K.J. Somaiya Collage of Science and Commerce

Proposed Syllabus for

Master of Science in Physics

M. Sc. in Physics

(Credit based with grading system)

For

Semesters - I and IV

With effect from the academic year 2020-21

Course Structure & Distribution of Credits.

M. Sc. in Physics Program consists of total 12 theory courses, total 6 practical lab courses and projects in third & fourth semesters. Twelve theory courses and practical lab course will be common and compulsory to all the students.

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 8 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. The course structure is as follows:-

Theory Courses

	Paper-1	Paper-2	Paper-3	Paper-4
Semester-I	Mathematical Methods	Classical Mechanics	Quantum Mechanics-I	Solid State Physics & Devices
Semester-II	Advanced Electronics	Electrodynamics	Quantum Mechanics-II	Atomic and Molecular Physics
Semester-III	Statistical Mechanics	Nuclear Physics	Microcontrollers and Interfacing	Embedded Systems and RTOS
Semester -IV	Experimental Physics	Applied Thermodynamics	32 – Bit Microprocessor & PIC Microcontroller	VHDL and Communication Interface

Practical Lab courses

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

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 Four lectures per paper per week

Theory Paper	Subject	Lectures (Hrs)	Credits
PSPH11	Mathematical Methods	60	04
PSPH12	Classical Mechanics	60	04
PSPH13	Quantum Mechanics I	60	04
PSPH14	Solid State Physics and Devices	60	04
	Total	240	16

Practical lab courses (2): 16 hours per week

Practical Lab Course	Practical Lab Sessions (Hrs.)	Credits
PSPHP11	120	04
PSPHP12	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 Four lectures per paper per week

Theory Paper	Subjects	Lectures (Hours)	Credits
PSPH21	Advanced Electronics	60	04
PSPH22	Electrodynamics	60	04
PSPH23	Quantum Mechanics II	60	04
PSPH24	Atomic and Molecular Physics	60	04
	Total	240	16

Practical lab courses (2): 16 hours per week

Practical Lab Course	Practical Lab Sessions (Hours)	Credits
PSPHP21	120	04
PSPHP22	120	04
Total	240	08

Semester III

M.Sc. in Physics Program for Semester-III consists of four theory courses, one practical course & Project. The details are as follows:

Theory Courses (4): 16 hours per week —Four lectures per paper per week

Theory Paper	Subjects	Lectures (Hrs)	Credits
PSPH31	Statistical Mechanics	60	04
PSPH32	Nuclear Physics	60	04
PSPHMA33	Microcontrollers and Interfacing	60	04
PSPHER34	Embedded Systems and RTOS	60	04
	Total	240	16

Practical lab courses :

Project (1): 8 hours per week

Project	Total Project period (Hrs)	Credits
PSPHP31	120	04

Practical lab courses (1): 8 hours per week

Practical Lab Course	Subject	Practical Lab Sessions (Hrs)	Credits
PSPHPAP32	Advanced Physics Lab-1	120	04

M.Sc. in Physics Program for Semester-IV consists of four theory courses, one practical course and one Project. The details are as follows:

Semester IV

Theory Paper	Subjects	Lectures (Hrs)	Credits
PSPH41	Experimental Physics	60	04
PSPH42	Applied Thermodynamics	60	04
PSPH43	32 – Bit Microprocessor & PIC Microcontroller	60	04
PSPH44	VHDL and Communication Interface	60	04
	Total	240	16

Project (1): 8 hours per week

Project	Total Project period (Hrs)	Credits
PSPHP41	120	04

Practical lab courses (1): 8 hours per week

Practical Lab Course	Subject	Practical Lab Sessions (Hrs)	Credits
PSPHPAP42	Advanced Physics Lab-2	120	04

The candidate shall be awarded the degree of Master of Science in Physics **(M. Sc. in Physics)** after completing the course and meeting all the evaluation criteria. The Elective Course Titles will appear in the statement of marks. When the elective courses are chosen from Electronics specialization, the statement of marks shall also carry a name of the specializations as.

