)- Device structure, Principles of operation, Current voltage (I-V) characteristics, High frequency performance. Modulation doped field effect transistor (MODFET); Introduction to ideal MOS device; MOSFET fundamentals, Measurement of mobility, channel conductance etc. from I_{ds} vs, V_{ds} and I_{ds} vs V_g characteristics. Introduction to Integrated circuits.

Main References:

1. S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002.
2. B.G. Streetman and S. Benerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000.
3. W.R. Runyan; Semiconductor Measurements and Instrumentation, McGraw Hill, Tokyo, 1975.
4. Adir Bar-Lev: Semiconductors and Electronic devices, 2nd edition, Prentice Hall, Englewood Cliffs, N.J., 1984.

Additional References:

1. Jasprit Singh; Semiconductor Devices: Basic Principles, John Wiley, New York, 2001.
2. Donald A. Neamen; Semiconductor Physics and Devices: Basic Principles, 3rd edition, Tata McGraw-Hill, New Delhi, 2002.
3. M. Shur; Physics of Semiconductor Devices, Prentice Hall of India, New Delhi, 1995.
4. Pallab Bhattacharya; Semiconductor Optoelectronic Devices, Prentice Hall of India, New Delhi, 1995.
5. S.M. Sze; Physics of Semiconductor Devices, 2nd edition, Wiley Eastern Ltd., New Delhi, 1985.

M.Sc. (Physics) Practical Lab Course

Semester –I Lab-1

Course number: PSPHP101 (120 hours, 4 credits)

Group A

Experiment	References
1. Michelson Interferometer	Advanced Practical Physics -Worsnop and Flint
2. Analysis of sodium spectrum	a).Atomic spectra- H.E. White b).Experiments in modern physics -Mellissinos
3. h/e by vacuum photocell	a). Advance practical physics - Worsnop and Flint b). Experiments in modern physics - Mellissinos
4 Study of He-Ne laser-Measurement of divergence and wavelength	a). A course of experiments with Laser - Sirohi b). Elementary experiments with Laser- G. white
5. Susceptibility measurement by Quincke's method/Guoy's balance method	Advance practical physics -Worsnop and Flint
6. Absorption spectrum of specific liquids	Advance practical physics -Worsnop and Flint
7. Coupled Oscillation	HBCSE Selection camp 2007 Manual

Group B:

Experiment	References
1 , Diac - Triac phase control circuit	a) Solid state devices- W.D. Cooper b) Electronic text lab manual - P.B. Zbar
2. Delayed linear sweep using 1C 555	a) Electronic Principles - A. P. Malvino
3. Regulated power supply using 1C LM 317 voltage regulator IC	a) Opeational amplifiers and linear Integrated circuits - Coughlin & Driscoll b) Practical analysis of electronic circuits through experimentation - L.MacDonald
4. Regulated dual power supply using IC LM 317 & 1C LM 337 voltage regulator ICs	a) Opeational amplifiers and linear Integrated circuits - Coughlin & Driscoll b) Practical analysis of electronic circuits through experimentation - L.MacDonald
5. Constant current supply using IC 741 and LM 317	Integrated Circuits - K. R. Botkar
6. Active filter circuits (second order)	a) Op-amps and linear integrated circuit technology- R. Gayakwad b) Operational amplifiers and linear integrated circuits - Coughlin &. Driscoll

7. Study of 4 digit multiplex display system	Digital Electronics - Roger Tokheim

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Goup B: 03

Semester –I Lab-2
Course number: PSPHP102 (120 hours, 4 credits)

Group A

Experiment	**References**
1. Carrier lifetime by pulsed reverse method	Semiconductor electronics by Gibson
2. Resistivity by four probe method	Semiconductor measurements by Runyan
3. Temperature dependence of avalanche and Zener breakdown diodes	a) Solid state devices - W.D. Cooper b) Electronic text lab manual - PB Zbar c) Electronic devices & circuits - Millman and Halkias
4. DC Hall effect	a) Manual of experimental physics - E.V.Smith b)Semiconductor Measurements - Runyan c) Semiconductors and solid state physics - Mackelvy d) Handbook of semiconductors - Hunter
5. Determination of particle size of lycopodium particles by laser diffraction method	a). A course of experiments with Laser - Sirohi b). Elementary experiments with Laser- G. white
6. Magneto resistance of Bi specimen	Semiconductor measurements by Runyan
7. Microwave oscillator characteristics	a) Physics of Semiconductor Devices by S.M.Sze

