THANTHAI PERIYAR GOVERNMENT ARTS AND SCIENCE COLLEGE

(Autonomous), (Affiliated to Bharathidasan University) TIRUCHIRAPPALLI - 23

PG AND RESEARCH DEPARTMENT OF PHYSICS

M.Sc., PHYSICS – COURSE PATTERN - 2023 ONWARDS

CORE COURSE PATTERN FOR M.Sc., PHYSICS – 2023-2024 ONWARDS									
S.No	**Subject code**		Course	**Examhrs**	**Hrs**	**Credits**	**CIA**	**Semester Exam**	**Total**
SEMESTER – I									
1	Core I		Classical Mechanics	3	6	5	25	75	100
2	Core II		Mathematical Physics	3	6	5	25	75	100
3	Core III		Thermodynamics and Statistical Mechanics	3	5	4	25	75	100
4	Core IV		Advanced Analog and Digital Electronics	3	5	4	25	75	100
5	Core V-P		Practical - I (General & Electronics)	4	6	4	40	60	100
6	SEC		Skill Enhancement Course-I : Communication Electronics		2	2	25	75	100
			Total		**30**	**24**	**165**	**435**	**600**
SEMESTER – II									
7	Core VI		Numerical methods and C-Programming	3	5	5	25	75	100
8	Core VII		Electromagnetic Theory	3	5	5	25	75	100
9	Core VIII		Molecular Spectroscopy	3	5	4	25	75	100
10	Core IX- P		Practical – II (General & Electronics)	4	5	4	40	60	100
11	DSE I		Discipline Specific Elective-I	3	5	3	25	75	100
12	NME I		Non Major Elective I	3	3	2	25	75	100
13	SEC		Skill Enhancement Course-II: Mathematical methods		2	2	25	75	100
			Total		**30**	**25**	**190**	**510**	**700**

SEMESTER– III									
14	Core X		Quantum Mechanics	3	6	5	25	75	100
15	Core XI		Nuclear and Particle Physics	3	5	4	25	75	100
16	Core XII - P		Practical –III (Advanced GeneralExperiments & C Programming)	4	5	4	40	60	100
17	DSE II		Discipline Specific Elective-II	3	4	3	25	75	100
18	DSE III		Discipline Specific Elective-III	3	5	3	25	75	100
19	NME II		Non Major Elective-II	3	3	2	25	75	100
20	SEC		Skill Enhancement Course-III: Medical Physics		2	2	25	75	100
		Total			**30**	**23**	**190**	**510**	700
SEMESTER– III									
21	Core XIII		Condensed Matter Physics	3	6	4	25	75	100
22	Core XIV- P		Practical – IV (Microprocessor 8085 & Microcontrollers 8051)	4	5	4	40	60	100
23	DSE IV		Discipline Specific Elective-IV	3	5	3	25	75	100
24	SEC		Skill Enhancement Course-I: Computational spectroscopy		2	2	25	75	100
25	EA		Extension Activity		-	1	25	75	100
26	Project*		Project Work	12	4	25	75*	100	100
	***Viva -voce**	**Total**			**30**	**18**	**165**	**435**	**600**
		Grand Total			**120**	**90**	**710**	**1890**	**2600**

CBCS-GENERAL COURSE PATTERN FOR PG-SCIENCE

2023-24 BATCH CREDIT ALLOCATION

PART	COURSE	TOTAL PAPER COURSE	CREDIT ALLOTMENT	TOTAL CREDIT	GRAND TOTAL CREDIT
	Core Paper	10	5X5 5X4	45	61
	Core Practical	4	4X4	16	
	Discipline Specific Elective (DSE)	4	4X3	12	12
	Skill Enhancement Course	4	4X2	8	8
	Non Major Elective	2	2X2	4	4
	Project	1	1X4	4	4
	Extension Activities	1	1X1	1	1
	Total	**26**		90	**90**

NON MAJOR ELECTIVE COURSES FOR PG

Receiving from other departments

Sl. No	Title		Offering department
1	NME I		**Chemistry**
2	NME II		**Geography**

Offering for other departments

Sl. No	Title		Receiving department
1	NME I	Non - conventional energy resources	**Chemistry**
2	NME II	Solar energy Utilization	**Geography**

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-Lasers and non-linear Optics
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

M.Sc., PHYSICS SYLLABUS

Physics is one of the basic and fundamental sciences. The curriculum for the graduate programme in Physics is revised as per the UGC guidelines on Learning Outcome based Course Framework. The learner-centric courses let the student progressively develop a deeper understanding of various aspects of physics. The objectives of PG course in physics is to

- Provide students with a deeper understanding of the fundamental concepts and principles of physics.
- Develop the analytical and problem-solving skills necessary for research and innovation in the field of physics.
- Equip students with the knowledge and skills required to pursue careers in academia, research, and industry.
- Provide students with an opportunity to engage in research and experimentation, leading to the development of new ideas and technologies.

The curriculum of the M.Sc Physics program is based on guidelines provided by the University Grants Commission (UGC), for maintaining the standards of higher education in the country. The following is a brief overview of the typical curriculum:

1. Core papers: The program is usually devoted to core courses in classical mechanics, quantum mechanics, analog and digital electronics, mathematical physics, electromagnetic theory, molecular spectroscopy, statistical mechanics, condensed matter physics, nuclear and particle physics. Students also undertake a research project under the supervision of a faculty member.
2. Electives: Students can choose elective courses based on their interests and career goals. Elective courses may include Lasers and non-linear optics, Thin films and crystal growth, Nano science and technology, microprocessors and Microcontrollers etc,.
3. Seminars: Students are required to attend seminars on current topics in physics and present their research work at such seminars.
4. Project Work: The final semester of the program is usually dedicated to project work. Students are expected to work on a research project under the guidance of a faculty member and submit a dissertation.

The M.Sc Physics program prepares students for careers in academia, research, and industry. Graduates can work as research scientists, professors, science writers, science

communicators, and in various technical roles in industries such as manufacturing, telecommunications, and aerospace.

Programme	**M.Sc., Physics**
Programme Code	
Duration	**2 Years [PG]**
Programme Outcomes: (These are mere guide lines. Faculty can create POs based on their curriculum or adopt from UGC or the University for their Programme)	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully; read and write analytically and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply the analytic thought to a body of knowledge; analyse and evaluate the proofs, arguments, claims, beliefs on the basis of empirical evidences; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach. **PO4: Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing

	viewpoints. **O6: Research-related skills**: sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO 8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO 9: Reflective thinking**: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society. **PO 10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life,

	formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/re-skilling.

Programme Specific Outcomes: (These are mere guidelines. Faculty can create POs based on their curriculum or adopt from UGC or University for their Programme)	**PSO 1: Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, and beliefs and apply diverse frames of reference to decisions and actions. **PSO 2**: **Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate start-ups and high potential organizations **PSO 3**: **Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO 4**: **Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5**: **Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit

Course Title	**CLASSICAL MECHANICS**	Core Course	CC: I	
Course Code	23PPH1C1	Credits	5	
Semester	I	Marks	25	75

Pre-Requisites
Fundamentals of mechanics, Foundation in mathematical methods
Learning objectives
• To understand fundamentals of classical mechanics. • To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. • To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. • To discuss the theory of small oscillations of a system. • To learn the relativistic formulation of mechanics of a system.

Unit–I: Principles of classical mechanics

Mechanics of system of particles – conservation laws – Constraints – Holonomic & Non-holonomic constraints – Degrees of freedom – Generalized coordinates – Configuration space – Transformation equations – Principle of virtual work – Generalized displacement, velocity, acceleration and momentum.

Unit–II: Lagrangian formulation

D'Alembert's principle – Lagrange's equations from D'Alembert's principle – Lagrange's equations of motion – Conservative and Non – conservative system –Rayleigh's dissipation function – Applications of Lagrange's equations of motion: Linear harmonic oscillator – Simple pendulum – Dumb bell – Atwood's machine.

Unit–III: Hamiltonian Formulation

Phase space – Cyclic coordinates and Conservation theorem – Hamiltonian function – Lagrange's equation from Hamilton's principle – Hamilton's canonical equations of motion – Applications of Hamilton's equations of motion: Compound pendulum – Two dimensional isotropic harmonic oscillators – Particle moving near the surface of earth – Charged particle in an electromagnetic field.

Unit–IV: Central Force Motion and Small Oscillations

General features – Kepler problem: inverse square law force – Kepler laws – Scattering in a central force field – Rutherford scattering. **Small Oscillations:** Theory of small oscillations – Eigen value problem – Frequencies of free vibrations – Normal coordinates – Linear tri–atomic molecule – Forced vibrations – Dissipation.

Unit –V: Relativity

Basic postulates of special relativity – Inertial and non-inertial reference frames – Addition of Velocities, Mass, Energy – Mass-Energy equivalence – Galilean & Lorentz

transformations –Minkowski's four dimensional space – Lorentz transformation as rotation in Minkowski's space four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations

Books for Study:

1. Classical Mechanics – S. L. Gutpa, V. Kumar and H.V. Sharma, Pragati Prakashan, Meerut, 26th edition, 2012. (Unit–I & II: Chapter–1: Page No. 3-24. 36-41; 47-49; 52-53; 58. Unit–III: Chapter–3: Page No.100-101; 109-111; 112; 114. Unit–IV: Chapter–4: Page No. 202-205; 208-220; 226-234; 341-343; 352-356. Unit–V: Chapter–7: Page No.307-313).
2. Classical Mechanics – B. D. Gupta and Satya Prakash, Kedar Nath Publishers, Meerut, Revised Edition, 2017. (Unit–III: Chapter–7: Page No. 313-320; 322; 334-335. Chapter–11: Page No. 424-429; 430-431. Chapter–12: Page No. 446-451. Chapter–13: Page No. 470-476).
3. Morden Physics – R. Murugeshan and Kiruthiga Sivaprasath, S. Chand & Company Ltd, 12th revised edition, 2005. (Unit–V: Chapter–1: Page No. 1-24).

Books for Reference

1. Classical Mechanics –H. Goldstein, C. Poole and J. Safko, Pearson Education Asia, New Delhi, Third Edition, 2002.
2. Classical Mechanics of Particles and Rigid Bodies – K. C. Gupta, New Age International Publishers, New Delhi, Third edition, 2018.
3. Classical Mechanics – J. C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore, Second edition, 2017.
4. Classical Mechanics – G. Aruldhas, PHI Learning Private Limited, New Delhi, 7th Printing, 2016.
5. Relativistic Mechanics – Satya Prakash, Pragati Prakashan, Meerut, 11th edition 2003.

WEB SOURCES:

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

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Discuss the fundamental principles of mechanics of particles, Lagrange equations from D'Alembert's principle, applications of Lagrange equations of motion.

CO2: Understand Hamilton's equations of motion, Poisson brackets and its properties.

CO3:Acquire knowledge on the centre force problem: Kepler's problem, virial theorem, Rutherford scattering, classical scattering, theory of resonant frequencies, the normal modes of a linear tri-atomic molecule and discuss the nature of oscillations.

CO4: Analysis kinematics of rigid body and relative co–ordinate systems: Euler's theorem, Euler angle, Chasle's theorem, Coriolis force, formation of cyclones and Focault pendulum.

