M.Sc PHYSICS

Course Structure and Syllabus

(For the candidates admitted from the academic year 2023-2024 onwards)

CHOICE BASED CREDIT SYSTEM - LEARNINGOUTCOMESBASEDCURRICULUMFRAME WORK(CBCS-LOCF)

THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)

(Nationally Re-Accredited by NAAC with B^{++})

(Affiliated to Bharathidasan University, Tiruchirappalli)

ELAMBALUR, PERAMBALUR – 621 220

Vision

To build a base for pre-eminence and strengthen the augmentation of the institutions as a prime Institution by igniting and promoting impetuosity, interest in the study of Physics.

Mission

- To establish a platform for the dissemination and creation of knowledge through teaching and research in Physics at various levels.
- The study of physics promotes understanding of the basic workings of nature. It also extends that understanding beyond the realms of our everyday lives, from the scales of atomic nuclei to those of galaxies.
- It is essential for understanding the role of technology in society as well as important policy issues.

PROGRAMME OUTCOMES

Upon completion of the programme, the postgraduate will be able to

1. Gain advanced knowledge resulting in entrepreneurship; innovation and newer opportunities for being employable in public and private sectors, research and development organizations.
2. Apply enhanced new techniques and adopt new technologies needed in the respective disciplines.
3. Appreciate the diversity of behavior in professional practice and act in accordance with the core values of chosen profession.
4. Demonstrate the knowledge, values and skills to be critical consumer of research practice and possess investigative skills to evaluate the practice.
5. Engage in lifelong learning process, have the ability to communicate the findings of Physical Sciences with the current knowledge.

PROGRAMME SPECIFIC OUTCOMES

1. Conceptual knowledge and awareness on the impact of Physics.
2. Observational acquired experimental skills measuring and computational techniques.
3. Problem analyzing and solving skill: understanding and logical thinking, reasoning and troubleshooting.
4. Acquire analytical and logical skills for Higher education.
5. Research oriented internship and employability enhancement.

Thanthai Hans Roever College (Autonomous), Elambalur, Perambalur - 621 220

M.Sc. PHYSICS

CHOICEBASEDCREDITSYSTEM–
LEARNINGOUTCOMESBASEDCURRICULUMFRAMEWORK (CBCS- LOCF)

(For the candidates admitted from the academic year 2023 - 2024 onwards)

Semester	Course Code	Title of the Course	Ins. Hours/ Week	Credits	Exam Hrs	Max. Marks		
						CIA	ESE	Total
I	23PPH1CC1	Mathematical Physics	6	5	3	25	75	100
	23PPH1CC2	Classical Mechanics and Relativity	6	5	3	25	75	100
	23PPH1CC3	Linear and Digital ICs and Applications	6	5	3	25	75	100
	23PPH1CC4P	Core Practical –I	6	4	3	40	60	100
	23PPH1EC11 23PPH1EC12	Crystal Growth and Thin films Energy Physics	6	3	3	25	75	100
	23PPHVA1	Value Added Course-1*	-	2*	2	50	50	100*
		Total	**30**	**22**	**-**	**-**	**-**	**500**
II	23PPH2CC5	Statistical Mechanics	6	5	3	25	75	100
	23PPH2CC6	Quantum Mechanics	6	5	3	25	75	100
	23PPH2CC7P	Core Practical – II	6	4	3	40	60	100
	23PPH2EC21 23PPH2EC22	Advanced optics Bio-Physics	5	3	3	25	75	100
	23PPH2EC31 23PPH2EC32	Microprocessor 8085 and Microcontroller 8051 Medical Physics	5	3	3	25	75	100
	23PPH2NME1	NME 1	2	2	3	25	75	100
	23PPH2OC	SWAYAM/NPTEL Online Course		2**				
		Total	**30**	**22**				**600**
III	23PPH3CC8	Electro Magnetic Theory	6	5	3	25	75	100
	23PPH3CC9	Numerical Methods and Programming	6	5	3	25	75	100
	23PPH3CC10P	Core Practical – III	6	4	3	40	60	100
	23PPH3EC41 23PPH3EC42	Physics of Nano Science and Technology Digital Communication	5	3	3	25	75	100
	23PPH3EC51 23PPH3EC52	Condensed Matter Physics Characterization of Materials	5	3	3	25	75	100
	23PPH2NME2	NME 2	2	2	3	25	75	100
		Internship/Industrial Activity***	-	2	-	-	-	100
	23PPHVA2	Value Added Course-2*	-	2*	2	50	50	100*
		Total	**30**	**24**	**-**	**-**	**-**	**700**

IV	23PPH4CC11	Nuclear and Particle Physics	6	5	3	25	75	100
	23PPH4CC12P	Core Practical - IV	6	5	3	40	60	100
	23PPH4PW	Project with Viva-Voce	6	5	-	25	75	100
	23PPH4EC6	Spectroscopy	6	3	3	25	75	100
	23PPH4SE1	Sewage and Waste Water Treatment and Reuse	3	2	3	25	75	100
	23PPH4SE2	Soft Skill	3	2	3	25	75	100
		Extension Activity	-	1	-	-	-	-
		Total	**30**	**23**				**600**
		Grand Total	**120**	**91**				**2400**

*** Internship/Industrial Activity- Internship after 2nd semester during summer vacation -30 Hours and 2 credits will be included in the 3rdsemester.
* The value-added course credit will not be included in the total CGPA.These courses are extra- credit courses. Instruction hours for these courses is 30 hours
** SWAYAM/NPTEL Online Course -Extra Credit Course. Not considered for grand total &CGPA

List of Core Course:

S. No.	Course	Title of the Course
1	CC1	Mathematical Physics
2	CC2	Classical Mechanics and Relativity
3	CC3	Linear and Digital ICs and Applications
4	CC4P	Core Practical – I
5	CC5	Statistical Mechanics
6	CC6	Quantum Mechanics
7	CC7P	Core Practical – II
8	CC8	Electro Magnetic Theory
9	CC9	Numerical Methods and Programming
10	CC10P	Core Practical – III
11	CC11	Nuclear and Particle Physics
12	CC12P	Core Practical – IV
13	CC13PW	Project with Viva-Voce

ELECTIVE PAPERS

LIST 1

1. Energy Physics
2. Crystal Growth and Thin films
3. Analysis of Crystal Structures
4. Materials Science
5. Physics of Nano Science and Technology
6. Digital Communication
7. Communication Electronics

