M.Sc Physics

Syllabus

(with effect from June 2015)

DEPARTMENT OF PHYSICS
The Gandhigram Rural Institute – Deemed University
Gandhigram – 624 302 Tamil Nadu

Scheme of the programme
(For the batches joining in 2015-2016 and afterwards)

			Credits	Contact hours		Exam	Marks		
Semester	**Course Code**	**Course Title**		**L**	**P**	**Hours**	**CFA**	**ESE**	**TOTAL**
I	15PHYP0101	MATHEMATICAL PHYSICS-I	4	4	-	3	40	60	100
	15PHYP0102	STATISTICAL MECHANICS	4	4	-	3	40	60	100
	15PHYP0103	CLASSICAL MECHANICS	4	4	-	3	40	60	100
	15PHYP0104	ANALOG ELECTRONICS	4	4	-	3	40	60	100
	15PHYP0105	PRACTICAL – I	2	-	4	3	60	40	100
	15GTPP0001	GANDHI IN EVERYDAY LIFE*		**2**	**-**	2	50	-	50
		TOTAL CREDIT	**18**	**18**	**4**				
II	15PHYP0206	MATHEMATICAL PHYSICS – II	4	4	-	3	40	60	100
	15PHYP0207	SOLID STATE PHYSICS-I	4	4	-	3	40	60	100
	15PHYP0208	QUANTUM MECHANICS-I	4	4	-	3	40	60	100
	15PHYP0209	PRACTICAL-II	2	-	4	4	60	4 0	100
		NON MAJOR ELECTIVE	4	4	-	3	40	60	100
	15ENGP00C1	COMMUNICATION / SOFTSKILLS*		2			50		50
		TOTAL CREDIT	**18**	**18**	**4**				
III	15PHYP0310	DIGITAL ELECTRONICS	3	3	-	3	40	60	100
	15PHYP0311	SOLID STATE PHYSICS-II	3	3	-	3	40	60	100
	15PHYP0312	QUANTUM MECHANICS-II	4	4	-	3	40	60	100
	15PHYP0313	PRACTICAL –III	2	-	4	3	60	4 0	100
	15PHYP03EX	MAJOR ELECTIVE	4	4	-	3	40	60	100
	15PHYP03MX	MODULAR COURSE – I	2	2			50		50
	15EXNP03V1	VPP	2	-		-	50	-	50
	15PHYP03F1	EXTENSION /FIELD VISIT*			2		50		50
		TOTAL CREDIT	**20**	**16**	**6**				
IV	15PHYP0414	MOLECULAR SPECTROSCOPY	3	3	-	3	40	60	100
	15PHYP0415	NUCLEAR AND PARTICLE PHYSICS	3	3	-	3	40	60	100
	15PHYP0416	ELECTROMAGNETICS AND WAVE PROPAGATION	3	3	-	3	40	60	100
	15PHYP0417	PRACTICAL – IV	2	-	4	4	60	40	100
	15PHYP0418	DISSERTATION	6	-	12	-	75	75+50	200
	15PHYP0419	SEMINAR & VIVA-VOCE	1	-	2	-	75	25	100
	15PHYP04MX	MODULAR COURSE – II	2	2			50		50
	15PHYP04F1	EXTENSION /FIELD VISIT*			2		50		50
		TOTAL CREDIT	**20**	**11**	**20**				

TOTAL CREDITS 78 Total Marks 2600

Theory: 1hour = 1 credit; Practical : 3hours = (1.5 credit) -rounded off to 2credits

L – Lecture; P – Practical ; T – Total * COMPULSARY NONCREDIT COURSE

** 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.

Theory: 1hour = 1 credit; Practical: 3hours = (1.5 credit) -rounded off to 2credits

L – Lecturer; P – Practical; T – Total. *COMPULSARY NONCREDIT COURSE.