CO5: Reveal the theoretical information of the relativistic addition of velocity formula in the special theory of relativity and mass - energy equivalence and Lorentz transformation as rotation in Minkowski's space.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	2	2	2	3	3	2	2
CO2	2	2	3	2	3	2	2	3	3	2
CO3	2	2	3	2	2	2	3	3	3	2
CO4	3	3	2	3	2	2	2	2	3	2
CO5	2	2	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	2	3	2	2	2	2	2
CO2	2	2	3	2	3	3	2	3	2	2
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	3	2	2	3	3	2	2
CO5	2	2	3	2	2	3	3	2	2	3

Course Title	**MATHEMATICAL PHYSICS**	Core Course	CC: II	
Course Code	23PPH1C2	Credits	5	
Semester	I	Marks	25	75

Pre-Requisites
Matrices, vectors, differentiation, integration, differential equations
Learning Objectives
• To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program • To extend their manipulative skills to apply mathematical techniques in their fields • Evaluation of complex integral and its application to trigonometric functions. • Understand the basic properties of matrices, types of matrices and compute the eigenvalues and eigen vectors of matrix. • Understand Fourier and Laplace Transform and its applications • Get introduced to Beta, Gamma, special functions

Unit I: **Linear Vector Space**

Curvilinear co-ordinates- Differential of an arc length – Divergence – Curl - Laplacian operator – Cylindrical co-ordinates –Spherical polar co-ordinates

Linear independence of vectors – Dimensionality of space – basis for a space – inner product of two vectors – properties of inner properties of vectors – Schmidt orthonormalization procedure –linear transformation.

Unit II: Complex Variables

Analytic function – The Necessary condition for f (Z) to be an analytic- Sufficient condition for f (Z) to be an analytic- C-R equations in Polar form –Harmonic function-Important definition- Cauchy's integral theorem - Cauchy's integral formula for the derivative of an analytic function- Zero of an analytic function-Singular point-Residue- Cauchy's residue theorem - Evaluation of definite integrals by contour integration (Integration round the unit circle of the type).

Unit III: Matrices

Rank of a Matrix –simultaneous equation- Types of linear equations-Linear dependence and independence of vectors-Characteristic root of Eigen values- Cayley–Hamilton theorem – characteristic vectors or Eigen vectors-Diagonalisation of a matrix.-Power of a matrix-Sylvester's theorem.

Unit IV: Fourier and Laplace Transforms

Fourier integral theorem − Fourier sine integrals - Fourier cosine integrals – Fourier Transforms - Fourier sine and cosine transforms - Properties of Fourier Transform - Fourier Transform of derivatives - Relation between Laplace and Fourier Transform-Solution of boundary value problems by using integral transform .

Laplace Transform - important formulae - Properties of Laplace's Transform Change of scale property- Laplace transform of the derivative of f(t) − Laplace transform of the derivative of order n Laplace transform of integral of *t, tf(t),* and *f(t)/t* –Inverse Laplace transform – Multiplication by *s* and division by *s*- Solution of differential equation by Laplace transforms.

Unit V: Special Functions

Gamma function - Transformation of Gamma Function- Beta functions –Property of Beta function- Transformation of Beta function -Relation between Beta and Gamma function Legendre and Bessel functions - Series solutions – Generating functions – Recurrence relations and orthogonal properties.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them

CO2: Apply techniques of complex analysis such as contour integrals and able to differentiate analytic and harmonic functions.

CO3: Analyze characteristics of matrices and its different types, and the process of diagonalization.

CO4: Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology.

CO5: Apply special functions in computation of solutions to real world problems

TEXT BOOKS:

1. Mathematical Physics - H.K. Dass, Dr Rama Verma S. Chand & Co, New Delhi.7th Revised Edition Reprint 2016 Pragati Prakashan

Unit I-Chapter 5 5.46, 5.47, 5.50-5.54.

Unit-II- Chapter 7-7.7-7.10, 7.12, 7.31, 7.33, 7.34, 7.41-7.45.

Unit III- Chapter 4-4.36-4.38, 4.41, 4.43-4.45, 4.51-4.53.

Unit IV- Chapter14.3,14.4,14.6-14.8, 14.13-14-15,13.2-13.9,13.20-13.23,13.30.

Unit V- Chapter 21.1-21.3, 21.5-21.7., 8.8,8.9,8.11,8.12,8.17, 8.17.1,8.18, 8.19, 8.22-8.24.

2 A Text Book of Mathematical physics – Suresh Chandra- Narosa Publishing House – New Delhi-2003.**Unit 1 -4, 4.1, 4.2,5.**

REFERENCE BOOKS:

1. Mathematical Physics – Sathya Prakash, S. Chand & Co, New Delhi.
2. Mathematical Physics – B.D. Gupta, Vikas Publishing House, 2008.
3. Mathematical Physics – P.K. Chattopadhyay, New Age International PVT. Ltd. 2004.
4. Mathematical Physics –B.S Rajput 28th Edition 2015, Reprint 2016

WEB SOURCES:

1. http://www.scholarpedia.org/article/Mathematical_physics
2. https://plato.stanford.edu/entries/physics-mathematics/
3. https://ocw.mit.edu/courses/mathematics/18-085-mathematical-methods-for-engineers-ii-spring-2006/
4. https://www.maths.ox.ac.uk/groups/mathematical-physics
5. https://physics.stackexchange.com/questions/tagged/mathematical-physics

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	2	3	3	2	3	2	2
CO3	2	3	3	3	2	3	2	3	2	2
CO4	3	2	2	2	2	3	2	3	2	2
CO5	3	2	2	3	3	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	2	3	2	3	3	2	3	2
CO2	2	3	3	3	2	3	3	2	2	2
CO3	3	2	3	2	2	3	2	2	3	2
CO4	3	3	2	3	2	3	3	2	2	2
CO5	3	2	3	2	2	3	3	2	2	2

Course Title	**THERMODYNAMICS AND STATISTICAL MECHANICS**	Core Course	CC: III	
Course Code	23PPH1C3	Credits	4	
Semester	I	Marks	25	75

Pre-Requisites
Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium
Learning Objectives
• To provide introduction to thermodynamics through thermodynamical postulates and various physical parameters. • To study the micro and macroscopic properties of the matter through the statistical probability laws and distribution of particles. • To learn the fundamental classical and quantum statistical mechanics. • To discuss some of the applications of quantum statistical mechanics.

Unit I: BASIC CONCEPTS OF THERMODYNAMICS

The first law of thermodynamics - Molar specific heats - Second law of thermodynamics –Entropy - Change of entropy in reversible and irreversible process - Formulation of the second law in terms of entropy - Thermodynamic functions and Maxwell's relations - The third law of thermodynamics – Consequences of the third law – The unattainability of absolute zero.

Unit II: PHASE TRANSITIONS

Phase, Components and Variations – Gibb's phase rule – Triple point – Vander waal's equation and phase transition – First and second order phase transitions - Ehrenfest's equations – Ising Model – One dimensional Ising Model – Landau theory of phase transitions – Landau theory of first order transition

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Unit III: CLASSICAL STATISTICAL MECHANICS

Phase space – Ensembles – Liouville's theorem – Microstates and macrostates – Thermodynamic probability – Maxwell-Boltzmann distribution law of momenta and energy – Law of equipartition of energy – Microcanonical ensemble – Perfect gas in microcanonical ensemble – Partition function and thermodynamical quantities.

Unit IV: QUANTUM STATISTICAL MECHANICS

Introduction – Quantum statistics of identical particles – Bose- Einstein statistics – Fermi-Dirac statistics – Maxwell- Boltzmann statistics – A comparison of three statistics – Bose-Einstein gas – Degeneracy and Bose-Einstein condensation – Fermi-Dirac gas – Degeneracy.

Unit V: APPLICATION OF QUANTUM STATISTICAL MECHANICS

Black body radiation and the Planck radiation law – Quantum theory of specific heats – Dulong and Petit's law – Einstein theory of the specific heat of solids – Debye's theory of the specific heat of solids – Liquid helium – Explanation based on Bose-Einstein condensation – Free electron model and Electronic emission – Pauli's theory of paramagnetism.

COURSE OUTCOMES:

On successful completion of the course the students will be able to

CO1: Understand the laws thermodynamics, various thermodynamic relations and explain about the phase transitions.

CO 2: Get thorough knowledge in Phase transition.

CO 3: Understand ensemble, calculate partition function and compute thermodynamic relations.

CO 4:Distinguish between three basic distribution laws

CO 5: Apply the methods of statistical physics in other fields of physics.

TEXT BOOKS:

1. Statistical Mechanics – Satya Prakash, Kedarnathramnath, Meerut,2016
   UNIT I: [1.7, 1.10, 1.17, 1.19, 1.20, 1.22, 2.1, 2.7, 13.1, 13.5]
   UNIT II: [2.9, 2.10, 13.1, 13.2, 13.4, 13.5, 13.7, 13.8, 13.10]
   UNIT III: [6.6, 6.7, 6.21, 6.26, 7.6, 7.7]
   UNIT IV: [8.1, 8.4, 8.12, 8.13, 8.14, 8.19, 8.19(b), 8.20, 8.20(a)]
2. Statistical Mechanics – Dr. S. L. Gupta and Dr. V. Kumar, Pragati Prakashan, Meerut,2010
   Unit-3: [1.7, 2.1, 2.3, 3.0, 3.0-2]
   UNIT V: [6.10, 7.2, 7.2-1, 7.2-2, 7.2-3, 8.4, 9.4, 9.5]

BOOKS FOR REFERENCE

1. Thermodynamics and Statistical Physics – Singhal, Agarwal, Prakash- Prakashan, Meerut, 2003
2. Introduction to Statistical Mechanics – S.K.Sinha- Narosa, NewDelhi,2007

3. Statistical Mechanics- K.Huang – Wiley Eastern Limited,NewDelhi,1963

WEB SOURCES:

1. http://www.scholarpedia.org/article/Statistical_physics
2. https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/
3. https://www2.physics.ox.ac.uk/contacts/people/williamsl
4. http://hyperphysics.phy-astr.gsu.edu/hbase/thermo.html
5. https://www.clear.rice.edu/compphys/statistical_physics/

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	2	3	3	2	2
CO2	2	3	3	2	2	2	2	3	2	2
CO3	2	2	3	3	2	2	2	3	2	2
CO4	2	3	2	3	2	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	3	3	3	3	2	3	2
CO2	2	3	3	2	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	2	2	2	2	2	2	2	2
CO5	3	2	3	2	2	3	3	2	2	2

Course Title	**ADVANCED ANALOG AND DIGITAL ELECTRONICS**	Core Course	CC: IV	
Course Code	23PPH1C4	Credits	4	
Semester	I	Marks	25	75

Pre-Requisites
Fundamentals of Electronics
Learning objectives
• To impart in-depth knowledge about Semiconductor Devices. • To understand Operational Amplifiers. • To understand Waveform Generators. • To discuss the function of Flip - flop, Counters, Shift Registers. • To learn the Converters and Memory.

Unit I: Special Semiconductor Devices

Types of Field Effect Transistors - Principle and Working of JFET - Schematic symbol of JFET - Output characteristics of JFET - Parameters of JFET - Relation among JFET parameters –MOSFET – Types –Symbols - Circuit operation of MOSFET - Transfer characteristics –EMOSFET – SCR – Working - V - I characteristics - SCR as switch - TRIAC – Construction - Operation – Characteristics – DIAC - Unijunction Transistor – Characteristics.

Unit II: Operational Amplifier and its Application

The basic information of Op Amp - The Ideal Operational Amplifier - Ideal Inverting Amplifier - Ideal Non - Inverting Amplifier - Differentiator – Integrator - Voltage Follower - Differential Amplifier - DC Characteristics - Input Bias Current - Input Offset Current - Input Offset Voltage - Total Output Offset Voltage - Slew Rate - Instrumentation amplifier - V to I and I to V Converter.