Group B:

Experiment	**References**
1. Temperature on-off controller using. IC	a) Op-amps and linear integrated circuit technology by Gayakwad

2. Waveform Generator using ICs	a) Operational amplifiers and linear integrated circuits-— Coughlin & Driscoll b) Op-amps and linear integrated circuit technology — R. Gayakwad c) Opertional amplifiers : experimental manual C.B. Clayton
3. Instrumentation amplifier and its applications	a) Operational amplifiers and linear integrated circuits - Coughlin &. Driscoll b) Integrated Circuits - K. R. Botkar
4. Study of 8 bit DAC	a) Op-amps and linear integrated circuit technology — R. Gayakwad b) Digital principles and applications by Malvino and Leach
5. 16 channel digital multiplexer	a) Digital principles and applications by Malvino and Leach b) Digital circuit practice by RP Jain
6. Study of elementary digital voltmeter	Digital Electronics by Roger Tokheim (5^{th} Edition, page 371)

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Goup B: 03

Additional references:

[1] Digital theory and experimentation using integrated circuits - Morris E. Levine (Prentice Hall)
[2] Practical analysis of electronic circuits through experimentation - Lome Macronaid (Technical Education Press)
[3] Logic design projects using standard integrated circuits - John F. Waker (John Wiley & sons)
[4] Practical applications circuits handbook - Anne Fischer Lent & Stan Miastkowski (Academic Press)
[5] Digital logic design, a text lab manual - Anala Pandit (Nandu printers and publishers Pvt. Ltd.)

Note:

1. Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Such students, who do not have certified journals, will not be allowed to appear for the practical examinations.
2. Total marks for the practical examinations = 200

M.Sc. (Physics) Theory Courses

Semester –II

Semester-II: Course no.: PSPH201: Advanced Electronics (60 lectures, 4credits)

Unit-1 Microprocessors and Microcontrollers:

(a)Microprocessors: Introduction to Microprocessors, Organization of Microprocessors, Signal Description of Microprocessors, Instruction Sets, Programming Techniques with Additional Instructions, Counters and Time Delays, Stack and Sub-routines, Physical Memory Organization, Bus Operation, I/O Addressing Capability, Application of Microprocessors.

(b) Microcontrollers: Introduction to Microcontrollers, Embedded versus External Memory Devices, 8–bit and 16–bit Microcontrollers, CISC and RISC Processors, Harvard and Von Neumann Architectures, Commercial Microcontroller Devices. MCS–51 Architecture, Registers in MCS, 8051 Pin Description, Connections, I/O Ports and Memory Organization. Addressing Modes, Instructions and Simple programming's, Stack Pointer, Assembly Language Programming, Introduction to Atmel 89C51 & 89C2051 Microcontrollers, Applications of Microcontrollers.

Unit-2 Analog and Data Acquisition Systems:

(a) Power Supplies: Linear Power supply, Switch Mode Power supply, Uninterrupted Power Supply, Step up and Step down Switching Voltage Regulators.

(b) Inverters: Principle of voltage driven inversion, Principle of current driven inversion, sine wave inverter, Square wave inverter.

(c) **Signal Conditioning:** Operational Amplifier, Instrumentation Amplifier using IC, Precision Rectifier, Voltage to Current Converter, Current to Voltage Converter, Op-Amp Based Butterworth Higher Order Active Filters and Multiple Feedback Filters, Voltage Controlled Oscillator , Analog Multiplexer, Sample and Hold circuits, Analog to Digital Converters, Digital to Analog Converters.

Unit-3 Data Transmissions, Instrumentations Circuits& Designs:

(a) Data Transmission Systems: Analog and Digital Transmissions, Pulse Amplitude Modulation, Pulse Width Modulation, Time Division Multiplexing, Pulse Modulation, Digital Modulation, Pulse Code Format, Modems.