$ 25 marks for evaluation of the project report by external examiner and 25 marks for viva voce jointly by the project 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 15PHYP03EX

15PHYP03E1	Solar Energy
15PHYP03E2	Bio Medical Electronics
15PHYP03E3	Astro Physics
15PHYP03E4	Introduction to Optoelectronics

List of non-major electives for 15PHY02NX

15PHYP02N1	Non Conventional Energy Systems
15PHYP02N2	Resonance Spectroscopy
15PHYP02N3	Micro Processor &assembly language

List of modular courses 15PHYP03MX

15PHYP03M1	Semiconductor Nanostructure
15PHYP03M2	Basics of microwaves
15PHYP03M3	Nanophysics
15PHYP03M4	Supercapacitors

List of modular courses 15PHYP04MX

15PHYP03M5	Introduction to EPR Spectroscopy
15PHYP03M6	Materials Preparation and characterization
15PHYP03M7	Luminescence Spectroscopy
15PHYP03M8	Solar Energy Utilization

M.Sc. PHYSICS – I SEMESTER

15PHYP0101 – MATHEMATICAL PHYSICS – I (4+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: The basic concepts of mathematics related to courses taught in this programme are introduced

UNIT I : LINEAR VECTOR SPACES : Definition, linear independence basis and dimension – scalar product – orthonormal basis – Gram Schmidt orthogonalisation process, linear operators, (Mathematical Physics, P.K. Chattopadhyay – Wiley Eastern (1990) pages 211 – 215 and related problems)

MATRICES : Inverse of a matrix – eigenvalues and eigenvectors – diagonalisation of matrices – Cayley Hamilton theorem – condition for diagonalization, diagonalization of Hermitian matrices.**(14 Lectures)**

(Matrices and Tensors in Physics , II Edition – A.W. Joshi, Wiley Eastern, (1988), page 47-52, 88 – 114 and related problems)

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.

(9 Lectures)

(Mathematical Physics – P.K. Chattopadhyay – Wiley Easter, (1990) Chapter – 2, Page No. 49 to 59)

UNIT III: SECOND ORDER DIFFERENTIAL EQUATIONS Ordinary and singular points – series solution at an ordinary point, around a regular singular point – Frobenious method – Wronskian method, systems of linear first order differential equations.. Boundary value problem – Series solution and related problem – Sturm – Liouville problem**(14 Lectures)**

(Mathematical Physics, P.K. Chattopadhyay, Wiley Eastern (1990) Page 62 to 82 and 94 to 117).

UNIT IV : SPECIAL FUNCTIONS : Hermite differential equation – solution – Hermite polynomial – recurrence relations – generating function – orthogonality - Legendre differential equation – solution – Legendre polynomial – properties – Rodriguez formula – generating function – recurrence relations – orthogonality – Associated Legendre differential equation – solution – Orthogonality (statement only). - Beta, Gamma functions

(13 Lectures)

UNIT V: - Bessel differential equation - Bessel function properties – recurrence relations – generating function – orthogonality – integral representation of Bessel function – Hankel function- Laguarre differential Equation – solution – Laguarre - polynomials – recurrence relations – generating function – orthogonality – Associated Laguerre differential equation – solution – Orthogonality (statement only) - Greens function and applications **(14 Lectures)**

(Introduction to Mathematical Physics – Charlie Harper – Prentice Hall India (1987) New Delhi, Chapter 6, Page 163 – 194 and related problems)

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)

Total 64 hours

M.Sc. PHYSICS – I SEMESTER
15PHYP0102 – STATISTICAL MECHANICS (4+0)
(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: The principles of Statistical Physics and few applications of the same are introduced

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 – microcanonical ensemble – 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)**

Statistical Mechanics by B.K. Agarwal and Melvin Eisner, Wiley Eastern (1989), Page 1 to 17 of ch.1 and Page 20 to 35 of ch.2)

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

(ibid page 38 to 59 of ch.3)

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 Plank's law : Maser and Laser – equation of state for ideal quantum gases.**(12 Lectures)**

(ibid page 62 to 89 of ch. 4)

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)**

(ibid page 92 to 118 of ch. 5)

UNIT V : IDEAL BOSE – EINSTEIN and FERMI DIRAC GAS : Bose – Einstein distribution – Bose Einstein condensation – Thermodynamic properties of an ideal BE gas – Liquid Helium. F-D Distribution (Distribution only)(with out applications)

FLUCTUATIONS : Introduction – mean square deviation – fluctuations in ensemble – concentration fluctuations in quantum statistics – one dimensional random walk – Random walk and Brownian motion – Fourier analysis a random function – Electrical noise (Nyquist theorem) **(12 Lectures)**

(ibid page 120 to 130 of ch.6 and page 200 to 212 of ch.10)

REFERENCE:

1. Statistical Mechanics, Third reprint, Kerson Huang, Wiley Eastern, (1988)
2. Fundamentals of Statistical and Thermal Physics 16th Printing, Federick Reif, McGraw Hill, (1983).
3. Thermal Physics by C. Kittal and Kroemer, CBS Publication.
4. Statistical Mechanics R.K.Pathria

Total 64 hours

M.Sc. PHYSICS – I SEMESTER
15PHYP0103 - CLASSICAL MECHANICS (4+0)
(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: Mechanics of macroscopic bodies is introduced
Prerequisites: Langrange's equation – Applications – Hamilton's principle,
(Classical Mechanics, Herbert Golstein, II Edition, Chapters 1 to 3, Narosa Publishing (1989), New Delhi.

