SYLLABUS FOR

M.Sc. PHYSICS

(For the batches joining in 2018-2019 and afterwards)

Department of Physics

The Gandhigram Rural Institute-Deemed to be University

Gandhigram – 624 302

Dindigul District

Tamil Nadu

India

M.Sc., (Physics)

Scheme of the programme

(For the batches joining in 2018-2019 and afterwards)

Semester	Course Code	Course Title	Credits	Hours	ESE Hours	CFA	ESE	TOTAL
I	18PHYP0101	MATHEMATICAL PHYSICS-I	4	4	3	40	60	100
	18PHYP0102	STATISTICAL MECHANICS	4	4	3	40	60	100
	18PHYP0103	CLASSICAL MECHANICS	4	4	3	40	60	100
	18PHYP0104	ANALOG ELECTRONICS	4	4	3	40	60	100
	18PHYP0105	PRACTICAL – I	2	6	3	60	40	100
	18PHYP01M1	MODULAR COURSE-I	2	2	-	50	-	50
	18GTPP0001	GANDHI IN EVERYDAY LIFE*	-	-	2	50	-	50
		TOTAL CREDIT	**20**			**320**	**280**	**600**
II	18PHYP0206	MATHEMATICAL PHYSICS – II	4	4	3	40	60	100
	18PHYP0207	SOLID STATE PHYSICS-I	4	4	3	40	60	100
	18PHYP0208	QUANTUM MECHANICS-I	4	4	3	40	60	100
	18PHYP0209	PRACTICAL-II	2	6	4	60	40	100
	18PHYP02M2	MODULAR COURSE-II	2	2	-	50	-	50
		NON MAJOR ELECTIVE	4	4	3	40	60	100
	18ENGP00C1	COMMUNICATION / SOFTSKILLS*	-	2		50		50
		TOTAL CREDIT	**20**			**320**	**280**	**600**
III	18PHYP0310	DIGITAL ELECTRONICS	4	4	3	40	60	100
	18PHYP0311	SOLID STATE PHYSICS-II	4	4	3	40	60	100
	18PHYP0312	QUANTUM MECHANICS-II	4	4	3	40	60	100
	18PHYP0313	PRACTICAL –III	2	6	3	60	40	100
	18PHYP03EX	MAJOR ELECTIVE	4	4	3	40	60	100
	18PHYP03MX	MODULAR COURSE – III	2	2		50		50

	18EXNP03V1	VPP #	-	2	-	100	-	100
	18PHYP03F1	EXTENSION/FIELD VISIT*	-	2		50		50
		TOTAL CREDIT	**20**			**420**	**280**	**700**
IV	18PHYP0414	MOLECULAR SPECTROSCOPY	4	4	3	40	60	100
	18PHYP0415	NUCLEAR AND PARTICLE PHYSICS	4	4	3	40	60	100
	18PHYP0416	ELECTROMAGNETICS AND WAVE PROPAGATION	4	4	3	40	60	100
	18PHYP0417	PRACTICAL – IV	1	3	4	60	40	100
	18PHYP0418	DISSERTATION	4	-	-	75	125**	200
	18PHYP0419	SEMINAR & VIVA-VOCE	1	2	-	75	25	100
	18PHYP04MX	MODULAR COURSE – IV	2	2		50		50
	18PHYP04F1	EXTENSION /FIELD VISIT*		2		50		50
		TOTAL CREDIT	**20**			**430**	**370**	**800**

TOTAL CREDITS 80 Total Marks 2700

** 75 marks for evaluation of the dissertation report by external examiner and 50 marks for viva voce jointly by supervisor and external examiner.

CFA = Continuous Formative Assessment, ESE – End Semester Examination.

Village Placement Programme (VPP) is common to all students. It has a weightage of 2 credits.

List of major electives for 18PHYP03EX

18PHYP03E1	Solar Energy
18PHYP03E2	Bio Medical Electronics
18PHYP03E3	Astro Physics
18PHYP03E4	Introduction to Optoelectronics

List of non-major electives for 18PHY02NX

18PHYP02N1	Non Conventional Energy Systems
18PHYP02N2	Resonance Spectroscopy
18PHYP02N3	Micro Processor &assembly language

List of modular courses for 18PHYP01MX

18PHYP01M1	Basics of Microwaves

18PHYP01M2	Supercapacitors

List of modular courses 18PHYP02MX

18PHYP02M3	Luminescence Spectroscopy
18PHYP02M4	Solar Energy Utilization

List of modular courses 18PHYP03MX

18PHYP03M5	Semiconductor Nanostructure
18PHYP03M6	Nanophysics

List of modular courses 18PHYP04MX

18PHYP04M7	Introduction to EPR Spectroscopy
18PHYP04M8	Materials Preparation and characterization

M.Sc. PHYSICS – I SEMESTER

18PHYP0101 – MATHEMATICAL PHYSICS – I (4+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: To learn and acquire knowledge on linear vector spaces, linearly independent vectors, Orthonormalbasis.
CO 2: To acquire knowledge about matrix formulation and diagonalisation of matrices and determination of Eigen values and Eigen vectors.
CO 3: Acquire knowledge about usage of partial differential equations in Physics and determination of solutions by method of variable separable
CO 4: To explore different methods to solve a second order differential equations.
CO 5: To disseminate knowledge on Special functions such as Bessel, Laguerre, Hermite and Legendreand to make use of them in various real time situations.
CO 6: To impart knowledge on Green's function and its usage to solve non-homogenous differential equations.
CO 7: To improve the capacity to solve boundary value problems using the techniques acquired from the first four units

UNIT I :LINEAR VECTOR SPACES : Definition, linear independence basis and dimension – scalar product – orthonormal basis – Gram Schmidt orthogonalisation process, linear operators,

MATRICES : Matrices, Orthogonal, Unitary and Hermitian Matrices – eigenvalues and eigenvectors – Matrix diagonalisation – Cayley Hamilton theorem – Hermitian and Unitary operators-Simultaneous Eigen vectors and commutativity **(12 Lectures)**

UNIT II :DIFFERENTIAL EQUATIONS : Important partial differential equations in physics – solutions by the method of separation of variables – solution to Laplace's , Poisson's and Helmholtz equation in Cartesian, Spherical and Cylindrical polar co-ordinate systems, Choice of co-ordinate system.

SECOND ORDER DIFFERENTIAL EQUATIONS Ordinary and singular points – series solution at an ordinary point, around a regular singular point – Frobenius method – Wronskian method, Systems of linear first order differential equations **(12 Lectures)**

UNIT III: - Bessel differential equation - recurrence relations – orthogonality – integral representation–– Hankel function – recurrence relations- Spherical Bessel function – Recuurence relations - orthogonality. Legendre differential equation – solution – Legendre polynomial – recurrence relations – orthogonality – Associated Legendre function –recurrence relations and Orthogonality (statement only) **(13 Lectures)**

UNIT IV : **SPECIAL FUNCTIONS** : Hermite differential equation – solution – Hermite polynomial – recurrence relations – generating function – orthogonality - Laguerre differential Equation – solution – Laguerre polynomial – recurrence relations – orthogonality – Associated Laguerre differential equation – recurrence relations and Orthogonality (statement only) – Gamma and Beta functions. **(14 Lectures)**

UNIT V: Boundary value problem – Series solution and related problem – Eigen values, Eigen functions and Sturm – Liouville problem-Non-homogeneous boundary value problems, Greens function – Green's function for one-dimensional problems- Eigen function expansion of Green's function

(13 Lectures)

Book for Study

Mathematical Physics, P.K. Chattopadhyay, Wiley Eastern (1990)

Unit I	: Chapter 7: pages 211 – 246 and related problems)
Unit II	: Chapter – 2, Page No. 49 to 59, Chapter – 3, Page No. 60 to 82
Unit III and IV	: Chapter 5, Page 124 to 162
Unit V	: Chapter 4, Page 94 to 120 and Chapter 6, Page 176 to 187

BOOKS FOR REFERENCE :

1. Mathematical methods for Physicists – III Edn. George . B. Arfken, and Hans J Weber – Prism Books (1995) Bangalore.
2. Applied Mathematics for Engineers and Physicists, III Edn. – Pipes &Harveill 0 McGraw Hill (1971)
3. Advanced Engineering Mathematics, V Edn. – Erwin Kreyszing – Wiley Eastern (1983)
4. Matrices, Frank Ayres Jr, Schaum series, McGraw Hill (1983)
5. Matrices and Tensors in Physics , II Edition – A.W. Joshi, Wiley Eastern, (1988),

Total 64 hours

Related Online Courses - MOOC for differential equations

1) **https://www.edx.org/course/differential-equations-linear-algebra-and-nxn-systems-of-differential-equations**
2) **https://www.edx.org/course/linear-differential-equations-bux-math226-2x-1**
3) **https://www.edx.org/course/differential-equations-2x2-systems-mitx-18-032x**
4) **https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1**
5) **https://www.edx.org/course/introduction-differential-equations-mitx-18-031x**

M.Sc. PHYSICS – I SEMESTER
18PHYP0102 – STATISTICAL MECHANICS (4+0)
(For the batches joining M.Sc. in 2018-2019 and after wards)

UNIT I :BASICS OF CLASSICAL STATISTICAL MECHANICS : Introduction – phase space Ensemble – Ensemble average – Liouville theorem – Conservation of extension in phase – equation of motion and Liouville theorem – equal apriori probability – statistical equilibrium – microcanonicalensemble – Ideal gas.
QUANTUM PICTURE :Microcanonical ensemble – quantization of phase space – basic postulates – classical limit – symmetry of wave functions – Effect of symmetry on counting – Maxwell-Boltzmann, Bose - Einstein, Fermi - Dirac distributions using microcanonical ensemble (ideal gas). **(14 Lectures)**

UNIT II : STATISTICAL MECHANICS AND THERMODYNAMICS : Entropy – equilibrium conditions – quasistatic processes – Entropy of an ideal Boltzmann gas using the micro canonical ensemble – Gibbs paradox – Sackur Tetrode equation – entropy and probability – probability distribution and entropy of a two level system – entropy and information theory. **(14 Lectures)**

UNIT III :CANONICAL AND GRAND CANONICAL ENSEMBLES : Canonical ensemble – entropy of a system in contact with a heat reservoir – Ideal gas in canonical ensemble – Maxwell velocity distribution – Equipartition of energy – Grand canonical ensemble – Ideal gas in grand canonical ensemble – comparison of various ensembles – third law of thermodynamics – photons – Einstein's derivation of Planck's law : Maser and Laser – equation of state for ideal quantum gases. **(12 Lectures)**

UNIT IV :PARTITION FUNCTION : Canonical partition function – molecular partition function - translational partition function – Rotational partition function – vibrational partition function – electronic and nuclear partition function – application of rotational partition function – Homonuclear molecules and nuclear spin – Application of vibrational partition function to solids – vapour pressure – chemical equilibrium – Real gas **(12 Lectures)**

UNIT V : **IDEAL BOSE – EINSTEIN and FERMI DIRAC GAS** : Bose – Einstein distribution – Bose Einstein condensation – Thermodynamic properties of an ideal BE gas – Liquid Helium – two fluid model – F-D Distribution -degeneracy – electrons in metals – thermionic emission.
FLUCTUATIONS : Introduction – mean square deviation – fluctuations in ensemble – concentration fluctuations in quantum statistics – one dimensional random walk – Random walk and Brownian motion– Fourier analysis of a random function – Electrical noise (Nyquist theorem) – one dimensional Ising model – diamagnetism - Para magnetism and ferromagnetism. **(12 Lectures)**

BOOKS FOR STUDY:
Statistical Mechanics by B.K. Agarwal and Melvin Eisner, New Age International (P)ltd, Third edition(2013)
UNIT I : Chapter 1 and 2- page 1 to 41
UNIT II :Chapter 3- page 42 to 69
UNIT III :Chapter 4- page 70 to 102
UNIT IV :Chapter 5- page 103 to 132
UNIT V :Chapter 6, 7,10 and 11- page 133 to 150, 165 to 175, 223 to 236, 240 to 244 and 250 to 253.