(b) Optical Fiber: Introduction to optical fibers, wave propagation and total internal reflection in optical fiber, structure of optical fiber, Types of optical fiber, numerical aperture, acceptance angle, single and multimode optical fibers, optical fiber materials and fabrication, attenuation, dispersion, splicing and fiber connectors, fiber optic communication system, fiber sensor, optical sources and optical detectors for optical fiber.

Unit-4 Instrumentation Circuits and Designs :

Microprocessors/ Microcontrollers based D C motor speed controller. Microprocessors /Microcontrollers based temperature controller. Electronic weighing single pan balance using strain gauge/ load cell. Optical analog communication system using fiber link. Electronic intensity meter using optical sensor. IR remote controlled ON/OFF switch.

Reference Books:

1. Microprocessor Architecture, Programming and Applications with the 8085 R. S. Gaonkar, 4th Edition. Penram International.
2. The 8051 Microcontroller and Embedded Systems, Rajiv Kapadia, Jaico Publishing House.
3. Power Electronics and its applications, Alok Jain, 2nd Edition, Penram International India.
4. Op-Amps and Linear Integrated Circuits - R. A. Gayakwad , 3rd Edition Prentice Hall India.
5. Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin and Frederic F. Driscoll, 6th Edition, Pearson Education Asia.
6. Optical Fiber Communications, Keiser, G. Mcgraw Hill, Int. Student Ed.
7. Electronic Communication Systems; 4th. Ed. Kennedy and Davis, (Tata-McGraw. Hill, 2004.
8. Electronic Instrumentation, H.S. Kalsi , Tata-McGraw. Hill, 1999

Semester-II: Course no.: PSPH202: Electrodynamics (60 lectures, 4credits)

Unit-1 :

Maxwell's equations, The Pointing vector, The Maxwellian stress tensor, Lorentz Transformations, Four Vectors and Four Tensors, The field equations and the field tensor, Maxwell equations in covariant notation.

Unit-2:

Electromagnetic waves in vacuum, Polarization of plane waves. Electromagnetic waves in matter, frequency dependence of conductivity, frequency dependence of polarizability, frequency dependence of refractive index.Wave guides, boundary conditions, classification of fields in wave guides, phase velocity and group velocity, resonant cavities.

Unit-3:

Moving charges in vacuum, gauge transformation, The time dependent Green function, The Lienard- Wiechert potentials, Leinard- Wiechert fields, application to fields-radiation from a charged particle, Antennas, Radiation by multipole moments, Electric dipole radiation, Complete fields of a time dependent electric dipole, Magnetic dipole radiation

Unit-4:

Relativistic covariant Lagrangian formalism: Covariant Lagrangian formalism for relativistic point charges, The energy-momentum tensor, Conservation laws.

Main Texts:

1. W.Greiner, Classical Electrodynamics (Springer- Verlag, 2000) (WG).
2. M.A.Heald and J.B.Marion, Classical Electromagnetic Radiation, 3rd edition (Saunders, 1983) (HM)

Additional references:

1. J.D.Jackson, Classical Electrodynamics, 4Th edition, (John Wiley & sons) 2005 (JDJ)
2. W.K.H. Panofsky and M.Phillips, Classical Electricity and Magnetism,2nd edition, (Addison -Wesley) 1962.
3. D.J. Griffiths, Introduction to Electrodynamics,2nd Ed., Prentice Hall, India,1989.
4. J.R. Reitz ,E.J. Milford and R.W. Christy, Foundation of Electromagnetic Theory, 4th ed., Addison -Wesley, 1993

Semester-II : Course no.: PSPH203: Quantum Mechanics-II (60 lectures, 4credits)

Unit-1: Angular Momentum:

1. Ladder operators, eigenvalues and eigenfunctions of L^2 and L_z using spherical harmonics, angular momentum and rotations.
2. Total angular momentum J; L.S coupling; eigenvalues of J^2 and J_z.
3. Addition of angular momentum, Clebsch Gordon coefficients for $j_1=j_2=1/2$ and $j_1= 1$, $j_2 =1/2$, coupled and uncoupled representation of eigenfunctions.
4. Angular momentum matrices; Pauli spin matrices; spin eigenfunctions; free particle wave functions including spin, addition of two spins.
5. Identical particles: symmetric / antisymmetric wavefunctions.

