M.Sc. PHYSICS

SYLLABUS

(For the batches joining in 2021–2022 and afterwards)

DEPARTMENT OF PHYSICS

The Gandhigram Rural Institute–Deemed to be University

Gandhigram – 624 302

Dindigul District –Tamil Nadu, India

Annexure – III

OBE Elements for M.Sc. (Physics) Programme

Programme Educational Objectives (PEO)

PEO1: To make the students proficient in the subject of Physics from the advanced level to Research/Applied level.
PEO 2: To prepare the graduates towards Research and Development and/ or career plan.
PEO 3: To initiate the graduates for continuous learning and updation of knowledge.
PEO4: To develop skill to apply innovative ideas for the development of low cost/no cost Instruments to improve the science learning.
PEO 5: To enable the students to assess and optimize the usage of energy and other resources.
PEO 6: To train the graduates in understanding and arriving at the solutions to problems in both theoretical /Experimental domains.

<u>Program Outcome (PO)</u>

On completion of the M.Sc. Physics programme, the graduate will:

PO1: Become knowledgeable in the advanced areas of Physics.
PO2: Become employable in Scientific Laboratories/ Research Institutions/Government Sectors/Industries/Educational Institutions.
PO3: Use the knowledge of analytical, experimental, mathematical and computational skills to solve problems.
PO4: Be able to disseminate the knowledge gained.
PO5: Be competent to develop minor instruments and systems and become an entrepreneur.

<u>PROGRAMME SPECIFIC OUTCOME (PSO)</u>

On completion of the M.Sc., Physics Programme, the graduates will be capable of :

PSO1: Applying the advanced Physical principles.
PSO2: Using the knowledge of analytical, experimental, mathematical and computational skills to solve problems.
PSO3: Designing, Fabricating, fault finding and servicing of gadgets commonly used Physics laboratories.
PSO4: Exploring and acquiring advanced knowledge in the thrust areas of research in Physics.
PSO5: Qualifying in the competitive examinations for getting admission in leading research institutions
PSO6: Getting employed gainfully in R&D Laboratories/ Government sectors / Industries / Educational Institutions.
PSO 7: Disseminating the knowledge gained.

M.Sc., (Physics)
(For the batches joining in 2021–2022 and afterwards)

Name of the Programme	M.Sc. Physics									
Year of Introduction	1987				Year of Revision		2021			
Semester–wise Courses and Credit distribution	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
No. of Courses	7	7	8	8	–	–	–	–	–	–	30
No. of Credits	22	21	22	24	–	–	–	–	–	–	89

Scheme of the Programme

Sl.No	Semester	Course Code	Course Title	Credits	No. of Hours	ESE Hours
1	I	21PHYP0101	MATHEMATICAL PHYSICS–I	4	4	3
		21PHYP0102	STATISTICAL MECHANICS	4	4	3
		21PHYP0103	CLASSICAL MECHANICS	4	4	3
		21PHYP0104	ANALOG ELECTRONICS	4	4	3
		21PHYP0105	PRACTICAL – I	2	6	3
		21PHYP01M1	MODULAR COURSE–I	2	2	–
		21GTPP0001	GANDHI IN EVERYDAY LIFE	2	2	2
		21PHYPVAC1	**Physics of Sensors and Transducers**	**2***		
			TOTAL CREDIT	**22**		
2	II	21PHYP0206	MATHEMATICAL PHYSICS – II	4	4	3
		21PHYP0207	SOLID STATE PHYSICS–I	4	4	3
		21PHYP0208	QUANTUM MECHANICS–I	4	4	3
		21PHYP0209	PRACTICAL–II	2	6	3
		21PHYP02M2	MODULAR COURSE–II	2	2	–
			GENERIC ELECTIVE	3	3	3
		21ENGP00C1	COMMUNICATION / SOFT SKILLS	2	2	3
		21PHYPVAC2	**Physics of Crystal Growth and Thin Film**	**2***		
			TOTAL CREDIT	**21**		
3	III	21PHYP0310	DIGITAL ELECTRONICS	4	4	3
		21PHYP0311	SOLID STATE PHYSICS–II	4	4	3
		21PHYP0312	QUANTUM MECHANICS–II	4	4	3
		21PHYP0313	PRACTICAL –III	2	6	3
		21PHYP03DX	DISCIPLINE CENTRIC ELECTIVE	3	3	3
		21PHYP03MX	MODULAR COURSE – III	2	2	–
		21EXNP03V1	VPP	2	2	–
		21PHYP03F1	EXTENSION/FIELD VISIT	1	2	–
			TOTAL CREDIT	**22**		
4	IV	21PHYP0414	MOLECULAR SPECTROSCOPY	4	4	3
		21PHYP0415	NUCLEAR AND PARTICLE PHYSICS	4	4	3
		21PHYP0416	ELECTROMAGNETICS AND WAVE PROPAGATION	4	4	3
		21PHYP0417	PRACTICAL – IV	1	3	3
		21PHYP0421	DISSERTATION	6	–	–
		21PHYP0422	SEMINAR AND VIVA–VOCE	1	2	–
		21PHYP04MX	MODULAR COURSE – IV	2	2	
			HUMAN VALUE AND PROFESSIONAL ETHICS	2	2	–
			TOTAL CREDIT	**24**		

OVERALL CREDITS 89

* **Value added courses credits**
CFA = Continuous Formative Assessment, ESE – End Semester Examination.

LIST OF DISCIPLINE CENTRIC ELECTIVE FOR 21PHYP03DX

21PHYP03D1	Solar Energy
21PHYP03D2	Bio Medical Electronics
21PHYP03D3	Astro Physics
21PHYP03D4	Introduction to Optoelectronics

LIST OF GENERIC ELECTIVES FOR 21PHY02GX

21PHYP02G1	Non Conventional Energy Systems
21PHYP02G2	Resonance Spectroscopy
21PHYP02G3	Micro Processor and Assembly Language
21PHYP02G4	Nanophysics

LIST OF MODULAR COURSES FOR 21PHYP01MX

21PHYP01M1	Basics of Microwaves
21PHYP01M2	Supercapacitors

LIST OF MODULAR COURSES 21PHYP02MX

21PHYP02M3	Luminescence Spectroscopy
21PHYP02M4	Solar Energy Utilization

LIST OF MODULAR COURSES 21PHYP03MX

21PHYP03M5	Semiconductor Nanostructure
21PHYP03M6	Nanophysics

LIST OF MODULAR COURSES 21PHYP04MX

21PHYP04M7	Introduction to EPR Spectroscopy
21PHYP04M8	Materials Preparation and Characterization

LIST OF VALUE ADDED COURSES 21PHYPVACX

21PHYPVAC1	Physics of Sensors and Transducers
21PHYPVAC2	Physics of Crystal Growth and Thin Film

<table>
<tr><td>Semester</td><td>I</td><td>Course Code</td><td colspan="2">21PHYP0101</td></tr>
<tr><td>Course Title</td><td colspan="4">MATHEMATICAL PHYSICS – I</td></tr>
<tr><td>No. of Credits</td><td>4</td><td>No. of contact hours per Week</td><td colspan="2">4</td></tr>
<tr><td>New Course /Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td colspan="2">3%</td></tr>
<tr><td>Category</td><td colspan="4">Core Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="4">• Basic Skill /Advanced Skill
• Skill Development
• Employability</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="4">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="4">The Course aims to
• Impart the students the basic mathematics and methods involved in solving problems in different areas of Physics.
• Educate to frame equations pertaining to the specific problem.
• Make them solve partial differential equations.
• Make them realize the applications of special functions.
• Train them to solve problems in different areas of Physics.</td></tr>
<tr><td>UNIT</td><td colspan="3">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="3">LINEAR VECTOR SPACES: Definition, linear independence basis and dimension – scalar product – orthonormal basis – Gram Schmidt orthogonalization process – linear operators – MATRICES : Matrices, Orthogonal, Unitary and Hermitian Matrices – eigen values and eigenvectors – Matrix diagonalization – Cayley Hamilton theorem – Hermitian and Unitary operators–Simultaneous Eigen vectors and commutatively.</td><td>12</td></tr>
<tr><td>II</td><td colspan="3">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.</td><td>13</td></tr>
</table>