Unit III: Wave form Generators

Introduction – Comparator - Regenerative Comparator (Schmitt Trigger) - Square wave generator (Astable multivibrator) - Monostable Multivibrator - Triangular wave generator - Sine wave generator - Phase shift oscillator - Wein's bridge oscillator - IC 555 Timer – Introduction - Description of functional diagram - Monostable Operation - Astable Operation.

Unit IV: Sequential Circuits

Flip Flops: RS Latches - NOR Latches - NAND Latches - Level Clocking - Clocked RS

Latch - Edge Triggered JK Flip Flop - Master Slave Flip Flop.

Counters: Ripple Counter - Ring Counter - Mod (10) Counter.

Shift Registers: Types - Serial in Serial out Shift Register using JK Flip Flop - Serial in Parallel out Shift Register.

Unit V: D/A and A/D Conversion and Memory

Variable, Resister Networks - Binary Ladder - D/A Accuracy and Resolution - A/D Converter - Simultaneous Conversion - A/D Techniques - Successive Approximation converter - A/D Accuracy and Resolution.

Memory**:** Basic Terms and Ideas - Semiconductor Memory – Characteristics – RAM – ROM - Magnetic Memory - Hard Disk - Floppy Disk.- Master Slave Flip Flop.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the working function of FET, MOSFET, TRAIC and DIAC.

CO2: Analysis the construction, working and applications of op amp.

CO3: Construct comparator, multivibrator circuits using op amp and IC 555 Timer.

CO4: Understand the practical usages and working of Flip flop, counter and shift register.

CO5: Acquire knowledge on A/D and D/A converter and different semiconductor memories such as RAM, ROM, etc,.

TEXT BOOKS:

1. Principle of Electronics - V.K.Mehta and Rohit Mehta, 11th Edition - 2014, S. Chand and Company, New Delhi.

UNIT I: 19.1 - 19.4, 19.8, 19.13, 19.14, 19.27, 19.36, 20.1, 20.2, 20.5, 20.7, 21.3, 21.5, 21.6, 21.9, 21.11, 21.13

2. Linear integrated circuits - D. Roy Choudhury and Shail Jain, New age international Limited, Publishers, New Delhi.15th reprint 1999

UNIT II: 2.2, 2.3, 2.3.3 - 2.3.6, 3.2, 3.2.1 - 3.2.4, 3.3.4, 4.3, 4.5; **UNIT III:** 5.1 - 5.7, 8.1 - 8.4.

3. Digital Computer Electronics - An Introduction to Microcomputers - Albert Paul Malvino Ph.d, Tata Mc Graw - Hill publishing company limited, New Delhi. 1983 TMH [II] Edition

UNIT IV: 7.1,7.2,7.5,7.6, 8.4, 8.6, 8.7.

4. Digital Principles and Applications (sixth Edition) - Donald P Leach/Albert Paul Malvino/Goutam Saha, Tata Mc Graw - Hill Publishing Company Limited, New Delhi.

UNIT IV: 9.1 - 9.3; **UNIT V**: 12.1,12.2, 12.4,12.5, 12.8,12.10,1311,13.2.

REFERENCEBOOKS:

1. Digital Electronics – AK Saxena, CBS Publishers and Distributors Pvt Ltd, First edition, 2014.
2. A Text Book of Digital Electronics - Dr R. S. Sedha, S. Chand & Company Ltd
3. An Introduction to Integrated Electronics (Digital & Analog) - V. Vijayendran
4. S.Viswanathan Printers & Publishers, PVT., LTD - 2005.

WEB SOURCES:

1. https://www.allaboutcircuits.com/textbook/digital/
2. https://www.analog.com/en/education/education-library/analog-university.html
3. https://www.electronics-tutorials.ws/
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-004-computation-structures-spring-2009/
5. https://www.youtube.com/playlist?list=PLBlnK6fEyqRiw-GZRqfnlVIBz9dxrqHJS
6. https://www.electronicshub.org/digital-electronics-tutorial/

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	2	3	2	2
CO2	2	2	2	2	3	2	2	2	2	2
CO3	3	3	2	3	2	3	3	2	3	2
CO4	2	2	3	2	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	2	3	2	3	2	3	2	2	2
CO3	3	3	3	2	2	3	2	2	3	2
CO4	3	2	2	3	2	3	2	2	2	2
CO5	3	2	3	2	2	3	2	2	2	2

Course Title	**PRACTICAL - I (GENERAL AND ELECTRONICS)**	Core Course	CC-V: P	
Course Code	23PPH1P5	Credits	4	
Semester	I	Marks	40	60

Pre-Requisites
Knowledge and hands on experience of basic general and electronics experiments of Physics
Learning Objectives
• To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. • To calculate the thermodynamic quantities and physical properties of materials. • To analyze the optical and electrical properties of materials. • To analyze the characteristics of UJT, SCR, FET etc. • To study the applications of OP-AMP.

(Any 12 Experiments)

1. Determination of q, n, σ - Elliptical fringes method.
2. Determination of q, n, σ - Hyperbolic fringes method.
3. Determination of bulk modulus of a liquid - Ultrasonic wave propagation.
4. Spectrometer - wavelength of spectral lines of Hg spectrum - Hartmann's formula.
5. Specific charge (e/m) of an electron – Magnetron Valve method.
6. Thermionic work function of a diode.
7. Determination of dielectric constant at high frequency - Lecher wire.
8. Determination of Stefan's constant.
9. Dual regulated power supply using IC 7809 and 7909.
10. OP - AMP –Sine wave generation (Wein bridge Oscillator).
11. OP - AMP –Square and triangular wave generation.
12. Characteristics of UJT and Relaxation oscillator.
13. Characteristics of SCR.
14. FET – Common source amplifier.
15. Determinations of wavelength of a laser source and thickness of a wire using Planediffraction grating.
16. Schmitt Trigger - Op. Amp.
17. Characteristics of DIAC.
18. Astable and Monostable multivibrators using IC 555.

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: Understand the strength of material using Young's modulus.

CO2: Acquire knowledge of thermal behaviour of the materials.

CO3: Construct new circuits and troubleshooting the error occurring in the experiments.

CO4: Understand theoretical principles of magnetism through the experiments.

CO5: Acquire knowledge about Astable and Monostable multivibrators using IC 555.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	3	3	3	3	2	3	3	3	3	2
CO4	2	2	2	2	3	2	2	2	2	2
CO5	2	3	3	3	2	2	2	3	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	3	3	3	3	2	3	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	2	2	3	2	3	3	3	2	3
CO4	3	2	3	2	2	3	2	3	2	2
CO5	2	3	3	2	2	3	2	2	2	2

Course Title	**COMMUNICATION ELECTRONICS**	Core Course	**SEC I**	
Course Code		Credits	2	
Semester	I	Marks	25	75

Pre-Requisites
Knowledge of basic electronics
Learning Objectives
To acquire basic concepts of modulation. To introduce the basic concepts of fiber optics. To study the basis of Facsimile. To obtain the knowledge of wireless communication. To have form a basic ideas of Mobile communication.

Unit I: Modulation and Demodulation

Modulation - Types of modulation - Amplitude modulation -Spectrum and power in AM signal – Generation of SSB Signal – VSB – Frequency and Phase modulation - FET Reactance and FM modulator – Armstrong method of FM generation – Comparisons of AM, FM and PM

Unit II: Optical Fiber Communication – Fundamentals

Light propagation in fibers – Optical fiber modes – Variation of fiber types - Single and multi mode fibers – Step and Graded - index fiber – Advantages – Optical fiber Attenuation.

Unit III: Fascimile

Fascimile introduction - Fascimile transmitter – Fascimile receiver – Conversion of electrical signal to an optical image – Transmission of facsimile telegraph signal

Unit IV: Wireless Transmission

Frequencies for radio transmission – Signals – Antennas – Signal propagation – Multiplexing (SDM, FDM, TDM & FDM) – Modulation (ASK, FSK, PSK, Advanced FSK, Advanced PSK).

Unit V: Mobile Communication

Cellular Concept – GSM - Mobile services – System Architecture – Network and Switching – Radio interface – Logical channels – Protocols – DECT (Digital Enhanced Cordless Telecommunication).

TEXT BOOKS:

1. Principles of communication Engineering – Umesh Singh – Tech India Publication, New Delhi.

   UNIT I : 4.2, 4.3, 4.4, 4.8, 4.10 – 4.13.

   UNIT III: 20.1 – 20.4

2. Mobile Communications – Jochen Schiller – Pearson Education (Singapore) Private Limited, Indian Branch – Patparganj – New Delhi.

   UNIT IV: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6

   UNIT V : 4.1, 4.1.1, 4.1.2, 4.13, 4.14, 4.2, 4.2.1, 4.2.2

3. Optical Fibre Communication, Gerd Keiser, Tata Mc Graw Hill, 1984.

   UNIT II: 4.1 – 4.5

REFERENCE BOOKS:

1. Electronic Communication system – George Kennedy – Tata Mc Graw Hill, 3rd Edition.
2. Electronic Communications system – Wayne Tomasi – Addison Wesley Longman (Singapore) Private Limited, Patparganj – New Delhi.
3. Communication Electronics – Deshpande N.D., Deshpande D.A, Rangole P.K., Tata Mc Graw Hill publishing company limited, New Delhi.

WEB SOURCES:

1. www. electronics-notes.com

2. www. Allaboutcircuits.com

3. electronicsforu.com

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1	Understand the basic concepts of AM, FM, and PM
CO2	Learn the basic concepts of fiber optics and its types.
CO3	Apply knowledge on Facsimile.
CO4	Learn the working principle of Wireless Communication.
CO5	Learn the basic concepts of Mobile communication.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (2)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO20**
CO1	3	3	3	2	2	2	3	3	2	3
CO2	3	3	3	2	2	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	3	3	2	2	2	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO20**
CO1	3	3	3	2	2	2	3	3	2	3
CO2	3	3	3	2	2	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	3	3	2	2	2	3	3	2	3

Course Title	**NUMERICAL METHODS AND C PROGRAMMING**	Core Course	CC: VI	
Course Code	23PPH2C6	Credits	5	
Semester	II	Marks	25	75

Pre-Requisites
Prior knowledge on computer and basic mathematics
Objectives
• To make students understand different numerical approaches to solve a problem • Learn Numerical methods of data analysis to curve fitting, interpolation integration and solution of ordinary differential equation. • To understand the basics of C - programming simulation of numerical methods

Unit-I- Curve fitting and interpolation

principle of least squares - Fitting a straight line - Fitting a parabola - Fitting an exponential curve - - Gregory-Newton Forward Interpolation Formula - Gregory-Newton Backward Interpolation Formula - Equidistant terms with one or more missing values - Error in Newton's interpolation formula – Lagrange's interpolation formula. Newton's Forward difference formula to compute the derivatives - Newton's backward difference formula to compute the derivatives.

UNIT II: Solution of linear and system of equations

Solution of equation – Method of successive approximations or iteration method - Newton's Iteration method or Newton-Raphson method - Convergence of Newton's method and rate of convergence - Gauss - Elimination method - Inverse of a matrix using Gauss Elimination method- Method of triangularization - Gauss- Seidel method.

