Preamble

The PG department of Physics aims to develop the potential of students through rigorous academic and practical exposure, field projects and robust industry interactions. Industrial visits, workshops, guest lectures and skill development programmes are conducted to hone the skills of students to suit the requirement of recruiters, thereby enhancing the career aspects of our students. We promote a nurturing environment to help our students in identifying their core competencies and refining them.

Vision

To build a foundation for excellence and encourage the development of the institution as a premier institution by igniting and promoting enthusiasm, interests and passion, in the study of Physics as a part of curriculum.

Mission

To awaken the young minds and discover their talents both in theory and in practical Physics, through dedication to teach, commitment towards students and innovative instructional methods like PPT and visual aids.

To develop strategy in the department for continuous improvement.

Programme Outcomes

PO No.	After completion of the Postgraduate programme the students of St. Mary's College will be able to
PO 1	acquire expertise knowledge in their respective disciplines and become professionals.
PO 2	develop critical/logical thinking skills, managerial skills and become locally, nationally & globally competent and be a lifelong learner
PO 3	pursue research / higher learning programme & apply their experiment and research skills to analyse and solve complex problems.
PO 4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO 5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Program Specific Outcomes:

PSO No	Students of M.Sc., Physics will be able to	PO Mapped
PSO 1	To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours, beliefs and apply diverse frames of reference to decisions and actions.	1
PSO 2	To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.	2
PSO 3	Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development.	3
PSO 4	To produce employable, ethical and innovative professionals to sustain in the dynamic business world.	4
PSO 5	To contribute to the development of the society by collaborating with stakeholders for mutual benefit.	5

ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI

Master of Science (Physics)

Course Structure (w. e. f 2023)

Semester – I

Components	Course Code	Course Title	Hours/ Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	23PPHC11	Mathematical Physics	7	5	25	75	100
Core II	23PPHC12	Classical Mechanics and Relativity	7	5	25	75	100
Core III	23PPHC13	Linear and Digital ICs and Applications	6	4	25	75	100
Core Practical I	23PPHCR1	Practical	6	3	40	60	100
Discipline Specific Elective I	23PPHE11 23PPHE12	**Crystal growth and Thin films**/ Energy Physics	4	3	25	75	100
		Total	**30**	**20**			

Semester – II

Components	Course Code	Course Title	Hours/ Week	Credits	Max. Marks		
					CIA	ESE	Total
Core IV	23PPHC21	Statistical Mechanics	5	5	25	75	100
Core V	23PPHC22	Quantum Mechanics I	5	5	25	75	100
Core Practical II	23PPHCR2	Electronics Practical	4(2+2)	2	40	60	100
Discipline Specific Elective II	23PPHE21/ 23PPHE23	**Advanced Optics**/ Advanced Mathematical Physics	4	3	25	75	100
Discipline Specific Elective III	23PPHE22/ 23PPHE24	**Microprocessor 8085 and Microcontroller 8051**/ Solar Energy Utilization	4	3	25	75	100
Core/Elective Practical III	23PPHCR3	Non Electronics Practical	4(2+2)	2	40	60	100
Skill Enhancement Course I	23PPHSE1	Aptitude Physics	4	2	25	75	100
			30	**22**			

Semester – III

Components	Course Code	Course Title	Hours /Week	Credits	Max. Marks		
					CIA	ESE	Total
Core VI	23PPHC31	Quantum Mechanics II	5	5	25	75	100
Core VII	23PPHC32	Electromagnetic Theory	5	5	25	75	100
Core VIII	23PPHC33	Solid State Physics I	4	4	25	75	100
Core Practical IV	23PPHCR4	Microprocessor and Microcontroller Practical	4	2	40	60	100
Core Practical V	23PPHCR5	Programming in C++ Practical	4	2	40	60	100
Discipline Specific Elective IV	23PPHE31/ 23PPHE32	**Physics of Nano Science and Technology**/ Communication Electronics	4	3	25	75	100
Skill Enhancement Course II	23PPHSE2	Numerical Methods and C++	4	3	25	75	100
Internship /Self Study	23PPHI31/ 23PPHSS1	Physics for Lectureship		+2			
			30	**24+2**			

Semester – IV

Components	Course Code	Course Title	Hours/ Week	Credits	Max. Marks		
					CIA	ESE	Total
Core IX	23PPHC41	Spectroscopy	5	5	25	75	100
Core X	23PPHC42	Nuclear and Particle Physics	5	5	25	75	100
Core XI	23PPHC43	Solid State Physics II	5	5	25	75	100
Core Practical VI	23PPHCR6	Microprocessor and C++ Practical	4	2	40	60	100
Discipline Specific Elective V	23PPHE41/ 23PPHE42	**Characterization of Materials**/ Medical Physics	4	3	25	75	100
Core XII (Project)	23PPHP41	Project and Viva Voce	7	4	40	60	100
			30	**24**			

Note:

1. It is mandatory for all I PG students to complete a MOOC course in the Swayam NPTEL Portal. Two credits will be awarded to the students who successfully pass the MOOC course in the Portal. Students who fail to pass in their first and second attempts via the Swayam NPTEL Portal will be eligible to take a supplementary exam given by the college for which one credit will be given.
2. Internship can be completed during the second semester vacation.

Semester	Hours	Credits	Extra Credits
I	30	20	--
II	30	22	2
III	30	24	2
IV	30	24	--
Total	120	90	4

Master of Science (Physics)

Courses	Number of Courses	No. of Hours	Credits	Extra Credits
Core Theory	11	59	53	--
Core Practical	6	26	13	--
Discipline Specific Elective	5	20	15	--
Group Project	1	7	4	--
Skill Enhancement Course	2	8	5	--
MOOC (Compulsory)	1	--	-	2
Internship/Self Study Paper (Optional)	1	--	-	2
Total		**120**	**90**	**4**

SEMESTER - I			
Core I - MATHEMATICAL PHYSICS			
Course Code: 23PPHC11	**Hrs/Week: 7**	**Hrs/Semester: 105**	**Credits:5**

OBJECTIVES:

- To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
- To extend their manipulative skills to apply mathematical techniques in their fields
- To help students apply Mathematics in solving problems of Physics.

COURSE OUTCOMES:

CO No.	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	K1
CO 2	Understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	K2
CO 3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	K3
CO 4	Solve equations using Laplace transform and analyse the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	K4
CO 5	Find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	K5

SEMESTER - I			
CORE I - MATHEMATICAL PHYSICS			
Course Code: 23PPHC11	**Hrs/Week: 7**	**Hrs/Semester: 105**	**Credits:5**

UNIT I: LINEAR VECTOR SPACE

Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure –linear operators – Dual space-ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation.

UNIT II: COMPLEX ANALYSIS

Review of Complex Numbers -de Moivre's theorem - Functions of a Complex Variable- Differentiability - Analytic functions - Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials -Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders

UNIT III: MATRICES

Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices - Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem –Diagonalization

UNIT IV: FOURIER TRANSFORMS & LAPLACE TRANSFORMS

Definitions - Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function - Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string.

Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions - Application - Laplace equation:Potential problem in a semi - infinite strip

UNIT V: DIFFERENTIAL EQUATIONS

Second order differential equation – Sturm - Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function – Rodrigue formula – Orthogonality properties –Dirac delta function – One dimensional Green's function and Reciprocity Theorem- Sturm - Liouville's type equation in one dimension & their Green's function

TEXT BOOKS:

1. George Arfken and Hans J Weber, 2012, *Mathematical Methods for Physicists – AComprehensive Guide* (7th edition), Academic press.
2. P.K.Chattopadhyay, 2013, *Mathematical Physics* (2nd edition), New Age, New Delhi
3. AWJoshi,2017,*Matrices and Tensors in Physics*, 4th Edition (Paperback), New AgeInternational Pvt. Ltd., India
4. B. D. Gupta, 2009, *Mathematical Physics* (4th edition),Vikas Publishing House, New Delhi.
5. H.K.Dass and Dr.Rama Verma, 2014, *Mathematical Physics*, Seventh Revised Edition, S.Chand & Company Pvt. Ltd., New Delhi

BOOKS FOR REFERENCE:

1. E.Kreyszig,1983,Advanced Engineering Mathematics,Wiley Eastern, New Delhi,
2. D.G.Zilland M.R.Cullen,2006,Advanced Engineering Mathematics, 3rd Ed. Narosa,New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, NewYork
4. E.Butkov,1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
5. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, AffiliatedEast West, New Delhi.
6. C.R.Wylie and L.C.Barrett,1995,Advanced Engineering Mathematics,6th Edition,International Edition, McGraw-Hill, New York

WEB SOURCES:

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath.
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	2	3	3	3	3	3
CO-2	3	2	3	3	2	2	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	2	3
CO-4	3	3	3	3	2	3	3	3	3	2
CO-5	3	3	3	3	3	3	2	3	3	2
Ave.	3	2.8	3	3	2.4	2.8	2.8	3	2.8	2.6

SEMESTER - I			
CORE II - CLASSICAL MECHANICS AND RELATIVITY			
Code : 23PPHC12	**Hrs/Week: 7**	**Hrs/Semester: 105**	**Credits:5**

OBJECTIVES:

- To understand fundamentals of classical mechanics.
- To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.
- To understand Hamiltonian formulation of mechanics and apply it to solve equationof motion.
- To discuss the theory of small oscillations of a system.
- To learn the relativistic formulation of mechanics of a system.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Understand the fundamentals of classical mechanics.	K1
CO 2	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K2
CO 3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3
CO 4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K4
CO 5	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K5

SEMESTER - I			
CORE II - CLASSICAL MECHANICS AND RELATIVITY			
Code : 23PPHC12	**Hrs/Week: 7**	**Hrs/Semester: 105**	**Credits:5**

UNIT I: PRINCIPLES OF CLASSICAL MECHANICS

Mechanics of a single particle – mechanics of a system of particles –conservation laws for a system of particles – constraints – holonomic & amp; non-holonomic constraints – generalized coordinates –configuration space – transformation equations – principle of virtual work.

UNIT II: LAGRANGIAN FORMULATION

D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.

UNIT III: HAMILTONIAN FORMULATION

Phase space – cyclic coordinates – conjugate momentum –Hamiltonian function – Hamilton's canonical equations of motion –applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.

UNIT IV: SMALL OSCILLATIONS

Formulation of the problem – transformation to normal coordinates –frequencies of normal nodes – linear triatomic molecule.

UNIT V: RELATIVITY

Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities– Einstein's mass-energy relation – Minkowski's space – four vectors– position, velocity, momentum, acceleration and force in for vector notation and their transformations.

TEXTBOOKS

1. H. Goldstein, 2002, *Classical Mechanics*, 3rd Edition, Pearson Edu.
2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publishing. Co. New Delhi.
3. R. Resnick, 1968, *Introduction to Special Theory of Relativity*, Wiley Eastern, New Delhi.
4 R. G. Takwala and P.S. Puranik, *Introduction to Classical Mechanics* –Tata – McGraw Hill, New Delhi, 1980.
5. N. C. Rana and P.S. Joag, *Classical Mechanics* - Tata McGraw Hill, 2001

REFERENCE BOOKS

1. K. R. Symon, 1971, *Mechanics*, Addison Wesley, London.
2. S. N. Biswas, 1999, *Classical Mechanics*, Books & Allied, Kolkata.
3. Gupta and Kumar, *Classical Mechanics*, Kedar Nath.
4. T.W.B. Kibble, *Classical Mechanics*, ELBS.
5. Greenwood, *Classical Dynamics*, PHI, New Delhi.

WEB SOURCES

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html 3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5. https://www.britannica.com/science/relativistic-mechanics

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	2	3	3	3	3	3	3
CO-4	3	3	1	2	2	3	3	3	3	3
CO-5	3	3	2	1	1	2	2	2	2	2
Ave.	3	2.8	2	2.2	2.4	2.8	2.8	2.8	2.8	2.8

SEMESTER - I			
CORE III - LINEAR AND DIGITAL ICs AND APPLICATIONS			
Course Code: 23PPHC13	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits:4**

OBJECTIVES

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital IC‘s

COURSE OUTCOMES:

CO No.	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Gain knowledge about PLL and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	K1
CO 2	Learn about various techniques to develop A/D and D/A converters.	K2
CO 3	Develop skills to design linear and non linear applications circuits using Op-Amp and design the active filters circuits.	K3
CO 4	Acquire the knowledge about the CMOS logic, combinational and sequential Circuits	K4
CO 5	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	K5

SEMESTER - I			
CORE III - LINEAR AND DIGITAL ICs AND APPLICATIONS			
Course Code: 23PPHC13	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits:4**

UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER

Introduction- Classification of IC's- basic information of Op-Amp 741 and its features- the ideal Operational amplifier- Op-Amp internal circuit and Op-Amp Characteristics.