UNIT I : KINEMATICS OF RIGID BODY MOTION : Independent coordinates of a rigid body – orthogonal transformation – properties of the transformation matrix – Euler's theorem – finite rotations – infinitesimal rotation- rate of change of a vector – Coriolis Force. (ibid Chapter IV – pages 128 to 187).

(13 Lectures)

UNIT II : EQUATION OF MOTION OF A RIGID BODY : Angular momentum and Kinetic energy – Moment of inertia tensor – eigenvalues – principal axis, transformation – solution to rigid body problems – Euler's equation of motion – torque free motion – symmetric top.

(ibid chapter 5 – sections 5.1 to 5.7 and related problems, pages 188 – 225 and related problem)
SMALL OSCILLATIONS : Eigenvalue equation – principal axis transformation – frequencies of normal vibration and normal coordinates (free vibrations of a linear triatomic molecule (forced vibrations and the effect of dissipative forces) (ibid chapter VI – pages 243 to 274)**(13 Lectures)**

UNIT III : HAMILTON'S EQUATIONS OF MOTION : Legendre transformation – Hamilton's equation of motion – deduction from variational principle – cyclic coordinates and conservation theorems. (ibid Chapter VIII – pages 339 to 377)**(13 Lectures)**

UNIT IV : CANONICAL TRANSFORMATIONS : Equations – examples – Poisson brackets – equations of motion – infinitesimal canonical theorems – angular momentum Poisson bracket relations – symmetry group of mechanical systems – Liouville's theorem . (ibid Chapter IX – pages 378 to 437)

(13 Lectures)

UNIT V : HAMILTON JACOBI EQUATION – application to Harmonic oscillator – Hamilton principle and characteristic functions – separation of variables in the Hamilton – Jacobi equation – action- angle variables – Kepler problem – Hamilton – Jacobi theory geometrical optics and wave mechanics .

(12 Lectures)

(ibid Chapter X – pages 438 to 498)

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
15PHYP0104 – ANALOG ELECTRONICS (4+0)
(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: The student will be able to design simple electronic circuits for the laboratory and home with the help of knowledge gained through this course.

UNIT I : ACTIVE DEVICES : Principle and working of JEET, MOSFET Enhancement and depletion mode operations – GUNN Diode . Thyristors – SCR, DIAC, TRIAC and their applications to switching and wave shaping – UJT and its application to relaxation oscillators.**(13 lectures)**

1. Transistor and integrated electronics, 4^{th} Edn Milton S. Kiver, McGraw Hill,(1992) chapter 12.
2. Integrated circuits and semiconductor devices, 2^{nd} Edn. Gorden J. Deboo and Clifford, N. Burrows (1985)
3. Electronic Principles, Fifth Edition A.P. Malvino, Tata McGraw Hill (1997)

UNIT II: FEEDBACK AMPLIFIERS : Classification of feedback amplifiers voltage, current, transconductance and transresistance – concept of feed back – effect of negative feedback on band width, stability, gain and phase margins – voltage series and shunt, current series and shunt feed back amplifiers with transfer gain.**(14 lectures)**

1. Micro electronics, Jacob Millman, Tata McGraw Hill (1979) Chapters 12, 14.
2. Electronic circuits, II Edn, Schilling and Belove, McGraw Hill (1985) Chapter 7 and 10.

UNIT III: DIFFERENCE AMPLIFIER: Difference amplifier – emitter coupled difference amplifier – difference amplifier supplied with constant current source – Darlington amplifier – Cascade amplifier. **(12 lectures)**

(Electronic circuits, 2^{nd} Edn, Schilling and Balove, McGraw Hill (1985) Chapter 7)

UNIT IV: OPERATIONAL AMPLIFIERS : Basic operational amplifier – parameters – offset voltage and current and their measurement – CMRR and slew rate – input and output impedances – operations: basic arithmetic operations, differentiator, integrator, scaling – solution to simultaneous equations and differential equations (up to 2^{nd} order) – sample and hold circuit – active filters: low pass, high pass, band pass and band reject circuits – current to voltage and voltage to current conversions.