LIST 2

8. Plasma Physics
9. Bio Physics
10. Non-linear Dynamics
11. Quantum Field Theory
12. General Relativity and Cosmology
13. Advanced Optics
14. Advanced Mathematical Physics

LIST 3

INDUSTRY ORIENTED ELECTIVE (IOE)

15. Advanced Spectroscopy
16. Microprocessor 8085 and Microcontroller 8051
17. Characterization of Materials
18. Medical Physics
19. Solid Waste Management (SWM)
20. Sewage and Waste Water Treatment and Reuse
21. Solar Energy Utilization

Value Added Course:

23PPHVA1 -Safety and Electrical Works

23PPHVA2 - Research Publication and Ethics

MATHEMATICAL PHYSICS

Core Course: I	Semester: I
Course Code: 23PPH1CC1	Maximum Marks: 100
Hours / Week: 6	Internal Marks : 25
Credit: 5	External Marks : 75

Objectives:

- ❖ To practice mathematical methods for Physics through vector analysis
- ❖ To know about the evaluation of definite integrals
- ❖ To derive some special functions like Legendre, Bessel, Laugerre and Hermite differential equations

COURSE OUTCOMES

After successfully completing the course, the student will learn the:

- Usefulness of vector integration theorems and relation between surface, line and volume integration are shown. Application of these theorems in electromagnetic theory and other physical problems are illustrated.
- Understand the usefulness of matrices and matrix operations in different physical contexts
- Discuss the tensor analysis
- Complex analysis, residues and singularities
- Group theory classes and symmetry

UNITI :LINEARVECTOR 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

UNITII :COMPLEXANALYSIS

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

UNITIII :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

UNITIV :FOURIERTRANSFORMS&LAPLACETRANSFORMS

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

UNITV: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. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
2. Satya Prakash, 2004, Mathematical Physics, 4 th Edition, Sultan Chand & Sons, New Delhi.
3. B. D. Gupta, 2009, *Mathematical Physics* (4^{th} edition), Vikas Publishing House, New Delhi.
4. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
5. P.K. Chattopadhyay, 2013, *Mathematical Physics* (2^{nd} edition), New Age, New Delhi
6. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt.Ltd., India

REFERENCEBOOKS

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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
I	23PPH1CC1		MATHEMATICAL PHYSICS			6			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓		✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches (✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CLASSICAL MECHANICS AND RELATIVITY

Core Course: II
Course Code: 23PPH1CC2
Hours / Week: 6
Credit: 5

Semester: I
Maximum Marks: 100
Internal Marks: 25
External Marks: 75

Objectives:

- ❖ To learn about the fundamentals of classical generalized coordinates and formation
- ❖ To know about both Lagrangian and Hamiltonian formalisms
- ❖ To study the general theory of small oscillations and rigid body dynamics

COURSE OUTCOMES

After successfully completing the course, the student will

- Derive of Euler Lagrange equations for a system of particles (D'Alembert's principle and Variation Principle)
- Describe of Hamiltons equations of motion
- Discuss on the center force problem: Kepler's problem, classical scattering
- Obtain the resonant frequencies and the normal modes of a linear tri-atomic molecule and discuss the nature of oscillations
- Derive of the relativistic addition of velocity formula for parallel velocities in the special theory of relativity and Lagrangian and Hamiltonian of realistic particles.

UNIT I:PRINCIPLES OFCLASSICAL MECHANICS

Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & 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 modes – linear tri-atomic 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

TEXT BOOKS

1. H. Goldstein, 2002, *Classical Mechanics*, 3rd Edition, Pearson Edu.
2. Gupta and Kumar, *Classical Mechanics*, Kedar Nath.
3. J. C. Upadhyaya, *Classical Mechanics*, HimalayaPublshing. Co.New Delhi.
4. R. Resnick, 1968, *Introduction to Special Theory of Relativity*, Wiley Eastern, New Delhi.
5. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 1980.
6. 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. T.W.B. Kibble, *Classical Mechanics*, ELBS.
4. 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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits		
I	23PPH1CC2		CLASSICAL MECHANICS AND RELATIVITY			6		5		
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓		✓		
CO2	✓	✓	✓	✓	✓	✓		✓	✓	
CO3	✓		✓		✓	✓		✓		✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	
CO5	✓		✓	✓	✓	✓		✓	✓	
Number of Matches (✓) = 34, Relationship: Moderate										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

LINEAR AND DIGITAL ICs AND APPLICATIONS

Core Course: II
Course Code: 23PPH1CC3
Hours / Week: 6
Credit: 5

Semester: I
Maximum Marks: 100
Internal Marks: 25
External Marks: 75

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

After successfully completing the course, the student will

- Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems.
- Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.
- Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.
- Learn about various techniques to develop A/D and D/A converters.
- Acquire the knowledge about the CMOS logic, combinational and sequential circuits.

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-AMPSolution 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 waveform generators.

UNIT III :ACTIVE FILTERS &TIMER AND PHASE LOCKED LOOPS

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

TIMER AND PHASE LOCKED LOOPS Introduction to IC 555 timer, description of functional diagram, monostable and a stable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), 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, IC 723 general purpose regulators, Switching Regulator.

D to A AND 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 LOGICCMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCDto 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154).SEQUENTIAL CIRCUITS USING TTL 74XX ICs Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

TEXT BOOKS

1. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
2. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi
4. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt.Ltd., NewDelhi,India
5. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, NewDelhi.
6. 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 integrated circuits, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
3. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
4. Integrated Electronics, Millman & Halkias, Tata McGraw Hill, 17th Reprint (2000)

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/

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code	Title of the Course	Hours	Credits
I	23PPH1CC3	LINEAR AND DIGITAL ICs AND APPLICATIONS	6	5

Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓		✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CORE PRACTICAL - I

Core Practical - I
Course Code: 23PPH1CC4P
Hours / Week: 6
Credit: 4

Semester: I
Maximum Marks: 100
Internal Marks: 40
External Marks: 60

COURSE OUTCOMES

- Understand various technique and concepts in electronics experiments
- Develop the skill in handling instruments
- Various techniques and concepts in electronics
- Study the characteristics of FET, UJT and SCR.
- Design and study the Multivibrator.