UNIT II: APPLICATIONS OF OP-AMP

LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations - Instrumentation amplifiers - V to I and I to V converters.

NON-LINEAR APPLICATIONS OF OP - AMP: Sample and Hold circuit- Log and Antilog amplifier- multiplier and divider-Comparators, Schmitt trigger-Multivibrators - Triangular and Square wave form generators.

UNIT III: ACTIVE FILTERS &TIMER AND PHASE LOCKED LOOPS

ACTIVE FILTERS: Introduction- Butterworth filters – 1st order, 2nd order low pass andhigh pass filters, band pass, band reject and all pass filters.

TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description offunctional diagram-monostable and astable operations and applications-Schmitt trigger, PLL – introduction- basic principle- phase detector/comparator- voltage controlled oscillator (IC566), low pass filter-monolithic PLL and applications of PLL

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS

VOLTAGE REGULATOR: Introduction- Series Op-Amp regulator - IC Voltage Regulators- IC723 general purpose regulators- Switching Regulator-D to A & A to D CONVERTERS: Introduction- basic DAC techniques -weighted resistor DAC- R-2R ladder DAC- inverted R-2R DAC- A to D converters -parallel comparator type ADC- counter type ADC- successive approximation ADC and dual slope ADC- DAC and ADC Specifications

UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs

CMOS LOGIC: CMOS logic levels - MOS transistors- Basic CMOS Inverter-NAND and NOR gates-CMOS AND-OR-INVERT and OR-AND-INVERT gates- implementation of anyfunction using CMOS logic.

COMBINATIONAL CIRCUITS USING TTL 74XXICs: Study of logic Gates using 74XXICs, Four-bit parallel adder (IC7483)-Comparator (IC7485)- Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447)-Encoder (IC74147)- Multiplexer (IC74151)- Demultiplexer (IC 74154).

SEQUENTIAL CIRCUITS USING TTL 74XXICs: Flip Flops (IC7474, IC7473), Shift

Registers, Universal Shift Register (IC74194)-4-bit asynchronous binary counter (IC 7493).

TEXT BOOKS

1. D. Roy Choudhury, Shail B. Jain (2012), *Linear Integrated Circuit*, 4th edition, New Age International Pvt. Ltd. ,New Delhi, India
2. Ramakant A. Gayakwad, (2012), *OP-AMP and Linear Integrated Circuits*, 4th edition, Prentice Hall / Pearson Education, NewDelhi.
3. B.L. Theraja and A.K. Theraja, 2004, *A Textbook of Electrical technology*, S. Chand& Co.
4. V.K. Mehta and Rohit Mehta, 2008, *Principles of Electronics*, S. Chand & Co, 12th Edition.
5. V. Vijayendran, 2008, *Introduction to Integrated electronics (Digital & Analog)*, S.Viswanathan Printers & Publishers Private Ltd,Reprint. V.

REFERENCE BOOKS

1. Sergio Franco(1997), *Design with operational amplifiers and analog integratedcircuits*, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), *Analysis and Design of Analog Integrated Circuits*, Wiley International, New Delhi.
3. Malvino and Leach (2005), *Digital Principles and Applications* 5thEdition, Tata McGrawHill, New Delhi
4. Floyd,Jain (2009), *Digital Fundamentals*,8thedition,PearsonEducation, New Delhi.
5. Millman & Halkias (2000) *Integrated Electronics*, Tata McGrawHill, 17thReprint

WEB SOURCES

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	3	3	2	3	3	3	3	3
CO-2	3	3	3	3	3	3	2	3	3	3
CO-3	3	2	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	2.6	3	3	2.8	3	2.8	3	3	3

SEMESTER I			
Core Practical I	**PRACTICAL**		
Course Code: 23PPHCR1	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits:3**

OBJECTIVES

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Acquire knowledge of thermal and magnetic behaviour of the materials.	K1
CO 2	Understand the strength of material using Young's modulus.	K2
CO 3	Improve the analytical and observation ability in Physics Experiments	K3
CO 4	Apply knowledge of arithmetic and logical circuits using IC's , Combinational Logic Circuits and Sequential Logic Circuits	K4
CO 5	Analyze the applications of counters and registers	K5

SEMESTER - I			
Core Practical I	**PRACTICAL**		
Code: 23PPHCR1	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits:3**

(Minimum of Twelve Experiments from the list)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes- Cornu's Method
2. Determination of Viscosity of the given liquid – Meyer's disc
3. Measurement of Coefficient of linear expansion- Air wedge Method
4. B-H loop using Anchor ring.
5. Determination of Thickness of the enamel coating on a wire by diffraction
6. Determination of Rydberg's Constant - Hydrogen Spectrum
7. Thickness of air film - FP Etalon
8. Measurement of Band gap energy- Thermistor
9. Determination of Specific charge of an electron – Thomson's method.
10. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
11. GM counter – Characteristics and inverse square law.
12. Measurement of Conductivity - Four probe method.
13. Molecular spectra – ALO band.
14. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
15. Measurements of Standing wave and standing wave co - efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
16. UV-Visible spectroscopy–Verification of Beer Lambert's law and identification of wavelength maxima – Extinction coefficient
17. Construction of relaxation oscillator using UJT
18. FET CS amplifier- Frequency response, input impedance, output impedance
19. Study of important electrical characteristics of IC741.
20. V- I Characteristics of different colours of LED.
21. Study of attenuation characteristics of Wien's bridge network and design of Wien's b ridge oscillator using Op-Amp.
22. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
23. Construction of Schmidt trigger circuit using IC741 for a given hysteresis-application as squarer.
24. Construction of square wave Triangular wave generator using IC 741
25. Construction of a quadrature wave using IC 324
26. Construction of pulse generator using the IC 741 – application as frequency divider
27. Study of R-S, clocked R-S and D-Flip flop using NAND gates
28. Study of J-K, D and T flip flops using IC 7476/7473

29. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
30. Study of Arithmetic logic unit using IC 74181.

TEXT BOOKS

1. Gupta and Kumar, *Practical Physics*, Pragati Prakasan.
2. R. Srinivasan K. R Priolkar, *Kit Developed for doing experiments in Physics- Instruction manual*, Indian Academy of Sciences.
3. S. Poornachandra, B. Sasikala, *Electronic Laboratory Primer a design approach* Wheeler Publishing, New Delhi.
4. K A Navas, *Electronic lab manual Vol I*, Rajath Publishing.
5. K A Navas, *Electronic lab manual Vol II*, PHI eastern Economy Edition

BOOKS For REFERENCE

1. Advanced Practical Physics, S.P Singh, Pragati Prakasan.
2. Anadvanced course in Practical Physics, D. Chattopadhayay, C. R Rakshit, New Central Book Agency Pvt. Ltd
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley &Sons (Asia) Pvt. Ltd.
5. Electronic lab manual Vol II, Kuriachan T. D, Syam Mohan, Ayodhya Publishing.

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	3	3	3	3	3	3	3	3	3

SEMESTER - I			
DISCIPLINE SPECIFIC ELECTIVE I – CRYSTAL GROWTH AND THIN FILMS			
Course Code: 23PPHE11	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

OBJECTIVES

- To acquire the knowledge on Nucleation and Kinetics of crystal growth
- To understand the Crystallization Principles and Growth techniques
- To study various methods of Crystal growth techniques
- To understand the thin film deposition methods
- To apply the techniques of Thin Film Formation and thickness Measurement

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
CO 2	Understand the Crystallization Principles and Growth techniques	K2
CO 3	Study various methods of Crystal growth techniques	K3
CO 4	Develop the knowledge of Thin film deposition methods	K4
CO 5	Apply the techniques of Thin Film Formation and thickness Measurement	K5

SEMESTER - I			
DISCIPLINE SPECIFIC ELECTIVE I – CRYSTAL GROWTH AND THIN FILMS			
Course Code: 23PPHE11	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

UNIT I: CRYSTAL GROWTH KINETICS

Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation- Formation of critical Nucleus -Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth- Growth mechanism and classification -Kinetics of growth of epitaxial films

UNIT II: CRYSTALLIZATION PRINCIPLES

Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram -Super solubility - expression for super saturation - Metastable zone and introduction period- Miers TC diagram - Solution growth - Low and high temperatures solution growth-Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.

UNIT III: GEL, MELT AND VAPOUR GROWTH

Gel, Melt and Vapour growth techniques Principle of Gel techniques -Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth – Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth –Hydrothermal growth -Vapour phase growth-Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

UNIT IV: THIN FILM DEPOSITION METHODS

Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemica lbath deposition.

UNIT V: THIN FILM FORMATION

Thin Film Formation and thickness Measurement Nucleation, Film growth and structure-Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Role of substrate, Role of film thickness, Film thickness measurement-Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.

TEXT BOOKS

1. V. Markov *Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth andEpitaxy* (2004) 2nd edition
2. A. Goswami, *Thin Film Fundamentals* (New Age, New Delhi, 2008)
3. M. Ohora and R.C. Reid, "*Modeling of Crystal Growth Rates from Solution*"
4. D. Elwell and H. J. Scheel, "*Crystal Growth from High Temperature Solution*"
5. Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.

BOOKS for REFERENCE

1. J.C. Brice, *Crystal Growth Process* (John Wiley, New York, 1986)
2. P. Ramasamy and F.D. Gnanam, 1983, "*UGC Summer School notes*
3. P. Santhana Raghavan and P. Ramasamy, "*Crystal Growth Processes*", KRU Publications.
4. H.E. Buckley, 1951, *Crystal Growth*, John Wiley and Sons, New York
5. B.R. Pamplin, 1980, *Crystal Growth*, Pergman Press, London.

WEB SOURCES

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER - I			
DISCIPLINE SPECIFIC ELECTIVE II – ENERGY PHYSICS			
Course Code: 23PPHE12	**Hrs/Week: 3**	**Hrs/Semester: 45**	**Credits:3**

OBJECTIVES

- To learn about various renewable energy sources.
- To know the ways of effectively utilizing the oceanic energy.
- To study the method of harnessing wind energy and its advantages.
- To learn the techniques useful for the conversion of biomass into useful energy.
- To know about utilization of solar energy

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Identify various forms of renewable and non-renewable energy sources	K1
CO 2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	K2
CO 3	Discuss the working of a windmill and analyze the advantages of wind energy.	K3
CO 4	Distinguish aerobic digestion process from anaerobic digestion.	K4
CO 5	erify the components of solar radiation, their measurement and select them to utilize solar energy.	K5

SEMESTER - I			
DISCIPLINE SPECIFIC ELECTIVE II – ENERGY PHYSICS			
Course Code: 23PPHE12	**Hrs/Week: 3**	**Hrs/Semester: 45**	**Credits:3**

UNIT I: INTRODUCTION TO ENERGY SOURCES

Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution

UNIT II: ENERGY FROM THE OCEANS

Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems

UNIT III: WIND ENERGY SOURCES

Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy

UNIT IV: ENERGY FROM BIOMAS

Biomass conversion Technologies– wet and dry process– Photosynthesis - Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion– factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas- utilization of biogas.

UNIT V: SOLAR ENERGY SOURCES

Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar Pond and its applications.

TEXT BOOKS

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.

2. S. Rao and Dr. ParuLekar, Energy technology.

3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).

4. Solar energy, principles of thermal collection and storage by S.P.Sukhatme, 2 ndedition, Tata McGraw-

Hill Publishing Co. Lt., New Delhi (1997).

5. Energy Technology by S.Rao and Dr.Parulekar.

REFERENCE BOOKS

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.

2. Applied solar energy, A.B.MeinelandA.P.Meinal

3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York.