UNIT III: Numerical Differentiation and Integration:

Introduction - Newton-Cote's formula - Trapezoidal rule - Geometrical interpretation – Truncation error in Trapezoidal rule - Simpson's 1/3 rule - Simpson's 3/8 rule - Truncation error in Simpson's formula - Two and Three points Gaussian Quadrature formulae. Solution of differential equation by Talyor Series - Euler's method - Modified Euler's method - Runge-Kutta method - Second and Fourth order- Runge - Kutta method for simultaneous first order differential equations – Runge - Kutta method for second order differential equation.

UNIT IV: Fundamental of C Programming

Character set - C Tokens - Keywords and Identifiers – Constants – Variable - Data types – Operators - getc- putc- Formatted I/O- scanf and printf statement - control statements-if-if-else-else-if ladder- Swtch- break, goto- while,do-while, for and continue – Arrays - One dimensional arrays #define macro substitution – Function.

UNIT V: C Programming for Numerical methods

C program for

1. Fitting data in straight line and parabola
2. Lagrange interpolation -
3. Iteration method,

4. Newton-Raphson method
5. Solving integration by Trapezoidal rule, Simpson's ⅓ and ⅜ rule
6. First order differential equation by Euler's method,
7. Runge-Kutta (II and IV order) method.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand and apply numerical methods to find out solution of algebraic equation using different methods and numerical solution of system of algebraic equation

CO2: Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.

CO3: Understand how interpolation will be used in various realms of physics and apply to some simple problems, analyze the Newton forward and backward interpolation.

CO4: Recollect and apply methods in numerical differentiation and integration.

CO5: Gets acquainted with the basic concepts in C-programming and realization of numerical method problems using C language.

TEXT BOOKS:

1. Numerical Methods in Science and Engineering-Dr M. K. Venkataraman - The National Publishing Company Fifth Edition June 1999 Reprinted July 2013.
   UNIT I-5.2-5.4, 5.6, 6.3-6.5, 6.7 8.4;
2. Numerical Methods – Dr. P. Kandasamy, Dr. K. Thilagavathy Dr. K. Gunavathi- S. Chand Publishing- Third Revised Edition
   UNIT I: 1.6-1.9; **UNIT II:** 3.3, 3.5-3.7, 4.1-4.4, 4.9; **UNIT III:** 9.1-9.3, 9.7-9.11, 9.13, 9.14, 9.16 (Appendix C).; **UNIT IV:** 11.5, 11.9-11.15
3. Programming in ANSI –C, E. Balagurusamy-Seventh Edition McGraw Hill Education (India) Private Limited.
   UNIT V:Page No. 22-35, 51-60, 86-89, 94-97, 112-117, 133 - 134, 151-157, 189-192.

REFERENCE BOOKS:

1. Mathematical Physics - Sathya Prakash, Sultan Chand & Sons.
2. Numerical methods and computer programming- Veerarajan and others.,
3. Numerical methods- Dr. P. Kandasamy, Dr. K. Thilagavathy, Dr. K. Gunavathi, S.Chand and Company Pvt. Ltd, reprint 2016.

WEB SOURCES:

1. https://www.konenig-solutions.com
2. https://www.coursera.org
3. htttps://onlinecourses.swayam2.ac.in

4. https://atozmath.com
5. https://play.google.com

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	3	2	2	3	3
CO2	2	3	2	3	2	2	2	2	2	2
CO3	3	2	3	2	2	3	2	2	3	3
CO4	3	3	2	2	2	2	3	2	3	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**ELECTROMAGNETIC THEORY**	Core Course	CC: VII	
Course Code	23PPH2C7	Credits	5	
Semester	II	Marks	25	75

Pre-Requisites
Different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma
Learning Objectives
• To understand Biot – Savart's law and Ampere's circuital law • To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws • To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves • To grasp the concept of plasma as the fourth state of matter

UNIT I: Electrostatics:

Coulomb's law – Electric field – Continuous charge distributions – Gauss law (□. E) - Electric Potential - Multipole expansion - Poisson's and Laplace's equations: Cartesian Coordinates – Potential of parallel plate capacitor - Spherical coordinates – Conducting sphere in a uniform field – Dielectric sphere in a uniform field - Cylindrical Coordinates - Conducting cylinder in a uniform field – Force on dielectrics.

UNIT II: Magnetostatics

Current density – Ampere's law - Biot - Savart law –Magnetic field due to a straight wire and circular loop - Ampere's circuital law – Magnetic field due to long straight current carrying conductor - Force on a current carrying conductors and charges – Magnetic Scalar Potential – Application: Current Whirl - Magnetic Vector Potential – Application: Magnetic dipole – Multipole expansion of a current distribution.

UNIT III: Field equation and conservation laws

Equation of Continuity - Maxwell's Displacement current - Maxwell equation in differential and integral form - Energy in electromagnetic fields (Poynting's theorem) - Electromagnetic Scalar and vector potentials –Concept of Gauge - Coulomb Gauge and Lorentz Gauge - Continuous distribution: Retarded Potential.

UNIT IV: Wave propagation

Plane wave equation – Propagation of EMW in isotropic dielectric – Anisotropic - Free space: pointing vector, power flow, energy density and significance - Partly conducting medium:

skin effect, relative direction of E and H, pointing vector, energy density - Propagation in ionized gases - Wave Guide - Propagation of waves in a rectangular wave guide – TM mode and TE mode.

UNIT V: Wave guide and Interaction of EM waves with matter

Reflection and refraction of E.M.W– Kinematic properties – Dynamic Property: Fresnel Formula - Brewster law and degree of polarization – Total internal Reflection.

Scattering and scattering parameters - a free electron (Thomson's scattering) and bound electron (Rayleigh's scattering) – Dispersion - Normal and Anomalous dispersion in liquids and solids - Dispersion in Gases.

UNIT VI: Plasma physics (*Self - study Unit - *Not for Question Setting):

Plasma existence - Plasma oscillations - Occurrence of plasma - Charged particle in Electric and magnetic fields.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the relation between concepts of electrostatic, magnetostatic field and dielectrics.

CO2: Receive knowledge on Ampere's law, Magnetic vector and scalar potential and some applications

CO3: Analysis the concept of Energy in electromagnetic fields, Concept of Gauge such as Coulomb Gauge and Lorentz Gauge

CO4: Understand the wave equation concept and reflection and refraction phenomenon.

CO5: Solve the wave guide problems and scattering phenomenon.

TEXT BOOKS:

1. Introduction to Electrodynamics - David J. Griffith, Prentice Hall, 4th Edition - 2020. (**Unit I - V**)
2. Electromagnetic Theory - Chopra and Agarwal, K. Nath & Co, Meerut (6th Edition 2016-17).
   UNIT I: 1.1 - 1.5, 2.2 - 2.4; **UNIT II:** 3.1 - 3.7; **UNIT III**: 4.1 - 4.11;
   UNIT IV: 5.1 – 5.5, 6.2 - 6.5; **UNIT V**: 6.8, 7.1 - 7.3, 7.5 - 7.8.
3. Electromagnetic theory and Electrodynamics – Satyaprakash (Publication: Kedar NathRam Nath, Edition - 2016) **UNIT V:** 9.12 – 9.13, 10.4 – 10.9); (**UNIT VI**: 14.1 - 14.4)

REFERENCE BOOKS:

1. Electromagnetic Waves and Radiating Systems – Edward C. Jordan & Keith G. Balmain (Prentice – Hall India, New Delhi, 2005)
2. Electromagnetic Theory and Wave Propagation – S.N. Ghosh (Narosa PublishingHouse, 2nd Edition, 2002)
3. Electromagnetics – J A. Edminister (Tata McGraw Hill, 2nd Edition, 2006).

WEB SOURCES:

1. https://www.khanacademy.org/science/physics/electricity-and-magnetism
2. https://ocw.mit.edu/courses/physics/8-02-physics-ii-electricity-and-magnetism-spring-2007/
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
4. https://www2.physics.ox.ac.uk/contacts/people/williamsl

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	3	3	2	2
CO2	2	2	2	3	2	3	3	2	2	3
CO3	2	2	3	2	2	2	2	3	3	2
CO4	2	2	2	3	2	3	2	3	2	2
CO5	2	3	3	3	2	2	3	2	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	3	3	3	3	2
CO2	2	3	2	3	3	2	3	2	2	3
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**MOLECULAR SPECTROSCOPY**	Core Course	CC: VIII	
Course Code	23PPH2C8	Credits	4	
Semester	II	Marks	25	75

Pre-Requisites
Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour.
Learning Objectives
• To comprehend the theory behind different spectroscopic methods • To know the working principles along with an overview of construction of different types of spectrometers involved • To understand the concepts of microwave, IR,Raman and other spectroscopic techniques. • To realize the atomic and electronic transitionstates in the presence of electric and magnetic field. • Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.

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UNIT I: Microwave spectroscopy:

Introduction to microwave spectroscopy – Theory of Microwave spectroscopy: Diatomic molecule as rigid rotator and non - rigid rotator - Classification of molecules: Linear molecules, symmetry top molecules – Stark Effect - Instrumentation - Applications – Structural determination of simple molecules.

UNIT II: Infrared Absorption Spectroscopy:

Introduction–Range of Infrared radiation – Nomenclature and requirements of Infrared radiation absorption – Theory of IR spectroscopy: Vibrating diatomic molecule as a harmonic oscillator and Anharmonic oscillator – Linear molecules - Symmetric top molecules - Instrumentation – Modes of vibration of atoms in polyatomic molecules – Applications of infrared spectroscopy to organic compounds: Hydroxy compounds (alcohol, phenol)

UNIT III: Raman Spectroscopy:

Introduction – Principle – Characteristic properties of Raman line – Difference between Raman and IR Spectra - Classical and quantum theory – Pure rotational Raman spectra of diatomic molecules – Vibrational - Rotational Raman spectra – Rule of mutual exclusion principle - Raman Spectrometer – Applications of Raman spectra in inorganic compounds.

UNIT IV: UV and Electronic spectroscopy:

Introduction – Absorption laws - Types of electronic transitions –Transition Probability

- Chromophore concept – Auxochromes –Types of absorption bands – Woodward - Fieser rulesfor calculating absorption maximum in Dienes.

Introduction – Franck Condon Principle – Vibrational coarse structure – Rotational finestructure – Fortrait diagram – Applications.

UNIT V: NMR and ESR Spectroscopy:

Introduction – Relaxation process – Number of signals – Position of signals - Internal standards – Shielding and Deshielding effect – Spin - Spin coupling - Coupling constant – Instrumentations.

Introduction – Comparison – Types substances with unpaired electrons - Theory of ESR - Instrumentation - Hyperfine splitting – Determination of 'g' value - line width – Applications.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Gain knowledge in microwave spectra, IR spectra, UV spectra, NMR spectra and ESR spectra.

CO2: Identify the terms in and describe deviations to Beer's Law and describe the vibrational, rotational spectra of molecules in IR and microwave region.

CO3: Explain the basics of Raman spectroscopy and quantum theory of Raman scattering.

CO4: Explain the state of resonance of nuclei and electron and their spectral characteristics.

CO5: Make Students aware of the fine structure of ESR absorption, hyperfine structure, double resonance in ESR, Techniques of ESR spectroscopy.

TEXT BOOKS:

1. *Spectroscopy (Atomic and molecular) - Gurdeep R. Chadwal, Shan K. Anand (Himalaya Publishing House, Edition: 5th - 2007)*

UNIT I: 2.1, 2.4, 2.5, 2.7, 2.9, 2.10, 2.11; **Unit II:** 3.1 - 3.7, 3.9, 3.11, 3.17; **UNIT III**: 4.1 - 4.6, 4.8, 4.11; **UNIT IV**: 24.1 - 24.4, 24.9; **UNIT V:** 10.1 - 10.12.