<table>
<tr><td>III</td><td>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</td><td>13</td></tr>
<tr><td>IV</td><td>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)</td><td>13</td></tr>
<tr><td>V</td><td>Boundary value problem – Series solution and related problem – Eigen values – Eigen functions and Sturm – Liouville problem–Non– homogeneous boundary value problems – Greens function – Properties – Green's function for one – dimensional problems– Eigen function expansion of Green's function</td><td>13</td></tr>
<tr><td rowspan="3">References</td><td colspan="2">Text Books (with chapter number and page number, wherever needed):
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 to162
Unit V: Chapter 4, Page 94 to 120 and Chapter 6, Page 176 to187
Introduction to Mathematical Physics, Charlie Harper PHI</td></tr>
<tr><td colspan="2">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 and Harveill 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).</td></tr>
<tr><td colspan="2">E–Resources (URL sofe–books/You Tube videos/online learning resources, etc.)
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</td></tr>
</table>

Course Outcomes	**On completion of the course, students should be able to do** **CO1:** will be able to identify, solve linear vector spaces, linearly independent vectors and construct orthonormal basis. **CO2:** can Formulate and determine eigen values and eigen vectors of matrices and diagonalise matrices **CO3:** will acquire knowledge about usage of partial differential equations in Physics and will be capable to solve them **CO4:** capable of using Special functions such as Bessel, Laguerrre, Hermite and Legendre to solve real time problems in physics **CO5:** Capable of solving non–homogenous differential equations using Green's function.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	2	3	–	2	3	2	3	2
CO2	2	3	–	2	3	2	3	3
CO3	3	3	–	2	3	2	3	3
CO4	2	3	–	1	3	2	3	2
CO5	3	3	–	3	3	3	3	3

Mean = 131 /49 = 2.67

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	I	Course Code	21PHYP0102
Course Title	**STATISTICAL MECHANICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Core Course**		
Scope of the Course	• Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To understand the mechanics of macroscopic system as well as microscopic system. • It gives understanding about classical statistics and Quantum statistics. • It gives fundamental understanding about partial functions.		

UNIT	Content	No. of Hours
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 apriority probability – statistical equilibrium – micro canonical ensemble – Idealgas. Micro canonical 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 micro canonical ensemble (ideal gas).	14
II	**STATISTICAL MECHANICS AND THERMOYNAMICS** 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
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 thermo dynamics – photons Einstein's derivation of Planck's law – Maser and Laser – equation of statefor ideal quantum gases.	12

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
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 Using model – diamagnetism – Para magnetism and ferromagnetism.	12
References	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.	
	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. Kittel and Kroemer, Publisher: W. H. Freeman, 1980. 4. Statistical Mechanics R.K.Pathria,3rd Edition, Elsevier(2011)	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To emphasise the classical perspective of statistical mechanics. **CO2:** To give a detailed understanding of the ensembles of different thermodynamic systems and the methodology of understanding ideal gas behaviour through the three fundamental statistics. **CO3:** To imbibe a better vision on the correspondence between the statistical mechanics and thermodynamics **CO 4:** To give a perception of the molecular partition function envisioning through translational, rotational and vibrational, also tounderstand the nuclear and electronic partition functions **CO 5:** To give coverage of ideal Bose – Einstein and Fermi–Dirac statistical approach to understand the thermodynamics of the gaseous systems.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	2	–	3	3	–	3	2
CO2	3	3	1	3	3	2	3	3
CO3	3	3	1	3	3	1	3	2
CO4	2	2	1	3	2	2	2	1
CO5	3	3	–	3	3	1	3	2

Mean = 89 / 40= 2.40

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	I	Course Code	**21PHYP0103**
Course Title	**CLASSICAL MECHANICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	10%
Category	**Core Course**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Aims to give understanding about kinematics and dynamics of rigid bodies • It stenches about lagragian, halimtanian and Hamiltonian Jocbi dynamics. • It gives the rotational dynamics understanding		

UNIT	Content	No. of Hours
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
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 (Brief 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 – freevibrations of a linear triatomic molecule.	13

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
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
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
References	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 to 212. 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, and 426 to 428. Unit V: Chapter X – pages 438 to 462, 472 to 484.	
	1. Classical Mechanics, T.W.B. Kibble 2. Mechanics, K.R. Symon 3. Mechanics, L.D. Landau and E.M. Lifshitz, Pergamon Press.	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** To cover the description of the motion of rigid body systems with the due importance of constraints with reference to the different degrees of freedom. **CO 2:** To illustrate and formulate physical parameters such as angular momentum, Kinetic energy and the state of art of the equilibrium of the rigid body so as to make the students to understand the oscillating mechanism exhibited by them. **CO 3:** To understand the behaviour of the conservative systems bestowed with Lagrangian and Hamiltonian and to formulate with the specific reference to configuration phase and phase space. **CO4:** To learn that the Poission bracket connotation signifies the invariance of canonical transformations. **CO 5:** To know that the Hamilton –Jacoby relativistic mechanics fuses Lagrangian as well as Hamiltonian in the new perspectives and hence to illustrate the periodic systems with the matrix algebraic formalism.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	–	3	3	1	2	2
CO2	3	3	–	3	3	1	3	3
CO3	3	3	–	3	3	1	2	3
CO4	1	3	–	2	2	2	2	1
CO5	3	3	–	3	3	2	3	3

Mean = 85 / 34 = 2.5

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>I</td><td>Course Code</td><td>21PHYP0104</td></tr>
<tr><td>Course Title</td><td colspan="3">ANALOG ELECTRONICS</td></tr>
<tr><td>No. of Credits</td><td>4</td><td>No. of contact hours per Week</td><td>4</td></tr>
<tr><td>New Course /
Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected
(Minimum 20%)</td><td>20%</td></tr>
<tr><td>Category</td><td colspan="3">Core Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill
• Employability</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives
(Maximum: 5)</td><td colspan="3">The Course aims to provide knowledge on the
• Electronic circuits so that the student will be able to design electroniccircuits for home and laboratory environment
• Design of analog circuits using switching devices
• Op–amp based circuits
• Oscillators based on linear ICs and op–amps</td></tr>
</table>

UNIT	Content	No. of Hours
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
II	**Field Effect transistors and special two terminal devices: Field effect devices:** Construction and characteristics of JFETs – voltage controlled resistor – transfer characteristics –Depletion type MOSFET – enhancement type MOSFET – MOSFET handling – CMOS–MESFETs Special two terminal devices– Schottky barrier – varactor diodes – power diodes – tunnel diodes – liquid crystal display	12
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 – Uni–junction transistor – SCR triggering with UJT (relaxation oscillator) – phototransistor – opto isolators.	15

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
V	**Opamp circuits – II:** precision half and full wave rectifiers – square and triangle wave generators – Comparator – opamp as a comparator – window comparator – timer IC (555) – astable and monostable operation – Voltage controlled oscillator using IC566 – phase locked loop	12
References	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	
	1. Integrated circuits and semiconductor devices, Second Edition, Gorden J. Debooand 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).	
	E–Resources(URLsofe–books/YouTubevideos/onlinelearningresources,etc.) http://nptel.ac.in/courses/115102014	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** Able to design power supplies for specific requirements. **CO 2:** Capable of fault finding and rectifying problems in DC power supplies. **CO 3:** Competent to implement switching circuits. **CO 4:** Knowledgeable to design OP–amp based analog computers **CO 5:** Competent to design OP– amp analog circuits.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	3	3	3	2	3	–
CO2	3	3	3	1	2	2	2	1
CO3	3	3	3	–	1	1	3	–
CO4	3	3	3	–	1	1	1	–
CO5	3	3	3	1	1	1	1	–

Mean = 89/40 = 2.40

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	I	Course Code	**21PHYP0105**
Course Title	**PRACTICAL –I**		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	10%
Category	**PRACTICAL – I**		
Scope of the Course	• Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • It provides basic understanding about Unipolar abs bipolar VI charterstics • It gives understanding about electron hole concept in semiconducting devices.		