REFERENCE:
1. Statistical Mechanics, Third reprint, Kerson Huang, Wiley Eastern, (1988)
2. Fundamentals of Statistical and Thermal Physics 16th Printing, FederickReif, McGraw Hill, (1983).
3. Thermal Physics by C. Kittel and Kroemer, Publisher: W. H. Freeman, 1980.
4. Statistical Mechanics R.K.Pathria,3rd Edition, Elsevier(2011)

Total 64 hours

M.Sc. PHYSICS – I SEMESTER

18PHYP0103 - CLASSICAL MECHANICS (4+0)
(For the batches joining M.Sc. in 2018-2019 and after wards)

Prerequisites: Langrange's equation – Applications – Hamilton's principle

UNIT I :KINEMATICS OF RIGID BODY MOTION : Independent coordinates of a rigid body – orthogonal transformation – formal properties of the transformation matrix – Euler's angles - Euler's theorem on the motion of a rigid body – finite rotations – infinitesimal rotations- rate of change of a vector – the Coriolis Force. **(13 Lectures)**

UNIT II : **EQUATION OF MOTION OF A RIGID BODY** : Angular momentum and Kinetic energy of a motion about a point – the inertia tensor and the moment of inertia– Eigen values of inertia tensor and the principal axis transformation – methods of solving rigid body problems and the Euler's equation of motion - torque free motion of rigid body- the heavy symmetrical top with one point fixed (Breif mathematical derivation only).

SMALL OSCILLATIONS : formulation of the problem – the Eigen value equation and the principal axis transformation – frequencies of free vibration and normal coordinates - free vibrations of a linear triatomic molecule **(13 Lectures)**

UNIT III : **HAMILTON'S EQUATIONS OF MOTION** : Legendre transformations and the Hamilton equations of motion – cyclic coordinates and conservation theorems – Routh's procedure and oscillations about steady motion- derivation of Hamilton's equations from variational principle. **(13 Lectures)**

UNIT IV : **CANONICAL TRANSFORMATIONS** : The equations of canonical transformation– examples of canonical transformation – Poisson brackets and canonical invariance –angular momentum Poisson bracket relations – Liouville's theorem . **(13 Lectures)**

UNIT V : **HAMILTON JACOBI EQUATION** –The Hamilton Jacobi equation for Hamilton's principal function - Harmonic oscillator problem as an example of the Hamilton-Jacobi method – Hamilton-Jacobi equation for Hamilton's characteristic functions – separation of variables in the Hamilton–Jacobi equation – action angle variables in systems of one degree of freedom – the Kepler problem in action angle variables. **(12 Lectures)**

Book for Study

1.Classical Mechanics, Herbert Golstein, II Edition, Narosa Publishing (1989), New Delhi.

Prerequisites: Chapters 1 to 3
Unit I : Chapter IV – pages 128 to 148, 158 to182.
Unit II : Chapter 5 – sections 5.1,5.3 to 5.7, pages 188 – 192, 195 to 213
and chapter VI – pages 243 to 263.
Unit III : Chapter VIII – pages 339 to 356, 362 to 365.
Unit IV : Chapter IX – pages 378 to 390, 397 to 405,416 to 419, 426 to 428.
Unit V : Chapter X – pages 438 to 462, 472 to 484.

BOOKS FOR REFERENCES

1. Classical Mechanics, T.W.B. Kibble
2. Mechanics, K.R. Symon
3. Mechanics, L.D. Landau and E.M. Lifshitz, Pergamon Press. **Total 64 hours**

M.Sc. PHYSICS – I SEMESTER
18PHYP0104 ANALOG ELECTRONICS (4 + 0)
(For the batches joining M.Sc. in 2018-2019and after wards)

Course objectives:
The student will be imparted knowledge of
1. Power supplies, their functioning and design
2. Controlled chargers and battery eliminators
3. Understand the design of power control systems and their applications
4. opamp systems and their working.
5. Design of linear ICs
6. Design of different kinds of filters.

Course outcome:

CO 1: The students will be able to design power supplies for specific requirements.
CO 2: Fault finds and rectifies problems in DC power supplies.
CO 3: Will be capable of implementing switching circuits.
CO 4: Will make the students carry out power control system design.
CO 5: Can implement OP-amp based analog computers
CO 6: Will be competent to design OP- amp analog circuits.
CO 7: Will be able to develop oscillators and other circuits based on linear IC'S.
CO 8: Can design filters for specific applications.

Unit- I: POWER SUPPLIES: General filter considerations- capacitor filter – RC filter – series voltage regulator – shunt voltage regulator – IC voltage regulators – adjustable voltage regulators – power supplies – battery charger circuits. **(12 lectures)**

Unit – II: FIELD EFFECT TRANSISTORS: Construction and characteristics of JFETs - voltage controlled resistor – transfer characteristics – Depletion type MOSFET – enhancement type MOSFET – MOSFET handling – CMOS – MESFETs **(12 lectures)**

Unit – III: THYRISTORS AND OTHER DEVICES: Basic silicon controlled rectifier operation – SCR characteristics and rating – terminal identification – SCR applications – series static switch – variable resistor phase control – battery charging regulator – Emergency lighting system – Silicon controlled switch – gate turn off switch – light activated SCR – Schockley diode – Diac – triac – Unijunction transistor – SCR triggering with UJT (relaxation oscillator) – phototransistor – optoisolators. **(15 lectures)**

Unit – IV: OPAMP CIRCUITS: Opamp basics – virtual ground – inverting and non-inverting amplifier – voltage follower – summing circuit – integrator – differentiator – multistage amplifier using opamps – subtractor – voltage buffer – controlled sources – active filters: low pass, high pass, band pass and band reject (first order only) – analog computers using opamps: solution to simultaneous equations and second order differential equations. **(13 lectures)**

Unit – V: LINEAR ICs: Comparator – opamp as a comparator – window comparator – timer IC (555) – astable and monostable operation – Voltage controlled oscillator using IC566 – phase locked loop. **(12 lectures)**

Text book : Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit theory, tenth

edition, Pearson India (2009)
Unit- I : Chapter 15, page 773 -796
Unit- II :Chapter 6, page 368 – 405
Unit – III: Chapter 17, page 831-875
Unit – IV: Chapter 13, 711 -731
Unit – V : Chapter11, page 607 – 625

References:

1. Integrated circuits and semiconductor devices, Second Edition, Gorden J. Deboo and Clifford, N. Burrows, McGraw Hill (NewYork) (1985)
2. Micro electronics, Jacob Millman, Tata McGraw Hill (1979)
3. Electronic circuits, II Edn, Schilling and Belove, McGraw Hill (1985)
4. Op-amp and linear Integrated Circuits, 3rd Edn, Ramakant, Gayakward, Prentice Hall of India (1995)
5. http://nptel.ac.in/courses/115102014

Total 64 hours

M.Sc. PHYSICS – I SEMESTER
18PHYP0105 - PRACTICAL-I (0 + 4)

(For the batches joining M.Sc., in 2018-2019 and after wards)

Scope: It is expected to provide hands on experience in understanding devices and systems studied during first semester.

Any 18 practical from the list given

1. Errors and data analysis
2. FET – Characteristics
3. MOSFET – Characteristics – depletion and enhancement mode
4. Single stage amplifier – frequency response
5. Photo diode characteristics: Intensity and spectral analysis
6. SCR characteristics
7. Wave shaping and switching circuits using SCR
8. UJT characteristics
9. UJT relaxation oscillator
10. LDR characteristics and an application (Variation as a function of intensity of light)
11. Voltage series feedback – frequency response
12. Current series feedback
13. Voltage shunt feedback
14. Difference amplifier
15. Emitter follower
16. Cascade amplifier
17. Darlington amplifier
18. Operational amplifier characteristics
19. Clipper and clamper
20. Schmitt Trigger
21. LVDT study and characteristics
22. Strain gauge characteristics

M.Sc. PHYSICS – I SEMESTER

MODULAR COURSE - I

18PHYP01M1 - BASICS OF MICROWAVES (2+ 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO1: Study on dielectric materials both in macroscopic and microscopic levels
CO2: Foundation is provided for the dielectric behaviour in terms of macroscopic properties permeability, permittivity, polarization and magnetization.
CO3: Utilizing the properties to derive measurable parameters.
CO4: Measurement parameters are known through reflection and refraction of microwaves on the dielectric boundaries.
CO5: Foundation is given for the dielectric behaviour in terms of microscopic properties mechanism of molecular polarization.
CO6: Deriving information on the on the structure of atoms and molecules
CO7: Structure of molecules are derived from the experimental method relaxation polarization of dielectric material which are in liquid and solid phase.

UNIT I: MACROSCOPIC PROPERTIES OF DIELECTRICS: Complex Permittivity and Permeability –Polarization and Magnetization –Description of Dielectrics by Various Sets of Parameters-Reflection and Refraction of Electromagnetic Waves on Boundaries; Measurement of Dielectrics by Standing Waves. **(16 lectures)**

UNIT II: MOLECULAR PROPERTIES OF DIELECTRICS: Molecular Mechanisms of Polarization-Polarization and Atomic Structure- Structure and Dielectric Response of Molecules-Relaxation Polarization in Liquids and Solids-Piezoelectricity and Ferro electricity. **(16 lectures)**

Book for Study

1. Dielectric materials and its applications-Arthur Von Hippel. Pages 1-40.

Books for reference:

1. Microwave principles – Herbert J.Reich, East west press Ltd (1957).
2. Microwave circuits and passive devices – M.L.Sisodia and G.S.Raghuvanshi, Wiley Eastern Ltd (1987)
3. Techniques of microwave measurements – Carol.G.Mont Gomel, M.C graw Hill Book Ltd (1947)
4. Dielectric properties and molecular behavior. Nora.E.Hill. Worth.E.Vaghan, A.H.Price, Mansel Davies. Van Nostand Rein hold Company. London (1969)

Total 32 hours

M.Sc. PHYSICS – I SEMESTER

MODULAR COURSE I

18PHYP01M2 - SUPERCAPACITORS (2+ 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: Students will be able t differentiate the various energy storage devices.
CO 2: Will be capable of designing Symmetric and Asymmetric supercapacitors and test them.
CO 3: The students will be able to prepare nanomaterials for electrode applications.
CO 4: It permits students to evaluate the electrochemical performance of batteries and supercapacitors.

Unit – I: SUPERCAPACITORS:Introduction- classes of capacitor- types of Supercapacitor devices – EDLCs and pseudocapacitors. Electrolytes and choice of electrolytes.
INTRODUCTION AND OVERVIEW OF ELECTRODE PROCESS: Introduction – Non-Faradic processes- Faradic processes- Introduction to Mass- transfer- Controlled reaction. **(16 lectures)**

UNIT – II:ELECTROCHEMICAL INSTRUMENTATION: Operational Amplifier- Current feedback- Voltage feedback- Potentiostats- Difficulties with potential control- Measurement of low currents- Computer controlled instrumentation- Trouble shooting.

TECHINIQUES BASED ON CONCEPTS OF IMPEDANCE: Introduction- interpretation of the Faradic impedance- kinetic parameters- Electrochemical impedance spectroscopy- AC votammetry-Chemical analysis by AC Voltammetry- Instrumentation for Electrochemical impedance spectroscopy.

(16 lectures)

References:

1. B.E. Conway, Electrochemical supercapacitors, Kluwer- Plenum Pup. Co., Newyork (1999).
2. Electrochemical Methods Fundamentals and applications by ALLEN. J. BARD and LARRY R. FAULKNER, Second edition, wiley (2004).