Any **TWELVE** Experiments

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. FP Etalon
8. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes.
9. Measurement of Band gap energy- Thermistor
10. Determination of Planck Constant – LED Method
11. Determination of Specific charge of an electron – Thomson's method.
12. Determination of Compressibility of a liquid using Ultrasonics
13. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
14. GM counter – Characteristics, inverse square law and absorption coefficient.
15. Measurement of Conductivity - Four probe method.
16. Arc spectrum – Iron.
17. Molecular spectra – AlO band.
18. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
19. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
20. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
21. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
22. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
23. Construction of relaxation oscillator using UJT
24. FET CS amplifier- Frequency response, input impedance, output impedance
25. Study of important electrical characteristics of IC741.

26. V- I Characteristics of different colours of LED.
27. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
28. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
29. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer.
30. Construction of square wave Triangular wave generator using IC 741
31. Construction of a quadrature wave using IC 324
32. Construction of pulse generator using the IC 741 – application as frequency divider
33. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
34. Study of Binary to Gray and Gray to Binary code conversion.
35. Study of R-S, clocked R-S and D-Flip flop using NAND gates
36. Study of J-K, D and T flip flops using IC 7476/7473
37. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
38. Study of Arithmetic logic unit using IC 74181.
39. Construction of Encoder and Decoder circuits using ICs.

TEXT BOOKS

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. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi.
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. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
2. An advanced course in Practical Physics, Chattopadhyay, C.R Rakshit, New Central Book Agency Pvt. Ltd
3. Op-Amp and linear integrated circuit, Ramakanth A Gaikwad, 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.

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
I	23PPH1CC4P		CORE PRACTICAL - I			6			4	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓	✓	✓	✓		✓	✓
CO2	✓	✓		✓	✓	✓	✓		✓	✓
CO3	✓	✓		✓	✓	✓	✓		✓	✓
CO4	✓	✓		✓	✓	✓	✓		✓	✓
CO5	✓	✓		✓	✓	✓	✓		✓	✓
Number of Matches(✓) = 45, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CRYSTAL GROWTH AND THIN FILM PHYSICS

Elective Course: I
Course Code: 23PPH1EC11
Hours / Week: 6
Credit: 3

Semester: I
Maximum Marks: 100
Internal Marks: 25
External Marks: 75

OBJECTIVES:

- ❖ To understand the nucleation parameters
- ❖ To know about the different techniques of crystal growth and thin films
- ❖ To know the characterization techniques relating to the structural, molecular and optical phenomenon

COURSE OUTCOMES

On completion of this course the student will be able to carry out

- Understand the Growth of crystals using several techniques such as Slow Evaporation Method
- Study the Melt Method, Physical Vapour Deposition (PVD) and Chemical Vapour Deposition (CVD) and Gel Growth
- Understand the preparation of thin films using various Physical and Chemical Methods
- Know the characterization of thin films using Scanning Electron Microscopy (SEM), Electron Probe Micro-analysis

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, Chemical bath 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, Roll of substrate, Roll 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 and Epitaxy (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. 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.

REFERENCE BOOKS

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/

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits		
I	23PPH1EC11		CRYSTAL GROWTH AND THIN FILM PHYSICS			6		3		
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO4	✓	✓		✓	✓		✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) =47 , Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

STATISTICAL MECHANICS

Core Course: V
Course Code: 23PPH2CC5
Hours / Week: 6
Credit: 5

Semester: II
Maximum Marks: 100
Internal Marks : 25
External Marks : 75

Objectives:

- ❖ To review the fundamental concepts of thermodynamics in order to understand Statistical mechanics
- ❖ To understand the fundamental principles of Statistical mechanics
- ❖ To apply the quantum mechanical ideas to Statistical mechanics

COURSE OUTCOMES

Upon completion of this course students should able to

- Understand the ways to calculate the thermo dynamical quantities theoretically
- Describe the Liouville theorem and detailed description on different ensembles
- Derive Bose Einstein condensation
- Understand Fermi Dirac condensation
- Illustrate the way to obtain phase transition and their applications in calculating thermo dynamical quantities

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 AND THERMODYNAMICS

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 AND GRAND 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 onedimension. 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. A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata.
2. S. K. Sinha, 1990, Statistical *Mechanics*, Tata McGraw Hill, New Delhi.
3. B. K. Agarwal and M. Eisner, 1998, *Statistical Mechanics*, Second Edition New Age International, New Delhi.
4. J. K. Bhattacharjee, 1996, *Statistical Mechanics* An Introductory Text, Allied Publication, New Delhi.
5. F. Reif, 1965, *Fundamentals of Statistical and Thermal Physics*, McGraw -Hill, New York.
6. M. K. Zemansky, 1968, *Heat and Thermodynamics*, 5th edition, McGraw-Hill New York.

REFERENCE BOOKS

1. R. K. Pathria, 1996, *Statistical Mechanics*, 2nd edition, Butter WorthHeinemann, 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.

WEB SOURCES

1. https//byjus.com/chemistry/third-law-of-thermodynamics/
2. https//web.stanford.edu/~peastman/statmech/thermodynamics.html
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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
II	23PPH2CC5		STATISTICAL MECHANICS			6			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓	✓		✓		✓
CO2	✓	✓			✓	✓		✓	✓	
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓	✓	✓	✓		✓		✓	✓	
Number of Matches(✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

QUANTUM MECHANICS

Core Course: VI
Course Code: 23PPH2CC6
Hours / Week: 6
Credit: 5

Semester: II
Maximum Marks: 100
Internal Marks : 25
External Marks : 75

Objectives:

- To learn the approximation methods to study perturbation theory
- To study the concepts of Angular momentum
- To understand the basic idea of Dirac formalism in Quantum mechanics

COURSE OUTCOMES

Upon completion of this course students should able to

• Explaining the postulates of quantum mechanics.
• Identify the features of certain exactly solvable systems.
• Describing the time-independent and time-dependent perturbation theories.
• Describe the method of angular momentum and commutation relation.
• Application of the Born approximation and partial wave analysis to simple systems.
Determine the solution of a relativistic free Dirac particle.

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 – 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: PERTURBATION THEORY

Time dependent perturbation theory – First and Second order transition- Transition to continuum of states – Fermi Golden rule – Constant and Harmonic perturbation – Transition probability – Selection rules for dipole radiation.