UNIT	Content	No. of Hours
I	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 response12. 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	

<table>
<tr><td>Semester</td><td>I</td><td>Course Code</td><td>21PHYP01M1</td></tr>
<tr><td>Course Title</td><td colspan="3">BASICS OF MICROWAVES</td></tr>
<tr><td>No. of Credits</td><td>2</td><td>No. of contact hours per Week</td><td>2</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td>10%</td></tr>
<tr><td>Category</td><td colspan="3">Modular Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Skill Development
• Employability
• Entrepreneurship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• The importance of microwaves and related electronic devices in everyday applications.
• It gives the understanding about the physical , chemical properties and deduction and ranging in signal processing systems.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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.</td><td>16</td></tr>
<tr><td>II</td><td colspan="2">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.</td><td>16</td></tr>
<tr><td rowspan="2">References</td><td colspan="3">BOOK FOR STUDY
1. Dielectric materials and its applications–Arthur Von Hippel. Pages 1–40.</td></tr>
<tr><td colspan="3">BOOKS FOR REFERENCE
1. Microwave principles – Herbert J.Reich, East west press Ltd (1957).</td></tr>
</table>

	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 Nost and Rein Hold Company. London (1969)
Course Outcomes	**On completion of the course, students should be able to do** **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.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	–	1	1	1	2	2
CO2	3	–	–	2	2	1	2	2

Mean = 22/ 16 = 1.83

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>I</td><td>Course Code</td><td colspan="2">21PHYP01M2</td></tr>
<tr><td>Course Title</td><td colspan="4">SUPERCAPACITORS</td></tr>
<tr><td>No. of Credits</td><td>2</td><td>No. of contact hours per Week</td><td colspan="2">2</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td colspan="2">3%</td></tr>
<tr><td>Category</td><td colspan="4">Modular Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="4">• Skill Development
• Employability
• Entrepreneurship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="4">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="4">The Course aims to
• To understand the innovative energy storage device.
• It gives the understanding about electrochemical energy storage systems</td></tr>
<tr><td>UNIT</td><td colspan="3">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="3">SUPERCAPACITORS: Introduction – classes of capacitor – types of Super capacitor devices – EDLCs and pseudo capacitors. Electrolytes and choice of electrolytes. Introduction and overview of electrode process – Introduction – Non–Faradic processes – Faradic processes – Introduction to Mass – transfer – Controlled reaction.</td><td>16</td></tr>
<tr><td>II</td><td colspan="3">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 Voltammetry – Chemical analysis by AC Voltammetry – Instrumentation for Electrochemical impedance spectroscopy.</td><td>16</td></tr>
<tr><td>References</td><td colspan="3">1. B.E. Conway, Electrochemical super capacitors, Kluwer–Plenum Pup. Co., Newyork (1999).
2. Electrochemical Methods Fundamentals and applications by ALLEN. J. BARD and LARRY R. FAULKNER, Second edition, wiley (2004).</td><td></td></tr>
</table>

Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** The students will be able to prepare nano materials for electrode applications. **CO 2:** It permits students to evaluate the electro chemical performance of batteries and super capacitors.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	3	2	–	3	2	2
CO2	3	–	3	2	–	3	2	2

Mean = 30/ 16 = 2.5

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	**21PHYP0206**
Course Title	**MATHEMATICAL PHYSICS – II**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	**Core Course**		
Scope of the Course	• Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1: Introduced tensor concepts and its basic applications so that, the students can apply the knowledge in various fields of Physics. 2: Gain applicative knowledge of complex numbers and complex variables. Also to learn C–R equation, Cauchy's theorem, Cauchy's integral, Taylors and Maclaur in series.		

UNIT	Content	No. of Hours
I	**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
II	**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 ant symmetric 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

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
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
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
References	**BOOKS FOR STUDY** Matrices and Tensors in Physics, Second Edition, A.W. Joshi, Wiley Eastern (2288). Unit I: Relevant chapters in Pages : 159 to 217, 196 to 212, 222 to 232 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 – WileyLtd.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	3	2	–	3	2	2
CO2	3	–	3	2	–	3	2	2
CO3	3	3	–	3	2	–	2	3
CO4	3	3	–	3	2	–	2	3
CO5	3	3	–	2	2	–	2	2

Mean = 73 / 30 = 2.43

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	**21PHYP0207**
Course Title	**SOLIDSTATE PHYSICS – I**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Core Course**		
Scope of the Course	• Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Acquire knowledge and understand the behaviour of electrons in solids • Apply the knowledge and analyse the availablesemiconducting and super conducting materials • Able to differentiate between ferroelectric, anti–ferroelectric, piezoelectric, pyroelectric materials, Plasmons, polaritons and polarons • Develop and synthesize new materials for a requirement. Create an eco–friendly environment with lifelong development and usage of condensed matters.		

UNIT	Content	No. of Hours
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 – 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

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
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
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
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 – super lattices. 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 – pseudo potentials.	12
References	**Text Books (with chapter number & page number, wherever needed):** 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	
	Reference Books: 1. Solid State Physics, A.J. Dekker, Prentice Hall (1984) 2. Solid State Physics, II Edition, J.S. Blackmore, Cambridge University Press (1974). 3. Solid State Physics by N.W. Aschcroft and V.D. Maxmin, Saunders College, Publishing (1976). Elements of Solid State Physics, J.P.Srivastava, 2nd edition, PHI Publishers (2009)	

	E–Resources (URLs of e–books / YouTube videos / online learning resources, etc.) 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
Course Outcomes	**On completion of the course, students should be able** 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 quasi particle, phonon and thermal propertiesof 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 metals semiconductor and its properties CO5: To understand Wigner – Seitz method – pseudo potentials.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	2	2	–	3	3	2	3	2
CO2	3	2	–	3	3	2	3	2
CO3	3	2	–	3	3	2	3	2
CO4	3	2	–	3	3	2	3	2
CO5	1	2	–	1	–	–	1	1

Mean = 77 / 40= 2.33

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	21PHYP0208
Course Title	**QUANTUM MECHANICS – I**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	Syllabus is on par with CSIR syllabus
Category	**Core Course**		
Scope of the Course	• Skill Development • Employability • Value–Added Courses imparting transferable and life skills		
Cognitive Levels addressed by the Course	• **K–1: (Remember)** • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • **K–6: (Create)**		
Course Objectives (Maximum: 5)	**The Course aims to** • Imparts knowledge of basic quantum mechanics and gives a glimpse of perturbation methods for problem that cannot be exactly solved		

UNIT	Content	No. of Hours
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
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
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

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
V	**VARIATIONAL METHOD**: 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
References	**BOOKS 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 215 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	
	BOOK FOR REFERENCES: 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 Publishers(2009)	
Course Outcomes	**On completion of the course, students should be able to do** CO1: To explain the basic postulates and formalism quantum physics. CO2: To solve eigen value problems in LHO, Spherical harmonics and Hydrogen atom. CO3:To give exposure on matrix formalism and its applications in LHO and angular momentum CO4:To discuss various approximation methods to solve Schrodinger equations and real time applications CO5: To solve He atom problem using variation technique.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	–	3	3	3	3	2
CO2	3	3	–	3	3	3	3	3
CO3	3	3	–	3	3	3	3	3
CO4	3	3	–	3	3	3	3	3
CO5	3	3	–	3	3	3	3	3

Mean= 104/40 = 2.97

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>II</td><td>Course Code</td><td>21PHYP0209</td></tr>
<tr><td>Course Title</td><td colspan="3">PRACTICAL II</td></tr>
<tr><td>No. of Credits</td><td>2</td><td>No. of contact hours per Week</td><td>6</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td>5%</td></tr>
<tr><td>Category</td><td colspan="3">Core Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
1. It gives the understand about IC in electronic circuits.
2. It gives the basics understanding optic communication systems.
3. It basic knowledge about power measurements on electronic devices.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">1. Low pass, high pass and Band pass 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. Astable multivibrator using 741.
7. Bistable multibrator using 741.
8. Monostable multivibrator using 741
9. Wien bridge oscillator using 741.
10. GM counter, a. Michaelson’s interferometer
11. Ultrasonic interferometer
12. Solving simultaneous equations using 741
13. Owen’s bridge, a. Maxwell’s bridge
14. Scherring bridge
15. Power measurement of a device.
16. IC 555 Applications
17. Optical Fiber Characterization – Numerical Aperture,Bending loss, Splice loss
18. Zeeman Effect Apparatus–Determination of thickness of etalon
19. Zeeman Effect Apparatus – Calculation of Fundamentalconstants $\mu_{\circ}$ /hc</td><td></td></tr>
</table>

Semester	II	Course Code	**21PHYP02M3**
Course Title	**LUMINESCENCE SPECTROSCOPY**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	**MODULAR COURSE – II**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Will be able to differentiate between different processes in materials 2. Can predict energy transfer and choose rare earth ions for specific colour output.		