Unit-2: Perturbation Theory:

1. Time-independent perturbation theory: First-order and second-order corrections to non-degenerate perturbation theory. Degenerate perturbation theory - First order energies and secular equation.

   Time-dependent perturbation theory and applications.

Unit-3: Approximation methods:

2. Ritz variational method: basic principles, illustration by simple examples.
3. WKB Method.

Unit-4: Scattering theory:

Scattering cross section and scattering amplitude; partial wave phase shift -- optical theorem, S-wave scattering from a finite spherical attractive and repulsive potential wells; centre of mass frame; Born approximation.

Texts:

1. Richard Liboff, *Introductory Quantum Mechanics,* 4th ed., 2004. (RL)
2. DJ Griffiths, *Introduction to Quantum Mechanics*, 1995. (DG)
3. A Ghatak & S Lokanathan, *Quantum Mechanics: Theory & Applications.* 5thed., 2004. (GL)

Additional References:

1. W Greiner, *Quantum Mechanics: An Introduction*, 4th. ed., 2004.
2. R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
3. SN Biswas, *Quantum Mechanics*, 1998.

Semester-II : Course no.: PSPH204: Solid State Physics (60 lectures, 4credits)

Unit-1: Crystal Diffraction and Reciprocal Lattice:

Crystal Diffraction Methods for X rays- Laue, Rotating Crystal, Powder Method. Reciprocal Lattice and Brillouin Zones. Reciprocal Lattice to sc, bcc, fcc., Scattered wave amplitude, Fourier analysis of the basis ; Structure Factor of lattices (sc, bcc, fcc) ; Atomic Form Factor; Temperature dependence of reflection lines. Elastic scattering from Surfaces; Elastic scattering from amorphous solids.

Unit-2: Lattice Vibrations and thermal properties:

Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, normal mode frequencies, dispersion relation., Quanization of lattice vibrations, phonon momentum, Inelastic scattering of neutrons by phonons, Surface vibrations, Inelastic Neutron scattering. Anharmonic Crystal Interaction. Thermal conductivity – Lattice Thermal Resistivity, Umklapp Process, Imperfections

Unit-3: Diamagnetism and Paramagnetism:

Langevin diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Quantum Theory of Paramagnetism, Rare Earth Ions, Hund's Rule, Iron Group ions, Crystal Field Splitting and Quenching of orbital angular momentum; Adiabatic Demagnetisation of a paramagnetic Salt, Paramagnetic susceptibility of conduction electrons;

Unit-4: Magnetic Ordering:

Ferromagnetic order- Exchange Integral, Saturation magnetisation, Magnons, neutron magnetic scattering; Ferrimagnetic order, spinels, Yttrium Iron Garnets, Anti Ferromagnetic order. Ferromagnetic Domains – Anisotropy energy, origin of domains, transition region between domains, Bloch wall, Coercive force and hysteresis.

References:-

1. Charles Kittel "Introduction to Solid State Physics", 7th edition John Wiley & sons.

2. J.Richard Christman "Fundamentals of Solid State Physics" John Wiley & sons

3. M.A.Wahab "Solid State Physics –Structure and properties of Materials" Narosa Publications 1999.

4. M. Ali Omar "Elementary Solid State Physics" Addison Wesley (LPE)

5. H.Ibach and H.Luth 3rd edition "Solid State Physics – An Introduction to Principles of Materials Science" Springer International Edition (2004)

M.Sc. (Physics) Practical Lab Course

Semester –II Lab-1

Course number: PSPHP201 (120 hours, 4 credits)