UNIT- IV: APPROXIMATION 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

Orbital angular momentum – Spin angular momentum – Total angular momentum operators – commutation relations of total angular momentum with components – Commutation relation of J_z with J_+ and J_- – Eigen values of J^2,J_Z-Matrix representation of J^2,J_Z, J_+ and J_- – Addition of angular momenta – CG Coefficients – properties.

TEXT BOOKS

1. 1. Gupta, Kumar & Sharma, Quantum Mechanics, 23rd Edition, 2004.
2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
4. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw-Hill, New Delhi, 2010.
5. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
6. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982.
7. A. Ghatak and S. Lokanathan, Quantum Mechanics Theory and Applications, 4thEdition, Macmillan, India, 1984.

REFERENCE BOOKS

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

WEB SOURCES

1. http//research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
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
5. https//theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
II	23PPH2CC6		QUANTUM MECHANICS			6			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	
CO2	✓	✓		✓		✓				
CO3	✓		✓	✓	✓		✓		✓	
CO4	✓	✓			✓	✓		✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 32, Relationship: Moderate										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CORE PRACTICAL- II

Core Practical - II
Course Code: 23PPH2CC7P
Hours / Week: 6
Credit: 4

Semester: II
Maximum Marks : 100
Internal Marks : 40
External Marks : 60

Objectives:

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- 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

(Any Twelve Experiments)

Logic gates – Universality of NAND / NOR gates Using IC's
2. Verification of Demorgan's theorems and Boolean Expressions
3. Astable and monostable multivibrator using IC 555
4. FET amplifier (CD and CS configuration)
5. Phase shift network and Oscillator using IC 741
6. Construction of dual regulated power supply
7. Half and Full wave precision rectifier using IC 741
8. Characteristics of LDR
9. Digital to analog converter - R-2R method and Weighted method
10. Study the function of multiplexer and demultiplexer
11. Study the function of decoder and encoder
12. Flip flops
13. Half adder and Full adder (using only NAND & NOR gates)
14. Half subtractor and Full Subtractor (using only NAND & NOR gates)
15. Digital comparator using XOR and NAND gates
16. BCD to seven segment display
17. Study of counter using IC 7490 (0-9 and 00-99)
18. Determination of I-V Characteristics and efficiency of solar cell.
19. IC 7490 as scalar and seven segment display using IC7447
20. Solving simultaneous equations – IC 741 / IC LM324
21. Op-Amp –Active filters Low pass, High pass and Band pass filters (Second Order) Batter worth filter
22. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
23. Construction of second order Butterworth multiple feedback narrow band pass filter
24. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
25. Construction of square wave generator using IC 555 – Study of VCO
26. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer

27. Construction of pulse generator using the IC 555 – Application as frequency divider
28. BCD to Excess- 3 and Excess 3 to BCD code conversion
29. Study of binary up / down counters - IC 7476 / IC7473
30. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
31. Study of synchronous parallel 4-bit binary up/down counter using IC 74193
32. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493

TEXT BOOKS

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.R Rakshit, New Central Book Agency Pvt. Ltd
2. Advanced Practical Physics, S.P Singh, PragatiPrakasan
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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits	
II	23PPH2CC7P		CORE PRACTICAL - II			6		4	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches (✓) =48, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

ADVANCED OPTICS

Elective Course: II
Course Code: 23PPH1EC21
Hours / Week: 5
Credit: 3

Semester: IV
Maximum Marks: 100
Internal Marks: 25
External Marks: 75

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

Upon completion of this course students should able to

- Discuss the transverse character of light waves and different polarization phenomenon.
- Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices
- Demonstrate the basic configuration of a fiber optic – communication system and advantages
- Identify the properties of nonlinear interactions of light and matter
- Interpret the group of experiments which depend for their action on an applied magnetics and electric field.

UNIT-I: POLARIZATION AND 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 – NdYAG 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 multimode 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-OPTICS AND 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, 3rd Edition, 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 bookotonics, Wiley-Inter science,

REFERENCE BOOKS

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, 2011, 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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1. https//www.youtube.com/watch?v=WgzynezPiyc
2. https//www.youtube.com/watch?v=ShQWwobpW60
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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
II	22PPH3CC9		SPECTROSCOPY			5			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓		✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 46, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

Elective Course: II | Semester: IV
Course Code: 23PPH2EC31 | Maximum Marks: 100
Hours / Week: 5 | Internal Marks: 25
Credit: 3 | External Marks: 75

Objectives:

- ❖ To understand the hardware components and software programming instructions of INTEL 8085 microprocessor and 8051 microcontrollers
- ❖ To understand the concept of interfacing and peripheral devices

COURSE OUTCOMES

- Grasp the fundamentals of the Intel 8085 Microprocessor Architecture, memory mapping and data transfer schemes, know the addressing modes and perform arithmetic operation and sorting of a given data
- Know the architecture and memory organization of the Intel 8051 Microcontroller and the design of timers, counters and registers using it as well as understand the modes of operation and control
- Learn the architecture, operating mode and addressing modes of Intel 8086
- Learn the instruction set and assembly language programming for implementing arithmetic operations and sorting of a given data set using Intel 8051
- Know the various peripheral devices of Intel 8051and interfacing them.

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 INSTRUCTIONS SET AND ASSEMBLY LANGUAGE PROGRAMMING

Addressing modes – Data moving (Data transfer) 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 – Timer interrupts 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 and strain).

TEXT BOOKS

1. A. NagoorKani, Microprocessors & 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.

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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.html
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/

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code	Title of the Course	Hours	Credits
II	23PPH2EC31	MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	5	3

Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 47, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

ELECTROMAGNETIC THEORY

Core Course: VIII	Semester: III
Course Code: 23PPH3CC8	Maximum Marks : 100
Hours / Week: 6	Internal Marks : 25
Credit: 5	External Marks : 75

Objectives:

- ❖ To know about the derivation of Poisson's and Laplace equation
- ❖ To understand the relation connecting the different parameters in electrostatics and magneto statics
- ❖ To derive the Maxwell equations in terms of the vector and scalar potentials

COURSE OUTCOMES

After completion of this course the students will be able to explain the following

- The fundamentals of electrostatics
- The various concepts of magneto statics
- The application of electromotive force
- The elementary ideas of electromagnetic wave
- Gives idea to apply the application of electromagnetic wave

UNIT- I: ELECTROSTATICS

Coulomb's law – Gauss' law – Divergence and curl of electrostatic field – Electric field and potential due to an electric dipole – Poisson and Laplace Equations – Boundary conditions and uniqueness theorem – Green's theorem – Method of Images – Illustrations: Point charge in the presence of (i) a grounded conducting sphere (ii) an insulated conducting sphere (iii) a charged and insulated sphere.