No.	Group of Elective Courses chosen	Name appearing in the Statement of Marks	Name appearing in the Degree Certificate
1	Electronics	M. Sc. in Physics (Electronics-I)	M. Sc. in Physics

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 2.5 Hours duration for each course paper and continuous evaluation during practical .
2. All external examinations will be held at the end of each semester and will be conducted by the University as per the existing norms.
3. Term Work / Internal Assessment - IA (40%) and University examination (60%)- shall have separate heads of passing. For Theory courses, internal assessment shall carry 40 marks and Semester-end examination shall carry 60 marks for each Theory Course.
4. To pass, a student has to obtain minimum grade point E **(i.e., 40% marks)** , and above separately in the IA and external examination.
5. The semester end examination for Theory shall be conducted at the end of each Semester
6. The candidates shall appear for external examination of 4 theory courses each carrying 60 marks of 2.5 hours duration and practical courses each carrying 100 marks.
7. The candidate shall prepare and submit for practical 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.
8. PROJECT EVALUATION---Guideline given at the end of document.

3. Standard of Passing for 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	4 5 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 / practical / 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

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

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.

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

C_j = The number of credits earned in the j^{th} course up to the semester. For which 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 up to 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 up to the two decimal places.

The revised syllabus in Physics as per credit based system for the M.Sc. Course will be implemented from the academic year 2020-21
The systematic and planned curricula from these courses shall motivate and encourage learners to understand various concepts of Physics

Preamble:

The course is designed to offer in-depth knowledge of the subject starting from its basic concepts and moving on to the state of art technologies in use today with a view to catering to the present day requirements in Industries, Research and Development fields, Higher studies and Self-employment.
Also the course structure intends to inculcate strong laboratory skills in synchronization of latest trends and demands from the industry so that the student can take up independent projects which will help to be an entrepreneur.
M.Sc. Electronics is a four-semester course spread over the period of two years. Students are also provided extensive laboratory training on the course content and the current requirements of industries and research and development fields.
In the final semester every student has to undertake a project relevant to the industrial needs, the R& D activities and self –employment opportunities based on the specialization, he/she opts for.
In addition the course caters to the requirements of providing complete exposure to NET/SET syllabus for Electronics farmed by the U.G.C. .
The student after passing the M.Sc course has many opportunities of employment, self-employment and higher studies.

The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics.

Programme Outcomes

- Extensive command over Physics in general
- Specialization in Electronics
- Research based analytical and hands-on skill.

- Universally acceptable degree in Physics with theoretical and experimental advancements in electronic instrumentation.
- A thorough quantitative and conceptual understanding of the core areas of physics · Ability to use contemporary experimental apparatus and analysis tools to acquire, analyse and interpret scientific data.
- To familiarize with current and recent scientific and technological developments.
- To enrich knowledge through problem solving, hands on activities, study visits,etc.

M.Sc. (Physics) Theory Courses
Semester –I
Semester-I : Paper-I:

Course no.: PSPH11: Mathematical Methods (60 lectures, 4 credits) **(15 lectures)**

Learning Objectives:

1. To establish the mathematical background to understand core areas of physics.
2. To create a strong foundation for theoretical and experimental research in Physics.

Unit-1 **(15 lectures)**

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 **(15 lectures)**

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 **(15 lectures)**

Complex Variables, 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 **(15 lectures)**

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.

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 : Paper-II:

Course no.: PSPH12: Classical Mechanics (60 lectures, 4 credits)

Learning Objectives:

1. To establish new mechanics to overcome the difficulties in applying Newtonian Mechanics.
2. To introduce the concept of Lagrangian and Hamiltonian mechanics.
3. To learn to compare and create transformation amongst all the above mechanics.

Unit-1 **(15 lectures)**

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 **(15 lectures)**

The Two-Body Central Force 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 Keplerproblem : 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 **(15 lectures)**

Small Oscillations: Formulation of the problem, The eigen value 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 **(15 lectures)**

Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, Poissson 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.