4. Renewal Energy Technologies: A Practical Guide for Beginners C.S. Solanki-PHI Learning

5. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications

WEB SOURCES

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2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	2	3	3	3	2	2	3	3	3	2
CO-2	2	3	3	3	2	2	3	3	3	2
CO-3	2	3	3	3	2	2	3	3	3	2
CO-4	2	3	3	3	2	2	3	3	3	2
CO-5	2	3	3	3	2	2	3	3	3	2
Ave.	2	3	3	3	2	2	3	3	3	2

SEMESTER - II			
CORE IV - STATISTICAL MECHANICS			
Course Code: 23PPHC21	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits:5**

OBJECTIVES

- To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics
- To identify the relationship between statistic and thermodynamic quantities
- To comprehend the concept of partition function, canonical and grand canonical ensembles
- To grasp the fundamental knowledge about the three types of statistics
- To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

COURSE OUTCOMES:

CO No.	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermo dynamical quantities and partition function	K1
CO 2	Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	K2
CO 3	To discuss and examine the thermo dynamical behaviour of gasesunder fluctuation and also using Ising model	K3
CO 4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	K4
CO 5	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K5

SEMESTER - II			
CORE IV - STATISTICAL MECHANICS			
Course Code: 23PPHC21	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits:5**

UNIT I: PHASE TRANSITIONS

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule – Phase transitions and Ehrenfest's classifications – Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT II: STATISTICAL MECHANICS ANDTHERMODYNAMICS

Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT III: CANONICAL ANDGRAND CANONICAL ENSEMBLES

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

UNIT IV: CLASSICAL AND QUANTUM STATISTICS

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles – Maxwell -Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas –Degeneracy - Bose - Einstein statistics-Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

UNIT V: REAL GAS, ISING MODEL AND FLUCTUATIONS

Cluster expansion for a classical gas-Virial equation of state–Calculation of the first Virial coefficient in the cluster expansion – Ising model – Mean – field theories of the Ising model in three, two and one dimensions – Exact solutions in one dimension. Correlation of space- time dependent fluctuations –Fluctuations and transport phenomena-Brownian motion-Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation

TEXT BOOKS

1. S. K. Sinha, 1990, *Statistical Mechanics*, Tata McGraw Hill, New Delhi.
2. B. K. Agarwal and M. Eisner, 1998, *Statistical Mechanics*, Second Edition New Age International, New Delhi.
3. J. K. Bhattacharjee, 1996, *Statistical Mechanics*: An Introductory Text, Allied Publication, New Delhi.
4. F. Reif, 1965, *Fundamentals of Statistical and Thermal Physics*, McGraw -Hill, New York.
5. M. K. Zemansky, 1968, *Heat and Thermodynamics*, 5thedition, McGraw-Hill New York.

REFERENCEBOOKS

1. R. K. Pathria, 1996, *Statistical Mechanics*, 2nd edition, Butter Worth Heinemann, New Delhi.
2. L.D. Landau and E.M. Lifshitz, 1969, *Statistical Physics*, Pergamon Press, Oxford.
3. K. Huang, 2002, *Statistical Mechanics*, Taylor and Francis, London
4. W.Greiner, L.Neise and H.Stoecker, *Thermodynamics and Statistical Mechanics*, Springer Verlang, New York.
5. A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata.

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1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html3.
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	2	3	2	1	3	3	3	2	2
CO-2	3	2	2	2	2	3	3	2	2	3
CO-3	3	2	2	2	1	3	2	2	3	3
CO-4	3	2	2	2	2	3	2	3	2	3
CO-5	3	3	2	1	1	3	3	2	3	3
Ave.	3	2.2	2.2	1.8	1.4	3	2.6	2.4	2.4	2.8

SEMESTER - II			
CORE V - QUANTUM MECHANICS I			
Course Code: 23PPHC22	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits:4**

OBJECTIVES:

- To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
- To describe the propagation of a particle in a simple, one-dimensional potential.
- To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational andWKB methods for solving the Schrödinger equation.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Demonstrate a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1
CO 2	Apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K2
CO 3	Discuss the various representations, space formulations of time evolution	K3
CO 4	Formulate and analyze the approximation methods for various quantum mechanical problems	K4
CO 5	Apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K5

SEMESTER - II			
CORE V- QUANTUM MECHANICS I			
Course Code: 23PPHC22	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits:4**

UNIT I: BASIC FORMALISM

Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation.

UNIT II: ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator

UNIT III: GENERAL FORMALISM

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

UNIT IV: APPROXIMATIO N METHODS

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.

UNIT V: ANGULAR MOMENTUM

Eigen value spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

TEXT BOOKS:

1. P. M. Mathews and K. Venkatesan, *A Text book of Quantum Mechanics*, 2nd Edition (37th Reprint),Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, *Quantum Mechanics*, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, *Introduction to Quantum Mechanics*. 4th edition, Pearson, 2011.
4. SL Gupta and ID Gupta, *Advanced Quantum Theory and Fields*, 1st Edition, S.Chand& Co., New Delhi, 1982.

5. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications,* 4thEdition, Macmillan, India, 1984.

Books for Reference:

1. E. Merzbacher, *Quantum Mechanics*, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, *Quantum Mechanics*, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L. D. Landau and E. M. Lifshitz, *Quantum Mechanics*, 1st edition, Pergomon Press, Oxford, 1976.
4. S. N. Biswas, *Quantum Mechanics*, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, *Quantum Mechanics*, 2nd edition, Alpha Science International Ltd,Oxford , 2011

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2. http://www.feynmanlectures.caltech.edu/III_20.html
3. http://web.mit.edu/8.05/handouts/jaffe1.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/ Lecture_ 1.pdf
   https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	2	3	3	3	3	3
CO-2	3	2	3	3	2	3	3	2	3	3
CO-3	3	3	3	3	3	3	2	3	3	3
CO-4	3	3	3	3	2	2	2	2	3	3
CO-5	3	3	3	3	3	2	1	2	3	3
Ave.	3	2.8	3	3	2.4	2.6	2.2	2.4	3	3

SEMESTER - II			
CORE PRACTICAL II	**ELECTRONICS PRACTICAL**		
Course Code :23PPHCR2	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

OBJECTIVES:

- To analyze the electrical properties of materials.
- To observe the applications of FET and UJT.
- To study the different applications of operational amplifier circuits.
- To learn about Combinational Logic Circuits and Sequential Logic Circuits

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Recall various parameters related to operational amplifiers	K1
CO 2	Understand the concepts involved in arithmetic and logical circuits using IC's	K2
CO 3	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K3
CO 4	Analyze the applications of counters and registers	K4
CO 5	Conduct experiments on applications of FET and UJT	K5

SEMESTER - II			
CORE PRACTICAL II	**ELECTRONICS PRACTICAL**		
Course Code :23PPHCR2	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

(Any seven experiments)

1. Determination of I-V Characteristics and efficiency of solar cell
2. GM counter – Absorption coefficient – Maximum range of β rays
3. IC 7490 as scalar and seven segment display using IC7447
4. Solving simultaneous equations – IC 741 / IC LM324
5. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter
6. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
7. Construction of second order butter worth multiple feedback narrow band pass filter.
8. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
9. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer
10. Construction of pulse generator using the IC 555 – Application as frequency divider
11. BCD to Excess- 3 and Excess 3 to BCD code conversion
12. Study of binary up / down counters - IC 7476 / IC7473
13. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474

TEXTBOOKS

1. Practical Physics, Gupta and Kumar, PragatiPrakasan
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

REFERENCE BOOKS

1. An advanced course in Practical Physics, D.Chattopadhayay, C.RRakshit, New Central Book Agency Pvt. Ltd
2. Advanced Practical Physics, S.P Singh, Pragati Prakasan
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt.ltd
4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.
5. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	2	1	3	3	3	3	3
CO-4	3	3	1	1	1	3	3	3	3	3
CO-5	3	3	2	1	1	2	2	2	2	2
Ave.	3	2.8	2	2	1.8	2.8	2.8	2.8	2.8	2.8

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE II ADVANCED OPTICS			
Course Code: 23PPHE21	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

OBJECTIVES

- To know the concepts behind polarization and could pursue research work on application aspects of laser
- To impart an extensive understanding of fiber and non-linear optics
- To study the working of different types of LASERS
- To differentiate first and second harmonic generation
- Learn the principles of magneto-optic and electro-optic effects and its applications

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Discuss the transverse character of light waves and different polarization phenomenon	K1
CO 2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K2
CO 3	Demonstrate the basic configuration of a fiber optic–communication system and advantages	K3
CO 4	Identify the properties of nonlinear interactions of light and matter	K4
CO 5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	K5

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE II ADVANCED OPTICS			
Course Code: 23PPHE21	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

UNIT I: POLARIZATIONAND DOUBLE REFRACTION

Classification of polarization – Transverse character of light waves–Polarizer and analyzer – Malu's law – Production of polarized light–Wire grid polarizer and the polaroid– Polarization by reflection–Polarization by double refraction–Polarization by scattering–The phenomenon of double refraction–Normal and oblique incidence– Interference of polarized light: Quarter and half wave plates–Analysis of polarized light – Optical activity.

UNIT II: LASERS

Basic principles–Spontaneous and stimulated emissions–Components of the laser– Resonator and lasing action–Types of lasers and its applications–Solid state lasers–Ruby laser–Nd: YAG laser–gas lasers –He-Ne laser–CO_2 laser–Chemical lasers–HCl laser– Semiconductor laser

UNIT III: FIBER OPTICS

Introduction – Total internal reflection – The optical fiber – Glass fibers –The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multi mode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers–Fiber-optic sensors: precision displacement sensor– Precision vibration sensor

UNIT IV: NON-LINEAR OPTICS

Basic principles–Harmonic generation–Second harmonic generation–Phase matching– Third harmonic generation–Optical mixing– Parametric generation of light – Self-focusing of light

UNIT V: MAGNETO-OPTICSAND ELECTRO-OPTICS

Magneto-optical effects–Zeeman effect–Inverse Zeeman effect–Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect –Electric double refraction–Kerr electro-optic effect– Pockels electro-optic effect

TEXT BOOKS

1. B.B. Laud, 2017, *Lasers and Non–Linear Optics*, 3rdEdition ,New Age International (P) Ltd.
2. Ajoy Ghatak, 2017, *Optics*, 6th Edition, McGraw–Hill Education Pvt. Ltd.
3. William T. Silfvast, 1996, *Laser Fundamentals* Cambridge University Press, New York

4. J. Peatros, *Physics of Light and Optics*, a good (and free!) electronic book
5. B. Saleh, and M. Teich, *Fundamentals of Photonics*, Wiley-Inter science

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1. F.S. Jenkins and H.E. White, 1981, *Fundamentals of Optics*,(4th Edition), McGraw – Hill International Edition.
2. Dieter Meschede, 2004, Optics, *Light and Lasers*,Wiley–VCH,Varley GmbH.
3. Lipson, S.G. Lipson and H. Lipson, 011, *Optical Physics*,4th Edition, Cambridge University Press, New Delhi, 2011.
4. Y. B. Band, *Light and Matter*, Wiley and Sons (2006)
5. R. Guenther, *Modern Optics*, Wiley and Sons (1990)

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3. https://www.ukessays.com/essays/physics/fiber–optics–and–it-applications.php
4. https://www.youtube.com/watch?v=0kEvr4DKGRI
5. http://optics.byu.edu/textbook.aspx

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	3	3	3	3	2	3
CO-2	3	3	3	2	3	3	3	3	2	3
CO-3	3	3	3	2	3	3	3	3	2	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	3	3	2.4	3	3	3	3	2.4	3

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE II ADVANCED MATHEMATICAL PHYSICS			
Course Code: 23PPHE23	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

OBJECTIVES

- To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Gain knowledge of both discrete and continuous groups	K1
CO 2	Develop skills to apply group theory and tensors to peruse research	K2
CO 3	Apply various important theorems in group theory	K3
CO 4	Equip to solve problems in tensors	K4
CO 5	Construct group multiplication table, character table relevant to important branches of physics.	K5

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE II ADVANCED MATHEMATICAL PHYSICS			
Course Code: 23PPHE23	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

UNIT I: DISCRETE GROUPS

Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.