UNIT -II: FIELDS IN MATTER AND MAGNETOSTATICS

Electric quadrupole – Multipole expansion – Dielectric polarization and field due to a polarized sphere – The Claudius Mossotti relation – Magnetic interactions: Force between current carrying conductors – Biot and Savart law – Ampere's law – Divergence and curl of magnetic induction – Comparison of electrostatics and magneto statics – Magnetic vector potential – Application of Ampere's law: Magnetic field of a distant current loop.

UNIT- III: ELECTROMAGNETICS

Faraday's law of induction – Self and mutual inductance – Equation of continuity –Maxwell's displacement current – Maxwell equations and its derivation – Maxwell equations in free space, linear isotropic medium and harmonically varying fields – Lorentz and Coulomb Gauge invariance – Conservation of energy (Pointing's theorem) – Pointing Vector - Conservation of momentum for electromagnetic fields.

UNIT- IV: WAVEPROPAGATION

Plane electromagnetic waves in (i) free space, (ii) isotropic non-conducting medium, (iii) anisotropic dielectric medium and (iv) conducting medium – Polarization of electromagnetic waves (Linear, circular and elliptical polarization) – Kinematic properties of reflection and refraction of electromagnetic waves – Fresnel's equation (Dynamic properties) – Total internal reflection.

UNIT -V: WAVEPROPAGATION

Metallic reflection – Propagation of electromagnetic waves between parallel conducting medium – Waveguides: (i) circular (ii) cylindrical and (iii) rectangular – Theory of scattering of electromagnetic waves – Coherence and incoherence of scattered light – Lienard-Wiechert Potentials – Electromagnetic field of a moving point charge – Radiation from an accelerated charge (Larmor's formula).

TEXT BOOKS

1. B. P. Straughan and S. Walkar, Spectroscopy Vols.1, 2 (Chapman and Hall, Boca Raton, 1994).
2. R. Chang, Basic Principles of Spectroscopy (McGraw Hill, New York, 1980).
3. D. A. Long, Raman Spectroscopy (McGraw Hill, New York, 1977).
4. H. E. White, Introduction to Atomic Spectra (McGraw Hill, New Delhi, 2016).
5. S. L. Gupta, V. Kumar and H. V. Sharma, Elements of Spectroscopy (Pragati Prakashan, Mumbai, 2017).
6. C. N. Banwell, Fundamentals of Molecular Spectroscopy (McGraw Hill, New Delhi, 2016)
7. G. Aruldhas, Molecular Structure and Spectroscopy (Prentice Hall of India, New Delhi, 2014).
8. M. Chandra, Atomic Spectra and Chemical Bond (Dreamtech Press, New Delhi, 2019)

REFERENCE BOOKS

1. G. Herzberg, Molecular Spectra and Molecular Structure (Dover, New York, 2008).
2. P. C. Poole and H. A. Farach, Theory of Magnetic Resonance (Wiley, New Delhi, 1987).
3. J. Workman and A. Springsteen, Applied Spectroscopy (Boston Academic Press, Massachusetts, 1998).
4. D. L. Andrews and R. H. Lipson, Molecular Photophysics and Spectroscopy (IOP Publishing, Bristol, 2021).
5. P. N. Ghosh, Laser Physics and Spectrocopy (CRC Press, Boca Raton, 2018).

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1. http//www.plasma.uu.se/CED/Book/index.html
2. http//www.thphys.nuim.ie/Notes/electromag/frame-notes.html
3. https://resources.saylor.org/wwwresources/archived/site/wpcontent/uploads/2012/07/Chapter1011.pdf
4. https://nptel.ac.in/courses/104106122

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
III	23PPH3CC8		ELECTROMAGNETIC THEORY			6			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓		✓	✓		✓		
CO2	✓		✓	✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓		✓	✓		✓	✓	
CO4	✓		✓	✓	✓	✓		✓		✓
CO5	✓	✓	✓		✓	✓		✓	✓	
Number of Matches(✓) =35 , Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

NUMERICAL METHODS AND PROGRAMMING

Core Course: IX | Semester: I
Course Code: 23PPH4CC9 | Maximum Marks : 100
Hours / Week: 6 | Internal Marks : 25
Credit: 5 | External Marks : 75

Objectives:

- To familiarize the students with numerical methods and computer programming using C language
- To study Numerical Integration using different rules
- To determine the roots of non-linear equations using Newton-Raphson's method

COURSE OUTCOMES

After successfully completing the course, the student will

- Understand the concept of errors and the measurements
- Describe the concept of Numerical Integration
- Explain Numerical Solution of ordinary Differential Equation
- Understand the concept of Interpolation formulas
- Find out the solution of Linear and Non-Linear equations

UNIT -I: SOLUTIONS OF EQUATIONS

Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - Zeros of polynomials –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods – Convergence of solutions in Bisection and Newton-Raphson methods – Limitations of Bisection and Newton-Raphson methods.

UNIT -II: LINEAR SYSTEM OF EQUATIONS

Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.

UNIT- III: 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- IV: DIFFERENTIATION, INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS

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

UNIT -V: PROGRAMMING WITH C

Flow-charts – Integer and floating point arithmetic expressions – Built-in functions – Executable and non-executable statements – Subroutines and functions – Programs for the following computational methods (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.

TEXT BOOKS

1. V. Rajaraman, 1993, Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi
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. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, 1992, Numerical Recipes in FORTRAN, 2nd Edition, Cambridge Univ. Press

REFERENCE BOOKS

1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,)
2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley,
3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, New York.
4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley.
5. V. Rajaraman, Programming in FORTRAN / Programming in C, PHI, New Delhi

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
3. https//nptel.ac.in/course/122106033/
4. https//nptel.ac.in/course/103106074/
5. https//onlinecourses.nptel.ac.in/noc20_ma33/preview

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits		
I	23PPH4CC9		NUMERICAL METHODS AND PROGRAMMING			6		5		
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 45, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CORE PRACTICAL – III

Core Practical - III
Course Code: 23PPH3CC10P
Hours / Week: 6
Credit: 4

Semester: III
Max. Marks : 100
Internal Marks : 40
External Marks: 60

Objectives:

- The aim and objective of the course on Computational Practical is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as C
- To equip the computational skill using various mathematical tools.
- To apply the software tools to explore the concepts of physical science.
- To approach the real time activities using Microprocessor 8085 kit.