Reference:---

1.Classical Mechanics, H. Goldstein, Poole and Safco, 3rd Edition, Narosa Publication (2001)
2. N. C. Rana and P. S. Joag., Classical Mechanics, Tata McGraw Hill Publication.
3. S. N. Biswas, Classical Mechanics, Allied Publishers (Calcutta).
4. V. B. Bhatia, Classical Mechanics, Narosa Publishing (1997).
5. Landau and Lifshitz, Butterworth, Heinemann, Mechanics,.
6. R. V. Kamat, The Action Principle in Physics, New Age Intnl. (1995).
7. E. A. Deslougue, Classical Mechanics, Vol I and II, John Wiley (1982).

8. Schaum Series, Theory and Problems of Lagrangian Dynamics, McGraw (1967).
9. K. C. Gupta, Classical Mechanics of Particles and Rigid Bodies, Wiley Eastern (2001)

Semester-I : Paper-III:

Course no.: PSPH13: Quantum Mechanics-I (60 lectures, 4 credits)

Learning Objectives:

1. Starting with the early evolution of quantum Mechanics, to generate understanding in wave particle duality.
2. To develop an understanding of matter waves and applying it to various potentials.
3. To study about Hermitian operators and their properties, one-dimensional Schrodinger equation

Unit-1: Theory:

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.

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.

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

General properties of one-dimensional Schrodinger equation. Particle in abox. 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 center of mass; radial equation for a spherically symmetric central potential. Hydrogen atom, eigenvalues and radial eigenfunctions, degeneracy, probability distribution.

References :---

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.

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-I : Paper-IV:

Course no.: PSPH14: Solid State Physics and Devices (60 lectures, 4 credits)

Learning Objectives:

1. To study the crystal structure and various ways of analyzing it.
2. To develop theories to describe various kinds of magnetism in materials.
3. To understand the various concepts required for basic working of semiconductor devices and study fabrication techniques for p-n junctions..
4. To study about Metal – Semiconductor Contacts, Crystal Diffraction Methods for X rays & magnetic materials.

Unit-1: Semiconductor Physics: **(15 lectures)**

Classification of 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.

Unit-2: Semiconductor Devices : **(15 lectures)**

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, Ideal and Practical Current-voltage (I-V) characteristics; Tunneling and avalanche reverse junction break down mechanisms; Minority carrier storage, diffusion capacitance. Carrier life time measurement by reverse recovery of junction diode. Tunnel diode.
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.

Unit-3: Crystal Diffraction and Reciprocal Lattice: **(15 lectures)**

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-4: Magnetism **(15 lectures)**

Langevin's diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Langevin's Theory of Paramagnetism, Rare Earth Ions, Hund's Rule, Iron Group ions.
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.

References:-
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.

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

6. *J.Richard Christman "Fundamentals of Solid State Physics" John Wiley & sons*
7. *M.A.Wahab "Solid State Physics –Structure and properties of Materials" Narosa Publications 1999.*
8. *M. Ali Omar "Elementary Solid State Physics" Addison Wesley (LPE)*

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.

M.Sc. (Physics) Practical Lab Course
Semester –I

Semester –I Lab-1

Course number: PSPHP11 (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).Advanced 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	Advanced practical physics -Worsnop and Flint
6. Absorption spectrum of specific liquids	Advanced practical physics -Worsnop and Flint
7. Coupled Oscillations	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 IC 555	a) Electronic Principles - A. P. Malvino
3. Regulated power supply using IC LM 317 as voltage regulator	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 & LM 337 voltage regulator	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 Group B: 03

Semester –I Lab-2

Course number: PSPHP12 (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 powder 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 (5th 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 Group B: 03

References for Practicals:

[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.

2. Students, who do not have certified journals, will not be allowed to appear for the practical examinations.
3. Total marks for the practical examinations = 200

M.Sc. (Physics) Theory Courses
Semester –II

Semester-II : Paper-I:

Course no.: PSPH21: Advanced Electronics (60 lectures, 4 credits)

Learning Objectives:

1. To understand the concept of various circuits used in power electronics.
2. To develop theories to understand the various applications of Operational Amplifiers.
3. To understand the working and applications of optical fibres.

Unit-1: DC-DC Converter: Types , Analysis, Control of converter. (15 lectures)

(a) Principles of Step up and Step down Switching Voltage converters-Analysis of buck, boost, buck-boost converters, Cuk converters.
(b) Isolated converters.
(c) Control of converters : time ratio and current limit control.