NON LINEAR CIRCUITS : Comparator, window comparator, precision rectifiers – logarithmic and antilogarithmic amplifiers – clippers and clampers.**(12 lectures)**

UNIT V : OSCILLATORS : Wien bridge and phase shift oscillators – triangle and square wave generators – crystal oscillators – Multivibrators – IC 555 timer and its applications – voltage to frequency and frequency to voltage conversions – phase locked loop and its applications.**(13 lectures)**

Book for Study Unit IV and V.

1. Op-amp and linear Integrated Circuits, 3^{rd} Edn, Ramakant, Gayakward, Prentice Hall of India (1995)
2. Electronic devivces and circuits – J. Millman and C.C. Halkias, McGraw Hill, 1993).

Total 64 hours

M.Sc. PHYSICS – I SEMESTER

15PHYP0105 - PRACTICAL-I (0 + 4)

(For the batches joining M.Sc., in 2015-2016 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 – II SEMESTER

15PHYP0206 – MATHEMATICAL PHYSICS – II (4+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: The mathematics needed to various branches of Physics is imparted

UNIT I :

TENSOR ANALYSIS : Introduction, notation and convention, tensors of II rank, equality and multitensor, transformation of I and II rank tensors, addition, subtraction, outer product and inner product of tensors, contraction of tensors –rank of a tensor – antisymmetric tensors, Kronecker delta, quotient law, Cartesian tensor, stress and strain tensors, Hooke's law, susceptibility tensor, Moment of Inertia tensor. Covariant formulation of Electrodynamics: Lorentz gauge – Electromagnetic field strength tensor – Maxwells equation – Transformation of electromagnetic field.

(Matrices and Tensors in Physics, Second Edition, A.W. Joshi, Wiley Eastern (1988), Pages : 159 to 187, 196 to 212, 222 to 232 and related problems).**(14lectures)**

UNIT II :

COMPLEX VARIABLES : Functions of complex variables, single and many valued functions – Cauchy-Riemann conditions – conjugate functions – complex line integrals, Cauchy's integral theorem, integral formula – Taylor and Laurant expansion – Zeroes and singularities – Cauchy's residue theorem and its application.**(14lectures)**

(Mathematical Methods for Physicists, Fourth Edition, George. B. Arfken, Hans J Weber, Prism Books, Bangalore, relevant sections of Chapter 6, 7).

UNIT III :

INTEGRAL TRANSFORMS : Fourier series – Dirichlet conditions – sine and cosine series – Half range expansion – Fourier Transforms – Fourier integrals – Fourier Transform properties – Faltung theorem – application to heat conduction and plane wave solutions.

(Advanced Engineering Mathematics, Erwin Kreyszing, Wiley Eastern, Chapter 10)**(12 lectures)**

UNIT IV :

Laplace's transformation properties – convolution theorem – inverse Laplace's transforms – solving integral equations.

1. Advanced Engineering Mathematics, Erwin Kreyszing, Wiley Eastern, Chapter 5 and relevant section of Chapter 11.
2. Mathematical Methods for Physicists, Fourth Edition, George B Arfken, Hans J. Webber, Prism Books Bamgalore, Chapter 14).**(12 lectures)**

UNIT V :

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

(Elements of group theory for Physicists, III Edition A.W. Joshi, Wiley Eastern, *1982), Pages 1-25)

MOLECULAR SYMMETRY AND SYMMETRY GROUPS : Symmetry elements and operations – Definitions - symmetry planes and Reflections and inversion centre – proper axes & proper rotations – improper axes and improper rotations – symmetry point groups, Representations of groups – metrics notation for geometric transformations – reducible and irreducible representations. The Great Orthogonality theorem and the consequences – character tables – formation of character tables for C_3 and C_{2v} point groups, 32 Crystallography point groups.