UNIT	Content	No. of Hours
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 – colorof lanthanide intensities.	16
II	**RADIATIVE AND NON – RADIATIVE RETURN ANDENERGY 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 betweenunlike and identical luminescent centers.	16

References	**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
Course Outcomes	**On completion of the course, students should be able to do** CO 1: Will be able to differentiate between different processes in materials CO 2: Can predict energy transfer and choose rare earth ions for specific colour output

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	3	3	–	3	3	2
CO2	3	2	3	2	–	3	2	2

Mean = 34 / 16 = 2.61

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>II</td><td>Course Code</td><td>21PHYP02M4</td></tr>
<tr><td>Course Title</td><td colspan="3">SOLAR ENERGY UTILIZATION</td></tr>
<tr><td>No. of Credits</td><td>2</td><td>No. of contact hours per Week</td><td>2</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected
(Minimum 20%)</td><td>10%</td></tr>
<tr><td>Category</td><td colspan="3">MODULAR COURSE II</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development
• Employability
• Entrepreneurship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• To harvest solar energy through different trapping systems.
• It gives understanding about photo voltaic principles.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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</td><td>16</td></tr>
<tr><td>II</td><td colspan="2">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.</td><td>16</td></tr>
</table>

References	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	
	1. Solar Energy, S.P. Sukhatme, Tata McGraw Hill, New Delhi,(1984) 2. Solar Thermal engineering, Peter J. Lunde, John Wiley New York (1980)	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Handle the solar energy measuring instruments to collect the data. **CO 2:** Perform the testing procedures to study the thermal performance of FPC and solar air heaters.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	2	2	2	1	3	2	1
CO2	3	3	3	2	1	3	2	2

Mean = 35/16 = 2.18

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	**21PHYP02G1**
Course Title	**NON CONVENTIONAL ENERGY SYSTEMS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**GENERIC ELECTIVE**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To harvest solar energy through different trapping systems. • The multi faced understanding about different types energyharvesting.		

UNIT	Content	No. of Hours
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
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
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

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
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
References	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.	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Explain the solar constant and estimate the solar radiation on tilted surfaces. **CO 2:** State the principles behind the conversion of solar radiation into thermal energy and its application. **CO 3:** Define the different types of wind energy conversion technologies. **CO 4:** Illustrate the biomass conversion technologies and its classifications. **CO 5:** Explain the methods of generating energy form Geothermal sources.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	3	2	2	2	2	2
CO2	3	3	3	1	1	1	1	2
CO3	3	2	2	2	1	2	2	2
CO4	3	2	2	2	1	2	2	2
CO5	3	2	2	2	1	2	2	2

Mean = 82/40 = 2.05

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	**21PHYP02G2**
Course Title	**RESONANCE SPECTROSCOPY**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**GENERIC ELECTIVE**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Acquire knowledge of electron spin resonance (ESR) spectroscopy and its related studies. • Acquire knowledge of nuclear resonance spectroscopy for nucleus with spin > 1/2 to study the NQR. Understand the concept of recoilless emission and absorption of high energetic nuclear reactions and study the Mossbauer spectroscopy and related applications.		

UNIT	Content	No. of Hours
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
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

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
IV	**Nuclear Quadrupole resonance**: Fundamentals – experimentaltechniques – theory– nuclear quadrupole coupling in atoms and molecules – applications– nature of chemical bonds – structural information and study of charge transfer compounds.	13
V	**Mossbauer spectroscopy:** Introduction – experimental techniques – theory – isomer shifts – quardrupole splittings – nuclear Zeeman splittings – applications – nature of chemical bond – structural determination and biological applications.	12
References	**Text Books (with chapter number & page number, wherever needed):** Spectroscopy – Staughan and Walker Chapman and Hall, John Wileyand 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 Unit IV: Chapter 4 Unit V: Chapter 5 Basic Principles of Spectroscopy – Raymond Chang, Robert e.Kreiger Publishing Company, New York (1978)	
	Reference Books: 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).	
Course Outcomes	**On completion of the course, students should be able to do** CO1: Know the basic concepts of resonance spectroscopy CO2: Apply the knowledge of resonance spectroscopy for nuclear spin and study the nuclear magnetic resonance. CO3: Understand the basics of relaxation processes and apply it for the instrumentation purpose. CO4: Learn Fourier Transform technique for the study of FT spectrometer. CO5: Elucidate the structure of organic compounds with the knowledge of chemical shift and coupling constants.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	–	2	1	–	2	–
CO2	3	–	–	2	2	–	2	–
CO3	3	–	–	2	–	–	1	1
CO4	3	1	2	3	1	1	2	2
CO5	3	2	–	3	2	–	2	3

Mean=54/ 40= 2.07

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>II</td><td>Course Code</td><td>21PHYP02G3</td></tr>
<tr><td>Course Title</td><td colspan="3">MICROPROCESSOR 8085 AND ASSEMBLY LANGUAGE</td></tr>
<tr><td>No. of Credits</td><td>3</td><td>No. of contact hours per Week</td><td>3</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected
(Minimum 20%)</td><td></td></tr>
<tr><td>Category</td><td colspan="3">GENERIC ELECTIVE</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development
• Employability
• Entrepreneurship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
1. To impart knowledge on the instruction set with timing cycle by executing a simple program
2. To acquire knowledge on 16 bit instruction set with looping and counting techniques.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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.</td><td>12</td></tr>
<tr><td>II</td><td colspan="2">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 1K memory 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.</td><td>13</td></tr>
</table>

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
IV	**PROGRAMMING TECHNIQUES WITH ADDITIONALINSTRUCTIONS**: 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
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 subroutineconcepts.	13
References	**BOOK FOR STUDY** 1. Relevant sections of Microprocessor architecture, programming and applications with the 8085 / 8080A – R.S. Gaonkar, Wiley Eastern, New Delhi. **BOOK FOR 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.	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To impart basics about Microcomputers and Microprocessors. **CO 2:** To acquire knowledge onmicroprocessor architecture, operation with inputsabout memory **CO3:** 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**.**	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	–	1	1	–	1	–
CO2	3	2	–	1	1	–	1	–
CO3	3	2	–	1	1	–	1	–
CO4	3	–	–	1	1	–	1	–
CO5	3	2	–	1	1	–	1	–

Mean = 36/23 = 1.57

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	II	Course Code	**21PHYP02G4**
Course Title	**NANOPHYSICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	100%
Category	**GENERIC ELECTIVE**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Acquire knowledge on the various physical, chemical and biological techniques of synthesis of nano particles. 2. Get knowledge on the special types of nano materials and their applications.		

UNIT	Content	No. of Hours
I	**Physics of Nanostructures** Matter Waves – Heisenberg's Uncertainty Principle – Arrangement of Atoms –Two Dimensional Crystal Structures – Three Dimensional Crystal Structures – Some Examples of Three Dimensional Crystals – Planes in the Crystals – Crystallographic Directions – Reciprocal Lattice – Quasi Crystal – Liquid Crystals.	14
II	**Synthesis of Nanomaterials (Qualitative Description only)** **Physical Methods:** Mechanical Methods–Methods Based on Evaporation–Sputter Deposition – Chemical vapour deposition. **Chemical Methods:** Synthesis of Metal Nanoparticles by Colloidal Route – Synthesis of Semiconductor Nanoparticles by Colloidal Route–Sol Gel Method – Hydrothermal Synthesis – Sono chemical Synthesis. **Biological Methods:** Synthesis Using Microorganisms – Synthesis Using Plant Extracts – Use of Proteins – Templates Like DNA – S–Layers etc–Synthesis of Nanoparticles Using DNA.	16