Unit-2 : Operational Amplifier Fundamentals and Applications. (15 lectures)

Fundamentals : Properties of ideal and practical Op Amp, Virtual ground concept,
Linear Applications

Instrumentation Amplifier using IC, Current to Voltage Converter, Voltage to Current Converter.

Non Linear Applications

Voltage Comparator, Precision Rectifier (half wave and Full wave), Analog Switches, **Sample and Hold Amplifier, Op amp for high current ,voltage and Power** Application, Voltage Follower and buffers, Log/Antilog Amplifier, Analog Multiplexer.

Unit-3* PLL and *Data converters **(15 lectures)**

(a) **PLL**

VCO IC NE 566, Phase Locked Loops, Analog multiplexer and de- multiplexer

(b) ***Data converters***

D to A Converter Techniques, R-2R ladder, Multiplying DAC with Applications,
A to D Techniques, Dual Slope ADC, Ramp ADC, Successive approximation ADC, half flash and flash ADC.

***Unit-4* Optical Fiber:** **(15 lectures)**

(a) : Introduction to optical fibers, block Diagram, structure of optical fiber, Types of optical fiber, advantages of optical fiber communication, applications.

Ray theory transmission, total internal reflection, acceptance angle, Numerical aperture, and skew rays.

Modes, electromagnetic mode theory and propagation, single and multimode optical fibers.

(b): Optical Sources and Detectors

Coherent and Non- Coherent sources, quantum efficiency, modulation capability of optical sources,
LEDs: Working principle and characteristics.
Laser Diodes : Working principle and characteristics.
Working principle and characteristics of detectors: PIN and APD, noise analysis in detectors.

(C): Transmission Characteristics of Optical Fiber

Attenuation, absorption, Linear and non linear scattering losses, bending losses, fiber optic communication system.

Reference Books:

1. Alok Jain, Power Electronics and its applications, 2nd Edition, Penram International India.
2. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits 3rd Edition Prentice Hall India.
3. Robert F. Coughlin and Frederic F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th Edition, Pearson Education Asia.
4. Keiser, G. Optical Fiber Communications, Mcgraw Hill, Int. Student Ed.
5. H.S. Kalsi , Electronic Instrumentation, Tata-McGraw. Hill, 1999
6. Dr.P.S.Bimbhra" Power Electronics" Khanna Publishers 5th edition
7. M.D.Singh,K.B.KHanchandani "Power Electronics"Mc Graw Hill 7 Th Reprint 2010

Semester-II : Paper-II:

Course no.: PSPH22: Electrodynamics (60 lectures, 4 credits)

Learning Objectives:

1. To develop a strong understanding of Maxwell's equation and its various forms.
2. To apply the concept of electro -magnetic waves to vacuum, matter and waveguides.
3. To study retarded potentials and its applications to concept of radiation .

Unit-1: **(15 lectures)**

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: **(15 lectures)**

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: **(15 lectures)**

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: **(15 lectures)**

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

References:

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

Semester-II : Paper-III:

Course no.: PSPH23: Quantum Mechanics-II (60 lectures, 4 credits)

Learning Objectives:

1. Having earlier developed operator and commutator formalism, attention is provided to apply them to solve problems like angular momentum, bound state and scattering.
2. To develop new solution methods like perturbation, variational and WKB.

Unit-1: Angular Momentum:

1. Ladder operators, eigenvalues and eigen functions of L^2 and L_z using spherical harmonics.
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 eigen functions; free particle wave functions including spin, addition of two spins.

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:

1. Ritz variational method: basic principles, illustration by simple examples.
2. 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.

References:

1 Richard Liboff, *Introductory Quantum Mechanics,* 4th ed., 2004.

2. DJ Griffiths, *Introduction to Quantum Mechanics*, 1995. (DG)

3. A Ghatak & S Lokanathan, *Quantum Mechanics: Theory & Applications.* 5thed., 2004.
4. W Greiner, *Quantum Mechanics: An Introduction*, 4th. ed., 2004.
5. R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
6. SN Biswas, *Quantum Mechanics*, 1998.