Total 32 hours

M.Sc. PHYSICS – II SEMESTER - 18PHYP0206

MATHEMATICAL PHYSICS – II (4+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

CO1 : To introduce tensor concepts and its basic applications so that, the students can apply the knowledge in various fields of Physics.
CO2: To give applicative knowledge of complex numbers and complex variables. Also to learn C-R equation, Cauchy's theorem, Cauchy's integral, Taylors and Maclaurin series.
CO3: To explain how the function can be expanded into Fourier series and apply it to different physics concepts. Also to extend the ideas to level of Fourier transform and inverse property.
CO4: To make the students to solve difficult problems involving trigonometrical and exponential functions by transforming it into simple algebraic equations and thereafter to arrive at the solution of the problems by inverse transforming through Laplace transforming techniques.
CO5: To give a basic idea of application statistics and probability to handle data and analysis the same.

UNIT I :TENSOR ANALYSIS : Introduction, notation and convention, contravariant and covariant vector - tensors of second rank. Algebra of tensors: equality and null tensor, addition, subtraction, outer product and inner product of tensors, contraction of tensor – symmetric and antisymmetric tensors, Kronecker delta, quotient law, Cartesian tensor, stress, strain and Hooke's law, Moment of Inertia tensor. Covariant formulation of Electrodynamics: Lorentz gauge – Electromagnetic field strength tensor – Maxwell's equation – Transformation of electromagnetic field. **(14 lectures)**

UNIT II :COMPLEX NUMBERS : Complex plane- Polar form of complex numbers- Derivative.Analytic functions - Cauchy Riemann Equations – Laplace's equation- Cauchy's integral theorem- Cauchy's integral formula –Derivatives of Analytic Functions(without proof) - Taylor and Maclaurin series – Laurent series. Residue integration - Singularities and zeroes - Residue integration method. **(14 lectures)**

UNIT III:FOURIER SERIES, INTEGRALS AND TRANSFORMS: Periodic functions - Fourier series – Functions of any period - Even and odd functions - Half range expansions – Complex Fourier series - Fourier Transform – Complex form of Fourier integral – Fourier Transform and its inverse- Linearity- Fourier transform derivatives-convolution theorem. **(12 lectures)**

UNIT IV : **LAPLACE TRANSFORMATION**: Laplace transform, Inverse transform, Linearity-First Shifting theorem-Existence of Laplace transforms- Laplace transform of derivatives and integrals- Differential Equations, initial value problems-Differentiation and integration of transforms-Convolution theorem-Partial fraction,Differential equations: Unrepeated factor, repeated factor, unrepeated complex factors. **(12 lectures)**

UNIT V :PROBABILITY AND STATISTICS: Data-representation-average-spread-Graphical representation of data-mean-standard deviation-varianc. Probability-permutation and combinations- Binomial, Poisson and Hypergeometric distributions -Normal distribution-χ^2-Test-Regression Analysis- Correlation Analysis- Fitting straight lines-Least square method. **(12 lectures)**

Total 64 hours

Books for Study

1.Matrices and Tensors in Physics, Second Edition, A.W. Joshi, Wiley Eastern (1988),

Unit I : Relevant chapters in Pages : 159 to 187, 196 to 212, 222 to 232

2. Advanced Engineering Mathematics, Erwin Kreyszing, Wiley Eastern, 8th Edition

Unit II : Chapter 12 Pages:652-673, 713-726, 751-757, 770-786

Unit III : Chapter 10, Pages 526-549, 569-575

Unit IV : Relevant chapters from Chapter 5, Pages 250-286

Unit V : Chapter 22 , Pages 1050-1054, 1058-1069, 1079-1090, Chapter 23 1137-1140, 1145-1153

Book for References:

1. Mathematical Physics, H.K.Dass, Fourth revised edition 2003.
2. Mathematical Physics – P.K. Chattopadhyoy – Wiley Eastern Ltd.,
3. Advanced engineering Mathematics – Erwin Kreyzik – Wiley Ltd.

M.Sc. PHYSICS – II SEMESTER
18PHYP0207 – SOLID STATE PHYSICS – I (4+0)
(For the batches joining M.Sc. in 2018-2019 and after wards)

CO1: To provide basic knowledge on crystals like structure, properties, defects and dislocations during growth.
CO2: To give an idea of vibration of lattice and thereby the concepts of quasiparticle, phonon and thermal properties of crystals.
CO3: Understanding of electrical and magnetic properties of solids based on sample model like free electron gas.
CO4: To understand formation of energy bands of solid, classification of solids like semiconductor and its properties.

UNIT I : CRYSTAL STRUCTURE : Basis – primitive lattice cell – fundamental types of lattices – crystal plane indexing – simple crystal structures - packing fraction – glasses – x-ray diffraction – Bragg's law – Laue, rotating crystal and powder methods – Fourier analysis of the basis: reciprocal lattice – Brillouin zone – Fourier analysis of basis – Quasi crystals.
POINT DEFECTS AND DISLOCATIONS: lattice vacancies –diffusion-metals-color centers-F centers – other centers in alkali halides–Frenkel defects –Schottky vacancies –F center .DISLOCATIONS – burgers vectors –stress fields of dislocations –low angle grain boundaries-dislocation densities – dislocation multiplication and slips –strength of alloys –dislocation and crystal growth –whiskes – hardness of materials –problems –lines of closest packing –dislocation pairs-force on dislocation.
(13 lectures)

UNIT II: CRYSTAL VIBRATIONS : Vibrations of a mono atomic lattice – first Brillouin zone-force constants – lattice with two atom per primitive cell – quantization of lattice vibration – phonon momentum – inelastic scattering of neutron by phonon – **Thermal properties :** Lattice heat capacity - Einstein model – density of modes – Debye model – an harmonic an crystal interaction – thermal conductivity – Umklapp process. **(13 lectures)**

UNIT III :FREE ELECTRON GAS: Energy levels and Density of orbitals in one dimension – Effect of temperature on FD distribution – free electron gas in three dimensions – heat capacity of electron gas – electrical conductivity and Ohm's law – Experimental electrical resistivity of metals – Motion in magnetic fields – Hall effect – Thermal conductivity of metals – ratio of thermal to electrical conductivity-Nanostructures. **(13 lectures)**

UNIT IV : **ENERGY BANDS** : Nearly free electron model – Bloch function - Kronig Penney model – wave equation of an electron in a periodic potential – number of orbitals in a band – metals and insulators.
(13 lectures)

UNIT V : **SEMICONDUCTORS** : Band gap – equation of motion – holes – effective mass – intrinsic carrier concentration – mobility – impurity conductivity – thermal ionization of donors and acceptors – thermoelectric effects in semiconductors – semimetals – superlattices.
METALS – Reduced zone scheme – periodic zone scheme – construction of Fermi surfaces – orbits of electrons, holes – calculation of energy bands – tight binding methods – Wigner – Seitz method – pseudopotentials. **(12 lectures)**

Book for study

1. Solid State Physics, VII Edition, C. Kittel, John Wiley & Sons, Inc. Singapore (1996)

Unit I : Chapter 1 and 2 Page No 1 to 52, Page No 541 to 552 of chapter 19 and Page No 587 to 606 of chapter 20

Unit II : chapter 4 and 5 Page No 99 to 140

Unit III : chapter 6 Page No 143 to 169

Unit IV : chapter 7 Page No 175 to 196

Unit V : chapter 8 Page No 199 to 255

BOOKS FOR REFERENCE :

1. Solid State Physics, A.J. Dekker, Prentice Hall (1984)
2. SolidState Physics, II Edition, J.S. Blackmore, CambridgeUniversity Press (1974).
3. SolidState Physics by N.W. Aschcroft and V.D. Maxmin, SaundersCollege, Publishing (1976).
4. Elements of Solid State Physics, J.P.Srivastava, 2nd edition, PHI Publishers (2009)

Total 64 hours

Related Online Courses - MOOC

1) https://www.edx.org/course/introduction-solid-state-chemistry-mitx-3-091x-5
2) https://www.edx.org/course/electronic-optical-magnetic-properties-mitx-3-024x

M.Sc. PHYSICS – II SEMESTER

18PHYP0208 – QUANTUM MECHANICS – I (4+0)

(For the batches joining M.Sc. in 2015-2019 and after wards)

CO 1: To explain the basic postulates and formalism quantum physics.
CO 2: To solve Eigen value problems in LHO , Spherical harmonics and Hydrogen atom.
CO 3: To give exposure on matrix formalism and its applications in LHO and angular momentum.
CO 4:To discuss various approximation methods to solve Schrodinger equations and real time applications.
CO 5: To solve He atom problem using variation technique.
CO 6: Theory and applications of WKB approximations.

UNIT I :SCHRODINGER WAVE EQUATION : Development of the wave equation – interpretation of the wave function – energy eigen function – one dimensional square well potential – EIGEN FUCNTIONS AND EIGEN VALUES : Interpretative postulates and energy eigen functions – momentum eigen functions – motion of a free wave packet in one dimension. **(12 lectures)**

UNIT II:DISCRETE EIGEN VALUES : BOUND STATE : Linear Harmonic oscillator – Spherically symmetric potentials in three dimensions – three dimensional square well potential – hydrogen atom – **CONTINUOUS EIGEN VALUES** : Collision Theory – One dimensional square potential barrier. **(13 lectures)**

UNIT III:MATRIX FORMULATION OF QUANTUM MECHANICS: Matrix algebra Transformation theory – Hilbert space – Dirac's Bra and Ket notation – equation of motion – Schrodinger picture – Heissenberg picture – interaction picture – Matrix theory of harmonic oscillator – angular momentum commutation relation for angular momentum – angular momentum matrices – combination of angular momentum states – CG Coefficient for (J = ½). **(13 lectures)**

UNIT IV : **STATIONARY PERTURBATION THEORY** : Non degenerate case – first order perturbation – second order perturbation – perturbation of an oscillator – degenerate case – Removal of degeneracy – second order –Zeeman effect without electron spin – first order Stark effect in hydrogen – perturbed energy levels – occurrences of permanent electric dipole moment. **(13 lectures)**

UNIT V : **VARIATIONAL METHOD and WKB APPROXIMATION**: expectation value of energy – application to excited states – ground state of helium – electron interaction energy – variational parameter.

WKB APPROXIMATION: Classical limit –approximate solution – asymptotic nature of the solution – solution near the turning point – linear turning point – connection at turning point – energy levels of a potential well – tunneling through a barrier. **(13 lectures)**

Book for Study

Quantum Mechanics by Leonard I. Schiff, McGraw Hill (1968)

Unit I : page 19 to 44 of Chapter 2 and page 45 to 64 of Chapter 3

Unit II : page 66 - 98 of Chapter 4 and page 100 to 105 chapter 5

Unit III : page 148 to 185 of Chapter 6 and page 199 to 204 of Chapter 7 and 212 to 214 of Chapter 7

Unit IV : page 244 to 255 of Chapter 8

Unit V : page 255 to 259 of Chapter 8, page 268 to 279 of Chapter 8

BOOKS FOR REFERENCE :

1. Quantum Mechanics, Second Edition, Merzbacher, John wiley, (1970)
2. Quantum Mechanics, Franz Schwabl, Narosa (1992)
3. Modern Quantum Mechancis, Sakurai, Addison-Wesley (1994)
4. Quantum Mechanics, Mathews and Venkatesan

Total 64 hours

M.Sc. PHYSICS – II SEMESTER

18PHYP0209 –PRACTICAL – II (0 + 4)

(For the batches joining M.Sc. in 2018-2019 and after wards)

Scope: Provide hands on experience on devices and systems

Any 18 out of the list given below

1. Low pass, high pass and Bandpass filters using 741.
2. Log and exponential amplifiers, integrators, differentiators using 741.
3. Voltage – current and current to voltage converters using 741.
4. Precision rectifier
5. Phase shift oscillator, using 741.
6. Astablemultivibrator using 741.
7. Bistablemultibratorusing 741.
8. Monostablemultivibrator using 741
9. Wien bridge oscillator using 741.
10. GM counter
11. Michaelson's interferometer
12. Ultrasonic interferometer
13. Solving simultaneous equations using 741
14. Owen's bridge
15. Maxwell's bridge
16. Scherring bridge
17. Power measurement of a device.
18. IC 555 Applications
19. Optical Fiber Characterization - Numerical Aperture, Bending loss, Splice loss
20. Zeeman Effect Apparatus-Determination of thickness of Etalon
21. Zeeman Effect Apparatus - Calculation of Fundamental constants μ_0 / hc

M.Sc. PHYSICS – II SEMESTER

NON MAJOR ELECTIVE

18PHYP02N1 – NON CONVENTIONAL ENERGY SYSTEMS (4+0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: To give in-depth knowledge on measurement of Solar radiation and other solar parameters.
CO 2: To know and use the measuring instruments meant for solar radiation analysis.
CO 3: To learn the basic principles of flat plate collectors and its analysis .
CO 4: To use the knowledge of Flat plate and Concentrating collectors for the different day to day applications.
CO 5: To understand the different forms of indirect solar appliances and use them for energy conversion such as wind , biomass, geothermal and OTEC.