III	**Types of Nano materials and Their Properties (Qualitative Description only)** Introduction – Clusters – Types of clusters – Semiconductor Nano particles – Optical properties – Plasmonic Materials – Nano magnetism – Types of magnetic materials – Mechanical Properties of Nano materials –Structural Properties – Melting of Nano particles.	12
IV	**Some Special Nano materials** **Introduction – Carbon Nano materials:** Fullerenes – Carbon Nanotubes – Types of Carbon Nanotubes – Synthesis of Carbon Nanotubes – Growth Mechanism – Graphene – **Porous Material:** Porous Silicon– How to Make Silicon Porous? –Mechanism of Pores Formation – Properties of Porous Silicon Morphology– *Aerogels* – Types of Aerogels – Properties of Aerogels – Applications of Aerogels.	12
V	**Applications:** Applications – Solar cells – Fuel cells – Hybrid energy cells – Automobiles – Sports and Toys –Textiles – Cosmetics – Medical Field– Agriculture and food–Domestic Appliances –Space – Defense and Engineering – *Nanotechnology and Environment* – Environmental Pollution and Role of Nanotechnology – Effect of Nanotechnology on Human Health.	10
References	**BOOK FOR STUDY** Nanotechnology– Principles and Practices, Third Edition – Sulabha K.Kulkarni. Co–published by Springer International Publishing, Cham, Switzerland, with Capital Publishing Company, New Delhi, India. Unit I: Chapter 1: Pg No. 10–15, Chapter 2: Pg No. 31–44. Unit II:Chapter 3: Pg. 55–73, Chapter 4: Pg. 91–94, 103–107, Chapter–5: Pg. 116–123. Unit III: Chapter 8: Pg. 199–239. Unit IV: Chapter 11: Pg No. 273–303. Unit V: Chapter 12 and 13: Pg No: 317–354.	
	BOOK FOR REFERENCE: 1) Nano: The essentials by T.Pradeep, TMH Publishing Co (2008) 2) Introduction to Nanotechnology by Charles P.Poole Jr and Frank J.Owens, Wiley India (2008)	
Course Outcomes	**On completion of the course, students should be able to do** **CO1: U**nderstand the underlying Physics in nano materials **CO2:** Acquire knowledge on the various physical, chemical and biological techniques of synthesis of nano particles **CO 3:** Be aware of the different types of nano materials **CO 4:**Be able to appreciate the unique properties of nano materials **CO 5:** Get a knowledge on the special types of nano materials and their application.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	2	2	2	3	–	3	2
CO2	3	3	3	3	3	–	3	2
CO3	3	2	2	3	–	–	3	2
CO4	3	2	3	3	3	–	2	2
CO5	3	2	3	3	3	–	3	2

Mean = 89 /40 = 2.61

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>III</td><td>Course Code</td><td>21PHYP0310</td></tr>
<tr><td>Course Title</td><td colspan="3">DIGITAL ELECTRONICS</td></tr>
<tr><td>No. of Credits</td><td>4</td><td>No. of contact hours per Week</td><td>4</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum20%)</td><td>20%</td></tr>
<tr><td>Category</td><td colspan="3">Core Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">Basic Skill/Advanced Skill
Skill Development
Employability</td></tr>
<tr><td>Cognitive Levels addressed bythe Course</td><td colspan="3">K–1:(Remember)
K–2:(Understand)
K–3:(Apply)
K–4:(Analyze)
K–5:(Evaluate)
K–6:(Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
Provide knowledge on digital circuit simplification via K–map.
Make the student knowledgeable in the design of counters and registers.
Instruct the students on the digital to analog and analog to digital conversion processes.
Introduce different classes of digital circuits and their merits.
Provide knowledge on the design of advanced digital circuits.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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 – half and full adder – half and full subtractor – RS, D and JK flip flop. JK master– slave and T flip flop.</td><td>10</td></tr>
<tr><td>II</td><td colspan="2">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 – mod–5 and mod–6 counters– decade counter – mod 10 shift counter with decoding – digital clock.</td><td>10</td></tr>
</table>

III	**A / D and D/ A CONVERTORS and data manipulators:** A / D and D/ A CONVERTORS – 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. Data manipulators – Multiplexers – demultiplexers – encoder – decoder.	9
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 –currenttracers.	9
V	**CLOCKS, TIMING CIRCUITS AND APPLICATIONS:** Clock wave forms – TTL clock – Schmitt Trigger – 555 timer – as table – monostable – monostable with input logic – pulse forming circuits APPLICATIONS– Multiplexing displays – frequency counters – time measurement – using ADC 0804 – Microprocessor Compatible A/Dconverters – digital voltmeters.	10
References	**Text Books(with chapter number & page number, wherever needed):** D.P. Leach and 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	
	Reference Books: 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)	
Course Out comes	**On completion of the course, a student will be** **CO 1:** Capable of designing simplified digital systems using logic circuits. **CO 2:** Competent to designing registers, counters and related circuits **CO 3:** Knowledgeable in the design of analog to digital and digital analog conversion techniques. **CO 4:** Able to select ICs for specific applications. **CO 5:** Capable of understanding, fault finding and repairing digital systems like clocks and counters.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	–	1
CO2	3	2	3	–	2
CO3	3	3	3	–	1
CO4	3	2	2	–	–
CO5	3	3	3	1	1

Mean = 62/ 30 = 2.07

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>III</td><td>Course Code</td><td>21PHYP0311</td></tr>
<tr><td>Course Title</td><td colspan="3">SOLID STATE PHYSICS – II</td></tr>
<tr><td>No. of Credits</td><td>4</td><td>No. of contact hours per Week</td><td>4</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td>20%</td></tr>
<tr><td>Category</td><td colspan="3">Core Course</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development
• Employability</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• Acquire the knowledge and discuss about materials, and phase transitions of materials.
• Identify and analyze different energy conversion materials for conversion process.
• Understand materials dielectrics and ferroelectric behavior.
• Understand magnetic behavior of materials.
• Understand Ferri and Ferro magnetic order.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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).</td><td>12</td></tr>
</table>

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
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 – anti ferro electricity and ferro electric domains – Piezo electricity – ferro elasticity.	8
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
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

References	**Text Books (with chapter number & page number, wherever needed):** 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.
	Reference Books: Solid State Physics by N.W. Aschcroft and V.D. Mermin, Saunders College Publishing (1978) Solid State Physics, J.S. Blackmore, Cambridge UniversityPress, (1974). Elementary Solid State Physics, M. Ali Omar, Addition – Wesly (2000).Solid State materials – D.N. Srivastava
Course Outcomes	**On completion of the course, students should be able to do** CO1: (Fundamental concepts in condensed matter physics, and applies the physics they have learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real– world materials CO2: Optical properties of solids CO3: Dielectric and Ferro electric properties of solids CO4: Magnetic properties such as dia, para, ferro and anti ferro magnetismCO5: Understand superconductivity

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	–	3	3
CO2	3	–	–	3	1
CO3	3	–	–	3	1
CO4	3	3	–	3	3
CO5	–	3	–	3	1

Mean = 45/25 = 2.67

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**III**	Course Code	**21PHYP0312**
Course Title	**QUANTUM MECHANICS – II**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**Core Course**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development** • Value–Added Courses imparting transferable and life skills		
Cognitive Levels addressed bythe Course	• **K–1: (Remember)** • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • **K–5: (Evaluate)** • **K–6: (Create)**		
Course Objectives (Maximum: 5)	**The Course aims to** • To introduce time dependent perturbation methods, scattering theory, Schrodinger relativistic wave equation and glimpse of quantization of wave field.		

UNIT	Content	No. of Hours
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
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

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. Born approximation and application.	13
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
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.	
References	**Text Books (with chapter number & page number, wherever needed):** 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	
	Reference Books: 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)	

Course Outcomes	**On completion of the course, students should be able to do** **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

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	–	–	–	3	3	2	3	1
CO2	–	–	–	3	3	2	3	1
CO3	–	–	–	3	2	2	3	1

Mean = 35/15 = 2.33

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**III**	Course Code	**21PHYP0313**
Course Title	**PRACTICAL – III**		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	**PRACTICAL**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed by the Course	• K–1: (Remember) **K–2: (Understand)** • **K–3: (Apply) K–4: (Analyze)** • K–5: (Evaluate)K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • It gives fundamental understanding about different type of gates and their applications. • It gives the functioning of on and off switching circuits through mutlivibrators (Transistor/ ICs)		

UNIT	Content	No. of Hours
I	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.	

<table>
<tr><td>Semester</td><td>III</td><td>Course Code</td><td>21PHYP03D1</td></tr>
<tr><td>Course Title</td><td colspan="3">SOLAR ENERGY</td></tr>
<tr><td>No. of Credits</td><td>3</td><td>No. of contact hours per Week</td><td>3</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td></td></tr>
<tr><td>Category</td><td colspan="3">DISCIPLINE CENTRIC ELECTIVE</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development
• Employability
• Entrepreneurship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• It gives understanding about energy trapping storing and utilizing through different solar systems.
• It gives a basic physics of conduction convection and radiation of solar systems.
• It gives the understanding about the functionality about photovoltaic cells.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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.</td><td>12</td></tr>
<tr><td>II</td><td colspan="2">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.</td><td>13</td></tr>
</table>

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
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
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
References	1. Solar energy Utilization, G.D. Rai, Khanna Publishers, New Delhi, 1999, Unit I : Chapter 1, Page 1 – 11 Unit II: 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 217 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	
	Reference Books 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).	

Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Define earth sun angles and solar constant. **CO 2:** Explain the structure of the sun and the solar radiation received on the Earth's surface. **CO 3:** Estimate the sun rise, sun set, Day length, average solar radiation of any day of the year. **CO 4:** Solve problems relating to heat transfer mechanisms. **CO 5:** Explain the principle of working of Flat plate collector and its thermal performance analysis.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	2	1	2	2	1	2	1
CO2	3	2	1	2	2	1	2	1
CO3	3	2	1	2	2	1	2	3
CO4	3	2	3	2	2	2	2	3
CO5	3	3	3	2	2	2	2	2

Mean = 82/40= 2.05

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	III	Course Code	18PHYP03D2
Course Title	**BIOMEDICAL ELECTRONICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**DISCIPLINE CENTRIC ELECTIVE**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development** • Value–Added Courses imparting transferable and life skills		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum:5)	**The Course aims to** • To introduce the physics aspects of various instruments used in diagnostics.		

UNIT	Content	No. of Hours
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
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
III	**BIO–POTENTIAL RECORDERS**: System characteristics– ECG – EEG – EMG – ERG – EOG	13
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

V	**OPERATION THEATRE EQUIPMENPS:** 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
References	**Text Books (with chapter number & page number, wherever needed):** 1. Bio–medical instrumentation – M. Arumugam – Anuradhaagencies, 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).	
Course Outcomes	**CO 1:** To acquire knowledge on physical anatomy of human body. **CO 2:** To acquire the knowledge of the function of electrodes for picking up the bioelectrical potential and to study the different types of electrodes. **CO 3:** To study the function and working principle of important medical instruments like ECG, EEG, EMG, ERG and EOG. **CO 4:** To study the function of internal and external pacemakers and also the different types of batteries. **CO 5:** To introduce the surgical instruments and to acquire the knowledge of biotelemetry.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1	3	1	3	1	3	3	2
CO2	3	3	3	3	2	3	3	3
CO3	3	3	3	3	3	3	3	3
CO4	3	2	3	2	3	3	3	3
CO5	3	3	3	3	3	3	3	3

Mean= 108 / 40 = 2.7

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>III</td><td>Course Code</td><td>21PHYP03D3</td></tr>
<tr><td>Course Title</td><td colspan="3">ASTRO PHYSICS</td></tr>
<tr><td>No. of Credits</td><td>4</td><td>No. of contact hours per Week</td><td>4</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td></td></tr>
<tr><td>Category</td><td colspan="3">DISCIPLINE CENTRIC ELECTIVE</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development
• Employability</td></tr>
<tr><td>Cognitive Levels addressed bythe Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• It brings the totality of the Milky Way position of zodiac and index of star localization.
• Vivid understanding about a different celestial astronomic telescope and their importance in solar observatories.
• Basic understanding about designing of telescopes for sky observations.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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 distributionin 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.</td><td>13</td></tr>
<tr><td>II</td><td colspan="2">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 and K lines of Ca II and Ca 1 – luminosity effect of G0 – Peculiar stellar spectra</td><td>13</td></tr>
</table>

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 ofsources – rates of thermo nuclear reactions – rates of H burning reactions – Stellar opacity – free – free transitions – bound – free transitions – Electron scattering – convection in stellar interiors – 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.	12
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
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 2260s – Friedmann Universe of early 2270s – Past and future of the Universe – past – future.	13
References	**Text Books** 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	

	Reference Books 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.Wand 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).
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To help gaining knowledge on the stellar atmosphere through various sections and constituents. **CO 2:** To study the Surface temperatures of the stars through various physical models and hence to classify various stars. **CO 3:** To make the students understand, the internal structures of the stars through various equilibrium conditions suggestedby various theoretical models. **CO 4:** To study the Milky Way galaxy presence and theirproperties through various theoretical information. **CO 5:** To find the status of the universe through various theoretical models and to understand the status of the universe in the past, in the present and in the future

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	–	–	1	1	–	1	–
CO2	3	2	–	1	1	–	1	–
CO3	3	2	–	1	1	–	1	–
CO4	3	–	–	1	1	–	1	–
CO5	3	2	–	1	1	–	1	–

Mean = 36 / 23 = 1.57

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**III**	Course Code	**21PHY03D4**
Course Title	**INTRODUCTION TO OPTOELECTRONICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**DISCIPLINE CENTRIC ELECTIVE**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development**		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • The course enables the student to understand the cable structure. • The course permits students to measure different kinds of attenuation in an optical fiber.		

UNIT	Content	No. of Hours
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
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

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
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
V	**PHOTODETERCTORS:** Physical Principles of Photodiodes – The pin Photo detector – Avalanche Photodiodes – Photo detector Noise – Noise Sources – Signal – to – noise Ratio – Detector Response Time – Depletion Layer Photocurrent – Response Time Avalanche Multiplication Noise – Structures for In GaAs APDs Temperature Effect on Avalanche Gain Comparisons of Photo detectors.	13
References	Text Books (with chapter number & page number, wherever needed): Gerd Keiser, Opitcal Fiber Communication, Third Edition, McGraw Hill International (2000), relevant sections of chapter 1 to 6. **Reference Books:** Jasprit Singh, Optoelectronics: An introduction to materials and devices, McGraw Hill, Singapore (1996).	
Course Outcomes	**On completion of the course, students should be able to do** 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.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	1	–	–	3	3	1	–
CO2	3	–	–	1	2	2	2	–
CO3	3	–	–	–	2	2	2	–
CO4	3	3	3	–	2	2	2	–
CO5	3	3	2	3	2	2	1	–

Mean = 61 / 40 = 2.25

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	III	Course Code	21PHYP03M5
Course Title	**SEMICONDUCTOR NANOSTRUCTURES**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**MODULAR COURSE– III**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development** • **Employability**		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2**: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To impart the knowledge of semiconducting hetero structures and device fabrications such as Quantum well, wire and Dots,Quantum Rings, Anti–Dots etc.,		

UNIT	Content	No. of Hours
I	**Semiconductors and Hetero structures:** Mechanics of waves – Crystal structure – effective mass approximation – Band theory– Hetero junctions – Hetero structures – 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 hetero structures.	16
II	**Solutions to different problems:** variational method Infinite well – density of states – sub band population – finite well with constant mass – effective mass mismatch at hetero junctions–Infinite barrier height and mass limits– extension to multiple well systems–The asymmetric single Quantum well–addition of electric field–infinite super lattice – single barrier– double barrier–extension to include electric field–magnetic fields and Landau quantization	16

References	**Text Books (with chapter number and page number, wherever needed):** 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:188 – 146.
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To give some basic knowledge on semiconductor nanostructure. **CO 2:** To impart some elemental applications of semiconductor nanostructure.

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	–	3	–	3	3	3
CO2	3	2	–	3	–	3	3	3

Mean = 34/12= 2.833

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**III**	Course Code	**21PHYP03M6**
Course Title	**NANO PHYSICS**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**MODULAR COURSE – III**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development**		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: **(Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To introduces basic characterization techniques of Nano particles / structure. To impart some application of nano devices.		

UNIT	Content	No. of Hours
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	16
II	**Properties, Characterization of Clusters, Nano materials and Applications:** Types of clusters – Mechanical properties – Structural properties – Electrical Conductivity – Optical Properties – Magnetic Properties – spin valve magnetic tunnel junctions – Nanostructure devices – Resonant–tuneling diodes – Field effect transistors – Single electron – transfer devices–Potential effect transistors – LEDs and lasers – Nano electro mechanical system devices – Quantum dot cellular automata.	16

References	**Text Books (with chapter number and page number, wherever needed):** Int. to Nanelectronics – Science, Nanotechnology, Engineering and Applications,VladimirMitin, V.A.Kochelap and Michael A Stroscio, I Edn., Cambridge University Press, 2007, Ibid: Chapter VII, Page No. 115 to 140& Page No. 144 to 174. Ibid: Chapter VIII, Page No. 176 to 207. page: 242 – 321.
	Reference Books: 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).
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To introduces basic characterization techniques ofnano particles/structure. **CO 2:** To impart some application of nano devices.

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	**3**	**3**	**–**	**3**	**–**	**2**	**3**	**3**
CO2	**3**	**3**	**–**	**3**	**–**	**3**	**3**	**3**

Mean = 35 / 12 = 2.916

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**IV**	Course Code	**21PHYP0414**
Course Title	**MOLECULAR SPECTROSCOPY**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Core Course**		
Scope of the Course (may be more than one)	• **Basic Skill** • **Skill Development** • **Employability**		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Acquire Knowledge and understand the aspects of various spectroscopic methods like Rotational Spectroscopy and its Techniques. • Explain the theory and principles of vibrational spectroscopy and its techniques. • Comprehend the basics of Raman Spectroscopy and Evaluate and Examine the Molecular and Atomic Structure of different Advanced Materials. • Perceive the theory and principles of electronic and X–ray spectroscopy and Apply them to describe Fluorescence and Phosphorescence • Understand the Physics behind NMR and ESR spectroscopy, Mossbauer spectroscopic techniques and apply it Examine new materials and to make novel drugs in the field of medicine.		