<u>Semester-II : Paper-IV:</u>

<u>Course no: PSPH24 Atomic and Molecular Physics (60 hours 4 Credits)</u>

Learning Objectives:

1. To study the fine structure of hydrogen atom and apply Schrodinger equation to two electron system.

2. To acquire the knowledge of various types of coupling.
3. To study the molecular orbital theories and general theory of advanced spectrometers.

Unit 1: **(15 lectures)**

Fine structure of hydrogenic atoms, Lamb shift. Hyperfine structure and isotope shift. (ER 8-6) (2 lecture)
Linear and quadratic Stark effect in spherical polar coordinates. Zeeman effect in strong and weak fields, Paschen-Back effect. (BJ, GW)
Schrodinger equation for two electron atoms: Identical particles, The Exclusion Principle. Exchange forces and the helium atom (ER), independent particle model, ground and excited states of two electron atoms. (BJ)

Unit 2 **(15 lectures)**

The central field, Thomas-Fermi potential, The Hartree theory, ground state of multi-electron atoms and the periodic table (ER), The L-S coupling approximation, allowed terms in LS coupling, fine structure in LS coupling, relative intensities in LS coupling, j-j coupling approximation and other types of coupling (GW)

Unit 3: **(15 lectures)**

Interaction of one electron atoms with electromagnetic radiation: Electromagnetic radiation and its interaction with charged particles, absorption and emission transition rates, dipole approximation. Einstein coefficients, selection rules. Line intensities and life times of excited state, line shapes and line widths. (BJ)

Unit 4: **(15 lectures)**

Born-Oppenheimer approximation - rotational, vibrational and electronic energy levels of diatomic molecules, Linear combination of atomic orbitals (LCAO) and Valence bond (VB) approximations, comparison of valence bond and molecular orbital theories (4 lectures) (GA, IL)

A) Rotation of molecules: rotational energy levels of rigid and non-rigid diatomic molecules, classification of molecules, linear, spherical, symmetric and asymmetric tops.

B) Vibration of molecules: vibrational energy levels of diatomic molecules, simple harmonic and anharmonic oscillators, diatomic vibrating rotator and vibrational-rotational spectra.

C) Electronic spectra of diatomic molecules: vibrational and rotational structure of electronic spectra (GA, IL)

Quantum theory of Raman effect, Pure rotational Raman spectra, Vibrational Raman spectra, Polarization of light and the Raman effect, Applications (2 lectures)

General theory of NuclearMagnetic Resonance (NMR). NMR spectrometer, Principle of Electron spin resonance ESR. ESR spectrometer(2 lectures). (GA, IL)

(*Mathematical details can be found in BJ. The students are expected to be acquainted with them but not examined in these.)

Main References:

1. Robert Eisberg and Robert Resnick, Quantum physics of Atoms, Molecules, Solids, Nuclei and Particles, John Wiley & Sons, 2nd ed, (ER)
2. B.H. Bransden and G. J. Joachain, Physics of atoms and molecules, Pearson Education 2nd ed, 2004 (BJ)
3. G. K. Woodgate, Elementary Atomic Structure, Oxford university press, 2nd ed, (GW).
4. G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall of India 2nd ed, 2002 (GA)
5. Ira N. Levine, Quantum Chemistry, Pearson Education, 5th edition, 2003 (IL)

Additional references:

1. Leighton, Principals of Modern Physics, McGraw hill
2. Igor I. Sobelman, Theory of Atomic Spectra, Alpha Science International Ltd. 2006
3. C. N. Banwell, Fundamentals of molecular spectroscopy, Tata McGraw-Hill, 3rd ed
4. Wolfgang Demtröder, Atoms, molecules & photons, Springer-Verlag 2006
5. Sune Svanberg, Atomic and Molecular Spectroscopy Springer, 3rd ed 2004
6. C.J. Foot, Atomic Physics, Oxford University Press, 2005 (CF)

M.Sc. (Physics) Practical Lab Course

Semester –II Lab-1
Course number: PSPHP21 (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	A course of experiments with He-Ne Laser; Wiley Eastern Ltd. Sirohi
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: PSPHP22 (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 KCI & 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

References for Practicals:

[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