(Chemical applications of group theory, Second Edition , F Albert Cotton, Wiley Eastern (1988) , Chapter 3 and 4). **(12 lectures)**

Total 64 hours

M.Sc. PHYSICS – II SEMESTER
15PHYP0207 – SOLID STATE PHYSICS – I (4+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: The course provide knowledge on crystals, crystal diffraction and fundamentals of lattice vibrations, free electron theory and semiconductors, which is essential to understand the behavior of materials

UNIT I : CRYSTAL STRUCTURE : Periodic array – Symmetry operations – basis – primitive lattice cell – fundamental types of lattices – crystal plane indexing – simple crystal structures - packing fraction –non ideal crystal structures – 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 – effect of temperature on Bragg reflection.**(13 lectures)**
(Book for study Solid State Physics, VII Edition, C. Kittel, John Wiley & Sons, Inc. Singapre (1996))
Chapter 1 and 2 Page No 1 to 52

UNIT II : LATTICE 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)**
(ibid chapter 4 and 5 Page No 99 to 140)

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. **(13 lectures)**

(ibid chapter 6 Page No 144 to 168)
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. (ibid chapter 7 Page No 176 to 196)**(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 – thermo electric effects in semi conductors – semimetals – amorphous semiconductors.
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.
(ibid chapter 8 Page No 199 to 232)**(12 lectures)**

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

M.Sc. PHYSICS – II SEMESTER
15PHYP0208 – QUANTUM MECHANICS – I (4+0)
(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope : The course imparts knowledge of basic quantum mechanics and gives a glimpse of perturbation methods for problem that cannot be exactly solved

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.
(Quantum Mechanics by Leonard I. Schiff, McGraw Hill (1968) page 19 to 44 of Chapter 2 and page 45 to 64 of Chapter 3). **(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.
(ibid page 66 - 98 of Chapter 4 and page 100 to 105 chapter 5) **(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)**
(ibid page 148 to 185 of Chapter 6 and page 199 to 204 of Chapter 7 and 212 to 214 of Chapter 7)

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.
(ibid page 244 to 255 of Chapter 8) **(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. (ibid page 255 to 259 of Chapter 8)
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. (ibid page 268 to 279 of Chapter 8) **(13 lectures)**

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

15PHYP0209 –PRACTICAL – II (0 + 4)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: Provide hands on experience on devices and systems

Any 18 out of the list given below

01.	Low pass, high pass and Bandpass filters using 741.
02.	Log and exponential amplifiers, integrators, differentiators using 741.
03.	Voltage – current and current to voltage converters using 741.
04.	Precision rectifier
05.	Phase shift oscillator, using 741.
06.	Astable multivibrator using 741.
07.	Bistable multibrator using 741.
08.	Monostable multivibrator using 741
09.	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

M.Sc. PHYSICS – II SEMESTER

NON MAJOR ELECTIVE

15PHYP02N1 – NON CONVENTIONAL ENERGY SYSTEMS (4+0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope : To provide knowledge of solar energy utilization and other non- conventional sources to the students.

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)**

<u>BOOKS FOR STUDY:</u>

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
15PHYP02N2 - RESONANCE SPECTROSCOPY (4+0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: the course is expected to give a detailed knowledge of resonance spectroscopy like EPR, NMR AND NQR etc.,

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.

Book for Study: Spectroscopy – Staughan and Walker Chapman and Hall, John Wiley and sons Ltd., 1976, P. 110 – 135.**(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.

Book for Study: Ibid P. 121, 122, 130, 146 = 161, 169 & 170.**(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.

Book for Study : Ibid Chapter: 4 P. 209 – 226, 230 – 234, 239 – 241.**(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 – quardrupole splittings – nuclear zeeman splittings – applications: nature of chemical bond, structural determination and biological applications.

Book for Study : Chapter 4 & 5, Basic Principles of Spectroscopy – Raymond Chang, Robert e.Kreiger Publishing Company, New York (1978)**(12 lectures)**

Total 64 hours

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
15PHYP02N3 - MICROPROCESSOR 8085 AND ASSEMBLY LANGUAGE (4+0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To provide knowledge of assembly language and programming with 8085 processor

UNIT I : 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 – III SEMESTER

15PHYP0310 - DIGITAL ELECTRONICS (3 + 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To introduce and provide knowledge of digital electronics. This will enable students to deign simple digital systems.

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, product of sums method, product of sums simplification

(Digital Principles and Applications, - D.P. Leach & A.P. Malvino, V Edn. Tata Mc Graw Hill Publishing Co Ltd., Chap. 3 P. 93 to 130).**(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 counter, modulus, decade counters, presettable counters, shift counters, A mod 10 shift counter with decoding, digital clock.