UNIT	Content	No. of Hours
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 –	13

	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.	
II	**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
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
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
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–Multi photon Processes – Laser Induced Fluorescence.	12
References	**Text Books (with chapter number & page number, wherever needed):** 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. 351–367Unit V: Chapter 15, Pages 383–403	

	Reference Books: 1. Valency and molecular structure, Cartmell,E and G.W.A. Fowels, ELB Sedition (1974) 2. Molecular spectroscopy, Graybeal , J.D, Mcgraw Hill, New York (1968) 3. Introduction to molecular energies and spectra, Harmony, M.D, Holt Rinehart and Winston Inc. (1972) 4. Spectroscopy Vol.I and II Straughen R.P and S. Walker, Chapman and Hall London (1976) 5. Molecular spectroscopy, G.Hertzberg (1950) 6.Spectroscopy and molecular structure G.W.King
Course Outcomes	**On completion of the course, students should be able to** CO1: Get the basic knowledge on abstract group theory and application of the same for symmetry operations. CO2: Form simple character tables and use it for the study of IR and raman activities. CO3: Understand the nature of electronic band spectra and analyse the same to get knowledge about the molecular parameters CO4: Learn the application of the concept of resonance in spectroscopy and study the chemical environment of any molecule to identify the structure of compounds CO5: Realize the possibility of non–linear effect with the help of lasers and to learn different laser sources

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	–	2	2	1	1	1
CO2	3	3	–	2	2	1	1	2
CO3	3	2	–	1	2	2	1	2
CO4	3	3	–	2	2	2	1	3
CO5	3	3	–	2	2	2	1	3

Mean = 72 /40 = 2.05

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	IV	Course Code	21PHYP0415
Course Title	**NUCLEAR AND PARTICLEPHYSICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	Core Course		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To know about the size, shape and the determinations the nuclei of fundamental elements. • It gives a interaction mechanism of sub atomic particles through scattering processes via quantum mechanical treatment. • To elucidate the fundamental interaction in elementary particles.		

UNIT	Content	No. of Hours
I	**GENERAL PROPERTIES OF ATOMIC NUCLEUS ANDTWO NUCLEON:** PROBLEM – Scattering methods – electromagnetic methods – nuclear shapes – electric moments magnetic moments.	12
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
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

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
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 and decapler – discovery of Omega.	12
References	**Text Books** 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 Nuclear Physics, D.C. Tayal, Himalaya Publishing (1980) Unit V : Pages 583 to 626 and 635 to 642.	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To give elementary idea of structure, size and shape of nucleus. **CO 2:** To apply quantum mechanics to nuclear problems. **CO 3:** To introduce classification of elementary particles, properties and conservation laws involved in elementary particles. **CO4:** To understand the compound nucleus – continuum theory of cross section. **CO5:** To understand the elementary particles.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	–	–	3	3	2	3	2
CO2	3	2	–	3	3	2	3	2
CO3	3	2	–	3	3	2	3	2
CO4	1	2	–	–	–	–	–	1
CO5	2	–	–	–	–	1	1	1

Mean = 52/20 = 2.6

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	**IV**	Course Code	**21PHYP0416**
Course Title	**ELECTROMAGNETICS AND WAVE PROPAGATION**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	Core Course		
Scope of the Course	• **Basic Skill** • **Skill Development**		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To impart the knowledge of Maxwell's equation, propagation of electromagnetic waves through various medias including waveguides and antennas.		

UNIT	Content	No. of Hours
I	**MAXWELL'S EQUATIONS :** The conservation of electric charge – The potentials V and vector A – Lorentz condition – divergence of vector E and the non – homogenous wave equation for V – The non homogenous wave equation for vector A –The curl of vector B – Maxwell's equations – Duality – Lorentz's lemma – The non– homogenous wave equations for vector E and vector B.	13
II	**PROPAGATION OF ELECTROMAGNETIC WAVES – I PLANE WAVES IN INFINITE MEDIA:** Plane electromagnetic waves in free space – The vector E and vector 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.	14
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 example.	14

IV	**PROPAGATION OF ELECTROMAGNETIC WAVES – IIIGUIDED 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
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
References	**Text Books (with chapter number & page number, wherever needed):** 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		
	Reference Books: 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, Addison – Wesley publishing company, 2^{nd} edition(2008). 5. Fundamentals of Electromagnetic Theory, W. Miah, McGraw–Hill–Education (1982).		
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Would have understood conservation of charges and wave equation for E and H. **CO 2:** Will be capable of understanding the EM wave propagation and energy flow. **CO 3:** Will have a sound knowledge of propagation of electromagnetic waves in different media. **CO 4:** Using the knowledge gained will be able to calculate parameters related to reflection, transmission and absorption. **CO 5:** The course permits students to understand the propagation of microwaves inside waveguides.		

Mapping of COs with PSOs:

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	–	1	2	2	1	1
CO2	3	2	–	1	2	2	2	1
CO3	3	1	–	–	2	1	2	2
CO4	3	2	–	–	2	2	1	1
CO5	3	2	–	2	2	2	2	1

Mean = 61/ 40 = 1.8

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>IV</td><td>Course Code</td><td>21PHYP0417</td></tr>
<tr><td>Course Title</td><td colspan="3">Practical – IV</td></tr>
<tr><td>No. of Credits</td><td>1</td><td>No. of contact hours per Week</td><td>3</td></tr>
<tr><td>New Course / Revised Course</td><td>Revised</td><td>If revised, Percentage of Revision effected
(Minimum 20%)</td><td>20%</td></tr>
<tr><td>Category</td><td colspan="3">Practical</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill / Advanced Skill
• Skill Development</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1: (Remember)
• K–2: (Understand)
• K–3: (Apply)
• K–4: (Analyze)
• K–5: (Evaluate)
• K–6: (Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
• To understand the perspective of physics by novel experiments in modern physics and material science.
• It provides a platform for understanding the thin film technology and characterization techniques.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">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</td><td></td></tr>
</table>

Semester	IV	Course Code	**21PHYP04M7**
Course Title	**INTRODUCTION TO EPR SPECTROSCOPY**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	**MODULAR COURSE – IV**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • **K–2: (Understand)** • **K–3: (Apply)** • **K–4: (Analyze)** • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To understand the molecular dynamics of paramagnetic crystals through EPR spectroscopy. • It provides to explore the impurity of the crystals and the nonlinear optical properties.		

UNIT	Content	No. of Hours
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.	16
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.	16

References	**Text Books** 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
	Reference Books 1. Molecular structure and spectroscopy, G. Aruldhas, Prentice Hall of India pvt ltd (2007)
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Understand the paramagentic resonance spectroscopy through definitions and illustrations. **CO 2:** To understand the behaviour of the probe ions in the crystal lattice through theoretical models and hence apply for few applications.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	1	–	2	1	2	2	2
CO2	3	1	–	2	1	2	2	2

Mean = 26 / 14= 1.85

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

Semester	IV	Course Code	**18PHYP04M8**
Course Title	**MATERIALS PREPARATION AND CHARACTERIZATION**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	5%
Category	**Modular course**		
Scope of the Course	• **Basic Skill / Advanced Skill** • **Skill Development** • **Value–Added Courses imparting transferable and life skills**		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The course will permit students to understand different methods of preparing materials and their characterization.		

UNIT	Content	No. of Hours
I	**UNIT I: MATERIALS PREPARATION:** Crystal growth – solution growth – Czchrolski – Bridgemen methods – Glasspreparation – Powder – solid state reaction – sol – gel – combustion techniques.	**16**
II	**UNIT II: MATERIALS CHARACTERIZATION:** XRD – FTIR – UV– Vis –NIR absorption – Photoluminescence – Decay measurements – DTA – TGA and DSC – SEM – EDX.	**16**
References	**Text Books (with chapter number & page number, wherever needed):** 1. Santahna Raghavan P and Ramasamy P, "Crystal growth: Proicesses and methods" KRU Publications, Kumbakonam . 2. Willard, Merritt, Dean and Settle, "Instrumental Method of Analysis", 6 the dition, CBS publishers, Delhi, 1986	
	Reference Books: 1. Bhat, H.L. "Introduction to crystal Growth: Principles and Practice" Taylor& Francis,2013.	