Group A

Experiment	**References**
1 . Zeeman Effect using Fabry-Perot etalon / Lummer — Gehrecke plate	a). Advance practical physics - Worsnop and Flint b). Experiments in modern physics - Mellissinos
2. Characteristics of a Geiger Muller counter and measurement of dead time	a). Experiments in modern physics- Mellissions b). Manual of experimental physics --EV-Smith c). Experimental physics for students - Whittle &. Yarwood
3. Ultrasonic Interferometry- Velocity measurements in different Fluids	Medical Electronics- Khandpur
4. Measurement of Refractive Index of Liquids using Laser	Sirohi-A course of experiments with He-Ne Laser; Wiley Eastern Ltd.
5. I-V/ C-V measurement on semiconductor specimen	Semiconductor measurements - Runyan
6. Double slit- Fraunhofer diffraction (missing order etc.)	Advance practical physics - Worsnop and Flint
7. Determination of Young's modulus of metal rod by interference method	Advance practical physics - Worsnop and Flint (page 338)

Group B

Experiment	**References**
1. Adder-subtractor circuits using ICs	a) Digital principles and applications --Malvino and Leach b) Digital circuits practice - R.P. Jain
2. Study of Presettable counters - 74190 and 74193	a) Digital circuit practice - Jain & Anand b) Digital principles and applications --Malvino and Leach c) Experiments in digital practice -Jain & Anand
3. TTL characteristics of totem pole, open collector and tristate devices	a) Digital circuits practice - Jain & Anand b) Digital principles and applications --Malvino

	and Leach
4. Pulse width modulation for speed control of dc toy motor	Electronic Instrumentation - H. S. Kalsi
5. Study of sample and hold circuit	Integrated Circuits - K. R. Botkar
6. Switching Voltage Regulator	Integrated Circuits - K. R. Botkar

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Goup B: 03

Semester –II Lab-2
Course number: PSPHP202 (120 hours, 4 credits)

Group A

Experiment	**References**
1 .Carrier mobility by conductivity	Semiconductor electronics - Gibson
2. Measurement of dielectric constant, Curie temperature and verification of Curie— Weiss law for ferroelectric material	a) Electronic instrumentation & measurement- W. D. Cooper b) Introduction to solid state physics - C. Kittel c) Solid state physics — A. J. Dekkar
3. Barrier capacitance of a junction diode	Electronic engineering - Millman Halkias
4. Linear Voltage Differential Transformer	Electronic Instrumentation - W.D. Cooper
5. Faraday Effect-Magneto Optic Effect a) To Calibrate Electromagnet b) To determine Verdet's constant for KCl & KI solutions.	1. Manual of experimental physics - E.V. Smith 2. Experimental physics for students - Whittle & Yarwood
6. Energy Band gap by four probe method	Semiconductor measurements — Runyan
7. Measurement of dielectric constant (Capacitance)	a) Electronic instrumentation & measurement - W. D. Cooper b) Introduction to solid state physics - C. Kittel

Group B

Experiment	**References**
1. Shift registers	a) Experiments in digital principles-D.P. Leach b) Digital principles and applications - Malvino and Leach

2. Study of 8085 microprocessor Kit and execution of simple Programmes	a) Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar b) Microprocessor fundamentals. Schaum Series - Tokheim c) 8085 Kit user manual
3. Waveform generation using 8085	a) Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar b) Microprocessor fundamentals, Schaum Series —Tokheim. c) 8085 Kit user manual
4. SID& SOD using 8085	a) Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar b) Microprocessor fundamentals, Schaum Series —Tokheim. c) 8085 Kit user manual
5. Ambient Light control power switch	a)Electronic Instrumentation H. S. Kalsi b) Helfrick & Cooper, PHI
6. Interfacing TTL with buzzers, relays, motors and solenoids.	Digital Electronics by Roger Tokheim

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Goup B: 03

Additional references:

[1] Digital theory and experimentation using integrated circuits - Morris E. Levine (Prentice Hall)

[2] Practical analysis of electronic circuits through experimentation - Lome Macronaid (Technical Education Press)

[3] Logic design projects using standard integrated circuits - John F. Waker (John Wiley & sons)

[4] Practical applications circuits handbook - Anne Fischer Lent & Stan Miastkowski (Academic Press)

[5] Digital logic design, a text lab manual - Anala Pandit (Nandu printers and publishers Pvt. Ltd.)

Note:

1. Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Such students, who do not have certified journals, will not be allowed to appear for the practical examinations.
2. Total marks for the practical examinations = 200

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