(Any Twelve Experiments)

A. Microprocessor Practical

1. 8 bit addition, subtraction, multiplication and division using 8085.
2. 16 bit addition, 2's complement and 1's complement subtraction.
3. Conversion from decimal to octal and hexa systems.
4. Conversion from octal, hexa to decimal systems.
5. Study of ADC interfacing (ADC 0809).
6. Study of DAC interfacing (DAC 0900).
7. Traffic control system using microprocessor interfacing.
8. Control of stepper motor using microprocessor interfacing.
9. Arithmetic programs using microcontroller.
10. Key Interface using microcontroller.

B. Computer Practical (By C Language)

1. Roots of algebraic equations - Newton-Raphson method.
2. Least-squares curve fitting – Straight-line fit.
3. Solution of simultaneous linear algebraic equations – Gauss elimination method.
4. Solution of simultaneous linear algebraic equations – Gauss-Seidal method.
5. Interpolation – Lagrange method.
6. Numerical integration – Composite Trapezoidal rule.
7. Numerical integration – Composite Simpson's rules.
8. Numerical differentiation – Euler method.
9. Solution of ordinary differential equations – Runge-Kutta 2^{nd} order method.
10. Solution of ordinary differential equations – Runge-Kutta 4^{th} order method.

TEXT BOOKS

1. Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey 2006
2. Numerical methods in Science and Engineering - M.K. Venkataraman, National Publishing Co. Madras, 1996
3. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice-Hall, New Delhi.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Ed. New Age International, New Delhi.

REFERENCE BOOKS

1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw-Hill).
2. B.F. Gerald and P.O. Wheately, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.
3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York.
4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison - Wesley, London.
5. V. Rajaraman,Programming in FORTRAN/ Programming in C, PHI, New Delhi.

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
III	23PPH3CC10P		CORE PRACTICAL - III			6			4	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) =48 , Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

PHYSICS OF NANO SCIENCE AND NANO TECHNOLOGY

Major Based Elective: IV
Course Code: 23PPH3EC41
Hours / Week: 5
Credit: 3

Semester : IV
Max. Marks : 100
Internal Marks : 25
External Marks : 75

OBJECTIVES:

- ❖ To understand the Size Dependence of Properties of nano technology And chemical Potential, electric potential in Surface energy
- ❖ To study about the synthesis of Nanoparticles, special Nanomaterials With the different types of Physical properties and electrical conductivity of Nanomaterials

COURSE OUTCOMES:

After successfully completing the course, the student will

- Comprehend the Size Dependence of Properties of nano technology
- Identify about the chemical Potential, electric potential in Surface energy
- Training about the synthesis of Nanoparticles
- Identify about the special Nanomaterials
- Knowledge about the different types of Physical properties and electrical conductivity of Nanomaterials

UNIT- I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.

UNIT-II: PROPERTIES OF NANOMATERIALS

Physical properties of Nanomaterials Melting points, specific heat capacity, and lattice constant - Mechanical behavior Elastic properties – strength - ductility - superplastic behavior - Optical properties - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

UNIT- III: SYNTHESIS AND FABRICATION

Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography photolithography – Nanomanipulator.

UNIT- IV:CHARACTERIZATION TECHNIQUES

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT -V: APPLICATIONS OF NANOMATERIALS

Sensors Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application Air purification, water purification -Medicine Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy fuel cells - rechargeable batteries - supercapacitors - photovoltaics.

TEXT BOOKS

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructures Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).

REFERENCE BOOKS

1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004).
2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA
3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007)
4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012)

WEB SOURCES

1.www.its.caltec.edu/feyman/plenty.html
2. http//www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
3.http//www.understandingnano.com
4.http//www.nano.gov
5.http//www.nanotechnology.com

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

semester	code	Title of the Course				Hours		Credits		
IV	22PPH3EC41	PHYSICS OF NANO SCIENCE AND TECHNOLOGY				5		3		
Course outcomes (Cos)	Programme Outcomes					Programme specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓	✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓)=47,Relationship:Very high										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

CONDENSED MATTER PHYSICS

Elective Course: V	Semester: III
Course Code: 23PPH3EC51	Max. Marks : 100
Hours / Week: 5	Internal Marks : 25
Credit: 3	External Marks : 75

Objectives

- To describe various crystal structures, symmetry and to differentiate different types of bonding.
- To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.
- To critically assess various theories of electrons in solids and their impact in distinguishing solids.
- Outline different types of magnetic materials and explain the underlying phenomena.
- Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

COURSE OUTCOMES:

After successfully completing the course, the student will

- Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure
- Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.
- Student will be able to comprehend the heat conduction in solids
- Student will be able to generalize the electronic nature of solids from band theories.
- Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity

UNIT- I: CRYSTAL PHYSICS

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. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT- II: LATTICE DYNAMICS

Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye’s theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.

UNIT- III :THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

UNIT -IV : MAGNETISM

Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.

UNIT- V : SUPERCONDUCTIVITY

Experimental facts Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors.

Theoretical Explanation Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime- Nature of paring and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.

TEXT BOOKS

1. C. Kittel, 1996, *Introduction to SolidState Physics*, 7th Edition, Wiley, New York.
2. Rita John, Solid State Physics,Tata Mc-GrawHill Publication.
3. A. J. Dekker, *SolidState Physics*, Macmillan India, New Delhi.
4. M. Ali Omar, 1974, *Elementary SolidState Physics – Principles and Applications,* Addison - Wesley
5. H. P. Myers, 1998, *Introductory SolidState Physics,* 2nd Edition, Viva Book, New Delhi.

REFERENCE BOOKS

1. J. S. Blakemore, 1974 , *Solid state Physics*, 2nd Edition, W.B. Saunder, Philadelphia
2. H. M. Rosenburg, 1993, *The SolidState*, 3rd Edition, OxfordUniversity Press, Oxford.
3. J. M. Ziman, 1971, Principles *of the Theory of Solids*, CambridgeUniversity Press, London.
4. C. Ross-Innes and E. H. Rhoderick, 1976, *Introduction to Superconductivity*, Pergamon, Oxford.
5. J. P. Srivastava, 2001, *Elements of Solid State Physics,* Prentice-Hall of India, New Delhi.