Course Outcomes	**On completion of the course, students should be able to do** **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.

Mapping of COs with PSOs:

PSO / CO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	3	–	–	3	–	2	1	3
CO2	3	–	–	2	1	2	2	2
CO3	3	–	–	1	1	1	1	3
CO4	3	–	–	2	–	2	1	2
CO5	3	2	–	2	2	–	2	2
CO6	3	3	–	2	–	3	1	3

Mean = 72/ 34 = 2.11

Strongly Correlated (S)	3 marks
Moderately Correlated (M)	2 marks
Weakly Correlated (W)	1 mark
No Correlation (N)	0 mark
Note: No course can have "0" (Zero) score	

<table>
<tr><td>Semester</td><td>I</td><td>Course Code</td><td>21PHYPVAC1</td></tr>
<tr><td>Course Title</td><td colspan="3">PHYSICS OF SENSORS AND TRANSDUCERS</td></tr>
<tr><td>No. of Credits</td><td>2</td><td>No. of contact hours per Week</td><td>2</td></tr>
<tr><td>New Course / Revised Course</td><td>New Course</td><td>If revised, Percentage of Revision effected (Minimum 20%)</td><td></td></tr>
<tr><td>Category</td><td colspan="3">Value Added Programme</td></tr>
<tr><td>Scope of the Course</td><td colspan="3">• Basic Skill/ Advanced Skill
• Skill Development
• Employability
• Entrepreneurship
• Value–Added Courses imparting transferable and life skills
• Field Placement / Field Project
• Internship</td></tr>
<tr><td>Cognitive Levels addressed by the Course</td><td colspan="3">• K–1:(Remember)
• K–2:(Understand)
• K–3:(Apply)
• K–4:(Analyze)
• K–5:(Evaluate)
• K–6:(Create)</td></tr>
<tr><td>Course Objectives (Maximum: 5)</td><td colspan="3">The Course aims to
1. Compare the sensor principles, classify the sensors and transducers and design a transducer to sense the physical quantity.</td></tr>
<tr><td>UNIT</td><td colspan="2">Content</td><td>No. of Hours</td></tr>
<tr><td>I</td><td colspan="2">PHYSICAL PRINCIPLES OF SENSORS AND DETECTORS: Capacitance – Magnetism – Induction – Resistance – Piezoelectric Effect – Pyroelectric Effect – Hall Effect – Thermoelectric Effects – Temperature and Thermal Properties of Materials – Heat Transfer – Ultrasonic Detectors – Microwave Motion Detectors – Linear Optical Sensors – Optoelectronic Motion Detectors – Optical Presence Sensors – Pressure–Gradient Sensors – Gesture Sensing – Tactile Sensors.</td><td>16</td></tr>
<tr><td>II</td><td colspan="2">TRANSDUCERS (PRINCIPLE AND DESIGN): Metal detector – Magnetostrictive detector – proximity detector – ablation transducer – cryogenic liquid level transducer – Tachometer – laser gyroscope – Inclinometer – Seismic transducer – piezoelectric accelerometer – pressure sensitive film – vacuum pressure gauge – ultrasonic flow transducer –Condenser microphone – optical microphone – optical hygrometer – oscillating hygrometer – soil moisture – image detector – UV detector – thermal radiation detector – Ionization detector – ceramic PTC transducer – chemical transducer –biological transducer.</td><td>16</td></tr>
</table>

References	**Text Books (with chapter number and page number, wherever needed):** Jacob Fraden, "Handbook of Modern Sensors – Physics, Designs, and Applications", Fifth Edition, Springer, 2016. UNIT BOOK CHAPTERS SECTIONS I 1 1, 2, 3 1.1, 1.2, 2.1–2.3, 3.1–3.3, 3.5–3.12, 3.16, 3.21 II 1 4 4.2–4.9, 4.11, 4.12. III 1 7 7.1, 7.2, 7.5, 7.8–7.13 IV 1 8, 9, 10 8.4.5, 8.4.8, 8.5.2, 8.6.1, 9.1.2, 9.2.3, 9.3.2, 9.3.3, 9.3.6, 10.3, 11.10, 12.4 V 1 13, 14, 15, 16, 17, 18 13.3, 13.5, 14.6–14.8, 15.6–15.8, 16.2, 17.4.5, 18.1–18.4, 18.9
	Reference Books: 1. Michael Stanley and Jongmin Lee, "Sensor Analysis", Morgan and Laypool publishers, 2018.
	E–Resources (URLs of e–books / You Tube videos / online learning resources, etc.) 1. https://www.nap.edu/read/4782/chapter/4 2. https://www–physics.lbl.gov/~spieler/TSI–2007/PDF/Sensor_Physics_I.pdf 3. https://www.elprocus.com/tilt–sensor–types–working–principle–and–its–applications/
Course Out comes	**On completion of the course, students should be able to** CO–1 Describe and discuss different signals. CO–2 List, explain and use different sensors and transducers. CO–3 Compare the sensor principles, classify the sensors and transducers and design a transducer to sense the physical quantity. CO–4 Identify and recommend suitable sensors and transducers to an instrument.

Semester	II	Course Code	21PHYPVAC2
Course Title	**PHYSICS OF CRYSTAL GROWTH AND THIN FILM**		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	New Course	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	• Foundation course • Others (Specify) Value Added Programme		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • **Entrepreneurship** • **Value–Added Courses imparting transferable and life skills** • **Field Placement /Field Project** • Internship		
Cognitive Levels addressed by the Course	• K–1:(Remember) • K–2:(Understand) • K–3:(Apply) • K–4:(Analyze) • K–5:(Evaluate) • K–6:(Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Acquire the knowledge about the fundamentals of nucleation and understand the various crystallization theories.		

UNIT	Content	No. of Hours
I	**CRYSTAL GROWTHL:** Growth of crystals from solutions– Crystal growth system – Solvents and Solutions – solubility – preparation of solution – Saturation and super saturation – Measurement and expression of super saturation– Slow cooling method– Crystal growth in Gels – Czochralski method – Bridgmann – Stockbarger method – Zone Melting Method –Vapour growth– direct vapour transport method, Chemical transport method – Solution and Solubility – Choice of Solvent – Additives – Nucleation – Achievement of Super saturation – Mason–Jar Method – Holden's Rotary Crystallizer – Temperature Differential Method – growth from silica gel – High temperature solution growth – Flux growth – Top seeded solution growth –Hydrothermal growth .	**16**

II	**THIN FILM DEPOSITION:** Evaporation method– Vacuum evaporation – Electron beam evaporation – DC diode sputtering – Magnetron sputtering – Reactive ion sputtering – RF sputtering – Pulsed Laser Deposition – Molecular Beam Epitaxy – Chemical vapour deposition – typical chemical reactions – reaction kinetics – transport phenomena – CVD methods – Metal Organic Chemical Vapour Deposition – Plasma enhanced chemical vapour deposition – Langmuir – Blodgett films – Electrochemical deposition – Sol–gel films.	**16**
References	**Text Books (with chapter number and page number, wherever needed):** 1. W Mullin, Butterworth–Heinemann, Crystallization, 4th edition, Oxford,2001. 2. H. L. Bhat, Introduction to crystal growth principles and practice, CRC Press Taylor & Francis Group, New York, 2015. 3. Hartmut Frey, Hamid R. Khan, Hand book of Thin–Film Technology,Springer–Verlag Berlin Heidelberg, 2015. 4. Guozhong Cao, Nanostructures and nano materials: synthesis, properties and applications, Imperial college press, London, Reprinted2006.	
	Reference Books: 1. Crystal growth processes and methods, P. Santhana Raghavan, P.Ramasamy, Kru Publications, Kumbakonam, India, 2000. 2. Handbook of thin film deposition, processes and techniques, Krishna Seshan, Noyes Publication, USA, 2nd edition 2002. 3. Handbook of Thin Film Technology, Leon I. Maissel, Reinhard Glang, McGraw Hill Higher Education, New York, 1970. 4. Kasturi L Chopra "Thin film phenomena", McGraw Hill, Newyork.	
Course Out comes	**On completion of the course, students should be able to** CO–1 Acquire the knowledge about the fundamentals of nucleation and understand the various crystallization theories. CO–2 Gain the knowledge of various crystal growth and thin film deposition techniques. CO–3 Understand the fundamental processing of different crystal growth and thin film techniques. CO–4 Analyze the different growth techniques and choose an appropriate technique to grow crystals and thin films.	