UNIT I : SOLAR RADIATION AND ITS MEASUREMENT – Solar constant – Solar Radiation at the Earth's surface, Solar Radiation Geometry – Measurements and Data, Estimation of average Solar Radiation and Solar radiation on titled surfaces. **(12 lectures)**
UNIT II : **SOLAR ENERGY COLLECTORS**: Physical principles of the conversion of solar radiation into heat – Flat Plate Collector)FPC) – Performance analysis of FPC – concentrating collector (CC) – advantages and disadvantages of CC over FPC – selective coatings, photo voltaic cell.
APPLICATION OF SOLAR ENERGY : Solar water heating – space heating – space cooling – solar electric power generation – agricultural and industrial process heating – solar distillation – solar pumping – solar furnace – solar cooking. **(13 lectures)**
UNIT III: **WIND ENERGY** : Basic principles of wind energy conversion: Nature of the wind – the power in the wind – forces on the blades and thrust on turbines = wind energy conversion (WEC) – basic components of wind energy conversion – classification of types of WEC systems – advantage and disadvantage of WECs. **(13 lectures)**
UNIT IV : **BIOMASS** : Introduction – biomass conversion technologies – photosynthesis – biogas generation – factors affecting bio digestion on generation of gas – classification and types of biogas plants – advantages and disadvantages of floating drum plant and fixed dome type plant. **(13 lectures)**
UNIT V : **GEOTHERMAL AND OTEC: INTRODUCTION** – nature of geothermal fields – geothermal sources – hydrothermal(Convective resources) basic ideas of vapour dominated systems – liquid dominated systems – advantages and disadvantages of geothermal energy over other energy forms – applications of geothermal energy, OTEC : Introduction – Basic ideas of OTEC – methods of OTEC power generation – open cycle and closed cycle system. **(13 lectures)**

BOOKS FOR STUDY:

1. Non-conventional energy sources – G.D. Rai – Khanna Publishers, Books for reference.
2. Solar energy principles of thermal collection and storage – S.P. sukhatme, TMC – 1984.
3. Renewable energy sources and conversion technology – N.K. Bansal, M. Kleemann and M. Melinn.
4. Solar Energy Hand Book – John F. Kreider and F. Kreith.

Total 64 hours

M.Sc. PHYSICS – II SEMESTER
NON MAJOR ELECTIVE
18PHYP02N2 - RESONANCE SPECTROSCOPY (4+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: To know the basic concepts of resonance spectroscopy.
CO 2: To apply the knowledge of resonance spectroscopy for nuclear spin and study the nuclear magnetic resonance .
CO 3: To understand the basics of relaxation processes and apply it for the instrumentation purpose.
CO 4: To learn Fourier Transform technique for the study of FT spectrometer.
CO 5: To elucidate the structure of organic compounds with the knowledge of chemical shift and coupling constants.
CO 6: To use the knowledge of electron spin resonance (ESR) spectroscopy and its related studies.
CO 7: To apply the knowledge of nuclear resonance spectroscopy for nucleus with spin > 1/2 to study the NQR.
CO 8: To apply the concept of recoilless emission and absorption of high energetic nuclear reactions and study the Mossbauer spectroscopy & related applications.

UNIT I : NMR : High resolution NMR, Quantum mechanical description of NMR, Classical description of NMR, Bloch equations – relaxation processes – mechanism of spin lattice relaxation and spin spin relaxation – NMR spectrometer – description – magnet, magnetic field stabilization, field homogeneity, probe, Experimental procedure – sample preparation, referencing , integration, spectrometer operation, measurement of spin lattice relaxation time and spin – spin relation time. **(13 lectures)**

UNIT II : **FOURIER TRANSFORMATION**: Fourier transform spectrometer, double resonance methods, chemical shift – solvent effects – relation between structure and chemical shift, spin, spin coupling – The effect of molecular conformal motion – basics of application to structure study. **(13 lectures)**

UNIT III: **ESR** : Principle of ESR, thermal equilibrium and relaxation, Experimental method – ESR spectrometer, reflection cavity and microwave bridge, magnetic field modulation ESR spectrum – Characteristics of g factor, absorption intensity and concentration measurements, factors influencing line shape – hyper fine structure – origin of hyper fine structure – energy levels for a radical with electron spin half and nuclear spin half – energy levels for a radical with simple set of equivalent protons – integration of ESR spectra in solution – interpretation of spectra, origin of proton hyper fine coupling - anisotropic systems – anisotropic of factors, anisotropy of hyper fine coupling. **(13 lectures)**

UNIT IV : **NUCLEAR QUADRUPOLE RESONANCE** : Fundamentals – experimental techniques – theory: nuclear quadrupole coupling in atoms and molecules – applications: nature of chemical bonds, structural information and study of charge transfer compounds. **(13 lectures)**

UNIT V : **MOSSBAUER SPECTROSCOPY** : Introduction – experimental techniques – theory : isomer shifts – quardrupolesplittings – nuclear zeemansplittings – applications: nature of chemical bond, structural determination and biological applications. **(12 lectures)**

Total 64 hours

Books for Study

Spectroscopy – Staughan and Walker Chapman and Hall, John Wiley and sons Ltd., 1976,

Unit I : Pages 110 – 135

Unit II : Pages 121, 122, 130, 146 - 161, 169 & 170

Unit III : Chapter: 4 P. 209 – 226, 230 – 234, 239 – 241

Basic Principles of Spectroscopy – Raymond Chang, Robert e.Kreiger Publishing Company, New York (1978)

Unit IV : Chapter 4

Unit V : Chapter 5

REFERENCE:

1. Nuclear Magnetic Resonance – Andrews.
2. EPR of transition ions – A. Abraham and B. Belany, Clarendon Press.
3. ESR in Chemistry – P.B. Ayscough, Methuem& Co., Ltd (1967)
4. Paaramagnetic resonance in solids – W Low, Academic Press (1960).

M.Sc. PHYSICS – II SEMESTER
NON MAJOR ELECTIVE
18PHYP02N3 - MICROPROCESSOR 8085 AND ASSEMBLY LANGUAGE (4+0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: To impart basics about Microcomputers and Microprocessors.
CO 2: To acquire knowledge on microprocessor architecture, operation with inputs about memory.
CO 3: To impart knowledge on the instruction set with timing cycle by executing a simple program.
CO 4: To acquire knowledge on 16 bit instruction set with looping and counting techniques.
CO 5: To gain inputs about stack and subroutine with counters and time delay programmes.

UNIT I : INTRODUCTION: Micro computers, microprocessors and assembly language – digital computers – computer technology – microcomputer organization – microprocessor – computer language – machine language – 8085 machine language – 8085 assembly language – writing and execution of assembly language programs – high level languages – from large computers, medium size computers, single board computers. **(12 lectures)**

UNIT II : **MICROPROCESSOR ARCHITECTURE AND MICRO COMPUTER SYSTEM**: Microprocessor architecture and its operations – microprocessor initiated operations and 8085 bus organization – address bus, data bus , control bus – internal data operations and the registers –registers – accumulator – flags – program counter – stack pointer – peripheral or externally initiated operations – reset – interrupt – ready – hold – memory organization – memory map – memory map of 1Kmemory chip – memory and instruction fetch – types of memory – RAM, ROM, Masked ROM, PROM, EPROM, - EEPROM - example of a microcomputer system – interfacing devices – tristate devices – buffer – decoder – encoder – latch. **(13 lectures)**

UNIT III: INSTRUCTIONS **AND TIMINGS** : Instruction classifications – instructions format – executing a simple program – instruction timings and operation status.

INTRODUCTION TO 8085 BASIC INSTRUCTIONS: Data transfer instructions – arithmetic instructions – logical operations – branch operations – writing assembly language programs – debugging a program. (**13 lectures)**

UNIT IV : **PROGRAMMING TECHNIQUES WITH ADDITIONAL INSTRUCTIONS**: Programming techniques – looping – counting and indexing – additional data transfer and 16 bit arithmetic instructions – arithmetic operations related to memory – logical operations – compare – dynamic debugging. **(13 lectures)**

UNIT V : **COUNTER AND TIME DELAYS**: Counters and time delays – hexadecimal counter – pulse timing for flashing lights – debugging counter and time delay programs.

STACK AND SUBROUTINES: Stack – subroutine – conditional call and return instructions – advanced subroutine concepts. **(13 lectures)**

TEXT BOOK:

1. Relevant sections of Microprocessor architecture, programming and applications with the 8085 / 8080A – R.S. Gaonkar, Wiley Eastern, New Delhi.

REFERENCE:

1. Introduction to microprocessors – II Edn., A.P. Mathur, Tata McGraw Hill, New Delhi (1988)
2. 8080A / 8085 assembly language programming – L.A. Leventhal
3. 8080A / 8085 assembly language subroutines – L.A. Leventhal and W. Saville. **Total 60 hours**

M.Sc. PHYSICS – II SEMESTER

MODULAR COURSE - II

18PHYP02M3– LUMINESCENCE SPECTROSCOPY (2+0)

(For the batches joining M.Scin 2018-2019 and after wards)

UNIT I:LUMINESCENCE :Absorbance, Reflectivity and Transmittance, Electronic aspects of phosphors, Energy processes in a phosphor, properties associated with phosphors, Factors associated with phosphors, Factors associated with energy conversion by phosphors, prediction of electronic transition intensities , Mechanism of energy transfer in solids, summary of phonon process as related to phosphors. Transition mechanism for lanthanide ions, color of lanthanide intensities.

UNIT II:RADIATIVE AND NON- RADIATIVE RETURN AND ENERGY TRANSFER: Introduction – general discussion of emission from a Luminescent centre, rare earth ions – Line emission and band emission, stimulated emission, Non-radiative transition in an isolated Luminescent centre, Efficiency, Maximum efficiency for high energy excitation, photo ionization and electron – luminescence quenching, energy transfer between unlike and identical luminescent centers.

Books for study:

1. Studies in Inorganic Chemistry – Luminescence and the solid state, R.C.Ropp, Elseiverpublishers , (1990). Chapter 7 and 8.
2. Luminescent Materials, G.Blasse and B.C.Grabmaier , Springer-Verlag (1994) Chapters 3,4 and

M.Sc. PHYSICS – II SEMESTER

MODULAR COURSE - II

18PHYP02M4 – SOLAR ENERGY UTILIZATION (2+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: To learn solar energy measuring instruments and its use.
CO 2: To use the testing methods and analyze various solar appliances for its performances.
CO 3: To understand the types of energy storage devices and its uses.
CO 4: To learn and use the concepts of solar thermal and photovoltaic power generation.