UNIT II: CONTINUOUS GROUPS

Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.

UNIT III: SPECIAL UNITARY GROUPS

Definition of unitary, unimodular groups SU(2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)- Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the irreducible representations 3.3*-, 6,6 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G.coefficients for 3 x 3* and 3 x 6 representations. SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.

UNIT IV: TENSORS

Cartesian vectors and tensors illustration with moment of inertia, conductivity, dielectric tensors. Four vector in special relativitity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and 99 tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.

UNIT V: TENSOR CALCULUS

Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0. Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation G=0.

TEXT BOOKS

1. A.W.Joshi, Group Theory for Physicists

2. D.B.Lichtenberg, Unitary Symmetry and Elementary Particles

3. E.Butkov, Mathematical Physics

4. J.V.Narlikar, General Relativity & Cosmology

5. R. Geroch, M, Mathematical Physics, The University of Chicago press (1985)

REFERENCE BOOKS

1. M.Hamermesh Group Theory

2. M.E.Rose: Elementary Theory of Angular Momentum

3. Georgi : Lie Groups for Physicists

4. E.A.Lord: Tensors, Relativity & Cosmology

5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry,

Cambridge University Press

WEB SOURCES

1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles c4qsfejthkc0

2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf

3. https://www.hindawi.com/journals/amp/

4. https://projecteuclid.org/journals/advances-in-theoretical-and mathematical-physics

5. https://www.springer.com/journal/11232

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	2	2	2	3	3	2	2	2
CO-2	3	3	2	2	2	3	3	2	2	2
CO-3	3	3	2	2	2	3	3	2	2	2
CO-4	3	3	2	2	2	3	3	2	2	2
CO-5	3	3	2	2	2	3	3	2	2	2
Ave.	3	3	2	2	2	3	3	2	2	2

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE III		**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**	
Course Code : 23PPHE22	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

OBJECTIVES:

- To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor
- To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Gain knowledge of architecture and working of 8085 microprocessor.	K1
CO 2	Get knowledge of architecture and working of 8051 Microcontroller.	K2
CO 3	Be able to write simple assembly language programs for 8085A microprocessor.	K3
CO 4	Able to write simple assembly language programs for 8051 Microcontroller.	K4
CO 5	Understand the different applications of microprocessor and microcontroller.	K5

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE III		**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**	
Course Code : 23PPHE22	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:3**

UNIT I: 8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING

Instruction set - Addressing modes - Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer.

UNIT II: 8085 INTERFACING APPLICATIONS

Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature an strain).

UNIT III: 8051 MICROCONTROLLER HARDWARE

Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.

UNIT IV: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING

Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.

UNIT V: INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timerinterrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface-

Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities(Temperature an strain).

TEXT BOOKS

1. NagoorKani, *Microprocessors & amp; Microcontrollers*, RBA Publications (2009).
2. A. P. Godse and D. A. Godse, *Microprocessors*, Technical Publications, Pune (2009).
3. Ramesh Gaonkar, *Microprocessor Architecture, Programming and Applications with 8085*, Penram International Publishing (2013).
4. B. Ram, *Fundamentals of Microprocessors & Microcontrollers*, DhanpatRai publications New Delhi (2016).
5. V. Vijayendran, 2005, *Fundamentals of Microprocessor-8085*", 3rd Edition S.Visvanathan Pvt, Ltd.

REFERENCE BOOKS

1. Douglas V. Hall, *Microprocessors and Interfacing programming and Hardware*, Tata Mc Graw Hill Publications (2008)
2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, *The 8051 Microcontroller and Embedded Systems*, Pearson Education (2008).
3. Barry B. Brey, 1995, *The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486*, 3rd Edition, Prentice- Hall of India, New Delhi.
4. J. Uffrenbeck, "*The 8086/8088 Family-Design, Programming and Interfacing,Software, Hardware and Applications*", Prentice-Hall of India, New Delhi.
5. W. A. Tribel, Avtar Singh, "*The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications*", Prentice- Hall of India, New Delhi.

WEB SOURCES

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.ht ml
2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
4. http://www.circuitstoday.com/8051-microcontroller
5. https://www.elprocus.com/8051-assembly-language-programming/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	2	2	2	3	3	3	3	3
CO-5	2	2	2	1	1	2	2	2	2	2
Ave.	2.8	2.6	2.6	2.4	2.4	2.8	2.8	2.8	2.8	2.8

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE III		**SOLAR ENERGY UTILIZATION**	
Course Code: 23PPHE24	**Hrs/Week: 3**	**Hrs/Semester: 45**	**Credits:3**

OBJECTIVES

- To impart fundamental aspects of solar energy utilization
- To give adequate exposure to solar energy related industries
- To harness entrepreneurship skills
- To understand the different types of solar cells and channelizing them to the different sectors of society
- To develop an industrialist mindset by utilizing renewable source of energy

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Gained knowledge in fundamental aspects of solar energy utilization	K1
CO 2	Gained industrialist mindset by utilizing renewable source of energy	K2
CO 3	Equipped to take up related job by gaining industry exposure	K3
CO 4	Skilled to approach the needy society with different types of solar cells	K4
CO 5	Develop entrepreneurial skills	K5

SEMESTER - II			
DISCIPLINE SPECIFIC ELECTIVE III		**SOLAR ENERGY UTILIZATION**	
Course Code: 23PPHE24	**Hrs/Week: 3**	**Hrs/Semester: 45**	**Credits:3**

UNIT I: HEAT TRANSFER & RADIATION ANALYSIS

Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.

UNIT II: SOLAR COLLECTORS

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss

UNIT III: SOLAR HEATERS

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.

UNIT IV: SOLAR ENERGY CONVERSION

Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process: texturization, diffusion, Antireflective coatings, metallization.

UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS

Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage. Industrial visit – data collection and analysis - presentation

TEXT BOOKS

1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.
2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", Mc Graw-Hill, 2010.
3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems", Academic Press, London, 2009
4. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997

REFERENCE BOOKS

1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)
2. Solar energy thermal processes – John A.Drife and William. (1974)
3. John W. Twidell& Anthony D.Weir, 'Renewable Energy Resources,2005
4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013
5. Duffie, J.A., Beckman, W.A. , "Solar Energy Thermal Process", John Wiley and Sons,2007.

WEB SOURCES

1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb
2. https://books.google.vg/books?id=lXHcwZo9XwC&sitesec=buy&source=gbs_vpt_read
3. www.nptel.ac.in/courses/112105051
4. www.freevideolectures.com
5. http://www.e-booksdirectory.com

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	2	3	2	2	3	2	3	2	2	3
CO3	2	3	2	2	2	2	3	2	2	2
CO4	2	2	2	3	2	2	2	2	3	2
CO5	2	2	3	2	3	2	2	3	2	3
Avge	2.2	2.4	2.4	2.4	2.6	2.2	2.4	2.4	2.4	2.6

SEMESTER - II			
CORE/ ELECTIVE PRACTICAL III		**NON ELECTRONICS PRACTICAL**	
Course Code: 23PPHCR3	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

OBJECTIVES

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Understand the strength of material using Young's modulus	K2
CO 2	Acquire knowledge of thermal behaviour of the materials	K1
CO 3	Understand theoretical principles of magnetism through the experiments.	K2
CO 4	Acquire knowledge about spectrum and applications of laser	K1
CO 5	Improve the analytical and observation ability in Physics Experiments	K4

SEMESTER - II			
CORE/ ELECTIVE PRACTICAL III		**NON ELECTRONICS PRACTICAL**	
Course Code: 23PPHCR3	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

(Minimum of Seven Experiments from the list)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Determination of Stefan's constant of radiation from a hot body
3. Measurement of Susceptibility of liquid - Quincke's method
4. B-H curve using CRO
5. Thickness of LG Plate
6. Determination of the polarizability of the given liquid by determining the refractive index of the different wavelength of the spectrum
7. Determination of e/m - Millikan's method
8. Miscibility measurements using ultrasonic diffraction method
9. Determination of Thickness of thin film. - Michelson Interferometer
10. Solar absorption spectra
11. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
12. Measurement of Dielectric Constant
13. Hall Effect in Semiconductor . Determine the Hall coefficient, carrier concentration and carrier mobility
14. Interpretation of vibrational spectra of a given material

TEXT BOOKS

1. Gupta and Kumar, *Practical Physics,* Pragati Prakasan.
2. R. Srinivasan
   K.R Priolkar, *Kit Developed for doing experiments in Physics- Instruction manual,* Indian Academy of Sciences.

BOOKS FOR REFERENCE

1. S.P Singh, *Advanced Practical Physics,* Pragati Prakasan.
2. D. Chattopadhayay, C.RRakshit, *An advanced course in Practical Physics,* New Central Book Agency Pvt. Ltd
3. R.S.Sirohi, *A course on experiment with He-Ne Laser,* John Wiley & Sons (Asia)Pvt. Ltd.

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	3	3	3	3	3	3	3	3	3

SEMESTER - II			
SKILL ENHANCEMENT COURSE - APTITUDE PHYSICS			
Course Code : 23PPHSE1	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

OBJECTIVES:

- Helps students to go deeper into core concepts and apply the core ideas to solve complex applied problems.

COURSE OUTCOMES:

CO No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO 1	Determine the content covered in the competitive exams.	K1
CO 2	Recognize the principles of physics	K2
CO 3	Resolve the physics issues	K3
CO 4	Examine the ideas in Physics.	K4
CO 5	Analyze the results of the competitive exam field.	K5

SEMESTER - II			
SKILL ENHANCEMENT COURSE - APTITUDE PHYSICS			
Code : 23PPHSE1	**Hrs/Week: 4**	**Hrs/Semester: 60**	**Credits:2**

UNIT-I: GENERAL PHYSICS

Units & dimensions - scalars and vectors - Newton's law of motions - linear & angular momentum –Gravity & central force - Kepler's laws - orbital &escape velocity – viscosity&Stoke's Law - surface Tension.

UNIT-II: HEAT AND THERMODYNAMICS

Various scales of temperatures - thermal expansions- Rayleigh Jeans & Wiens Law-Planks radiation law- Stefan Boltzmann law – Internal energy & entropy- isothermal &adiabatic process - thermodynamics I& II law-Carnot engine & its efficiency –Maxwell relations.

UNIT-III: OPTICS

Spherical mirror & lens – refractive index –focal length –Biprism& Newton's rings – Fresnel-Fraunhoffer diffraction-Rayleigh scattering-Resolving power of optical instruments-zone plate &grating theory-Plane, circular & elliptical polarization- concepts of laser, Ruby& He-Ne laser.

UNIT-IV: ELECTRICITY AND MAGNETISM

Cells & internal resistance – combinations of resistance & capacitance – current & Ohm's law –Wheatstone Bridge& applications -Biot-Savart law - Ampere's circuital Law – Dia, para & Ferro magnetism – Electromagnetic wave – Maxwell's Theorem.

UNIT-V: RELATIVITY AND MODERN PHYSICS

Atomic structure - Einstein's photo electric equations - photoelectric effect -De Broglie wave- - Bohr's atomic theory.- Magic numbers – Nuclear force & its properties - radioactive decay - alpha decay, beta decay and gamma decay - Radioactive dating – Logic gates.

BOOKS FOR STUDY

1. J. Walker, D. Halliday, R. Resnick, *Fundamentals of Physics,* 10th Edition, Wiley, United states of America, 2007.
2. H.C Verma, *Concept of Physics, (Volume II),* 1st Edition, BharatiBhawan Publishers & Distributors, New Delhi, 2008.
3. H.C Verma, *Concept of Physics, (Volume I),* 1st Edition, BharatiBhawan Publishers & Distributors, New Delhi, 2008.
4. A. M. Mahajan, *Science Physics, volume I,*Youth competition times, 2023

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO- 3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	3	3	3	3	3	3	3	3	3

SEMESTER – III			
CORE VI	**QUANTUM MECHANICS II**		
Course Code: 23PPHC31	**Hrs/Week:5**	**Hrs/Semester: 75**	**Credits: 5**

OBJECTIVES:

- To enable students, acquire a thorough understanding about advanced quantum mechanics and their relevance in solving advanced quantum mechanical problems. Formaldevelopment of the theory and the properties of angular momenta, both orbital and spin
- To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation. Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field
- To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts

COURSE OUTCOMES:

CO No.	**At the end of the course the student will be able to:**	**CL**
CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	**K1**
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	**K2**
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	**K1, K4**
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	**K1, K3**
CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	**K5**

SEMESTER – III			
CORE VI	**QUANTUM MECHANICS II**		
Course Code: 23PPHC31	**Hrs/Week:5**	**Hrs/Semester: 75**	**Credits: 5**

UNIT I: PERTURBATION THEORY

Time dependent perturbation theory- First order perturbation- Second order perturbation- Harmonic perturbation- Fermi Golden rule- Adiabatic approximation- Sudden approximation.