2. Elementary organic Spectroscopy (Principles and Chemical Application) - Y.R. Sharma (Edition: 5th Revised Edition -2013). **UNIT IV**: 2.1, 2.2, 2.7 - 2.10, 2.12, 2.16; **UNIT V:** 5.1–5.7, 5.12, 5.16.

REFERENCE BOOKS:

1. Spectroscopy – H. Kaur (Pragathi Prakashan Publication) Edition 2019.
2. Elements of spectroscopy - Gupta Kumar Sharma (Pragathi Prakashan Publication –Edition2016
3. Organic spectroscopy – Principles and Applications) – Jag Mohan (Alpha Science International Ltd, 2nd Edition 2004)

4. Fundamentals of Molecular Spectroscopy – Colin N. Banwell and Elaine M. Mc Cash (McGraw Hill Publication, 4th Edition).

WEB SOURCES:

1. https://www.nist.gov/pml/molecular-spectroscopy
2. https://onlinelibrary.wiley.com/topic/molecular-spectroscopy
3. https://www2.chem.ox.ac.uk/contacts/people/james-kendrick
4. https://www.spectraschool.org/
5. https://www.rsc.org/spectroscopy/molecular-spectroscopy/
6. https://chemistry.berkeley.edu/publications/educational-resources/molecular-spectroscopy

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	2	3	2	2
CO2	2	3	3	2	2	2	2	3	2	2
CO3	2	3	3	2	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	3	3	3	3	2	3	2
CO2	2	3	2	3	3	2	3	2	3	3
CO3	3	3	2	2	2	3	2	2	3	2
CO4	3	3	3	3	2	3	3	3	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**PRACTICAL - II (GENERAL AND ELECTRONICS)**	Core Course	CC: IX – P	
Course Code	23PPH2P9	Credits	4	
Semester	II	Marks	40	60

Pre-Requisites
Knowledge and handling of basic general and electronics experiments of Physics
Learning Objectives
• To understand the optical properties using LASER. • To calculate the physical properties of materials. • To analyze the optical and electrical properties of materials. • To observe the applications of IC 555 Timer. • To study the different applications of operational amplifier circuits. • To learn about Combinational Logic Circuits and Sequential Logic Circuits

(Any 12 Experiments)

1. Determination of L and M of a coil - Anderson's method.
2. Determination of dielectric constant –Parallel plate capacitors.
3. Determination of Rydberg's constant - Hydrogen spectrum.
4. Determination of viscosity of the liquid –Meyer's disc method.
5. Specific charge (e/m) of an electron – Thomson method.
6. Determination of Planck's constant.
7. Determination of optical parameters using Laser.
8. Determination of thermal conductivity of a good conductor – Forbe's method.
9. OP - AMP D/A converter (weighted resistor method/R - 2R ladder method).
10. Half adder and Full adder using NAND.
11. Half subtractor and Full subtractor using NAND.
12. R - S & D Flip - flops using NAND gates.
13. J - K Flip flop using IC 7476.
14. Study of decade counter IC 7490, IC 7447 and FND507.
15. UP/DOWN counter using IC (JK Flip - Flop).
16. Encoder using OR gates.
17. Shift registers using D Flip flops.
18. Binary to Gray code and Gray to Binary code converter.

19. Schmitt Trigger using 555 timer.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Improve the practical and experimental skills.

CO2: Understand the need of apparatus and their usages.

CO3: Self ability to construct new circuits and troubleshooting the error occuring in theexperiments.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	3
CO2	2	2	3	3	2	3	2	2	2	2
CO3	3	3	3	3	2	3	3	2	3	2
CO4	3	2	3	2	2	3	3	2	2	2
CO5	3	2	3	3	2	3	2	2	2	2

Course Title	**MATHEMATICAL METHODS**	Core Course	**SEC II**	
Course Code		Credits	2	
Semester	II	Marks	25	75

Pre-Requisites
Knowledge of mathematical physics
Learning Objectives
To acquire basic concepts of eigen values and eigen vectors. To introduce the concepts of numerical integration. To solve partial differential equations. To obtain the knowledge of various statistical methods.

Unit I: Eigen value and Eigen vector

Eigen value and Eigen vector- Power method- Iteration method

Unit II: Numerical double integration

Double integration – Trapezoidal and Simpson's rule- problem

Unit III: Partial differential equations

Solution of equation by direct integration − Partial differential equation non-linear in p and q -Linear homogenous partial differential equation of n^{th} order with constant co-efficient − Rules for finding complimentary function − Rules for finding the particular integral. P.I of any function.

Unit IV: - Statistical Methods-I

Frequency distribution-Continuous Frequency Distribution- Averages or Measures of central Tendency-Requisites for an Ideal measure of Central Tendency- Arithmetic mean-Properties of Arithmetic mean-Median- Mode-Geometric mean- Harmonic mean.

Unit V: Statistical Methods-II

Dispersion-Range - Mean Deviation - Standard Deviation and Root Mean square deviation(s) – Variance - Relation between σ and s.

Text books:

1. Numerical Methods – Dr P. Kandasamy, Dr. K. Thilagavathy Dr. K. Gunavathi- S. Chand Publishing- Third Revised Edition.
2. Numerical Methods in Science and Engineering-Dr M. K. Venkataraman - The National Publishing Company Fifth Edition June 1999 Reprinted July 2013.
3. Elements of Mathematical Statistics- S. C. Gupta and V.K. Kapoor-Sultan Chand & Sons-Third Edition Reprinted 2003

REFERENCE BOOKS:

1. Mathematical Physics —Sathya Prakash, Sultan Chand & Sons.
2. Mathematical Physics – B. D. Gupta
3 Higher engineering mathematics – B.S Grewal- Khanna Publishers

WEB SOURCES:

1. stattrek.com
2.stats.idre.ucla.edu
3.khanacademy.org
4.www.itl.nist.gov

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Improve the numerical skills in Eigen values and Eigen vectors.

CO2: Acquire knowledge in numerical double integration

CO3: Understand the different methods of solving partial differential equations.

CO4: Gain knowledge basic concepts in mathematical statistics

CO5: Solve problems in various statistical methods

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	2	2	2	2	3	3	3	2	2
CO3	2	2	3	3	2	2	2	2	2	2
CO4	2	3	2	3	2	2	2	3	2	2
CO5	2	2	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	3	3	2	3	2	3	3
CO2	2	2	2	3	2	2	2	2	3	2
CO3	3	3	2	3	2	2	3	2	3	3
CO4	3	2	2	2	2	3	3	2	2	2
CO5	3	2	2	3	2	3	2	2	2	2

Course Title	**QUANTUM MECHANICS**	Core Course	CC: X	
Course Code	23PPH3C10	Credits	5	
Semester	III	Marks	25	75

Pre-Requisites
Knowledge of postulates of Quantum mechanics, properties of Hermitian operators, ladder operators, degeneracy, angular momentum techniques and commutation rules
Learning Objectives
• Formal development of the Schrodinger equation and the properties of angular momenta, both orbital and spin • To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation. • Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field • To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts

Unit I: Introduction to Quantum mechanics

Time - Dependent Schrodinger equation - Interpretation of the wave function - Ehrenfest's theorem - Time –independent Schrodinger equation - Linear operator - Eigen functions and eigen values - Hermitian operator - Postulates of Quantum mechanics - Square- well potential with rigid walls - Square-well potential with finite walls.

Unit II: Time - independent Perturbation theory

Introduction - Stationary Perturbation theory (Non - degenerate case): first order correction only - Physical applications of non - degenerate perturbation theory: Normal Helium atom (without spin considerations), Perturbed harmonic oscillator, Zeeman Effect (without electron spin) - Stationary Perturbation theory (degenerate case) - First order stark effect in hydrogen atom - WKB method – Connection formulas for penetration of a barrier –Electrons from a metal.

Unit III: Time - dependent perturbation theory

Introduction - Time dependent perturbation theory: Time development of states, Perturbation constant in time, Physical interpretation; Transition Probability: Fermi - Golden rule

- Adiabatic approximation - Sudden approximation - Harmonic perturbation - Einstein's A and B coefficients –Rayleigh's scattering –Raman scattering.

Unit IV: Scattering theory & Angular momentum

Scattering cross - section - Scattering amplitude - Partial wave –Scattering - a central potential: Partial wave analysis - Expression for phase shifts - Scattering - Screened coulomb potential - Commutation relations of total angular momentum with components - Addition of angular momenta: Clebsch - Gordon coefficients - Calculation of Clebsch - Gordon coefficients for j_1=½, j_2=½.

Unit V: Relativistic Quantum Mechanics

Introduction - Kelin Gordon equation - Kelin Gordon equation in electromagnetic field - Solution of Klein – Gordon equation for a particle with Coulomb potential V_0 - Dirac's relativistic equation - Dirac free particle solutions - Probability density and Current density - Electromagnetic Potentials: magnetic moment of the electrons.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Gains the basic concepts of quantum mechanics.

CO2: Get a better understanding of time independent and time dependent perturbation theory.

CO3: Have a depth knowledge on scattering theory and angular momentum.

CO4: Estimate the scattering cross-section for particles scattered by screened Coulomb potential.

CO5: Impart the knowledge on information about relativistic wave equation.

TEXT BOOKS:

1. Quantum mechanics - G. Aruldhas, Publisher: PHI (2nd edition Feb 2012)

UNIT I: 2.5 - 2.8,3.2 - 3.5,4.1 - 4.2; **UNIT III**: 12.3; 12.6, 12.8, 12.9;

UNIT IV:14.1 - 14.4, 14.9, 14.12

2. Quantum mechanics - Satya Prakash, Publisher: Kedar Nath Ram Nath, Meerut, Delhi. (Edition 2015)**UNIT II:** 11.1 - 11.5, 11.8 - 11.9, 11.13; **UNIT III**: 12.0, - 12.3;**UNIT IV**: 10.5,10.11 - 10.12; **UNITV**: 14.0 - 14.7.

REFERENCE BOOKS:

1. Quantum mechanics - Theory and application - A.K.Ghatak and Lokanathan, Macmillan India Ltd., Publication, Fifth Edition 2015.
2. Quantum mechanics - Leonard I. Schiff, Mc Graw Hill International Publication, Third Edition 1968.

3. Quantum mechanics - V.K.Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
4. Quantum mechanics - E.Merzbacher, John Wiley interscience Publications, ThirdEdition 2011.
5. Quantum mechanics(Vol.I) - Claude Cohen - Tannoudji, Bernard Diu, Franck Laloe,John Wiley inter-science Publications, First Edition,1991.

WEB SOURCES:

1. https://plato.stanford.edu/entries/qm/
2. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/
3. http://hyperphysics.phy-astr.gsu.edu/hbase/quantum.html
4. https://www2.physics.ox.ac.uk/contacts/people/blackett
5. https://www.khanacademy.org/science/physics/quantum-physics

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	2	3	2	3
CO2	2	2	3	2	2	2	2	2	3	2
CO3	2	3	3	2	2	2	2	3	2	3
CO4	2	3	3	3	2	3	2	3	3	2
CO5	2	3	3	2	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	3	3
CO2	2	2	2	3	3	2	3	3	2	2
CO3	3	3	3	2	2	2	3	2	2	2
CO4	3	3	2	3	2	3	3	2	2	3
CO5	3	3	3	3	2	3	3	2	2	2

Course Title	**NUCLEAR AND PARTICLE PHYSICS**	Core Course	CC: XI	
Course Code	23PPH3C11	Credits	4	
Semester	III	Marks	25	75

Pre-Requisites
Knowledge of basic structure of atom and nucleus.
Learning Objectives
• Introduces students to the different models of the nucleus in a chronological order • Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles • Provides students with details of nuclear decay with relevant theories • Exposes students to the concept of Elementary Particles

UNIT I: Nuclear models:

Liquid drop Model – Weizacker mass formula – Wheeler theory of fission - Nuclear Shell model – Spin Orbit coupling – Magic numbers - Single particle model: validity & limitation - Superconductivity model - Collective model.