Unit I: SOLAR ENERGY COLLECTORS AND STORAGE: Introduction – governing performance equation – measuring instruments and measurement methods – method of testing – general testing procedures – testing of a Liquid flat plate solar collector and solar air heaters – thermal performance testing of a cylindrical parabolic concentrator – overall performance of solar heating panels. Types of energy storage – thermal and electrical storage – storage in the form of fuel and hydraulic energy

Unit II: SOLAR THERMAL AND PHOTO VOLTAIC POWER GENERATION: Introduction – principle of solar thermal power generation – low temperature systems – medium temperature systems with concentrating collectors – Stirling cycle and Brayton cycle solar thermal power generation – tower concept of power generation –total energy systems – selective coatings – cost effectiveness.

Semiconductor principles – photo voltaic principles – power output and conversion efficiency – basic photovoltaic system for power generation – solar cell modules – advantages and disadvantages of photo voltaic solar energy conversion – solar cell modules – types of solar cells - solar cell construction – applications of solar photovoltaic systems – storage batteries – design of photovoltaic systems – some other considerations for PV systems – PV technology in India

Book for study

1.Solar Energy Utilization , G.D.Rai, Khanna Publishers, Fifth edition (2001)

Unit I : Chapter 8 Page No 237- 260 and chapter 9 page 261-287

Unit II: Chapter 14 and 15 page No 404 -432 and 433-487

BOOKS FOR REFERENCE:

1. Solar Energy, S.P. Sukhatme, Tata McGraw Hill, New Delhi, (1984)
2. Solar Thermal engineering, Peter J. Lunde, John Wiley New York (1980)

M.Sc. PHYSICS – III SEMESTER
18PHYP0310 - DIGITAL ELECTRONICS (3 + 0)
(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: This will enable students to design simple digital systems.
CO 2: The students will be able to design digital systems using K-map
CO 2: The students will be able to implement Multiplexers, Encoders and Decoders.
CO 3: The student will be capable of designing different kinds of counters.
CO 4: The course enables the learners to design D/A and A/D circuits
CO 5: It will help them to select the right kind of digital system for application.

UNIT I :COMBINATIONAL LOGIC CIRCUITS : Boolean laws and theorems, sum of products methods, truth table to Karnaugh map, pairs, quads and Octets, Karnaugh map simplifications, don't care conditions, sum of product and product of sum simplification **(9 lectures)**

UNIT II :REGISTERS AND COUNTERS : Types of registers, serial in – serial out, serial in – parallel out, parallel in – serial out, parallel in – parallel out, ring counters- asynchronous counters, decoding gates, synchronous counters, changing the count, modulus, decade counters, presettable counters, shift counters, mod-3 and mod-5 counters- decade counter - mod 10 shift counter with decoding, digital clock. **(10 lectures)**

UNIT III :A / D and D/ A CONVERSIONS : Variable resister networks, binary ladder type D/A converters - D/A accuracy and resolution- A/D converters – simultaneous conversion – counter type ADC- continuous type ADC - dual slope ADC – successive approximation ADC - ADC accuracy and resolution. **(9 lectures)**

UNIT IV :DIGITAL INTEGRATED CIRCUITS : Switching circuits- 7400 TTL - TTL parameters - TTL overview- open collector gates - three state TTL devices - external drive for TTL loads - TTL driving external loads - 74C00 CMOS - CMOS characteristics - TTL to CMOS interface - CMOS to TTL interface - current tracers. **(10 lectures)**

UNIT V :CLOCKS, TIMING CIRCUITS AND APPLICATIONS : Clock wave forms, TTL clock - Schmitt Trigger, 555 timer – astable, monostable, monostable with input logic, pulse forming circuits
APPLICATIONS: Multiplexing displays, frequency counters, time measurement, using ADC 0804, Microprocessor Compatible A/D converters, digital voltmeters **(10 lectures)**

Text Book:
D.P. Leach & A.P. Malvino, Digital Principles and Applications, Fifth Edition, Tata Mc Graw Hill Publishing C Ltd.,
Unit I : Chapter 3, page 93 to 130
Unit II: Chapter 9, page 311 to 339, Chapter 10, page 341 to 395
Unit III:Chapter 11, page 397 to 440
Unit IV: Chapter 13, page 487 to 546.
Unit V : Chapter 7, page 251 to 279 and Chapter 14, page 547 to 586

References:

1. Gothman W H, Digital Electronics, Second Edition, PHI, New Delhi (1991)
2. Floyd L, Digital Fundamentals, Third Edition, Universal Book Stall, New Delhi (1998)
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, Eleventh Edition, McGraw Hill Book Company,(1985)

M.Sc. PHYSICS – III SEMESTER
18PHYP0311 - SOLID STATE PHYSICS – II (4 + 0)
(For the batches joining M.Sc. in 2015-2016and after wards)

CO 1: To acquire knowledge on Plasma optics, polaritons and fermi liquid.
CO 2: To give exposure on excitons and Mott transition.
CO 3: To know the theory of superconductivity and its types.
CO 4: To give an insight on dielectrics, ferroelectrics and piezoelectric.
CO 5: To study the basic concepts of magnetic properties of solids.
CO 6: Exposure on quantization of spin waves.

UNIT I :PLASMONS, POLARITONS AND POLARONS : Dielectric Function of the electron gas : Plasma optics – dispersion relation for electromagnetic waves – Transverse optical modes on a plasma - transparency of alkali metals in the UV – longitudinal plasma oscillations plasmons: Pseudo potential component –Mott metal – insulator transition – screening and phonons in metals – Polaritons : LST relation – Electron – phonon interaction: Fermi liquid – Electron – phonon interaction: Polarons.
OPTICAL PROCESSES AND EXCITONS : Optical reflectance – Kramers-Kronig relations – Example:Conductivity of collision less electron gas – electronic Inter band transition – Excitons: Frenkel exciton – alkali halides – molecular - crystals – weakly bound (Mott – Wannier) excition – Exciton condensation into electron hole drops (EHD). **(12 lectures)**

UNIT II:SUPERCONDUCTIVITY : Experimental survey – occurrence of superconductivity – destruction of superconductivity by magnetic field – Meissner effect – Heat capacity – energy gap – microwave and infrared properties – isotope effect – Theoretical survey: Thermodynamics of the superconductivity transition – London equation – coherence length – BCS theory of superconductivity – BCS ground state – Flux quantization on a superconductivity ring – duration of persistent currents – Type II superconductors – duration of persistent currents – Type II superconductors – Vortex state – estimation of Hc1 and Hc 2 – single particle tunneling – Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect – Macroscopic quantum interference. **(12 lectures)**

UNIT III : **DIELECTRICS AND FERROELECTRICS** : Maxwells equation – Polarization – Macroscopic Electric field : depolarization electric field – Local electric field in an atom – Lorentz field – field of dipoles inside a cavity – dielectric constant and polaizability: Electric polarizability – structural phase transtition – Ferro electric crystals – classification of ferroelectrics crystal – Displacive Transition: soft optical phonon – London theory of the phase transition: soft optical phonon – London theory of the phase transition – second order transition – first order transition – antiferro electricity and ferro electric domains –Piezo electricity – ferro elasticity. **(8 lectures)**

UNIT IV : DIAMAGNETISM AND PARAMAGNETISM : Langevin diamagnetism equation – quantum theory of diamagnetism of mono nuclear systems – Paramagnetism – quantum theory of paramagnetism: rare earth ions – Hund rule – Iron group ions – Crystal field splitting – Quenching of the orbital angular momentum – spectroscopic splitting factor - Van Vleck temperature – independent Para magnetism cooling by isotropic demagnetization – Paramagnetic susceptibility of conduction electron. **(8 lectures)**

UNIT V :FERROMAGNETIC ORDER: Currie point and exchange integral – temperature dependence of the saturation magnetization – saturation magnetization at absolute zero - Magnons: Quantization of spin waves thermal excitation of magnons – Neutron Magnetic scattering – Ferri magnetic orders: Curie temperature and susceptibility of ferrimagnetisms – iron garnets – Anti ferromagnetic order: susceptibility below the Neel temperature – anti ferromagnetic magnons – Ferromagnetic domains: an isotropic energy – transition region between domains. **(8 lectures)**

Book for Study :

Introduction to Solid State Physics, C. Kittel., John Wiley (2201), Edn. VII
UNIT I : chapter 10 Page 270 – 304 and Chapter 11 Page 306 to 322
UNIT II : chapter 12 page 334 to page 377.
UNIT III: chapter 13 page 314 to 380.
UNIT V: chapter 14 page 416 to 440.

<u>BOOKS FOR REFERENCE :</u>

Solid State Physics by N.W. Aschcroft and V.D. Mermin, Saunders College Publishing (1978)
SolidState Physics, J.S. Blackmore, CambridgeUniversity Press, (1974)
Elementary SolidState Physics, M. Ali Omar, Addition – Wesly (2000).
SolidState materials - D.N. Srivastava

Total 48 hours

M.Sc. PHYSICS – III SEMESTER

18PHYP0312 - QUANTUM MECHANICS – II (4 + 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO1: Provides basic knowledge on time dependent perturbation and its application to absorption and emission of radiation.
CO2:To give a basic knowledge on scattering for understanding nuclear problems like n-p scattering, coherent and incoherent scattering in deuteron.
CO3: Glimpse of relativistic quantum mechanics and introduction to field theory.

UNIT I : METHODS FOR TIME DEPENDENT PROBLEMS: Time dependent perturbation theory – interaction picture – first order perturbation – Harmonic perturbation – transition probability – ionization of hydrogen atom-density of final states – ionization probability – second order perturbation –adiabatic approximation-connection with perturbation theory – discontinuous change in H and sudden approximation-disturbance of an oscillator. **(13 lectures)**

UNIT II:SEMICLASSICAL TREATMENT OF RADIATION: Absorption and induced emission – use of perturbation theory – transition probability – interpretation in terms of absorption and emission – electric dipole transitions-forbidden transition – spontaneous emission-line breadth-application of radiation theory: i) selection rules for a single particle ii) photoelectric effect. **(12 lectures)**

UNIT III: **COLLISION / SCATTERING THEORY** : Scattering coefficients – scattering of a wave packet – scattering cross section – relation between angles in the laboratory and centre of mass system – relation between cross sections-asymptotic behaviour – scattering by spherically symmetric potentials: asymptotic behaviour - differential cross section – total scattering cross section – phase shifts – calculation of relation between signs of δ_1 and V(r) Ramsauer Townsend effect – scattering by a perfectly square potential – resonance scattering – optical theorem – angular distribution at low energies.Born approximation and application. **(13 lectures)**

UNIT IV : **RELATIVISTIC WAVE EQUATION** : Schrodinger's relativistic equation – free particle – electromagnetic potential-separation of the equation-energy levels in a coulomb field – Hydrogen atom (qualitative discussion only) – Dirac's relativistic equation – free particle solution – charge and current densities – electromagnetic potential. Dirac's equation for a central field: Spin angular momentum – approximate reduction: spin-orbit energy-separation of the equation-Hydrogen atom – Qualitative discussion of Hydrogen atom – classification of energy levels – negative energy states. **(13 lectures)**

UNIT V:QUANTIZATION OF WAVE FIELDS: Classical and Quantum field equations: Coordinates of the field – time derivation – classical Lagrangian equation - functional derivative – classical Hamiltonian equation – quantum equations for the field – fields with more than one component – complex field – Quantization of the Non relativistic Schrodinger equation: Classical Lagrangian and Hamiltonian equation – Quantum equation – N representation – creation, destruction and number operators. **(13 lectures)**

Books for Study

1.Quantum Mechanics, Third Edition, L.I. Schiff, McGraw Hill,

Unit I : page 279 to 295

Unit II : Page 397 to 423

Unit III : page 110 to 129

Unit IV : Page 466 to 488

Unit V : page 490 to 503

2. A text book of Quantum Mechanics by P.M. Mathews and K. Venkatesan, Tata McGraw Hill

Unit III : page 182 to 188

BOOKS FOR REFERENCE:

1. Quantum Mechanics by Merzbacher John Wiley & Sons, II Edn., (1970)
2. Modern Quantum Mechanics by J.J. Sakurai, Addison Wesley, (1994)
3. Advanced Quantum Mechanics, J.J. Sakurai, Addition Wesley (1994)

Total 64 hours

M.Sc. PHYSICS – III SEMESTER

18PHYP0313- PRACTICAL - III (0 + 2)

(For the batches joining M.Sc. in 2018-2019and after wards)

Any 10 out of the list given below

Scope: It is expected to provide hands on experience in understanding Digital devices and systems studied during third semester.