UNIT II: SCATTERING THEORY

Definition and interpretation of scattering cross section – Quantum theory of scattering – Green'sfunction – The Born approximation and its validity – Scattering by Yukawa potential– Ramsauer –Townsend effect – Scattering by a perfect rigid sphere - Scattering by a square well potential – Resonance scattering – Coulomb potential

UNIT III: RELATIVISTIC QUANTUM MECHANICS

Klein – Gordon equation – Dirac equation for a free particle – Spin of a Dirac particle – Particle in a potential – Relativistic particle in a box – Relativistic hydrogen atom – Electron in a field – Spin orbit energy.

UNIT IV: SEMI CLASSICAL THEORY OF RADIATION

Absorption and induced emission –electric dipole approximation- Transition probability – Electric dipole transition – Einstein coefficient –Selection rules for a single particle – Photoelectric effect.

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

TEXT BOOKS:

1. P. M. Mathews and K. Venkatesan, *A Text book of Quantum Mechanics*,2nd Edition,Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, *Quantum Mechanics*, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, *Quantum Mechanics*, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968

4. V. Devanathan, *Quantum Mechanics*, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. NouredineZettili, *Quantum mechanics concepts and applications*, 2nd Edition, Wiley,2017

BOOKS FOR REFERENCE:

1. P. A. M. Dirac, *The Principles of Quantum Mechanics*, 4thEdition,Oxford University Press, London, 1973.
2. B.K. Agarwal & Hari Prakash, *Quantum Mechanics*, 7th reprint, PHILearning Pvt. Ltd.,New Delhi, 2009.
3. Deep Chandra Joshi, *Quantum Electrodynamics and Particle Physics*,1stedition,I.K.International Publishing house Pvt.Ltd., 2006
4. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications*, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, *Quantum Mechanics*, 2nd edition, John Wiley and Sons, New York, 1970

WEB SOURCES:

1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf
2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf
4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notesgk.pdf
5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER - III			
CORE VII	**ELECTROMAGNETIC THEORY**		
Course Code :23PPHC32	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits: 5**

OBJECTIVES:

- To know the fundamentals of electricity and magnetism
- To study the properties of electromagnetic waves and how they are propagated through waveguides.

COURSE OUTCOMES:

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Recall the fundamental concepts of electromagnetic theory	K1
CO-2	Compare electrostatics with magnetostatics	K2
CO-3	Construct Maxwell's equations and identify each mathematical operator and physical quantity in the equations	K3
CO-4	Distinguish transmission lines and waveguides and analyse propagation of signal in different modes	K4
CO-5	Obtain solutions for the problems in electromagnetic theory	K5

SEMESTER - III			
CORE VII	**ELECTROMAGNETIC THEORY**		
Course Code :23PPHC32	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits: 5**

UNIT I: ELECTROSTATICS

Coulomb's Law- Gauss Law – Poisson's Equation and – Laplace's Equation – Work done to move a point charge – Energy of a point charge and continuous charge distribution – Method of Images – Electric field in dielectric material – Gauss Law in the presence of dielectric – Susceptibility, Permittivity and Dielectric constant of linear dielectrics.

UNIT II: MAGNETOSTATICS

Biot-Savart's and Ampere's Law - Magnetic field of a steady current - Comparission of Magenetostatics and Elecrostatics - Magnetic vector potential – Multipole expansion ofthe vector potential – Effects of a Magnetic field on atomic orbits – Ampere's law in Magnetized Materials – Magnetic Energy.

UNIT III: ELECTRODYNAMICS

Ohm's Law – Faraday's Law - Maxwell Equation (Both Differential and Integral Formulations) – Scalar and Vector Potentials - Gauge transformations – Lorentz and Coulomb Gauges - Poynting Vector and Poynting's Theorem – Maxwell's Stress Tensor.

UNIT IV: ELECTROMAGNETIC WAVES AND RADIATIONS

Wave Equation for E and B – Propagation of Electro Magnetic Waves in Linear media – Reflection and transmission at normal and oblique incidence – Electro Magnetic waves in conductors – Radiation – Electric dipole radiation - Magnetic dipole radiation.

UNIT V: **WAVE GUIDES**

Waveguides – Rectangular wave guide Transverse Electric mode - Rectangular waveguide Transverse Magnetic mode – Circular wave guide (Transverse Electric mode and Transverse Magnetic mode)– resonant cavities- Transverse Electric mode – Transverse Magnetic mode

BOOKS FOR STUDY:

1. David J.Griffiths, *Introduction to Electrodynamics*, Pretice hall of India,2nd edition(1989)
2. Satya Prakash, *Mathematical Physics*, Fourth revised Edition 2004, Sultan Chand&Sons.

BOOKS FOR REFERENCE:

1. Paul Lorraius and Dale Corson, *Electromagnetic Fields and Waves*, CBS Publishers& distributors, 2nd edition 2003

E-LEARNING RESOURCES:

1. http://www.plasma.uu.se/CED/Book/index.html
2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html
3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html
4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_andTutorials/
5. https://www.cliffsnotes.com/study-guides/physics/electricity- andmagnetism/Electrostatics

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER – III			
CORE VIII	**SOLID STATE PHYSICS I**		
Course Code: 23PPHC33	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits: 4**

OBJECTIVES

- To enable the students to employ classical and quantum mechanical theories needed to understand the physical properties of solids

COURSE OUTCOMES:

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Recall about the crystal structure and degree of ordering to Atom indexing and packing, laws of electrons theory	K1
CO-2	Understand the bonding in solids, crystal structure, diffraction of waves and electron theory	K2
CO-3	Apply the role of effective electron mass in electrondynamics	K3
CO-4	Estimate the structure factor, thermal ionization of donors and acceptorsand crystal imperfections	K4
CO-5	Evaluate cohesive energy, neutron and electron diffraction and density of modes	K5

SEMESTER – III			
CORE VIII	**SOLID STATE PHYSICS I**		
Subject Code: 23PPHC33	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits: 4**

UNITI: BONDING IN SOLIDS

Forces between atoms–Cohesive Energy–Ionic Bonding– Lattice Energy of Ionic Crystals –Evaluation of Madelung constant–Covalent Bond– Metallic Bond–Intermolecular Bond – Dispersion Bond –Dipole Bonds–Hydrogen Bonds–Properties of various Bonds.

UNITII: CRYSTAL STRUCTURE

Lattice representation- Bravais Lattice – Unit Cell – Weigner - Sietz Cell – Miller Planes –Spacing – Crystal System – Metallic Crystal Structure: SC, BCC, FC, HCP– Structure Factor of Diamond, ZnS, NaCl, CsCl.

UNITIII: DIFFRACTION OF WAVES AND RECIPROCAL LATTICE

Bragg's Law – X-ray Spectrometer – Powder Crystal method – Neutron Diffraction and Electron Diffraction – Rotating Crystal Method – The Laue Method – Reciprocal lattice –Diffraction conditions **–** Laue equations –Reciprocal lattice to SC, BCC and FCC Crystals.

UNITIV: CRYSTAL IMPERFECTION AND LATTICE DYNAMICS

Point Defect – Vacancies, Schottky and Frenkel defect – Line Imperfection – Screw Dislocation – Burger Vectors– Grain Boundaries - Tilt, Twin Boundaries –Stacking Defect Specific Heat: Dulong – Petit Law – Einstein Debye's Theory –Density of modes in one and three dimensions Anharmonic crystalinteraction: Thermalexpansion, Thermalconductivity, Thermal resistivity–UMKLAPP process.

UNITV: ELECTRONS THEORY

Energy level – Fermi Dirac Distribution – Free electron gas in three dimensions – Heat capacity of electron gas – Electron conductivity ohms law, Matthiessen's rule – Hall effect –Wiedeman Franz law –Nearly free electron model – Blochfunction –Kronig – Penney model

TEXT BOOKS:

1. Pillai S O. *Solid State Physics*. New Age International (P) Limited. Reprint,8thEdition 2018.
2. Charles Kittel. *Introduction to Solid State Physics*. Wiley Publications.Reprint2019.

BOOKS FOR REFERENCE:

1. Puri R K, Babbar V K. *Solid State Physics*. New Delhi: S Chand Publications. Reprint, First Edition 2021.
2. Palanisamy P K. *Solid State Physics*. Chennai: Scitech publications Private Ltd. Reprint 2013.
3. Ali Omar M. *Elementary Solid-State Physics Principle and Applications*. Pearson Publication.Reprint2019.
4. Wahab M A. *Numerical Problems in Solid State Physics*. Narosa Publishing house Pvt. Ltd. Reprint2019.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=uDFLHTDJ4XA
2. https://www.youtube.com/watch?v=4e8EB1jzHIQ
2. https://www.youtube.com/watch?v=fuinLNKkknI
3. https://www.youtube.com/watch?v=ecn8bPDV6Sc
4. https://www.youtube.com/watch?v=sJxd4V7VT50

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	2	2	2	3	3	3	2
CO-3	3	1	2	3	3	3	3	2	3	3
CO-4	3	3	3	3	3	3	2	3	3	3
CO-5	2	3	2	2	2	3	3	2	2	3
Ave.	2.8	2.4	2.6	2.6	2.6	2.8	2.8	2.6	2.8	2.8

SEMESTER-III			
CORE PRACTICAL IV MICROPROCESSOR AND MICROCONTROLLER PRACTICAL			
Course Code:23PPHCR4	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:2**

(Any 7 experiments)

1. A/D converter using Microprocessor
2. D/A converter using Microprocessor
3. Rolling Display using Microprocessor
4. Stepper motor control using Microprocessor
5. Addition (using various addressing modes)
6. Subtraction (using various addressing modes)
7. Multiplication , (using various addressing modes)
8. Division(using various addressing modes)
9. Counters using Microprocessor
10. Display of any character

SEMESTER-III			
CORE PRACTICAL V PROGRAMMING IN C++ PRACTICAL			
Course Code:23PPHCR5	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:2**

C++ (Any 7 Experiments)

1. Lagrange interpolation with Algorithm, Flow chart and output.
2. Newton forward interpolation with Algorithm, Flow chart and output.
3. Newton backward interpolation with Algorithm, Flow chart and output.
4. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
5. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
6. Numerical integration by Simpson's 1/3 rule with Algorithm, Flow chart and output.
7. Numerical integration by Simpson's 3/8 rule with Algorithm, Flow chart and output.
8. Numerical solution of ordinary first order differential equations by Euler method with Algorithm, Flow chart andoutput.
9. Numerical solution of ordinary first-order differential equations by the Runge-Kutta methodwith Algorithm, Flow chart and output.
10. Finding roots of a Polynomial - Bisection Method

SEMESTER- III			
DISCIPLINE SPECIFIC ELECTIVE IV PHYSICS OF NANO SCIENCE AND TECHNOLOGY			
Course Code:23PPHE31	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:4**

OBJECTIVES:

- To synthesize the nanomaterial by eco-friendly methods, characterize the synthesized nanomaterialsand apply in different fields for the welfare of society.
- To introduce and give an insight into the fascinating area of Nanoscience.