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1. http//www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
2. http//www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html
3. https//www.britannica.com/science/crystal
4. https//www.nationalgeographic.org/encyclopedia/magnetism/
5. https//www.brainkart.com/article/Super-Conductors_6824/

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code	Title of the Course	Hours	Credits
III	23PPH3EC51	CONDENSED MATTER PHYSICS	5	3

Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) =48 , Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

NUCLEAR AND PARTICLE PHYSICS

Core Course: X I
Course Code: 23PPH4CC11
Hours / Week: 6
Credit: 5

Semester: IV
Max. Marks : 100
Internal Marks : 25
External Marks : 75

Objectives:

- ❖ To understand the basic structure and properties of the nucleus
- ❖ To study about nuclear radioactivity and reactions
- ❖ To study about the properties of elementary particles

COURSE OUTCOMES

After completion of this course the students will be able to

- Explain the fundamentals of nuclear properties
- Illustrate the radioactivity process and their corresponding theories
- Brief out the various nuclear reactions and mechanisms behind it
- Understand the concept of accelerators and reactors
- Elaborate the elementary particles and the fundamentals of particle physics

UNIT- I: NUCLEAR MODELS

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrapole moment - Bohr and Mottelson collective model – rotational and vibrational bands.

UNIT- II: NUCLEAR FORCES

Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.

UNIT –III: NUCLEAR REACTIONS

Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

UNIT –IV: NUCLEAR DECAY

Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay –– neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.

UNIT- V: ELEMENTARY PARTICLES

Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.

TEXT BOOKS

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011)
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996)
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968)

REFERENCE BOOKS

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973)
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002)
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001)
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

WEB SOURCES

1. http//bubl.ac.uk/link/n/nuclearphysics.html
2. http//www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp//www.scholarpedia.org/article/Nuclear_Forces
3. https//www.nuclear-power.net/nuclear-power/nuclear-reactions/
4. http//labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
5. https//www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits		
IV	23PPH4CC11		NUCLEAR AND PARTICLE PHYSICS			6		5		
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓		✓			✓		✓		
CO4	✓				✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches(✓) =34 , Relationship: Moderate										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

PHYSICS PRACTICAL - IV

Core Practical - IV
Course Code: 23PPH4C12P
Hours / Week: 6
Credit: 4

Semester: IV
Max. Marks : 100
Internal Marks : 40
External Marks : 60

COURSE OUTCOMES

Understand various technique and concepts in General Physics experiments

- Understand various technique and concepts in electronics experiments
- Develop the skill in handling instruments
- Various techniques and concepts in electronics
- Learn Forbe's method
- Understanding the characteristics of Laser Diode

Any TWELVE only

1. Four probe method – Determination of resistivity of powdered samples.
2. Determination of carrier concentration and Hall coefficients in semiconductors.
3. Determination of magnetic susceptibility of liquid by Guoys method.
4. Determination of magnetic susceptibility of liquids by Quincke's method.
5. Determination of dielectric constant of a liquid by RF oscillator method.
6. Determination of wavelength and thickness of a film by using Michelson's interferometer.
7. Brass spectrum – Determination of composition.
8. Charge of an electron by spectrometer.
9. Polarizability of liquids by finding the refractive indices at different wavelengths.
10. Determination of wavelength of monochromatic source using biprism.
11. Determination of refractive index of liquids using biprism (by scale & telescope method).
12. Determination of specific rotatory power of a liquid using polarimeter.
13. Rydberg's constant using spectrometer.
14. Determination of coefficient of coupling by AC bridge method.
15. Magnetoresistance of powder samples using CE bridge.
16. Forbe's method of determining thermal conductivity.
17. Particle size determination using He-Ne Laser.
18. Laser diode characteristics.
19. Determination of dielectric loss using CRO.

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
IV	23PPH4C12P		CORE PRACTICAL - IV			6			5	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) =48 , Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SPECTROSCOPY

Elective Course: VI
Course Code: 23PPH4EC6
Hours / Week: 6
Credit: 3

Semester: IV
Maximum Marks : 100
Internal Marks : 25
External Marks : 75

Objectives:

- ❖ To understand the elements of atomic and molecular spectroscopy
- ❖ To explain about the experimental procedure of NMR and ESR spectrum

COURSE OUTCOMES

- Understand the basic knowledge of Microwave spectroscopy
- Describe the concept of infra-red spectroscopy
- Understand the basic knowledge of Raman spectroscopy
- Explain the Instrumentation and application of NMR and ESR
- Describe Nuclear Quadrupole interaction and its applications.

UNIT- I: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra- Stark effect- Problems.

UNIT II: INFRA-RED SPECTROSCOPY

Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications.

UNIT III: RAMAN SPECTROSCOPY

Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS.

UNIT IV: RESONANCE SPECTROSCOPY

Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan

Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR.

UNIT- V: UV SPECTROSCOPY

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer - Simple applications.

TEXT BOOKS

1. C N Banwell and E M McCash, 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.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers.

REFERENCE BOOKS

1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link.

WEB SOURCES

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

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course				Hours		Credits	
IV	23PPH4EC6		SPECTROSCOPY				6		3	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓		✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 46, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEWAGE AND WASTE WATER TREATMENT AND REUSE

Skill Base Elective: I	Semester: IV
Course Code: 23PPH4SE1	Maximum Marks : 100
Hours / Week: 3	Internal Marks : 25
Credit: 2	External Marks : 75

Objectives:

- To gain basic knowledge in sewage and waste water Treatment procedures
- To gain industry exposure and be equipped to take up job.
- To harness entrepreneurial skills.
- To analyze the status of sewage and waste water management in the nearby areas.
- To sensitize the importance of healthy practices in waste water management.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

- Gained knowledge in solid waste management
- Equipped to take up related job by gaining industry exposure
- Develop entrepreneurial skills
- Will be able to analyze and manage the status of the solid wastes in the nearby areas
- Adequately sensitized in managing solid wastes in and around his/her locality

UNIT- I: RECOVERY & REUSE OF WATER

Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication

UNIT- II: DISINFECTION

Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile -Bacteriostatic and Bactericidal - factors affecting disinfection.

UNIT -III: CHEMICAL DISINFECTION

Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs).

UNIT- IV: PHYSICAL DISINFECTION

Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.