01, Universal NAND / NOR
02. Boolean expression and De Morgan's theorem.
03. Half adder and full adder
04. Half subtractor and full subtractor
05. Flip flop I – RS, D
06. Flip flop II – JK, JK Master slave
07. Encoder and Decoder
08. Multiplexer and Demultiplexer
09. Ripple counters
10. Modulo counters (Asynchronous)
11. A / D Converter
12. D / A Converter
13. Microprocessor familiarization
14. Addition, Subtraction, Multiplication using Microprocessor
15. Sample and holder circuits
16. Simulation of a memory device using D latch
17. Study of a VCO
18. 555 as an astable and monostable
19. Frequency of voltage converter
20. Testing for goodness of specification of a cathode ray oscilloscope
21. Testing for goodness of specification of an audio oscillator
22. Study of a relay operated voltage stabilizer.
23. Data acquisition using a microprocessor
24. Read and write ROM chips, ALU – Study of all functions.

M.Sc. PHYSICS – III SEMESTER

MAJOR ELECTIVE

18PHYP03E1– SOLAR ENERGY (4+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: To give in-depth knowledge on measurement of Solar radiation and other solar parameters.
CO 2: To know and use the measuring instruments meant for solar radiation analysis.
CO 3: To learn the basic principles of heat transfer mechanisms.
CO 4: To use the knowledge of Flat plate collectors for its thermal and performance analysis.
CO 5: To study solar air heaters and apply it for drying purpose.
CO 6: To understand the different types of solar water heaters and their installation details.
CO 7: To study focusing type of solar collectors, tracking systems and construction of reflectors.
CO 8: To test the performance of the solar collectors.
CO 9: To get teh knowledge of power generation through solar thermal & photovoltaic and study them in detail.

UNIT I : INTRODUCTION TO SOLAR ENERGY : SOLAR RADIATION ANALYSIS : The structure of the Sun, The Solar constant, solar radiation outside the Earth's surface solar terms and basic Earth sun angles, Determination of solar time, derived solar angles, Sun rise, sun set and Day length, Estimation of average solar radiation, direct and diffuse radiations. **(12 lectures)**

UNIT II: **HEAT TRANSFER MECHANISM** : Conduction, conduction in extenders, surfaces, radiation, reflectivity, transmissivity Transmittance – Absorptions product, convection, Forced convection and wind loss (Related problems)

LIQUID FLAT PLATE COLLECTORS: Physical principle of the conversion of solar radiation into heat, General description of Flat Plate Collectors, A typical liquid collector, a typical air collector, Thermal losses and efficiency of Flat plate collector, General characteristics of Flat Plate Collectors, Evaluation of overall loss coefficient, Thermal analysis of FPC and useful heat gained by the fluid, collector performance, selective absorber coatings. (Related problems) **(13 lectures)**

UNIT III:FLAT PLATE AIR HEATING COLLECTORS: Types of Air heaters – Performance of Solar air heaters, Application of solar air heaters, Heating and drying in use, Design procedure for a solar based forced convection type drier.

SOLAR WATER HEATING: Type of solar water heaters, Description of solar water heaters and their installation details, load and sizing of the systems. **(13 lectures)**

UNIT IV : **SOLAR COLLECTORS**: Focusing Types - The solar disc and theoretical solar images, solar concentrators and receiver geometrics, orientation and sun tracking systems, general characteristics of focusing collector systems, evaluation of optical losses, Thermal performance of focusing collectors, materials of concentrating collector and construction of reflectors.

PERFORMANCE TESTING OF SOLAR COLLECTORS: Performance equations, method of testing, General testing procedures, testing of liquid flat plate collectors, Testing of solar air heaters.

(13 lectures)

UNIT V:POWER GENERATION: Solar Thermal - Introduction, principle of solar thermal power generation, low temperature systems, medium temperature system with concentrating collectors, and Brayton cycle power generation, Tower concept for power generation, central receiver power plants.

SOLAR PHOTOVOLTAICS: Photovoltaic principles, semi conductor junctions, power output and conversion efficiency, limitations to PV cell efficiency, a basic PV system for power generation, solar cell modules, advantages and disadvantages of PV solar energy conversion, Types of solar cells, applications of solar Photo Voltaic system, design of photo voltaic system. **(13 lectures)**

Books for study

1. Solar energy Utilization, G.D. Rai, Khanna Publishers, New Delhi , 1999,

Unit I :

Unit II : Chapter 1, Page 1 – 11, chapter 2, pages 17 – 32, chapter 3, pages 39 to 69, chapter 4, pages 78 to 88). Chapter 5, pages 89 to 141

Unit III: Chapter 6, pages 156 to 187 and 193 to 199, Chapter 10, pages 312 to 321 and 232 to 335

Unit IV: Chapter 7, pages 200 to 233

Unit V : Chapter 14, pages 404 to 420, Chapter 15, pages 433 to 435, 440 to 465, 473 to 476, and 478 to 481

BOOKS FOR REFERENCE:

1. Solar Energy, S.P. Sukhatme, Tata McGraw Hill, New Delhi, (1984)
2. Fundamentals of Solar Energy, John Wiley, New York (1982)
3. Treatise on solar energy, Vol 1, H.P. Garg,
4. Solar Thermal engineering, Peter J. Lunde, John Wiley New York (1980)

Total 64 hours

M.Sc. PHYSICS – III SEMESTER

MAJOR ELECTIVE

18PHYP03E2– BIOMEDICAL ELECTRONICS (4+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

UNIT I : HUMAN PHYSIOLOGICAL SYSTEMS: Cells and their structure – nature of cancer cells – transport of ions through cell membrane- resting and action potentials – bio-electric potentials – nerve tissues and organs – different systems of human body. **(13 lectures)**

UNIT II:BIO-POTENTIAL ELECTRODES: Electrodes – half cell potential – purpose of electrode paste – electrode material – types of electrodes, micro electrodes, metal micro electrodes, micropipette, depth and needle electrodes, surface electrodes, metal plate electrodes, suction cup electrode, adhesive tape electrode, multi point electrode, floating electrode, chemical electrode, hydrogen electrode, practical reference electrode. **(12 lectures)**

UNIT III:BIO-POTENTIAL RECORDERS: System characteristics – ECG – EEG – EMG – ERG – EOG. **(13 lectures)**

UNIT IV : **PHYSIOLOGICAL ASSIST DEVICES** : Pace makers – pace maker batteries – defibrillators – ac, dc, synchronized dc and square pulse defibrillator – nerve and muscle stimulators – different types of waveforms used in stimulation – galvanic current, interrupted galvanic current, Faradic current and exponential current. **(13 lectures)**

UNIT V : **OPERATION THEATRE EQUIPMENTS**: Surgical diathermy – short wave diathermy – microwave diathermy – ultrasonic diathermy,

BIOTELEMETRY: Basis and design of a bio-telemetry system – radio telemetry systems – single channel telemetry system – transmission of bio-electric variables – active measurements – passive measurements - tunnel diode FM transmitter – Wartley type FM transmitter – radio telemetry with sub carrier – multiple channel telemetry system. **(13 lectures)**

Books for Study :

1. Bio-medical instrumentation – M. Arumugam – Anuradha agencies, Kumbakonam (1992)
2. Bio medical instrumentations and measurements – Lesli Cromwell – Prentice Hall NewYork (1990)
3. Principles of applied biomedical instrumentation – Geddes &Basker – John Wiely Inter Science New York (1975)
4. Medicine and Clinical Engineering – Prentice Hall of India, New Delhi (1979)
5. Biomedical Technology – Mackay, Stuart R – John Wiely (1968)
6. Biomedical instrumentation – Khandput R S – Tata McGraw Hill, (1987).

Total 64 hours

M.Sc. PHYSICS – III SEMESTER

MAJOR ELECTIVE

18PHYP03E3 - ASTRO PHYSICS (4+0)

(For the batches joining M.Sc. in 2018-2019and after wards)

UNIT I: Structure of stellar atmosphere radiative transfer – interaction of matter and radiation. equation of transfer, solution of the equation of transfer explanation of limb darkening. Temperature distribution in a grey atmosphere – solution to equation of transfer for grey atmosphere, temperature distribution and limb darkening, effect of line blanketing. Absorption coefficient – variation of absorption in the solar atmosphere, source of opacity in the solar atmosphere and other stars. Models of stellar atmosphere – basic equations, temperature distribution. Convection in stellar atmospheres – Schwarzschild's criterion for convection, application to a stellar atmosphere, convection zones in stellar atmosphere. **(13 lectures)**

UNIT II: surface temperature of stars: Laws of radiation in thermodynamic equilibrium – radiation field, laws of black body radiation, definition of temperature of a star. Application of radiation laws to stellar Photospheres – measured quantities, surface temperature of the sun, color temperature of stars, effective temperature of stars. Temperature of stars by matter laws – Maxwell's law of distribution of velocities, Boltzmann's equation. Saha's equation of ionization. Special classification of stars – early, Harvard, H.D classification. 2D classification. MK spectra – main criteria, general considerations, Balmer lines of hydrogen. H & K lines of Ca II and Ca 1.luminosity effect of G0. Peculiar stellar spectra **(13 lectures)**

UNIT III: Internal structure of stars: Equations of stellar structure – Equation of continuity, equation of hydrostatic equilibrium, equation of thermal equilibrium, equation of energy transfer. Russell – Vogt theorem. Polytropic models – Emden's equation properties of polytropic configuration. Applications to stars. Temperature distribution in polytropes – equation of state. State of ionization within the star, degeneracy, radiation pressure. Stellar energy sources- identification of sources, rates of thermonuclear reactions, rates of H burning reactions. Stellar opacity – free – free transitions, bound – free transitions. Electron scattering, convection in stellarinteriors. Preliminary models of main sequence stars – Eddington's model, homologous models, applications to stars on the main sequence. Models for real stars – Schwarzschild's method. Henyey'smethod Structure of white dwarfs – Equation of state for degenerate matter, mass radius relation for white dwarfs. **(12 lectures)**

UNIT IV: Milky Way galaxy: Olber's paradox, Milky way galaxy. Star counts – star count functions, uniform star density, luminosity function, Kapteyn universe. Evidence of interstellar extinction – Hubble's counts of galaxies, Trumpler's study of galactic clusters, study of dark clouds. Nature of interstellar dust-wavelength dependence of interstellar extinction, other characteristics, nature of dust particles. Estimation of interstellar extinction – redding line, normal colors, application of UBV photometry. Distribution of stars in the neighborhood – general procedure, distribution perpendicular to the plane of Milky way, distribution of OB stars **(13 lectures)**