COURSE OUTCOME:

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Recall a thorough knowledge of basic underline disciplines of nanoscience and nanotechnology	K1
CO-2	Explain the preparation, characterization and properties of nanomaterials	K2
CO-3	Assimilate existing and new concepts, methodology and researches and applythem in their academic research environment	K3
CO-4	Synthesize the nanomaterials by physical, chemical and biological methods and evaluate their properties.	K4
CO-5	Apply the nanomaterials in energy storage, food and in day to-day life.	K3

SEMESTER- III			
DISCIPLINE SPECIFIC ELECTIVE V - PHYSICS OF NANO SCIENCE AND TECHNOLOGY			
Course Code:23PPHE31	**Hrs/ Week:4**	**Hrs/Semester:60**	**Credits:4**

UNIT-I SYNTHESIS OF NANOPARTICLES

History of Nanotechnology- Nano structures - Physical vapour deposition - Chemical vapour deposition - sol-gel- electrochemical deposition method - pulsed laser deposition- Properties of Nanomaterials.

UNIT-II CARBON NANOTUBE

Carbon nanotube - Carbon allotropes (Diamond, Graphite, Carbon nanotubes) - Types of Carbon nanotubes – Graphene sheet to single walled nanotube - Synthesis of carbon nanotubes (Electric arc -Discharge method,) -Purification and properties of Carbon nanotubes.

UNIT-III QUANTUM WELL, QUANTUM WIRE AND QUANTUM DOTS

Introduction - preparation of Quantum nanostructures - Fermi gas and Density of states –Calculation of the density of states in 1,2 and 3 dimension- Infrared detector - Quantum wire (Production,Structure, Use), Quantum dot - Application of Quantum dots.

UNIT-IV MAGNETO ELECTRONICS

Magneto electronics: Nano crystalline soft magnetic materials-Permanent magnetic materials- Super para magnetism-Single electron transistor-Spintronics- Giant magneto resistance-Quantum Hall Effect.

UNIT-V APPLICATIONS OF NANOTECHNOLOGY

Applications of Nanotechnology: Chemistry and Environment - Energy applications of Nanotechnology -Information and Communication- Heavy industry - Consumer goods - Nano medicine - medical applications of molecular nanotechnology (Nanorobots, Cell repair machines, Nano nephrology)

TEXT BOOK:

1. Dr. Geraldin Jayam S R. *Nano Physics.* An edited book.

BOOKS FOR REFERENCE:

1. Shanmugam S. *Nanotechnology*. Chennai: MJP Publishers. 2011.
2. Parthasarathy B K. *Nanostructure and Nanomaterials*. Delhi: Isha Books. 2007.
3. Uday Kumar. *Concepts in Nano chemistry*. New Delhi: Anmol Publications Pvt. Ltd. 2013.
4. Bandyopadhyay A K. *Nano Materials*.New Age International Publishers. 2nd Edition.2012.
5. Viswanathan B. *Nano Materials*. New Delhi: Narosa Publishing House. 2013

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E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=2MsgwKANZCI
2. https://www.youtube.com/watch?v=mf5wPBpnRnQ
3. https://www.youtube.com/shorts/28w5VjKRafk
4. https://www.youtube.com/watch?v=q3-S5hM-3QY
5. https://www.youtube.com/watch?v=-gdILnzYZEg

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER- III			
DISCIPLINE SPECIFIC ELECTIVE IV COMMUNICATION ELECTRONICS			
Course Code:23PPHE32	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:4**

OBJECTIVES:

- To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth
- To gain knowledge in the generation and propagation of microwaves
- To acquire knowledge about radar systems and its applications and also the working principle of colour television
- To learn the working principle of fiber optics and its use in telecommunication
- To understand the general theory and operation of satellite communication systems

COURSE OUTCOME:

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	List the the working principle of fiber optics and its use in telecommunication	K1
CO-2	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface	K2
CO-3	Apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances	K3
CO-4	Analyze the propagation of microwaves through wave guides	K4
CO-5	Evaluate the energy and power radiated by the different types of antenna	K5

SEMESTER- III			
DISCIPLINE SPECIFIC ELECTIVE IV		**COMMUNICATION ELECTRONICS**	
Course Code:23PPHE32	**Hrs/ Week:4**	**Hrs/Semester:60**	**Credits:4**

UNIT I: ANTENNAS AND WAVE PROPAGATION

Radiation field and radiation resistance of short dipole antenna- grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Ecles and Larmor theory- Magnento ionic theory-ground wave propagation.

UNIT II: MICROWAVES

Microwave generation—multicavity Klystron-reflex klystron- magnetron travelling wave tubes (TWT) and other microwave tubes- MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio (SWR).

UNIT III: RADAR AND TELEVISION

Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers- radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception - colour mixing principle-colour picture tubes-Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV.

UNIT IV: OPTICAL FIBER

Propagation of light in an optical fibre -acceptance angle- numerical aperture-step and graded index fibres-optical fibres as a cylindrical waveguide-wave guide equations-wave guide equations in step index fibres -fibre losses and dispersion-applications.

UNIT V: SATELLITE COMMUNICATION

Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites

TEXT BOOKS

1. Handbook of Electronics by Gupta and Kumar, 2008 edition.
2. Electronic communication systems–George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.
3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill (1991).
4. M. Kulkarni, Microwave and radar engineering, Umesh Publications, 1998.
5. Mono Chrome and colour television, R. R. Ghulathi

REFERENCE BOOKS

1. Electroniccommunications–DennisRoodyandCoolen,Prentice Hall of India, IV edition, 1995.
2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998
3. Dennis Roddy and Coolen,1995,*Electronics communications*,Prentice Hall of India IV Edition.
4. WayneTomasi,1998*"AdvancedElectronicscommunicationSystem"* 4th edition, Prentice Hall of India, 1998
5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.

E- LEARNING RESOURCES

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. http://web.ewu.edu/
5. http://nptel.iitm.ac.in/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	3	3	3	3	3	2
CO-2	3	3	3	2	3	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	3	3	2	3	3	3	3	3	2
CO-5	3	3	3	2	2	3	3	3	3	3
Ave.	3	3	3	2.2	2.6	3	3	3	3	2.2

SEMESTER – III			
SKILL ENHANCEMENT COURSE II NUMERICAL METHODS AND C++			
Course Code: 23PPHSE2	**Hrs/Week:4**	**Hrs/Semester: 60**	**Credits:3**

OBJECTIVES

- To make students to understand different numerical approaches to solve a problem.
- To understand the basics of programming.

COURSE OUTCOMES:

CO No.	At the end of the course, the student will be able to:	CL
CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1, K2**
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	**K5**
CO3	Understand, how interpolation will be used in various realms of physics and Apply tosome simple problems Analyze the Newton forward and backward interpolation	**K2, K3**
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.	**K3**
CO5	Understand the basics of C-programming and conditional statements.	**K2**

SEMESTER – III			
SKILL ENHANCEMENT COURSE II		**NUMERICAL METHODS AND C++**	
Course Code: 23PPHSE2	**Hrs/Week:4**	**Hrs/Semester: 60**	**Credits:3**

UNIT I: NUMERICAL SOLUTION OF LINEAR EQUATIONS

Iterative method- Bisection method- Newton Raphson's method-convergence and error in the Newton method- direct methods-Gauss elimination-Gauss –Jordon methods-Iterative methods- Gauss-Seidal and Gauss- Jocobi methods.

UNIT II: INTERPOLATION AND CURVE FITTING

Interpolation with equally spaced points - Newton forward and backward interpolation - Interpolation with unevenly spaced points - Lagrange interpolation – Curve fitting – Method of least squares – Fitting a polynomial.

UNIT III: DIFFERENTIATION, INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS

Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss- Gauss Laguerre, Gauss-Chebyshev quadrature – solution of ordinary differential equations – Euler and Runga Kutta methods.

UNIT IV: PRINCIPLE OF OBJECT ORIENTED PROGRAMMING

Basic concepts of Principle of Object Oriented Programming – Paradigm – constructors: Multi constructors in a class – constructors with Default Arguments – copy constructor – destructors –A C++ program with class

UNIT V: C++ PROGRAMMING APPLICATIONS

Programme structure: header files, local, global and static variables - Euler's Method: Charging and discharging of a condenser – Runge - Kutta methods: Radioactive Decay- Newton Raphson method: Finding the equilibrium point in a Logistic map for a particular parameter 'a' between 1and 2 [x*=ax*(1-x*)] - Numerical differentiation: Newton's Law of cooling.

TEXT BOOKS:

1. Dr. A. Singaravelu, *Numerical Methods*, New Edition, Jan 2015, Meenakshi Agency, Chennai.
2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, *Numerical Methods for Scientific and Engineering Computation*,3rd Edition, New Age Intl., New Delhi
3. S. S. Sastry, *Introductory Methods of Numerical analysis*, PHI, New Delhi
4. F. Scheid, 1998, *Numerical Analysis*, 2nd Edition, Schaum's series, McGraw Hill, New York.
5. E. Balagurusamy, *Object Oriented Programming with C++*, 2nd Ed., Tata McGraw-Hill, 2002.

BOOKS FOR REFERENCE:

1. Dr. M.K. Venkataraman, *Numerical methods in science and engineering*, The national publishing company, Chennai.
2. Pipes, L.A. &Harvil, L.R., *Applied Mathematics for Engineers and Physicists*, McGraw Hill Company, New Delhi.
3. S. D. Conte and C. de Boor, 1981, *Elementary Numerical analysis-an algorithmic approach*, 3rd Edition, McGraw Hill
4. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, *Applied Numerical Methods*, Wiley, New York.
5. Salaria, R.S., *Programming in Fortran*, Khanna Publishing, (2008).
6. M. K. Jain, S. R. K. Iyengar, R. K. Jain, *Numerical Methods for Scientific and Engineering computation*, 3 rd edition, New age international (P) Ltd, Chennai (1998). E.Balagurusamy, *Computer Oriented Statistical and Numerical Methods*, Macmillan India Ltd, New Delhi (2000)

WEB SOURCES:

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO -1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	2	3	1	1	2	3	2	2	3
CO-2	3	2	3	1	1	2	3	2	2	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.6	2.4	2	2	2.4	2.8	2.4	2.4	2.8

SEMESTER - III	
SELF STUDY PAPER (COMPULSORY)	**PHYSICS FOR LECTURESHIP**
Course Code :23PPHSS1	**Credits: 2**

OBJECTIVES:

- To develop problem solving skills to crack government exams in an easy manner.

COURSE OUTCOME:

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Recall the basics behind Mathematical methods in Physics	K1
CO-2	Explain the concepts of Classical Mechanics and Statistical Physics	K2
CO-3	Assimilate existing and new concepts of Electronics and apply them inthe day to day life	K3
CO-4	Analyze the working of Electromagnetic theory in the environment	K4
CO-5	Use the basic concepts of Physics and solve problems	K5

SEMESTER - III	
SELF STUDY PAPER (COMPULSORY) PHYSICS FOR LECTURESHIP	
Course Code :23PPHSS1	**Credits: 2**

UNIT I : MATHEMATICAL METHODS OF PHYSICS

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions.

UNIT II: CLASSICAL AND QUANTUM MECHANICS

Newton's laws.Central force motions. Rigid body dynamics- moment of inertia tensor. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence. Time dependent Schrodinger equation –Time independent Schrodinger equation . Linear vector space – Linear operator.

UNIT III: ELECTROMAGNETIC THEORY AND SOLID STATE PHYSICS

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magneto statics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space -Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals.

UNIT IV: THERMODYNAMIC AND STATISTICAL PHYSICS

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro-and macro-states. Micro - canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Micro- and Macro- states. Micro- canonical, canonical, grand canonical ensembles and partition functions.

UNIT V:ELECTRONICS, ATOMIC AND NUCLEAR PHYSICS

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Liquid drop model – Weizacker mass formula- Beta decay – Continuous Beta spectrum – Fermi theory of beta decay- Classification of Elementary Particles – Types of Interaction and conservation laws

BOOK FOR STUDY:

1. Danika PublishingCompany, *Truman's Series UGC-CSIR JRF/NET Physical Sciences,* New Delhi

BOOKS FOR REFERENCE:

1. Goldstein, Poole and safko, *Classical Mechanics*, Third Edition (2002), Person Education, Inc. NewDelhi
2. Satya Prakash, *Mathematical Physics*, Sultan Chand & Sons, New Delhi.
3. H. K. Dass , *Mathematical Physics*, S. Chand& Company LTD, Fourth Revised Edition2004
4. Donald P. Leach, Albert Paul Malvino and goutam Saha, *Digital Principles and Applications*, Sixth edition 2008, The McGRAW-Hill Publishing CompanyLtd.,New Delhi.
5. David J.Griffiths, *Introduction to Electrodynamics*, Pretice hall of India,2nd edition(1989)
6. B.K Agarwal, Melvin Eisner, *Statistical Mechanics*, Reprint 2002, New age international P Ltd, New Delhi.