UNIT II: Nuclear Forces:

Introduction: Nature and properties of Nuclear forces – Types of interactions – Properties of deuteron - Charge independence and spin dependence of nuclear forces - Ground state of deuteron – Non - Central forces (Tensor forces) – Exchange forces - Yukawa's meson theory – Yukawa potential – Spin independence – Charge symmetry of Nuclear forces.

UNIT III: Radioactive decays:

Elementary ideas of alpha, beta and gamma decays - Geiger - Nuttal law - Neutrino hypothesis - Fermi theory of β decay – Beta spectrum - Selection rules – Non conservation of parity in beta decay – Gamma decay – Selection rules – Internal conversion – Nuclear isomerism.

UNIT IV: Nuclear reactions

Kinds of nuclear reactions – Conservation laws – Reaction Kinematics – Q- Value –Direct reactions – Nuclear chain reaction - four factor formula – Fission reactors - Nuclear reactors: Power type reactor.

Nuclear Fusion: Basic fusion processes– Solar fusion – Cold fusion – Controlled thermo nuclearreactions – Breeder reactor – Pinch effect.

UNIT V: Elementary Particles

Classification of elementary particles – Types of interactions – Conservation laws (charge, spin, parity, isospin, hypercharge, baryon number, lepton number, strangeness number) – Strange particles– GellMann - Nishijima formula – Space inversion invariance (Parity) – Time reversal – CPT theorem–Hyperons– Quark model - Colour and Charm quarks .

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Express reaction equation and Q values and energy of alpha particles

CO2: Calculate the half times based on quantum theory and beta decays.

CO3: List the types of beta decays and can express reaction equations and related Q valuesand energy of beta particles.

CO4: Explain beta decay process using the Fermi theory and selection rules and it's applications.

CO5: Describe the allowed and forbidden transitions.

TEXT BOOKS:

1. Nuclear physics - D.C. Thayal, Himalaya publishing House (Edition: 5^{th}) 2018

UNIT I: 9.1, 9.3, 9.4, 9.5, 9. 8. UNIT **III:** 5.1, 5.2, 5.3, 6.1 - 6.3, 6.5, 6.6

UNIT IV: 10.1-10.3, 13.1 - 13.3

2. Elements of Nuclear Physics - Pandya Yadav (Kedar Nath Ram Nath, Edition: 6^{th}) 2016

UNIT II: 4.1, 4.2, 4.5; **UNIT V:** 13.1, 13.2, 13.5, 13.6, 13.9, 13.10

REFERENCE BOOKS:

1. Nuclear Physics - V. Devanathan Narosa Publishing house (2006).
2. Concepts of Nuclear Physics - B.L. Cohen, Tata McGraw Hill, New Delhi, 1983.
3. Nuclear Physics – S.N. Ghosal, S. Chand Company Ltd (2010)
4. Nuclear physics – An Introduction – S.B. Patel, Wiley Eastern,
5. Nuclear Physics - R.R.Roy and B.P Nigam, Wiley Eastern.

WEB SOURCES:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear.html
2. https://ocw.mit.edu/courses/physics/8-422-physics-of-nuclear-reactors-fall-2002/
3. https://courses.lumenlearning.com/phys211/
4. https://www.khanacademy.org/science/physics/atomic-nuclear-physics

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	3	2	2	3	2	3
CO2	2	3	2	3	2	3	2	3	3	3
CO3	2	3	2	3	2	2	2	3	2	2
CO4	2	3	2	3	2	3	2	3	3	2
CO5	2	3	3	3	2	2	2	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	3	3	3	3	2	3	2
CO2	2	3	2	3	3	3	2	3	2	3
CO3	2	2	3	2	2	3	3	2	2	3
CO4	2	3	3	3	2	3	2	3	2	3
CO5	2	3	3	3	2	3	3	2	2	2

Course Title	**ADVANCED GENERAL EXPERIMENTS & C PROGRAMMING**	Core Course	CC: XII- P	
Course Code		Credits	4	
Semester	III	Marks	40	60

Pre-Requisites
Knowledge in heat, light, electricity and magnetism.   ***Basic knowledge in differential equation and linear algebra***   ***Knowledge of computer fundamentals.***
Learning Objectives
• To understand the principles that govern the behavior of electric and magnetic fields   • To understand how the heat energy is transferred.   • To apply the knowledge in light to practical applications.   • To familiarize the students with the numerical methods used in computation and programming using C language.   • To approach the real time activities using physics and mathematical formulations.

(Any 12 Experiment)

1. Four probe method – Determination of Resistivity.
2. Determination of carrier concentration and Hall coefficients in Semiconductor.
3. Determination of magnetic susceptibility – Guoy's method.
4. Determination of magnetic susceptibility of liquids - Quincke's method.
5. Determination of separation of wavelength λ and $d\lambda$ – Michelson's interferometer.
6. Determination of thickness of a thin film – Michelson interferometer.
7. Charge of an electron – Spectrometer.
8. Polarizability of liquids – Spectrometer.
9. Determination of wavelength of monochromatic source using bi – prism.
10. Determination of refractive index of liquids using bi – prism - Telescope method.
11. Determination of specific rotatory power of a liquid - Polarimeter.
12. Laser grating – Determination of λ.

COMPUTER PRACTICALS

1. Roots of algebraic equations – Newton Raphson method.
2. Least square curve fitting – Straight line fit.

3. Interpolation – Lagrange method.
4. Newton's forward interpolation formula
5. Newton's backward interpolation formula

Numerical Integration

6. Trapezoidal rules.
7. Simpson's 1/3 and 3/8 rules.

Solutions of ordinary differential equations

8. Runge – Kutta second and fourth order method**.**

9. Euler's method.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the practical skills for these experiments.

CO2: Improve the scientific sprit for doing such experiments.

CO3: Use various numerical methods in describing/solving physics problems.

CO4: Apply various interpolation methods and finite difference concepts.

CO5: To apply the knowledge of heat, light, electricity and magnetism to practical applications .

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	2	2	2	3	3	2
CO2	2	2	3	3	2	2	2	2	2	2
CO3	2	3	2	3	2	2	3	3	2	2
CO4	2	3	3	2	2	3	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	2	3	3	2	3	2
CO2	2	2	3	2	3	2	3	2	2	2
CO3	3	3	2	2	2	3	2	2	3	2
CO4	3	3	3	3	2	3	2	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**MEDICAL PHYSICS**	Core Course	**SEC III**	
Course Code		Credits	2	
Semester	III	Marks	25	75

Pre-Requisites
Fundamentals of physiological concepts, basics of instruments principle
Learning Objectives
To understand the major applications of Physics to Medicine To study the aid of different medical devices such as X-ray machines and transducers. To introduce the ideas of Radiography. To understand Magnetic Resonance Imaging To form a good base for further studies like research.

Unit I: X-rays and transducers

Electromagnetic Spectrum - Characteristic X-Ray – Coolidge Tube– Thermistors – photo electric transducers – Photo voltaic cells – Photoconductive cells– piezoelectric transducer.

Unit II: Blood pressure measurement

Basic principles of electrocardiogram (ECG) – Basic principles of electro - neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

Unit III: Radiation physics

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv)– Interaction of radiation with Matter.

Unit IV: Medical imaging physics

Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging

Unit V: Radiation protection

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices –Pocket Dosimeter

Text books:

1. Dr. K. Thayalan , *Basic Radiological Physics*, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Dr. K. Thayalan, *Textbook of radiological safety*, Jayapee Brothers Medical Publishing Pvt. Ltd. First edition New Delhi, 2010.
3. Curry, Dowdey and Murry, *Christensen's Physics of Diagnostic Radiology:* - *Lippincot*Williams and Wilkins, 2990.
4. FM Khan, *Physics of Radiation Therapy*, William and Wilkins, 3rd ed, 2003.

5. D. J. Dewhurst, *An Introduction to Biomedical Instrumentation*, 2st ed, Elsevier Science, 2024. R.S. Khandpur, *Hand Book of Biomedical Instrumentations*, 2st ed, TMG, New Delhi, 2005.

Reference books:

1. Muhammad Maqbool, *An Introduction to Medical Physics*, 2st ed, Springer International Publishing, 2027.
2. Daniel Jirák, FrantišekVítek, *Basics of Medical Physics*, 2st ed, Charles University, Karolinum Press, 2028
3. Anders Brahme, *Comprehensive Biomedical Physics*, Volume 2, 2st ed, Elsevier Science, 2024.
4. K. Venkata Ram, *Bio-Medical Electronics and Instrumentation*, 2st ed, Galgotia Publications, New Delhi, 2002.
5. John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

Web sources:

1. https:nptel.ac.in/courses/208/203/208203257/
2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. https://lecturenotes.in/notes/27929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
5. https://www.modulight.com/applications-medical/

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

CO2	Learn the fundamentals, production and applications of X-rays.
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC and basic principles of MRI.
CO3	Apply knowledge on Radiation Physics
CO4	Analyze Radiological imaging and Mammography
CO5	Assess the principles of radiation protection

MAPPING WITH PROGRAM OUTCOMES:
Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (2)**.**

	PO2	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO20**
CO2	3	3	3	2	2	2	3	3	2	3
CO2	3	3	3	2	2	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	3	3	2	2	2	3	3	2	3

	PSO2	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO20
CO2	3	3	3	2	2	2	3	3	2	3
CO2	3	3	3	2	2	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	3	3	2	2	2	3	3	2	3

Course Title	**CONDENSED MATTER PHYSICS**	Core Course	CC: XIII	
Course Code	23PPH4C13	Credits	4	
Semester	IV	Marks	25	75

Pre-Requisites
Basic knowledge of crystals, electricity, magnetism, atomic physics, quantum mechanics and statistical mechanics.
Learning Objectives
• To describe various crystal structures, symmetry and to understand dielectrics. • To construct reciprocal space, understand the lattice dynamics. • 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. • Distinguish various properties and application of various modern engineering materials

UNIT I: Magnetic Materials

Introduction-Magnetic permeability-Magnetization-Electric current in atoms- Bohr Magneton-Theory of magnetism in electrons- Diamagnetism-Paramagnetism- Weiss theory of paramagnetism-Ferromagnetism-Spontaneous magnetization in ferromagnetic materials-Antiferromagnetism-Ferrimagnetism-Ferrites and its applications-Magnetic materials.

UNIT II: Superconductivity

Thermodynamics of the superconducting transition – London equation – Coherence length – BCS theory of superconductivity – ground state – Flux quantization in a superconducting ring - duration of persistent currents – Type II superconductors – vortex state – estimation of Hc1 and Hc2 – single particle tunnelling – Josephson superconductor tunnelling – Dc Josephson effect – Ac Josephson effect – macroscopic quantum interference – High temperature superconductors.