UNIT V: Cosmology: Theoretical foundations – general relativistic equation, properties of Robertson – Walker metric. Solutions for uniform isotropic models. Specific cosmological models – Einstein static model, Lemaitre's expanding universe. Eddington – Lemaitre model. De Sitter's empty universe. pulsating universe, steady state model. Description of the observed universe – models and age, diagnostic tests. Observational evidence – MBR in 1960s. Friedmann Universe of early 1970s. Past and future of the Universe – past, future. **(13 lectures)**

Book for study:

1. Astrophysics Stars and galaxies. K.D.Abhyankar, University Press (India) LTD (1999)

Unit I : Chapter 7 p. no 115-141

Unit II : Chapter 5.p.48 – 78

Unit III : Chapter 9,p. 175-211

Unit IV : Chapter 14. p.323 – 345

Unit V : Chapter 18. P.420 – 451

Books for Reference:

1. Astrophysics. Vol I &Vol.II.aller.L.H.Ronaldpress.New York (1954.1963)
2. Radiative transfer.Chandrasekhar.S.Dover, New York
3. Stellar atmospheres, Mahilas. D.Freeman&Co.. San Fransico (1970)
4. Sun.Abetti.G.Faber and Faber.London (1955)
5. Atlas of low dispersion grating stellar spectra. Abt.H.AMeinel.A.B.Morgan. W.W and Tapscot, Yerkes observatories
6. Z Physik, Saha.M.N.6.40.(1921)
7. Astrop.sp.sc.Abhyankar, K.D.99.355.(1989)
8. Stellar structure. Chandrasekhar.S. Dover.New York (1957)

Total 64 hours

M.Sc. PHYSICS – III SEMESTER
MAJOR ELECTIVE
18PHYP03E4- INTRODUCTION TO OPTOELECTRONICS (4 + 0)
(For the batches joining M.Sc. in 2018-2019 and after wards)

CO 1: The student would have gained knowledge on an optical communication system.
CO 2: The course enables the student to understand the cable structure.
CO 3: The course permits students to measure different kinds of attenuation in an optical fiber.
CO 4: The student will be able to measure parameters related to LEDs as optical sources.
CO 5: The performance of different optical detectors can be evaluated by the student.
CO 6: The student will be able to obtain gainful employment in the telecommunication industry.

UNIT I :OPTICAL FIBERS AND OPTICAL COMMUNICATION SYSTEMS: Evolution of fiber optic systems – optic fiber transmission link – nature of light – basic laws of light – optic fiber modes and configurations : fiber types, ray optics representation, wave representation – mode theory for circular wave guides – Maxwell equations – wave guide equations – wave equations for step index fibers – modal equation – modes in step index fibers – linearly polarized modes – single mode fibers – graded index fiber – Fiber materials – Fiber fabrication – fiber optic cables. **(13 lectures)**

UNIT II:SIGNAL DEGRADATION IN OPTICAL FIBERS: Attenuation: Attenuation Units-Absorption losses- Scattering Losses- Bending Losses- Core and cladding Losses – signal Distortion in Optical Waveguides: Information capacity Determination, Group Delay, Material Dispersion, Waveguide Dispersion-Signal Distortion in Single Mode Fibers -Polarization Mode Dispersion, Intermodal Distortion – Pulse Broadening in Graded Index Waveguides – mode coupling – Design Optimization of Single Mode Fibers: Refractive Index Profiles-Cutoff Wavelength-Dispersion Calculations-Mode Field diameter- Bending Loss. **(12 lectures)**

UNIT III :**OPTICAL SOURCES** : Topics from Semiconductor Physics: Energy Bands, Intrinsic and Extrinsic Material, The pn junctions Direct and Indirect Band Gaps, Semiconductor Device Fabrication – Light-Emitting diodes (LED's) : LED Structures, Light Source Materials-Quantum Efficiency and LED Power-Modulation of an LED – Laser Diodes: Laser diode Modes and Threshold conditions-Laser diode Rate Equations-External Quantum Efficiency-Resonant Frequencies-Laser diode Structures and Radiation Patterns-Single-Mode Lasers- Modulation of Laser diodes- Temperature Effects – Light Source Linearity. **(13 lectures)**

UNIT IV :POWER LAUNCHING AND COUPLING: Source – to – Fiber Power launching: Source Output Pattern, Power – Coupling Calculation-Power Launching versus Wavelength-Equilibrium Numerical Aperture – Lensing Schemes for coupling Improvement: Non-imaging Micro sphere, Laser Diode to Fiber Coupling – Fiber to Fiber Joints: Mechanical Misalignment-Fiber Related losses, Fiber End-Face Preparation – LED Coupling to Single – Mode Fibers – Fiber Splicing: Splicing Techniques, Splicing single – Mode Fibers – Optical Fiber Connectors: Connector Types, Single-Mode Fiber Connectors – Connector Return loss. **(13 lectures)**

UNIT V :PHOTODETERCTORS: Physical Principles of Photodiodes - The pin Photo detector-Avalanche Photodiodes – Photodetector Noise: Noise Sources, Signal-to-noise Ratio – Detector Response Time -Depletion Layer Photocurrent- Response Time – Avalanche Multiplication Noise – Structures for InGaAs APDs – Temperature Effect on Avalanche Gain Comparisons of Photodetectors. **(13 lectures)**

Total 64 hours

Text Book:

Gerd Keiser, Opitcal Fiber Communication, Third Edition, McGraw Hill International (2000), relevant sections of chapter 1 to 6.

Reference:

Jasprit Singh, Optoelectronics: An introduction to materials and devices, McGraw Hill, Singapore (1996).

M.Sc. PHYSICS – III SEMESTER
MODULAR COURSE- III

18PHYP03M5– SEMICONDUCTOR NANOSTRUCTURES (2+0)

(For the batches joining M.Sc in 2018-2019 and after wards)

Unit I: SEMICONDUCTORS AND HETEROSTRUCTURES: Mechanics of waves-Crystal structure-effective mass approximation-Band theory-Heterojunctions- Heterostructures-Envelope function approximation-reciprocal lattice - Quantum Wells and Low dimensional systems: Infinitely deep square well-square well of finite depth-Parabolic well-Triangular well-Low dimensional systems-Quantum wells in heterostructures. **(16 lectures)**

Unit II: SOLUTIONS TO DIFFERENT PROBLEMS: Variational method Infinite well –density of states – sub band population – finite well with constant mass – effective mass mismatch at heterojunctions-Infinite barrier height and mass limits-extension to multiple well systems-The asymmetric single Quantum well-addition of electric field-infinite superlattice – single barrier-double barrier-extension to include electric field-magnetic fields and Landau quantization. **(16 lectures)**

Books for study

Quantum Wells, wires and dots – Paul Harrison,

Unit I : page: 1-12

Unit II : page: 17 – 71

The Physics of Low dimensional semiconductors – John H.Davies,

Unit I : page:118 – 146

Total 32 hours

M.Sc. PHYSICS – III SEMESTER

MODULAR COURSE - III

18PHYP03M6 - NANO PHYSICS (2+ 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

UNIT I: ANALYSIS TECHNIQUES : Microscopes – Optical Microscopes – Electron Microscopes – Scanning Probe Microscopes – Diffraction Techniques – Diffraction from different types of samples – Dynamic Light Scattering – Spectroscopy – Optical Absorption Spectrometer – UV –Vis – NIR spectrometer – Infrared Spectrometer – Raman Spectroscopy – Luminescence – Photo Luminescence Spectrometer – X-ray and UV Photoelectron Spectroscopy – Auger Electron Spectroscopy – Magnetic Measurements – Mechanical Measurements.

Ibid: Chapter VII, Page No. 115 to 140& Page No. 144 to 174. **(16 lectures)**

UNIT II: PROPERTIES,CHARACTERIZATION OF CLUSTERS, NANOMATERIALS AND APPLICATIONS: Types of clusters – Mechanical properties – Structural properties – Electrical Conductivity – Optical Properties –Magnetic Properties – spin valve magnetic tunnel junctions.

Ibid: Chapter VIII, Page No. 176 to 207.

NANOSTRUCTURE DEVICES: Resonant-tuneling diodes-Field effect transistors-Single electron – transfer devices-Potential effect transistors-LEDs and lasers-Nanoelectromechanical system devices-Quantum dot cellularautomata

(Int. to Nanelectronics – Science, Nanotechnology, Engineering and Applications, VladimirMitin, V.A.Kochelap and Michael A Stroscio, I Edn., Cambridge University Press, 2007, page: 242 – 321)

(16 lectures)

Books for reference:

1. Nano: The essentials by T.Pradeep, TMH Publishing Co (2008)

2. Quantum Wells, Wires and Dots by Paul Harisson, John Wiley (2006)

3. Introduction to Nanotechnology by Charles P.Poole Jr and Frank J.Owens, Wiley India (2008)

Total 32 hours

M.Sc. PHYSICS – IV SEMESTER

18PHYP0414 - MOLECULAR SPECTROSCOPY (4 + 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: To impart basic knowledge on abstract group theory and application of the same for symmetry operations.
CO 2: To form simple character tables and uses it for the study of IR and Raman activities.
CO 3: To understand vibrational spectroscopy applied in Infrared region.
CO 4: To study the basics of Raman spectroscopy and to compare the same with IR spectroscopy and hence elucidate the structure of molecules.
CO 5: To understand the nature of electronic band spectra and analyse the same to get knowledge about the molecular parameters.
CO 6: To learn the application of the concept of resonance in spectroscopy and study the chemical environment of any molecule to identify the structure of compounds.
CO 7: To apply the concept of resonance in high energetic nuclear reactions and apply it.
CO 8: To realize the possibility of non-linear effect with the help of lasers and to learn different laser sources.
CO 9: To learn the non-linear Raman phenomena.

UNIT I:GROUP THEORY: Basic definitions – group of symmetry generators of a Finite group – conjugate elements and classes - multiplication tables – subgroups – cyclic groups – theorem on subgroups – Normal groups and factor groups – Direct product of groups – isomorphism and homomorphism – permutation groups.

MOLECULAR SYMMETRY: Symmetry Operations-symmetry elements-algebra of symmetry operations- multiplication table-molecular point groups-matrix representation of symmetry operations-reducible and irreducible representations-the Great Orthogonality theorem-character table for $C_{2v}$and C_{3v} point groups-symmetry species of point groups-complete character table for point group-distribution of fundamental among the symmetry species-IR activity and Raman Activity. **(13 lectures)**

UNIT II:INFRARED AND RAMAN SPECTROSCOPY:Infrared Spectroscopy: Vibrational energy of a diatomic molecule-IR selection rules- vibrating diatomic molecule-diatomic vibrating rotator-asymmetry of rotation-vibration band- vibrations of polyatomic molecules – normal vibrations of linear and non – linear molecules. Fermi resonance, hydrogen bonding, rotation - vibration spectra of polyatomic molecules-Linear and Symmetric Top molecules

RAMAN SPECTROSCOPY: Classical and quantum theory, Rotational Raman spectra:linear, symmetric top molecules.Vibrational Raman spectra, -mutual exclusion principle- Structure determination – type of molecules - XY_2, XY_3, XY_4. Raman investigation of phase transition-Proton conduction in solids - Industrial applications-RRS-Raman microscopy. **(14 lectures)**

UNIT III:ELECTRONIC SPECTRA OF DIATOMIC MOLECULES: vibrational coarse structure-Vibrational analysis of Band systems-De'slandres table-Progressions and Sequences- Franck Condon principle- rotational fine structure of electronic-vibration spectra- Fortrat parabola-Dissociation-Pre-Dissociation-Photoelectron Spectroscopy. **(12 lectures)**

UNIT IV:**NMR SPECTROSCOPY**:Resonance condition- Instrument- relaxation processes- Bloch equations- dipolar interaction- chemical shift-indirect spin- spin interaction.