E-LEARNING RESOURCES:

1. **https://youtu.be/83QCm3LkuEg?si=U9iwoOFQ9k-ExBS_**
2. **https://youtu.be/9MTqD7yxHWg?si=wIviH9LMycMASt8B**
3. **https://youtu.be/G5P6dInMTFg?si=8c2PKacUuDMSAK0v**
4. **https://youtu.be/s3ypH3A_eTA?si=s8lmPSnsn8rU-U2h**
5. **https://youtu.be/c1R9PHHrS_0?si=jQzhbnH-vykcuLTB**

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER–IV			
CORE : IX	**SPECTROSCOPY**		
Course Code:23PPHC41	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

OBJECTIVES:

- To comprehend the theory behind different spectroscopic methods.
- To know the working principles along with an overview of construction of different types of spectrometers involved

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COURSE OUTCOMES:

CO No.	At the end of the course the student will be able to:	CL
CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties	K1
CO2	Outline the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules	K2
CO3	Identify structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	K3
CO4	Analyse resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	K4
CO5	Explain the Mossbauer and Surface spectroscopy	K5

SEMESTER–IV			
CORE : IX	**SPECTROSCOPY**		
Course Code:23PPHC41	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

UNITI: MICROWAVE AND UV-VISIBLE SPECTROSCOPY

Microwave Spectroscopy: Rotation of molecules - Rigid Rotor (Diatomic Molecules)- Intensityof Spectral Lines -Effect of isotopic substitution - Non rigid rotator - Polyatomic molecules (Linear molecules only) – Instrumentation techniques – Stark effect

UV -Visible Spectroscopy: Origin of UV spectra - Laws of absorption - Lambert - Beer Law -Transmittance and Absorbance - Double beam UV Spectrophotometer

UNITII: INFRARED SPECTROSCOPY

Vibrations of simple harmonic oscillator – Anharmonic oscillator – Diatomic Vibrating Rotator- Fundamental modes of vibration of H2O and CO2- Interpretation of vibrational spectra– IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy – Biological Applications

UNITIII: RAMAN SPECTROSCOPY

Theory of Raman Scattering - Classical theory – Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Raman activity of H_2O and CO_2 - Mutual exclusion principle- structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy

UNITIV: RESONANCE SPECTROSCOPY

Nuclear and Electron spin – Interaction with magnetic field –Population of Energy levels - Larmor precession- Relaxation times - Chemical shift- Indirect Spin - Spin Interaction – Instrumentation techniques of NMR spectroscopy –NMR Imaging- Electron Spin Resonance: Basic principle – Total Hamiltonian- Hyperfine Structure- ESR Spectra of Free radicals –g- factors – Instrumentation

UNITV: MOSSBAUER SPECTROSCOPY & SURFACE SPECTROSCOPY

Mossbauer Spectroscopy: Principles of Mossbauer-Mossbauer Spectroscopy- isomer shift- Quadrupole interaction.-Effect of magnetic field

Surface spectroscopy: Photoelectron Spectroscopy, Auger Electron Spectroscopy, X-ray Fluorescence

TEXT BOOKS:

1. CN Banwell and EM Mc Cash, 1994, *Fundamentals of Molecular Spectroscopy*, 4th Edition, Tata McGraw–Hill, New Delhi.

2. G Aruldhas, 1994, *Molecular Structure and Molecular Spectroscopy*, Prentice–Hall of India, New Delhi.

BOOKS FOR REFERENCE:

1. D. N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, NewAge International Publication.

2. B. K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.

3. Kalsi. P.S, 2016, *Spectroscopy of Organic Compounds* (7thEdition), New Age International Publishers.

WEB SOURCES:

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-HYPERLINK"https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee"8jEee
4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-HYPERLINK"https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu"introduction-XCWRu

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	ProgrammeOutcomes(PO)					ProgrammeSpecificOutcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	3	3	3	3	2	3
CO-2	2	2	2	3	3	2	2	2	3	3
CO-3	3	2	3	3	3	3	2	3	3	2
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	2
Ave.	2.8	2.4	2.9	2.8	3	2.8	2.4	2.8	2.8	2.6

SEMESTER- IV			
CORE X	**NUCLEAR AND PARTICLE PHYSICS**		
Course Code: 23PPHC42	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

OBJECTIVES

- To enhance the knowledge of nuclear reactor, bombs and the elementary particles
- To extend the knowledge about different nuclear models, nuclear decay, properties of nuclear forces and elementary particles.

COURSE OUTCOMES:

CO. No.	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO-1	List the basic atomic properties of nuclei	K1
CO-2	Classify the different types of nuclear reactions and elementary particles	K2
CO-3	Interpret the different types of nuclear models and their properties	K3
CO-4	Categorize the nuclear forces and the theories related to it	K4
CO-5	Distinguish the fission and fusion	K4

SEMESTER- IV			
CORE X	**NUCLEAR AND PARTICLE PHYSICS**		
Course Code: 23PPHC42	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

UNIT-I THEORIES OF DECAY

Gamow's theory of alpha decay - General features of beta ray spectrum - Fermi's theory of beta decay-Forms of interaction and selection rules- parity selection rules- Parity in beta decay-The neutrino (Helicity of Neutrino) - electron capture.

UNIT-II: NUCLEAR REACTION

Introduction of nuclear reaction-Conservation laws-Q value equation - Theories of nuclear reaction- Particle induced nuclear reactions-Electromagnetic radiation induced nuclear reactions- Direct reactions- Theory of stripping and pick up reactions.

UNIT-III NUCLEAR MODELS & NUCLEAR ENERGY

Liquid drop model- The Shell model-Bohr and collective model- nuclear fission-Neutron emission in fission Process - Spontaneous Fission- Barrier Penetration-Theory of Spontaneous Fission-The Nuclear Chain Reaction.

UNIT-IV NUCLEAR FORCES

The Deuteron -Ground state of Deuteron -Excited states of deuteron- Meson theory of nuclear force - Nucleon-nucleon scattering - Spin dependence of n-p scattering - Effective range theory of n-p scattering.

UNIT-V ELEMENTARY PARTICLES

Classification of elementary particles- Fundamental Interactions-Conservation laws- C-P-T Theorem- SU (2) and SU (3) symmetries- Baryon decouplet - Gellmann- Okubo mass Formula - Quarks.

TEXT BOOK:

1. Pandya M L and Yadav R P S. *Elements of Nuclear Physics*.Meerut : Kedar Nath& RamNath publications .Revised Reprint. 2008.
2. Tayal D C. *Nuclear Physics*. Himalaya Publishing House. Reprint 1985.

BOOKS FOR REFERENCE:

1. Irving Kaplan. *Nuclear Physics*. USA: Wesley publishing company. Nineteenth Reprint,Second Edition.
2. Sharma R C. *Nuclear Physics*. Meerut : KedarNath& Ram Nath publications .6th revisededition.
3. Devanathan V. *Nuclear Physics*. New Delhi: Narosa Publishing. Revised Reprint. 2008.

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E-LEARNINGRESOURCES:

1. https://youtu.be/3koOwozY4oc
2. https://www.youtube.com/watch?v=mf5wPBpnRnQ
3. https://www.youtube.com/shorts/28w5VjKRafk
4. https://www.youtube.com/watch?v=q3-S5hM-3QY
5. https://www.youtube.com/watch?v=-gdILnzYZEg

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	1	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	2	2	2	2	2	2	2	2
Ave.	2.8	2.8	2.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8

SEMESTER- IV			
CORE XI	**SOLID STATE PHYSICS II**		
Course Code:23PPHC43	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

OBJECTIVES:

- To enhance knowledge and understanding of the properties of condensed materials.

COURSE OUTCOMES:

CO No.	Upon completion of this course, students will be able to	CL
CO1	Recall the basic formulae in dielectrics, superconductivity and magnetic properties of materials	K1
CO2	Understand the concept of polarizability, superconductivity, phase transition and the properties of smart materials	K2
CO3	Illustrate polarizability, magnetic properties of solid materials and biomaterials	K3
CO4	Compare the different types of polarizability, magnetic properties Of solid materials and biomaterials	K4
CO5	Evaluate polarizability and how magnetic properties of solid materials are classified	K5

SEMESTER- IV			
CORE XI	**SOLID STATE PHYSICS-II**		
Course Code:23PPHC43	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:5**

UNIT I: DIELECTRICS

Review of basic formulas– Local field of an atom– Clausius-Mossotti relation– Polarizability – Electronic Polarizability – Ionic Polarizability – Orientational Polarizability –Dipolar relaxation – Dielectric loss – Dielectric breakdown – Frequency and Temperature dependence on Polarization.

UNIT II: SUPERCONDUCTIVITY

Introduction – Properties of superconductivity – Meissner effect – Thermal properties –Type I and type II superconductors – London Equation –BCS Theory – Quantum Tunneling– Josephson tunneling Applications: Magnetic mirror, SQUID, High Tc Superconductors

UNIT III: MAGNETIC PROPERTIES OF MATERIALS

Basic terms, Formulas – Classification of Materials – Magnetic Materials- Langevin's Theory of Diamagnetism – Langevin's Theory of Paramagnetism– Quantum Theory of Paramagnetism – Ferromagnetism–Weiss Molecular Field Theory– Ferromagnetic Domains– Domain Theory – Anti Ferromagnetism – Ferrimagnetism.

UNIT IV: FERROELECTRICS AND PIEZOELECTRIC

Ferro electric crystals–Displacive Transition–Landau Theory of Phase Transition Second Order Transition–First Order Transition –Ferro electric Domain –Piezoelectricity.

UNIT V: SMART MATERIALS

Metallic Glasses: Preparation- Properties- Applications- Shape Memory Alloys(SMA): Phases of SMA- Characteristics- Properties of Ni-Ti Alloy- Applications- Advantages and Disadvantages-Biomaterials: Classifications-Applications-ceramics-Bio-polymers.

TEXT BOOKS:

1. Pillai S O. *Solid State Physics.* New Age International (P) Limited. Reprint,8th edition.2018.
2. Charles Kittel.*Introduction to Solid State Physics*.WileyPublications. Reprint.2019.
3. Dr. Mani P. *Engineering Physics II.* Chennai: Shri Dhanam Publishers. 10th Edition 2016.