(Ibid Chap. 9 P. 311 to 339, Chap. 10 P. 341 to 395)**(10 lectures)**

UNIT III : A / D and D/ A CONVERSIONS : Variable register networks, binary ladders, D/A converters D/A accuracy and resolution, A/D converters – simultaneous conversion, A/D converter – Counter method, continious A/D conversion, A/D/ techniques, dual slope A/D conversion, A/D accuracy and resolution. (Ibid Chap. 11. P. 397 to 440).**(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. (Ibid Chap. 13 P. 487 to 546.)**(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

(Ibid Chap. 7 P. 251 to 279) (Ibid Chap.14 P. 547 to 586) **(10 lectures)**

Total 48 hours

M.Sc. PHYSICS – III SEMESTER

15PHYP0311 - SOLID STATE PHYSICS – II (3 + 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To provide knowledge of superconductivity, dielectrics and magnetic materials.

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).

Book for Study : Introduction to Solid State Physics, C. Kittel., John Wiley (2201), Edn. VII Page 270 – 304 of chapter 10 and Page 306 to 322 of Chapter 11.**(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 Hc_1 and Hc_2 – single particle tunneling – Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect – Macroscopic quantum interference.

Ibid . page 334 to page 377 of chapter 12.**(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.

Ibid . page 314 to 380 of chapter 13.**(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

Ibid page 416 to 440 chapter 14.**(8 lectures)**

<u>BOOKS FOR REFERENCE :</u>

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

Total 48 hours

M.Sc. PHYSICS – III SEMESTER

15PHYP0312 - QUANTUM MECHANICS – II (4 + 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To introduce perturbation methods, scattering theory, Schrodinger relativistic wave equation and glimpse of quantization of wave fields

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.

(Quantum Mechanics, Third Edition, L.I. Schiff, McGraw Hill, page 279 to 295) **(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.

Ibid . Page 397 to 423) **(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_l and V(r) Ramsauer Townsend effect – scattering by a perfectly square potential – resonance scattering – optical theorem – angular distribution at low energies.
(Ibid page 110 to 129)

Born approximation and application.

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

182 to 188) **(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.

Quantum Mechanics, Third Edition, L.I. Schiff, McGraw Hill, Page 466 to 488) **(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.

(Ibid , page 490 to 503) **(13 lectures)**

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

15PHYP0313- PRACTICAL - III (0 + 2)

(For the batches joining M.Sc. in 2015-2016and 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

15PHYP03E1– SOLAR ENERGY (4+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope: To provide knowledge of various ways of collecting solar energy and use the same for various applications.

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)

(Solar energy Utilization, G.D. Rai, Khanna Publishers, New Delhi , 1999, Chapter 1, Page 1 – 11, chapter 2, pages 17 – 32, chapter 3, pages 39 to 69, chapter 4, pages 78 to 88).

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)

(ibid: Chapter 5, pages 89 to 141) **(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. (ibid: Chapter 6, pages 156 to 187 and 193 to 199)

SOLAR WATER HEATING : Type of solar water heaters, Description of solar water heaters and their installation details, load and sizing of the systems. (ibid: Chapter 10, pages 312 to 321 and 232 to 335)

(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.

(ibid Chapter 7, pages 200 to 233)

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

(ibid: Chapter 8, pages 237 to 240 and 247 to 256). **(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.

(ibid: Chapter 14, pages 404 to 420)

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.

(ibid: Chapter 15, pages 433 to 435, 440 to 465, 473 to 476, and 478 to 481) **(13 lectures)**

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

15PHYP03E2– BIOMEDICAL ELECTRONICS (4+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

Scope : To introduce the physics aspects of various instruments used in diagnostics

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 – radi 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)**

<u>BOOK FOR STUDY</u> :

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

15PHYP03E3 - ASTRO PHYSICS (4+0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To introduce and provide knowledge of celestial objects and its properties

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

Book for study: Astrophysics Stars and galaxies. K.D.Abhyankar, University Press (India) LTD (1999)(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

(Ibid Chapter 5.p.48 – 78) (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's method Structure of white dwarfs – Equation of state for degenerate matter, mass radius relation for white dwarfs.

(Ibid Chapter 9,p. 175-211) (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

(Ibid Chapter 14. p.323 – 345) **(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

(Ibid Chapter 18. P.420 – 451) **(13 lectures)**

Books for Reference:

1. Astrophysics. Vol I & Vol.II.aller.L.H.Ronald press.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

15PHYP03E4- INTRODUCTION TO OPTOELECTRONICS (4 + 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope : To impart the knowledge of optical communication system, optical fibers , optical sources such as LED's, Lasers and photodetectors.