MOSSBAUER SPECTROSCOPY: Recoilless emission and absorption-experimental technique- source and absorber-spectrometer-isomer shift-quadrupole interaction-magnetic hyperfine interaction-Applications. **(13 lectures)**

UNIT V: **LASER SPECTROSCOPY**: Non-Linear optical effects-frequency generation-Sources for Laser Spectroscopy-Hyper Raman Effect- Classical treatment-Experimental techniques. Stimulated Raman Scattering-Inverse Raman Scattering-CARS-PARS-Multiphoton Processes-Laser Induced Fluorescence. **(12 Lectures)**

Books for Study

1. Elements of group theory for Physicists, III Edition A.W. Joshi, Wiley Eastern, *1982,
Unit I : Chapter 1, Pages 1-25
2.Molecular Structure and Spectroscopy, G.Aruldhas, PHI learning Pvt Ltd., Delhi 2015 2nd edition,
Unit I : Chapter 5, pages 121-141
Unit II : Chapter 7, Pages 176-193 and ibid Chapter 8, Pages 214 - 223, 230-239
Unit III : Chapter 9, Pages 246-265
Unit IV : Chap.10, Pages 273 – 291and ibid. Chap.13, Pages. 351-367
Unit V: Chapter 15, Pages 383-403

BOOKS FOR REFERENCE:

1.Valency and molecular structure, Cartmell,E and G.W.A.Fowels,ELBS edition(1974)

2.Molecular spectroscopy, Graybeal,J.D, Mcgraw Hill, NewYork(1968) 3.Introduction to molecular energies and spectra,Harmony, M.D,Holt Rinehart &Winston Inc. (1972)

4. Spectroscopy Vol.I&II Straughen R.P and S. Walker,Chapman& Hall London (1976)

5.Molecularspectroscopy,G.Hertzberg(1950) 6.Spectroscopy and molecular structure G.W.King Total 48 hours

M.Sc. PHYSICS – IV SEMESTER

18PHYP0415 - NUCLEAR AND PARTICLE PHYSICS (4 + 0)

(For the batches joining M.Sc. in 2018-2019and after wards)

UNIT I : **GENERAL PROPERTIES OF ATOMIC NUCLEUS AND TWO NUCLEON PROBLEM** : Scattering methods – electromagnetic methods – nuclear shapes – electric moments – magnetic moments. **(12 lectures)**

UNIT II: n-p SYSTEM :Introduction – the ground state of the deuteron – excited states of the deuteron – neutron – proton scattering at low energies – scattering length – spin dependence of Neutron-Proton scattering – singlet state in n-p system – effective range theory in n-p scattering significance of the sign of the scattering length – Coherent and incoherent scattering. **(13 lectures)**

UNIT III : **SEMI-EMPIRICAL MASS FORMULAE AND NUCLEAR FISSION** : Weizsacker's Semi-empirical mass formula: - Potential energy – Kinetic energy – Coulomb energy – pairing energy – shell effect – atomic masses – significance of atomic mass Nuclear fission : cross section – spontaneous fission – mass and energy destruction of fragments – liquid drop model – barrier penetration – comparison with experiment. **(14 lectures)**

UNIT IV : **NUCLEAR REACTION** : Compound Nucleus And Statistical Model - Nuclear Reactions and cross section – Resonance: Breit-Wigner Dispersion formula for 1=0 – the compound nucleus – continuum theory of cross section. **(13 lectures)**

UNIT V : ELEMENTARY PARTICLES : Classification of elementary particles – Particle interactions – conservation laws – electrons and positrons – protons and antiprotons – neutrons and antineutrons – neutrons and antineutrinos – protons – mesons – muons – pions – K-mesons – Hyperons – elementary particle symmetries – Quark theory – Octet &decapler – discovery of Omega. **(12lectures)**

Book for Study :

1. Nuclear Physics – Theory and Experiment by R.R. Roy & B.P. Nigam, Wiley Eastern Ltd., V Reprint (1993)
   - Unit I : Page 5-44 of Chapter 2.
   - Unit II : pages 46 to 72 of Chapter 3
   - Unit III : pages 141 to 181 of Chapter 5
   - Unit IV : pages 184 to 196 and 200-224 of Chapter 6
2. Nuclear Physics, D.C. Tayal, Himalaya Publishing (1980) , .
   - Unit V : Pages 583 to 626 and 635 to 642.

REFERENCE :

1. Introduction to Nuclear Physics, Herald Enge, Addison Wesley (1996)
2. Source book of Atomic energy, Samuel Glasstone, East – West Press (1997)
3. Concepts of Nuclear Physics, B.L. Cohen Tata McGraw Hill (1968)
4. Introductory Nuclear Physics, Samuel S.M. Wong, PHI (1996)
5. Nuclear physics by V. Devanathan second edition Alpha science publishers.

Total 64 hours

M.Sc. PHYSICS – IV SEMESTER

18PHYP0416 - ELECTROMAGNETICS AND WAVE PROPAGATION (4+0)

(For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: The course permits students to understand conservation of charges and the continuity Equation.
CO 2: The interrelation between the electric and magnetic fields in a medium will be understood.
CO 3: The propagation of electromagnetic waves in different kinds of media will be understood.
CO 4: Candidates can understand various phenomena related to propagation of electromagnetic waves in different media.
CO 5: The course permits students to understand the propagation of microwaves inside Waveguides.
CO 6: The design and working of antennae will be understood.

UNIT I : MAXWELL'S EQUATIONS : The conservation of electric charge – The potentials V and $\vec{A}$ – Lorentz condition - divergence of $\vec{E}$ and the non-homogenous wave equation for V – The non-homogenous wave equation for $\vec{A}$ –The curl of $\vec{B}$ **-** Maxwell's equations – Duality – Lorentz's lemma – The non-homogenous wave equations for $\vec{E}$ and $\vec{B}$. **(12 Lectures)**

UNIT II:PROPAGATION OF ELECTROMAGNETIC WAVES – I PLANE WAVES IN INFINITE MEDIA : Plane electromagnetic waves in free space - The $\vec{E}$ and $\vec{H}$ vectors in Homogenous, Isotropic, Linear and stationary media – Propagation of plane electromagnetic waves in non conductors and good conductors – propagation of plane electromagnetic waves in low - pressure ionized gases – related examples. **(13 lectures)**

UNIT III : **PROPAGATION OF ELECTROMANETIC WAVES – II REFLECTION AND REFRACTION:** The laws of reflection and Snell's law of refraction – Fresnel's equations – Reflection and refraction at the interface between two non magnetic nonconductors – Total reflection at an interface between two nonconductors – Reflection and refraction at the surface of a good conductor – Radiation pressure at normal incidence on a good conductor – Reflection of an electromagnetic wave by an ionized gas - related examples. **(14 lectures)**

UNIT IV :PROPAGATION OF ELECTROMAGNETIC WAVES – III GUIDED WAVES: Propagation in a straight line –TE and TM waves-TEM waves- Boundary conditions at the surface of metallic waveguides: The coaxial line- The hollow rectangular wave guide – The TE waves – Internal reflection – Energy transmission- Attenuation. **(13 lectures)**

UNIT V:RADIATION OF ELECTROMAGNETIC WAVES: Electric dipole radiation – Radiation from a half wave antenna – Antenna arrays – Electric quadrupole radiation – Magnetic dipole radiation – Magnetic quadruple radiation – The electric and magnetic dipoles as receiving antennas – The Reciprocity theorem. **(12 lectures)**

Total 64 hours

Book for Study :

Electromagnetic fields and waves, Second Edition, Paul Lorrain and Dale Corson, CBS Publishers & Distributors, New Delhi (1986),

Unit I : Chapter 10 Pages 422 – 453 and related problems.

Unit II : Chapter 11 Pages 459-492 and related problems

Unit III : Chapter 12 Pages 504 - 547 and related problems

Unit IV : Chapter 13 Pages 557 - 582 and related problems

Unit V : Chapter 14 Pages 595 - 633 and related problems

BOOKS FOR REFERENCE :

1. Theory of Electromagnetic waves, H.C. Chau, McGraw Hill (1985).
2. Electromagnetic waves and Radiating system, 2nd Edition, New Delhi, 1985 Jordan and Balmain, Prentice Hall of India(1993)
3. Classical Electrodynamics, J.D. Jackson, Wiley Eastern, (1975).
4. Foundations of Electromagnetic Theory, J. Reitz and F. Milford, Addison – Wesley publishing company,2nd edition(2008).
5. Fundamentals of Electromagnetic Theory, W. Miah, McGraw-Hill- Education(1982).

M.Sc. Physics – IV SEMESTER

18PHYP0417 – Practical - IV (0+2)

(For the batches joining M.Sc. in 2018-2019and after wards)

Scope: to provide hands on experience on the measurements related to the properties of materials

(Any 10 out of the list given below)

1. Diffraction studies using a LASER
2. Interference using a LASER
3. Susceptibility of solid
4. Susceptibility of a liquid
5. X-Ray power pattern analysis
6. Beta and Gamma absorption
7. Hall effect
8. Performance analysis of a solar thermal system
9. Calorific value of a fuel
10. Efficiency study of a stove
11. Study of a solar photovoltaic panel
12. Faraday rotation - Determination of Verdet Constant
13. Band gap of a semiconductor
14. Resistivity by four probe method
15. Gunn diode characteristics
16. VSWR of an unknown source
17. Preparation of nanoparticle
18. Dielectric measurements
19. Thin film preparation

M.Sc. PHYSICS – IV SEMESTER

MODULAR COURSE - IV

18PHYP04M7– INTRODUCTION TO EPR SPECTROSCOPY (2+0)

(For the batches joining M.Sc. in 2018-2019 and after wards)

Unit I :BASIC PRINCIPLE: A simple EPR spectrometer, EPR technique, energy flow in paramagnetic systems, quantization of angular momenta, relation between magnetic moment and angular momenta, magnetic field quantities and units, bulk magnetic properties – magnetic energies and states, interaction of magnetic dipoles with electromagnetic radiation, characteristics of spin systems – the g factor, characteristics of dipolar interaction, parallel field EPR, time resolved EPR.

Unit II:MAGNETIC INTERACTIONS BETWEEN PARTICLES: Theoretical considerations of the hyperfine interaction, angular momentum and energy operators, spin operators and Hamiltonians, electronic and nuclear Zeeman interactions, spin Hamiltonian including isotropic hyperfine interaction, energy levels of a system with one unpaired electron and one nucleus with I=½; and I=1, signs of isotropic hyperfine coupling constant, dipolar interactions between electrons

Book for study:

1.Electron paramagnetic resonance : Elementary theory and practical applications, John A.Weil and James R.Bolton, John Wiley and sons, Wiley interscience, A john wiley&sons,INC, publication, II Edn,(2007),

Unit I: pages.1-35.

Unit II : Pages 36-57

Book for Reference:

Molecular structure and spectroscopy, G. Aruldhas, Prentice Hall of India pvt ltd (2007)

M.Sc. PHYSICS – IV SEMESTER

MODULAR COURSE - IV

18PHYP04M8- MATERIALS PREPARATION AND CHARACTERIZATION (2+ 0)

For the batches joining M.Sc. in 2018-2019and after wards)

CO 1: The student can grow crystals.
CO 2: The learner will be able to design nano materials using different techniques.
CO 3: It enables students to analyse samples using different characterization techniques.
CO 4: The student will be able to differentiate different crystalline structures using XRD.
CO 5: The life time measurement for luminescence species will be made.
CO 6: It helps the students to identify various processes happening in materials under thermal treatment.

UNIT I: **MATERIALS PREPARATION**: Crystal growth – solution growth – Czchrolski , Bridgemenmethods – Glass preparation – Powder – solid state reaction – sol - gel , combustion techniques .

UNIT II: **MATERIALS CHARACTERIZATION** : XRD , FTIR , UV-Vis –NIR absorption , Photoluminescence , Decay measurements , DTA, TGA and DSC, SEM – EDX.