UNIT III: Crystal structure

Lattice and basis-Lattice Translational Vector- Wigner-Seitz cell- Indexing of planes, Directions and Positions of atoms-Crystal systems- Bravais Lattices-symmetry Operations-Point

groups- Space Groups –Screw axis-Glide Plane-Types of Lattices –X Ray diffraction - Bragg's law - Reciprocal Lattice (SC, BCC, FCC) - Brillouin zones - Types of crystal binding (general ideas).

UNIT IV: Dielectrics

Introduction –Review of basic formulae-The microscopic concept of polarization- Local Field or Internal Field in liquids and solids – Clausius - Mosotti Relation –Lorentz- Lorentz equation-The static dielectric constant of solids and liquids -Ferroelectricity- Absorption of energy and dielectric losses- Effects of dielectrics- Important requirements of good insulating materials-Some important insulating materials.

UNIT V: Modern Engineering Materials

Introduction - Metallic Glasses – Biomaterials –FRP-FRM-MMC-SAW Materials- Ceramics – Cermets-High temperature materials –Thermoelectric materials—Electrets-Nuclear engineering materials- Nanophase materials- Intermetallic compounds- Shape memory alloys –SMART materials-conducting polymers

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Gain knowledge about types of lattices.

CO2: Appraise the mechanism of Conducting Materials.

CO3: Distinguish Magnetic Properties of materials and Dielectric Materials.

CO4: Discuss the properties and application of Superconductivity.

CO5: Differentiate the modern engineering materials.

TEXT BOOKS:

1. Solid State Physics, S. O. Pillai, New age International Publishers, NewDelhi,2018.
   Unit 1- 9.1-9.4, 9.8,9.9, 9.11,9.12, 9.19,9.20, 9.31-9.34
   Unit 2- 8.1- 8.4, 8.6-8.14, 8.18, 8.20, 8.21, 8.24
   Unit 3- 1.1-1.14,2.1,2.6, 3.1-3.6
   Unit 4-11.1 - 11.7, 11.15-11.18
2. Materials Science – Dr. M. Arumugam Unit 5- 11.1 - 11.17

RFERENCE BOOKS:

1. Charles Kittel, Introduction to Solid State Physics, John Wiley & Sons Inc., NJ, 2005.
2. S.L. Gupta and V. Kumar, Solid State Physics, K. Nath & Co., Meerut, 2013.
3. A. J. Dekker, Solid State Physics, Macmillan, 2000

4. Solid State Physics - K. Ilangovan, MJP Publishers, Chennai, 2012.

WEB SOURCES:

1. https://arxiv.org/archive/cond-mat
2. https://journals.aps.org/browse-by-subject#condensed-matter
3. https://www.sciencedirect.com/browse/journals-and-books?contentType=JL&subject=materials-science&subject=sub7E0040
4. https://web.stanford.edu/group/gabriellaherbs/book/
5. https://global.oup.com/academic/content/physics/condensed-matter-physics/?cc=us&lang=en&

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	3
CO2	2	3	3	3	3	2	2	2	2	2
CO3	2	3	3	2	2	2	2	3	2	2
CO4	2	3	2	3	2	2	2	3	2	2
CO5	2	2	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	3	3	3	3	2	3	2
CO2	2	3	3	2	3	3	3	2	2	2
CO3	3	3	3	2	3	3	3	2	3	2
CO4	3	3	3	3	2	2	3	2	2	2
CO5	3	2	3	3	2	3	2	2	2	2

Course Title	**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051 - Practicals**	Core Course	CC: XIV-P	
Course Code	23PPH4P14	Credits	4	
Semester	IV	Marks	40	60

Pre-Requisites
Fundamentals of digital principles
Learning Objectives
• To understand the theory and working of Microprocessor, Microcontroller and their applications • To use microprocessor and Microcontroller in different applications

(Any 12 Experiments)

Microprocessor 8085

1. Program for multibyte hexadecimal addition/subtraction
2. Find largest / smallest numbers in a list.
6. Arrange in ascending /descending order.
7. Code conversion
3. ASCII to Decimal and Program for multibyte decimal addition/subtraction. .
4. Study of logical instructions (1's and 2's complement, Rotate left, right vice versa)
5. Decimal to Binary.
6. Binary to Decimal.
7. Decimal to Hexadecimal and Hexadecimal to Decimal.
8. Block of data transfer both forward and reverse order
9. Study of delay subroutine
10. Keyboard interface - Rolling display.
11. Study of Intel 8253
12. ADC interface (LED, RAM).
13. Wave form generation (saw tooth, square, triangular, stair case) DAC.
14. Stepper motor interface.
15. Traffic light interface.
16. Seven segment display interface.
17. Interrupt controller 8259
18. Study of PPI 8255.

Microcontroller 8051

19. Program for addition and subtraction in 8 bits
20. Program for multiplication and division in 8 bits.
21. Sum of N numbers
22. Block of data transfer
23. Boolean and logical instructions
24. counters
25. Code conversion
26. ASCII to Decimal and vice versa,Decimal to Binary and Binary to Decimal conversions.
27. Decimal to Hexa-decimal and Hexa-decimal to Decimal.
28. Interfacing key board display
29. DAC interface.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Develop the programming skills of Microprocessor

CO2: Appreciate the applications of Microprocessor programming

CO3: Understand the structure and working of 8085 microprocessor and apply it.

CO4: Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO 1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**COMPUTATIONAL SPECTROSCOPY**	Core Course	**SEC IV**	
Course Code		Credits	2	
Semester	IV	Marks	25	75

Pre-Requisites
Basic knowledge of spectroscopy
Learning Objectives
To understand basic concepts of spectroscopy. To introduce the basic concepts of group theory. To study the fundamentals of hybridization. To obtain the knowledge of molecular orbitals.

Unit I: Introduction to Molecular vibrations:

Electromagnetic radiation - absorption, emission-kinds of molecular motion: rotation-vibration-translation-energy levels and spectral transition-description of internal vibration-bond stretching-angle deformation-rocking-wagging-out of plane deformation-fundamental vibrations-number of vibrational modes in a molecule-degrees of freedom-vibrational modes in linear and nonlinear molecules: CO_2, CH_4 (Example).

Unit II: Structure elucidation and computations methods:

Introduction to HF, Semiempirical, DFT methods-Input Cartesian coordinates -basis sets- Z matrix of single atom- molecular geometry- Koopman's Theorem-Structure analysis of Benezene, Pyrole.

Unit III; Group theory:

Definition of group – Symmetry operations – Group and its properties – Point groups – symmetry class -sub-group - co-sets - classes and characters- simple applications.

Unit IV: Bonding:

V-B theory- postulates of V-B theory – application to the formation of simple molecules like H_2 and O2- overlap of atomic orbitals – S-S, S-P and P-P overlap - principle of hybridization SP, SP_2, SP_3 hybridization.

Unit V: M-O theory:

Formation of MO's – bon ding, antibonding and non- bonding orbitals – MO diagram of H_2, F_2, He.

TEXT BOOKS:

1. Vibrational Spectroscopy – Theory and Applications- D. N. Sathyanarayana, New Age International (P) Ltd, 2005
   Unit 1: 1.1 - 1.2-1.7-1.8-2.03.0-4.0-5.0- 1.7- 1.7-1.9
   Unit II: **https://dft.uci.edu/teaching/lausanne/B.pdf**

   Unit III; 3.1– 3.4, 3.5-3.8

   Unit IV: http://www.adichemistry.com/general/chemicalbond/vbt/valence-bond-theory-hybridization.html

   UNIT V: https://byjus.com/jee/molecular-orbital-theory/

Reference books:

1. Computational Chemistry, F. Jenson, 2nd (2006 edition, Wiley-Blackwell)
2. Chemical Bonding – M. S. Yadav, Anmol Publisher, 2000
3. Elements of Group Theory for physicists- A. W. Joshi, New Age International (P) Ltd, 2018.
4. Parr, R. G. , Yang. W, Density functional theory of atoms and molecules, Oxford University Press, Oxford, UK, 1996.

WEB LINKS:

1. https://www.com chem.org/
2. https://www.quantum – chemistry – archive.org
5. https://chem.libretexts.org/
6. http://www.arguslab.com/arguslab.com/ArgusLab.html
5. https://online-chemdraw-software.peatix.com/

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Develop the fundamental knowledge in molecular vibrations

CO2: Appreciate the applications of molecular spectroscopy in structure elucidation

CO3: Understand the basic concepts of group theory

CO4: Acquire knowledge about the various types of hybridization and molecular orbitals.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	3	3	2	2	2	3	2	2
CO2	2	2	3	3	3	3	2	3	2	2
CO3	2	3	2	2	2	2	2	3	2	2
CO4	2	3	3	3	2	3	2	3	2	2
CO5	2	3	2	2	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	3	3	3	2	3	2
CO2	2	2	2	3	2	3	2	2	3	2
CO3	3	3	2	2	2	3	3	2	3	2
CO4	3	3	3	2	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**PHYSICS OF NANOSCIENCE AND TECHNOLOGY**	Core Course	DSE: I	
Course Code	23PPH2E1	Credits	3	
Semester	II	Marks	25	75

Pre-Requisites
Basic knowledge in Solid State Physics
Learning Objectives
• Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale. • To provide the basic knowledge about nanoscience and technology. • To learn the structures and properties of nanomaterials. • To acquire the knowledge about synthesis methods and characterization techniques and its applications.

UNIT I: Introduction to Nanomaterials:

Definition of Nanometer, nanaomaterials and nanotechnology - Classification of nano materials – Bulk properties of nanomaterials–Optoelectronic property of bulk and nano structures – Electronic structure of Nanomaterials and Fermi surface–Energy consideration: Bound states and density of states (DOS) – Quantum confinement: 3D, 2D, 1D and zero dimensional DOS.

UNIT II: Preparation of Nanomaterials:

Introduction - Top - Down and Bottom - up approaches - Top - Down techniques - Ball milling - Etching - Nanolithography - Electron beam lithography - X - ray lithography - Molecular beam epitaxy - Bottom - up technique - Soft chemical method – Sol - Gel synthesis - Electro - Chemical deposition - Atomic layer deposition - Langmuir - Blodgett film (2D nano structure) preparation.

UNIT III: Quantum Dots and Carbon Nanotubes:

Quantum dots (QDs) - Quantum confinement - Production and applications of QDs - Quantum wires - Quantum wells –Carbon Molecules - Carbon Clusters - Carbon Nanotubes (CNTs)–Applications of CNTs.

UNIT IV: Analytical Techniques for Nanomaterial Characterization:

Structural characterisation - Principles of x - ray powder diffraction - Determination of

structural parasites - Surface morphological analysis - Scanning electron microscope (SEM) - Atomic - force microscope (AFM) - Scanning tunnelling microscope (STM) - Transmission electron microscopes (TEM) - Optical characterization UV - vis - NIR spectrometry – Band gap determination - Tauc's plot method - Photo luminescent (PL) spectroscopy.

UNIT V: Applications of Nanomaterials:

Introduction - Nano - electronics –Micro and Nano electromechanical systems (MEMs/NEMs) – Nano Sensors – Nano catalysts – Food and Agriculture industry – Cosmetic and Consumer goods – Structure an Engineering – Automotive Industry – Water treatment and the Environment – Nano - medical Applications –Textiles – Paints –Energy – Defence and Space Applications – Structural Applications.