BOOKS FOR REFERENCE:

1. Puri R K, Babbar V K. *Solid State Physics*. New Delhi: S ChandPublications. Reprint, First Edition.2021.
2. Palanisamy P K. *Solid State Physics.* Chennai: Scitech publications PrivateLtd.Reprint. 2013.
3. Wahab M A. *Numerical Problems in Solid State Physics.* Narosa Publishinghouse Pvt.Ltd.Reprint.2019.
4. Ali Omar M, *Elementary Solid-State Physics Principle and Applications.* Pearson Publication.Reprint. 2019.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=MsDfu0kh14Q
2. https://www.youtube.com/watch?v=D-9M3GWoBrw
3. https://www.youtube.com/watch?v=1xFRtdN5IJA
4. https://www.youtube.com/watch?v=urJN4aPs4oE
5. https://www.youtube.com/watch?v=H6gJvYx6fJo

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	3	2
CO-3	3	3	2	3	2	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	2	3	3	2	3	3	2	3	2	3
Ave.	2.8	2.8	2.8	2.8	2.8	3	2.8	3	2.8	2.8

SEMESTER-IV			
CORE PRACTICAL VI	**MICROPROCESSOR AND C++ PRACTICAL**		
Course Code:23PPHCR6	**Hrs/Week:6**	**Hrs/Semester:90**	**Credits:3**

MICROPROCESSOR AND MICROCONTROLLER

(Any 6 Experiments)

1. Multiplication (using various addressing modes)
2. Division (using various addressing modes)
3. Digital clock
4. Rolling of a word using microcontroller
5. Data manipulation using Microprocessor (Ascending)
6. Data manipulation using Microprocessor (Descending)
7. Data manipulation using Microprocessor (Smallest and largest number)
8. Voltage/Temperature measurement
9. Frequency measurement

C++

(Any 6 Experiments)

1. The Discrete Fourier transform
2. Currents in a network
3. Area under a curve using Monte Carlo and Simpsons rule
4. Runge Kutta solution radioactive decay problem
5. Euler solution to two-dimensional motion of a particle in a gravitational field
6. Roots of a transcendental equation
7. Curve fitting to a Gaussian, an exponential function,Cauchy's constant problem to a straight line
8. Eigen value and Eigen vectors of a matrix
9. Solution of linear harmonic oscillator and anharmonic oscillator
10. Frequency response of a series/parallel LCR Resonance circuit –Evaluation ofQ-factor and bandwidth

SEMESTER-IV			
DISCIPLINE SPECIFIC ELECTIVE VI - CHARACTERIZATION OF MATERIALS			
Course Code:23PPHE41	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:3**

OBJECTIVES

- To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.
- To make the students understand some important electrical and optical characterization techniques for semiconducting materials.
- To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

COURSE OUTCOMES:

CONo.	Upon completion of this course, students will be able to	CL
CO1	Describe the different techniques to characterize the materials andmake Interpretation of the results.	**K1**
CO2	Analyse the concept of image formation in Optical microscope, developments In other specialized microscopes and their applications.	**K4**
CO3	Apply the working principle and operation of SEM, TEM, STM and AFM.	**K3**
CO4	Understand Photoluminescence and electroluminescence experimental Techniques with necessary theory.	**K2**
CO5	Evaluate the properties of materials using the characterization techniques	**K5**

SEMESTER-IV			
DISCIPLINE SPECIFIC ELECTIVE VI - CHARACTERIZATION OF MATERIALS			
Course Code:23PPHE41	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:3**

Unit I :THERMAL ANALYSIS

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermo mechanical parameters.

Unit II : MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques–Bright field optical microscopy– Dark field optical microscopy – fluorescence microscopy - confocal microscopy—digital holographic microscopy-oil immersion objectives-quantitative metallography-imageanalyzer.

Unit III : ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPE

SEM, EDAX, TEM: working principle and Instrumentation – sample preparation – Data collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM)

Unit IV: OPTICAL CHARACTERISATION

Photoluminescence – light – matter interaction – instrumentation –electroluminescence – instrumentation – Applications. Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy

Unit V : X-RAY AND SPECTROSCOPIC METHODS

Powder diffraction -Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis – Particle size, texture studies - X-rayfluorescence spectroscopy - uses.

TEXT BOOKS

1. R. A. Stradling and P. C. Klipstain. *Growth and Characterization ofsemiconductors*. Adam Hilger, Bristol, 1990.
2. J. A. Belk. *Electron microscopy and microanalysis of crystalline materials*. AppliedScience Publishers, London, 1979.
3. Lawrence E. Murr. *Electron and Ion microscopy and Microanalysis principlesand Applications*. Marcel Dekker Inc., New York, 1991

4. D. Kealey and P. J. Haines. *Analytical Chemistry*. Viva Books Private Limited,New Delhi, 2002.
5. Li, Lin, Ashok Kumar *Materials Characterization Techniques* Sam Zhang; CRCPress,(2008).

REFERENCE BOOKS

1. Cullity, B.D., and Stock, R.S., "*Elements of X-Ray Diffraction*", Prentice- Hall, (2001).
2. Murphy, Douglas B, *Fundamentals of Light Microscopy and Electronic Imaging*,Wiley- Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., *Advanced Techniques for Materials Characterization*, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009).
4. Wendlandt, W.W., *Thermal Analysis*, John Wiley & Sons, (1986).
5. Wachtman, J.B., Kalman, Z.H., *Characterization of Materials*,Butter worth Heinemann, (1993)

WEB SOURCES

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	3	3	3	3	2	3
CO-2	2	2	2	3	3	2	2	2	3	3
CO-3	3	2	3	3	3	3	2	3	3	2
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	2
Ave.	2.8	2.4	2.9	2.8	3	2.8	2.4	2.8	2.8	2.6

SEMESTER-IV			
DISCIPLINE SPECIFIC ELECTIVE VI – MEDICAL PHYSICS			
Course Code:23PPHE42	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:3**

OBJECTIVES

- To understand the major applications of Physics to Medicine
- To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
- To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics.
- To introduce the ideas of Radiography.
- To form a good base for further studies like research.

COURSE OUTCOMES:

CONo.	Upon completion of this course, students will be able to	CL
CO1	Learn the fundamentals, production and applications of X-rays.	**K1**
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	**K2**
CO3	Apply knowledge on Radiation Physics	**K3**
CO4	Analyze Radiological imaging and filters	**K4**
CO5	Assess the principles of radiation protection	**K5**

SEMESTER-IV			
DISCIPLINE SPECIFIC ELECTIVE VI – MEDICAL PHYSICS			
Course Code:23PPHE42	**Hrs/Week:4**	**Hrs/Semester:60**	**Credits:3**

UNIT I: X-RAYS AND TRANSDUCERS

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photovoltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer

UNITII: BLOOD PRESSURE MEASUREMENTS

Introduction –sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro- neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

UNIT III: RADIATION PHYSICS

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness–Effective Dose–Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter.

UNIT IV: MEDICAL IMAGING PHYSICS

Radiological Imaging–Radiography–Filters–Grids–Cassette–X-Ray Film–Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography– Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)

UNITV: RADIATION PROTECTION

PrinciplesofRadiationProtection–ProtectiveMaterials–RadiationEffects– Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

TEXT BOOKS

1. Dr.K.Thayalan,*BasicRadiologicalPhysics*,JayapeeBrothersMedical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry,DowdeyandMurry,*Christensen'sPhysicsofDiagnostic Radiology: -Lippincot*Williams and Wilkins,
   1990.
3. FM Khan, *Physics of Radiation Therapy*, William and Wilkins, 3rd ed,2003.
4. D.J.Dewhurst,*AnIntroductiontoBiomedicalInstrumentation*,1sted, Elsevier Science, 2014.
5. R.S. Khandpur, *Hand Book of Biomedical Instrumentations*, 1st ed, TMG, New Delhi, 2005.

REFERENCE BOOKS

1. Muhammad Maqbool,*AnIntroductiontoMedicalPhysics*,1sted, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, *Basics of Medical Physics*, 1st ed, CharlesUniversity, Karolinum Press, 2018
3. Anders Brahme, *Comprehensive Biomedical Physics*, Volume 1, 1st ed,Elsevier Science, 2014.
4. K.VenkataRam,*Bio-MedicalElectronicsandInstrumentation*,1sted, Galgotia Publications, New Delhi, 2001.
5. JohnR.CameronandJamesG.Skofronick,2009,MedicalPhysics,John Wiley Interscience Publication, Canada, 2nd edition.

E- LEARNING RESOURCES

1. https:nptel.ac.in/courses/108/103/108103157/
2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
5. https://www.modulight.com/applications-medical/

PSO RELATION MATRIX – SPECIMEN TABLE

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	3	3	3	3	2	3
CO-2	2	2	2	3	3	2	2	2	3	3
CO-3	3	2	3	3	3	3	2	3	3	2
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	2
Ave.	2.8	2.4	2.9	2.8	3	2.8	2.4	2.8	2.8	2.6

SEMESTER - IV			
Core XII -PROJECT AND VIVA VOCE			
Course Code : 23PPHP41	**Hrs/Week: 7**	**Hrs/Semester: 105**	**Credits: 4**

FORMAT FOR PREPARATION OF PROJECT REPORT FOR M.Sc. Physics

1. IDENTIFICATION OF THE PROBLEM:

Students are given the freedom of choosing the topic of the project. It may be theoretical or practical and may be from any one of the following areas.

a) Physics-Theoretical
b) Physics-Practical
c) Electronics
d) Computational Physics
e) Micro Processor
f) Interdisciplinary projects involving concepts of physics

2. ARRANGEMENT OF CONTENTS:

The sequence in which the project report material should be arranged and bound shouldbe as follows:

Cover page and Title page
Bonafide Certificate
Abstract
Table of contents
List of Tables List
of Figures
List of Symbols, Abbreviations&
NomenclatureChapters
Appendices
References

3. PAGE DIMENSION AND BINDING SPECIFICATIONS:

The dimension of the project report should be in A4 size. The project report should be bound using flexible cover of the thick white art paper. The cover should be printed in black letters and the text for printing should be identical.
Total number of pages should not exceed 70.

4. PREPARATION FORMAT:

Cover page & Title page-A specimen copy of the cover page &Title page of the project report are given in Appendix 1.

Bonafide Certificate –The Bonafide Certificate shall be in double line spacing using Font Style Times New Roman and Font Size 14.

The Certificate shall carry the supervisor's signature and shall be followed by the supervisor's name, academic designation (not any other responsibilities of administrative

nature), department and full address of the institution where the supervisor has guided the student. The term SUPERVISOR must be typed in capital letters between the supervisor's name and academic designation.

Preface- preface should be one page synopsis of project report typed double line spacing Font Style Times New Roman and Font Size 14.

Table of contents-The table of contents should list all material it as well as any material which precedes the title page and Bonafide Certificate will not find a place among the items listed in the Table of Contents but the page numbers of which are in lower case Romanletters. One and a half spacing should be adopted for typing the matter under this head.

List of Tables- The list should use exactly the same caption as they appear above the tables in the text. One and a half spacing should be adopted for typing the matter under this head. The table should be introduced in the appropriate places in the text.

List of Figures-The list should use exactly the same captions as they appear below the figures in the text. One and a half spacing should be adopted for typing the matter under this head. The figures should be introduced in the appropriate places in the text.

List of Symbols, Abbreviation & Nomenclature- One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviation should be used.

Chapters-The chapters may be divided into 5 parts

1. Introduction to project
2. Literature survey
3. Method and methodology/Working/ Experimental Techniques
4. Result Analysis
5. Conclusion

1. The main text will be divided into several chapters and each chapter may be further divided into several divisions and subdivisions.
2. Each chapter should be given an appropriate title.
3. Tables and figures in the chapter should be placed in the immediate vicinity of the reference where they are cited.
4. Footnotes should be sparingly. They should be typed single space and placed directly underneath in the very Same page, which refers to the materials they annotate.

Appendices- Appendices are provided to give supplementary information, which is included in the main text may serve as a distraction and cloud the central theme

1. Appendices should be numbered using numerals, Eg. Appendix 1, Appendix2 etc.
2. Appendices tables and references appearing in theAppendices should be numbered and referred to at appropriate places just as in the case of chapters.
3. Appendices shall the title of the work reported and the same title shall be made inthe contents page also.

List of references: The listing of references should be typed 4 spaces below the heading "REFERENCES "in alphabetical order in single spacing left- justified. The reference material should be listed in the alphabetical order of the first author. The name of the author / authorsshould be immediately followed by the year and other details.

A typical illustrative list given below relates to the citation examples coated above

REFERENCES

1. Ariponnammal, S. and Natrajan, S.(1994)'transport phenomena of Sm Sel – X Asx',Pramana- journal of physics vol. 42 , No.1,pp 421-425.
2. Bernard R.W and Kellogg, C. (1980)'applications of convolution operators to problems in univalent function theory ', Michigan Mach, J., Vol.27,pp.81-94 .
3. Shin, K.G.& Mckay, N.D.(1984) "Open loop minimum time control of mechanical manipulations & its applications", Proc. Amer. Contr. Conf., San Diego, C A, pp. 1231- 1236.

Tables and Figures- By the word table, is meant tabulated numerical data in the bodyof the project report as well as in the appendices. All other non- verbal materials usedin the body of the project work and appendices such as charts , graphs, maps, photos& diagrams may be designated as figures .

5. TYPING INSTRUCTIONS

The impression on the typed copies should be black in colour.

One and a half spacing should be used for typing the general text. The general text shall be typed in the Font style "Times New Roman" & Font size 14.

Book For Reference :

1. C.R.Korthari, *Research Methodology-Methods and Techniques* (2nd Edition,New Age International Publishers, New Delhi(2005)