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 Spurce 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: Nonimaging 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)

TEXBOOK:

1. Optical Fiber Communications – III Edition – Gerd Keiser, McGraw Hill International Editions(2000), relevant sections of chapter 1 to 6.

REFERENCES:

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

Total 64 hours

M.Sc. PHYSICS – III SEMESTER

MODULAR COURSE- I

15PHYP03M1 – SEMICONDUCTOR NANOSTRUCTURES (2+0)

(For the batches joining M.Sc in 2015-2016 and after wards)

Scope : To impart the knowledge of semiconducting heterostructures and device fabrications such as Quantum well, wire and Dots, Quantum Rings, Anti-Dots etc.,

Unit I: Semiconductors and Heterostructures: Mechanics of waves-Crystal structure-effective mass approximation-Band theory-Heterojunctions- Heterostructures-Envelope function approximation-reciprocal lattice

(Ref: Quantum Wells, wires and dots – Paul Harrison, page: 1-12)

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

(**The Physics of Low dimensional semiconductors – John H.Davies**, page:118 – 146)

(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

(**Quantum Wells, wires and dots – Paul Harrison**, page: 17 – 71)

(16 lectures)

Total 32 hours

M.Sc. PHYSICS – III SEMESTER

MODULAR COURSE - I

15PHYP03M2 - BASICS OF MICROWAVES (2+ 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To impart the knowledge of.

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 – III SEMESTER

MODULAR COURSE - I

15PHYP03M3 - NANO PHYSICS (2+ 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To impart the knowledge of synthesis, analysis and characterisation of naonmaterials and enlighten the students with some applications of nanomaterials.

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, Vladimir Mitin, V.A.Kochelap and Michael A Stroscio, I Edn., Cambridge University Press, 2007, page: 242 – 321)

(16 lectures)

Book 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 – III SEMESTER

MODULAR COURSE I

15PHYP03M4 - SUPERCAPACITORS (2+ 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope: To impart the knowledge of various .

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 – IV SEMESTER

15PHYP0414 - MOLECULAR SPECTROSCOPY (3 + 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope : The course is expected to give the knowledge of rotational, vibrational, electronic and resonance spectroscopy.

UNIT I:Rotational Spectroscopy: Classification of molecules, Interaction of radiation with rotating molecule – Rotational spectra of rigid diatomic molecules – isotopic effects in rotational spectra – intensity of rotational lines – non-rigid rotator – vibrational excitation effect – linear polyatomic molecules – symmetric and asymmetric top molecules – stark effect – Quadrupole hyperfine interaction – interstellar molecules – microwave spectrometer – information derived from rotational spectra.

(10 lectures)

(Molecular structure and spectroscopy, G. Aruldhas, Prentice Hall of India pvt ltd (2007) Chap. 7.p.148 to 162)

UNIT II:Infrared Spectroscopy: Vibrational energy level of a molecule, IR selection rules, vibrates diatomic molecule, vibrating rotator, asymmetry of rotation – vibration band, vibration of polyatomic molecules – normal vibrations of linear and non – linear molecules. Fermi resonance, hydrogen bonding, rotation – vibration of polyatomic molecules, inversion of vibration of ammonia. IR instrument, FTIR principle and applications.

(ibid Chap. 7.p.176 to 213)

(10 lectures)

UNIT III:Raman spectroscopy: Classical and quantum theory, rotational Raman spectra – linear, symmetric top molecules, vibrational Raman spectra, Raman spectrometer – normal, Fiber coupled, FT Raman. Structure determination – type of molecules - XY2, XY3, XY4. Applications – phase transitions, conduction in solids. Developed instruments –resonance Raman scattering, Raman microscopy.

(ibid. Chap.8.p.214 - 245)

(9 lectures)

UNIT IV:Electronic spectra diatomic molecules: vibrational course structure, De'slandres table, Franck Condon principle, rotational fine structure of electronic vibration, Fortrat parabola. Photoelectron spectroscopy – principle and instrument.

(ibid. Chap.9.p.246 – 272)

(10 lectures)

UNIT V:NMR and Mossbaur spectroscopy: Nuclear resonance condition, Instrument, relaxation processes, Bloch equations, dipolar interaction, chemical shift, indirect spin- spin interaction. Recoilless emission and absorption, experimental technique- source and absorber, spectrometer, isomer shift, quadrupole interaction, magnetic hyperfine interaction.