UNIT -V: INDUSTRIAL VISIT

Industrial visit – data collection and analysis - presentation

TEXT BOOKS

1. Drinking water and disinfection technique, Anirudhha Balachandra. CRC press (2013)
2. Design of Water and Wastewater Treatment Systems (CV-424/434), ShashiBushan,Jain Bros (2015)
3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION (2013)
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007
5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCE BOOKS

1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020
2. Wastewater Treatment Technologies, MritunjayChaubey, Wiley, 2021.
3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002.
4. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989
5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.

WEB SOURCES

1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en

2.https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?

3.https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB

4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits	
IV	23PPH4SE1		SEWAGE AND WASTE WATER TREATMENT AND REUSE			3		2	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓		✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 46, Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

TECHNICAL WRITING AND PRESENTATION

Skill Base Elective Course: II — Semester: IV
Course Code: 23PPH4SE2 — Maximum Marks : 100
Hours / Week: 3 — Internal Marks : 25
Credit: 2 — External Marks : 75

Objectives of the Course:

- Aims to teach oral and written skills in English with illustrations and examples drawn from project reports, paper presentations and published papers in scientific journals.
- The grammar exercises are not taught in a rule-based manner but through observation and use in specific contexts.
- Newspaper and popular scientific reports are also included as course material.
- Presentation skills are taught through practice sessions. During the course, all participants make presentations and also critique the presentations by others.
- Emphasis is placed on teaching how to present the same findings orally and in writing.

Course Out comes

At the end of the course, the student will be able to:

- Gained knowledge in type of technical reports
- Equipped to take up related organization of ideas
- Develop Report writing skills
- Will be able to analyze and manage the Format of the document
- Adequately gain knowledge to presentation of report.

Unit I: Reinforcement of Language Skills [Correcting common errors] – Verbosity – How to avoid unnecessary jargon – Words and Usage – List of "aura" words, Synonyms and Antonyms – Phrasing, Tense, Voice, Prepositions, Punctuation. Type of technical reports – creating specs, lab manuals, worksheets.

Unit II: Organization of Ideas 1. Preparing a Basic plan – Structuring the ideas, collecting the relevant materials 2. Creating Outlines – Headings of Sections, Topic Sentences. 3. Reviewing Sentences and Rewriting Paragraphs 4. Revising Drafts.

Unit III: Contents of a Report [Some Basic Research Methodology] 1. Cover and title page 2. Table of Contents 3. List of Tables and Figures 4. Preface, Foreword, Acknowledgement 5. Abstract 6. Introduction 7. Body (in Sections and Subsections) 8. Results 9. Conclusions and Recommendations 10. Appendices 11. References.

Unit IV: Format [Both physical and stylistic] 1. Margins 2. Headings 3. Indentation 4. Pagination 5. Type face and fonts 6. Abbreviations 7. Symbols 8. Layouts 9. Proofreading Symbols.

Unit V: Presentation of the Report 1. Difference between Oral Presentations and Written Reports (Even when the material is the same) 2. How to give a good presentation? 3. Proper use of technological aids 4. Discussion skills Recommended.

Reference Texts: 1.E Handouts of Renssalaer Polytechnic, USA. [necessary permission has to be obtained by the course instructor for classroom use]

2 www.rpi.edu Gupta, Ruby and Anugrah Rohini Lall. Basic Technical Communication. Cambridge University Press, 2009.

3. Hoover, Hardy. Essentials for the Scientific and Technical Writer.1970; Rpt.New York: Dover Publications, Inc.,1980

4.Kirkman, John. Good Style for Scientific and Engineering Writing. London: Pitman Publishing Ltd., 1980.

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours		Credits		
IV	23PPH4SE2		TECHNICAL WRITING AND PRESENTATION			3		2		
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓		✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

NON-MAJOR ELECTIVE COURSE

NME 1 –SOLAR ENERGY UTILIZATION

Non Major Elective Course: I	Semester: II
Course Code: 23PPH2NME1	Maximum Marks : 100
Hours / Week: 2	Internal Marks : 25
Credit: 2	External Marks : 75

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 Out comes

At the end of the course, the student will be able to:

- Gained knowledge in fundamental aspects of solar energy utilization
- Equipped to take up related job by gaining industry exposure
- Develop entrepreneurial skills
- Skilled to approach the needy society with different types of solar cells
- Gained industrialist mindset by utilizing renewable source of energy

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=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read
3. www.nptel.ac.in/courses/112105051
4. www.freevideolectures.com
5. http://www.e-booksdirectory.com

Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code	Title of the Course	Hours	Credits
II	23PPH2NME1	SOLAR ENERGY UTILIZATION	2	2

Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓		✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

NME 2 - SOLID WASTE MANAGEMENT

Non Major Elective Course: II	Semester: III
Course Code: 23PPH3NME2	Maximum Marks : 100
Hours / Week: 2	Internal Marks : 25
Credit: 2	External Marks : 75

Objectives

- To gain basic knowledge in solid waste management procedures
- To gain industry exposure and be equipped to take up a job.
- To harness entrepreneurial skills.
- To analyze the status of solid waste management in the nearby areas.
- To sensitize the importance of healthy practices in waste managements

Course Out comes

At the end of the course, the student will be able to:

- Gained knowledge in solid waste management
- Equipped to take up related job by gaining industry exposure
- Develop entrepreneurial skills
- Will be able to analyze and manage the status of the solid wastes in the nearby areas
- Adequately sensitized in managing solid wastes in and around his/her locality

UNIT -I: SOLID WASTE MANAGEMENT

Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.

UNIT- II:SOLID WASTE CHARACTERISTICS

Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation

UNIT -III: TOOLS AND EQUIPMENT

Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique.

UNIT -IV: ECONOMIC DEVELOPMENT

SWM for economic development and environmental protection Linking SWM and climate change and marine litter.

UNIT- V:INDUSTRIAL VISIT

SWM Industrial visit – data collection and analysis - presentation

TEXT BOOKS

1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).
2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006).

3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, PSB / snoitacilbuP SBBooks (.(2020
4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014).
5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016

REFERENCE BOOKS

1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012
2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2
3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237
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4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28
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Relationship Matrix for course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code		Title of the Course			Hours			Credits	
II	23PPH3NME2		SOLID WASTE MANAGEMENT			2			2	
Course Outcomes (Cos)	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓		✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 38, Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High