(ibid Chap.10.p.273 – 291 and ibid. Chap.13. p. 351 – 370)

(10 lectures)

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.Molecular spectroscopy,G.Hertzberg(1950)
6.Spectroscopy and molecular structure G.W.King

Total 48 hours

M.Sc. PHYSICS – IV SEMESTER
15PHYP0415 - NUCLEAR AND PARTICLE PHYSICS (3 + 0)
(For the batches joining M.Sc. in 2015-2016and after wards)

Scope : The course imparts knowledge of general properties of nucleus, deuteron , nuclear models and elementary particles.

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

Book for Study : Nuclear Physics – Theory and Experiment by R.R. Roy & B.P. Nigam, Wiley Eastern Ltd., V Reprint (1993) Page 5-44 of Chapter 2**.** **(10 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.
IBID pages 46 to 72 of Chapter 3. **(10 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.
IBID pages 141 to 181 of Chapter 5**..** **(10 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.
IBID, pages 184 to 196 and 200-224 of Chapter 6**..** **(9 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.

Book for Study : Nuclear Physics, D.C. Tayal, Himalaya Publishing (1980) , Pages 583 to 626 and 635 to 642**..** **(9 lectures)**

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)

Total 48 hours

M.Sc. PHYSICS – IV SEMESTER

15PHYP0416 - ELECTROMAGNETICS AND WAVE PROPAGATION (3+0)

(For the batches joining M.Sc. in 2015-2016and after wards)

Scope : To impart the knowledge of Maxwell's equation, propagation of electromagnetic waves through various medias including waveguides and antennas

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 $\vec{B}$. **(9 Lectures)**

BOOK FOR STUDY :Electromagnetic fields and waves, Second Edition, Paul Lorrain and Dale Corson, CBS Publishers & Distributors, New Delhi (1986), Chapter 10 Pages 422 – 453 and related problems.

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.**(10 lectures)**

(Ibid: Chapter 11 Pages 459-492 and related problems)

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.

(Ibid: Chapter 12 Pages 504 - 547 and related problems)**(10 lectures)**

UNIT IV : PROPAGATION OF ELECTROMAGNETIC WAVES – III GUIDED WAVES Propagation in a straight line –The coaxial line – The hollow rectangular waveguide.

(Ibid: Chapter 13 Pages 557 - 582 and related problems) **(10 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.

(Ibid: Chapter 14 Pages 595 - 633 and related problems) **(9 lectures)**

Total 48 hours

BOOKS FOR REFERENCE :

1. Theory of Electromagnetic waves, H.C. Chau, McGraw Hill (1985).
2. Electromagnetic waves and Radiating system, 2^{nd} 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
5. Fundamentals of Electromagnetic Theory, W. Miah

M.Sc. Physics – IV SEMESTER

15PHYP0417 – Practical - IV (0+2)

(For the batches joining M.Sc. in 2015-2016and 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)

01. Diffraction studies using a LASER
02. Interference using a LASER
03. Susceptibility of solid
04. Susceptibility of a liquid
05. X-Ray power pattern analysis
06. Beta and Gamma absorption
07. Hall effect
08. Performance analysis of a solar thermal system
09. Calorific value of a fuel
10. Efficiency study of a stove
11. Study of a solar photovoltaic panel
12. Faraday rotation
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 - II

15PHYP04M5 – INTRODUCTION TO EPR SPECTROSCOPY (2+0)

(For the batches joining M.Sc. in 2015-2016 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.

Book for study: 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),p.1-35.

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

(ibid) p.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 - II

15PHYP04M6 - MATERIALS PREPARATION AND CHARACTERIZATION (2+ 0)

(For the batches joining M.Sc. in 2015-2016and after wards)

UNIT I: Materials preparation: Crystal growth – solution growth – Czchrolski , Bridgemen methods – 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.

M.Sc. PHYSICS – IV SEMESTER

MODULAR COURSE - II

15PHYP04M7– LUMINESCENCE SPECTROSCOPY (2+0)

(For the batches joining M.Sc in 2015-2016 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.

Book for study:

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

M.Sc. PHYSICS – IV SEMESTER

MODULAR COURSE - II

15PHYP04M8 – SOLAR ENERGY UTILIZATION (2+0)

(For the batches joining M.Sc. in 2015-2016 and after wards)

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

(Book for study: Solar Energy Utilization , G.D.Rai, Khanna Publishers, Fifth edition (2001) Chapter 8 Page No 237- 260 and chapter 9 page 261-287)

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

(ibid 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)