UNIT VI: New Trends in Nanoscience and Nanotechnology (Not for Question Setting):

Introduction – Applications in material science – Applications in biology and medicine – Applications in surface science – Applications in energy and environment – Applications of nanostructure – Thin films - Applications of quantum dots – Applications of magnetic nanoparticles.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the theories and properties of nanomaterials.

CO2: Classify the difference between Top-Down and Bottom-Up approaches and different methods to prepare nanoparticles.

CO3: Recognize the quantum dots, quantum nanotubes, different characterisation techniques and applications of Nanomaterials.

CO4: Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.

CO5: Understand the process and mechanism of synthesis and fabrication of nanomaterials.

TEXT BOOKS:

1. Nanoscience and Nanotechnology: Fundamentals to Frontiers - M.S. Ramachandra Rao, ShubraSingh, Wiley India Pvt Limited, (Edition 2016)
   Unit I: 1.2, 1.3, 2.5, 2.8, 2.9, 3.2, 3.3;
   Unit VI: 10.1, 10.2, 10.3, 10.4, 10.5,10.6, 10.7, 10.9
2. Introduction to Nanotechnology - K. Ravichandran, K. Swaminathan, P.K.Praseetha, and P.Kavitha, JAZYM Publications - 2019.
   Unit II: 3.1 - 3.4; **Unit III**: 2.2 - 2.4; **Unit IV**: 4.2, 4.6, 5.2 - 5.5, 7.2, 7.4;
3. Introduction to Nanotechnology - Charles P.Poole Jr. and Frank. J. Owens, John Wiley

& Sons,2010; **Unit III: 5.2 - 5.5.**

4. Textbook of NanoScience and NanoTechnology - B.S. Murty, P. Shankar, Baldev Raj, Baldev Raj,and James Murday, Springer Universities Press - **Unit V:** 4.1 - 4.15

REFERENCE BOOKS:

1. Nano - The essentials - T. Pradeep, **,** Tata McGraw – Hill publishing company limited (2007).
2. Nanostructures and Nanomaterials : Synthesis, Properties, and Applications,

WEB SOURCES:

1. https://www.nano.gov/
2. https://www.nanowerk.com/
3. http://www.understandingnano.com/
4. https://pubs.acs.org/journal/nalefd

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	2	2	2	3	2	2
CO2	3	3	2	3	3	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	3	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	3	3	3	3	2	3	2
CO2	2	2	2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	3	3	3	3	2
CO4	3	2	2	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**LASER AND NON LINEAR OPTICS**	Core Course	DSE: II	
Course Code	23PPH3E2	Credits	3	
Semester	III	Marks	25	75

Pre-Requisites
Fundamentals of optics
Learning objectives
• To understand fundamentals of Lasers. • To enhance comprehension in methods of Lasers. • To familiarize with diverse applications ofLasers. • To learn the different types of Lasers

Unit I: Basic Principles of Lasers

Introduction –Directionality - Intensity – Monochromacity – Waves and Interference – Coherence – Polarization – Speckles – Einstein's Prediction - The three process: Absorption, Spontaneous emission, Stimulated emission – Einstein relations – Popular Inversion – Pumping – Pumping Methods: Optical, electrical – Laser Rate Equations: Two Level, Three Level, Four Level Systems.

Unit II: Types of Lasers

Solid State Laser – Ruby Laser – Three Level System – Nd : YAG Lasers – Gas Lasers – He - Ne Laser – CO_2 Laser – Chemical Lasers – Dye lasers – Semiconductor Laser.

Unit III: Applications of Lasers

Ether Drift – Absolute Rotation of the Earth – Isotope Separation – Thermonuclear Fusion – Lasers in Chemistry – Communication - Lasers – Lasers in Astronomy – Lasers in Biology – Lasers in Medicine – Lasers in Industry.

Unit IV: Non Linear Optics

Harmonic generation – Second Harmonic generation – Phase matching – Third Harmonic generation – Optical mixing – Parametric generation in Light – Self Focusing of Light.

***Unit V:* Laser Spectroscopy**

Rayleigh and Raman Scattering – Stimulated Raman effect - Hyper – Raman effect – Coherent Anti – Stokes Raman scattering – Spin Flip Raman Laser – Free electron laser (FEL

Photo – Acoustic Raman Spectroscopy (PARS) - Brillouin Scattering.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understanding the basic concepts of Lasers, different pumping.

CO2: Know about the different types of Laser.

CO3: Describe the applications of Lasers in various fields.

CO4: Understand the basic knowledge in the field of Non Linear Optics.

CO5: To understand the applications of LASERS in Raman spectroscopy.

TEXT BOOKS:

1. *An Introduction to Lasers Theory and Applications - M. N. Avadhavanulu and P. S. Hemne,* S. Chand & Company Ltd (Second revised edition 2012), New Delhi.

UNIT I: 1.1, 1.2, 1.19 - 1.22, 1.27 - 1.29, 1.48, 3.1 – 3 . 7

UNIT II: 2.3, 2.3.1 - 2.3.4. 2.4, 2.4.1, 2.4.3, 2.4.5, 2.5, 2.7, 2.7.1 - 2.7.12.

2. Lasers and Non Linear Optics - B. B Laud, New age international publisher (Third edition 2011), New Delhi

UNIT III: 17.2, 17.3, 17.5, 17.7, 17.8, 17.9, 17.12–17.15. UNIT IV: 13.1–13.7.

UNIT V: 15.1–15.8

REFERENCE BOOKS:

1. *Laser – Theory and applications - K. Thiyagarajan and A. Ghatak, Lakshmi Publication* – 2nd Edition- 2019.

WEB SOURCES:

1. https://www.osapublishing.org/topic.cfm?topic=Laser%20Science
2. https://spie.org/Fields-of-Interest/Laser-Technology-and-Nonlinear-Optics
3. https://www.aps.org/publications/apsnews/201005/laserfest.cfm
4. https://www.osapublishing.org/abstract.cfm?URI=LNO
5. https://spie.org/publications/books/titles/fundamentals-of-photonics

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	3	3	2	2
CO3	2	3	3	3	2	2	2	2	3	3
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	2	2	2	2	2
CO3	2	2	3	2	2	3	3	2	3	2
CO4	2	3	3	3	2	2	3	2	2	2
CO5	2	2	3	3	2	3	2	2	2	2

Course Title	**MICROPROCESSOR AND MICROCONTROLLER**	Core Course	DSE: III	
Course Code	23PPH3E3	Credits	3	
Semester	III	Marks	25	75

Pre-Requisites
Knowledge of number systems and binary operations
Learning Objectives
• To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor • To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

Unit I: Microprocessor 8085 Architecture, Interfacing and Programming

Intel 8085 Architecture - Pin configuration - Registers and Flags - Stacks - Interrupts - Addressing modes - Complete instructions set - Memory mapped I/O and I/O mapped I/O scheme - Data transfer schemes: Synchronous and Asynchronous data transfer - Interrupt driven data – DMA data transfer scheme - Assembly language programming - Arithmetic Operation.

UNIT II: Advanced Microprocessor

Intel 8086 Architecture - Internal register - Minimum mode and Maximum mode system - Addressing modes - Instruction set: Data transfer, Arithmetic, Logical and Rotate instruction - salient features of Pentium II and III.

Unit III: Microprocessor Interfacing and Application

Basic concepts of programmable device - Programmable peripheral interface Intel 8255 A-Interface of ADC and DAC - 7 segments interface-Stepper motor -Traffic controller-Generate square wave and sine wave using microprocessor 8085.

Unit IV: Microcontroller 8051

Features of 8051 - Architecture – memory organisation - data memory and program memory - Special Function Register (SFR) – Stack - Addressing modes - complete instructions set - Assembly language programming - Arithmetic Operation.

Unit V: Serial data Communication Interfacing

Basic Serial data communication - RS 232A– USATR (Intel 8251A) - Pin description - 8051serial communication-DAC (0800) - ADC (0809) - Interfacing with 8051.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Get strong foundation of the architecture of microprocessor and data transfer schemes.

CO2: Enhance the knowledge in different types of microprocessor and its salient features.

CO3: Gain the clear knowledge on microprocessor interfacing with various real time applications.

CO4: Acquire knowledge about microcontroller and assembly language program.

CO5: Improve their knowledge on the concepts on the Serial data communication interfacing.

TEXT BOOKS:

1. Fundamentals of Microprocessor and Microcomputers - B.Ram, Dhanpat Rai Publications (P) LTD, New Delhi (2005)
   UNIT-I: 3.1, 4.3, 4.4, 4.6, 5.5, 5.6, 6.21, 6.22, 6.24, 6.25, 6.31, 6.34, 7.1-7.4, 9.2
   UNIT-III: 7.7, 8.1-8.4, 8.12, 9.3, 9.7-9.9
2. Advanced Microprocessors and Peripherals - A K Ray & K M Bhurchandi, The McGraw Hill Companies Second Edition.-2008
   UNIT-II: 1.2-1.9. 2, 10.2, 10.13, 11.11, 11.13, 12, 2
3. Microprocessors and Microcontrollers (Second Edition- 2012) - A.Nagoor Kani, Tata McGraw Hill Education Private Limited, New Delhi.
   UNIT IV: 2.1, 2.2, 5.2-5.8; **UNIT V:** 9.3, 9.6, 9.7

REFERENCE BOOKS:

1. Microprocessor Architecture, Programming and application - R.Goanker, (Wiley Eastern, New Delhi,1985)
2. Introduction to Microprocessors - Aditya P Mathur, Tata McGraw –Hill Publishing Company Limited, third edition,Delhi,2003.
3. Microprocessor and its Applications, Technical - A.P Godse and D.A Godse, Publications, Pune, 2006.
4. The 8051 Microcontroller: Architecture, Programming and Application - Keneeth J.Ayala, Penram International Publishing, Pvt. Ltd second Edition.1996.

WEB SOURCES:

1. https://www.tutorialspoint.com/microprocessor/index.htm
2. https://www.microchip.com/en-us/education/microcontroller-basics
3. https://web.stanford.edu/class/ee282/

4. https://www.arduino.cc/en/Guide/HomePage
5. https://www.youtube.com/playlist?list=PLBlnK6fEyqRjMH3mWf6kwqiTbT798eAOm

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**CRYSTAL GROWTH AND THIN FILM PHYSICS**	Core Course	DSE: IV	
Course Code		Credits	3	
Semester	IV	Marks	25	75

Pre-Requisites
Fundamentals of Crystal Physics
Learning Objectives
• To understand the theoretical concepts involved in crystal growth, thin film sciences. • To acquire the knowledge on Nucleation and Kinetics of crystal growth • To understand the Crystallization Principles and Growth techniques • To study various methods of Crystal growth techniques • To understand the thin film deposition methods

Unit I: Basic Concepts, Nucleation and Kinetics of Growth

Ambient phase equilibrium – Super saturation – Equilibrium of finite phases – Introduction –Nucleation - Formation of critical nucleus – Classical theory of nucleation Types of nucleation –Theory of Nucleation - Homo and heterogeneous formation of 3D nuclei – Rate of nucleation - Equation of Thomson - Gibbs for vapour – Thomson's equation for melt – Gibb's – Thomson Equation for solution – Energy of formation of nucleus – Spherical, cylindrical, cap sized nucleus and Disc shaped nucleus.

Unit II: Gel Growth Technique

Solvents and solutions – Solubility diagram – Super solubility – Expression for super saturation – Metastable zone and induction period – Mier's TC diagram – Principle of gel technique – Various types of gel - Structure and importance of gel – Methods of gel growth (single diffusion method, double diffusion method, complex – decomplexion method and solubility reduction method) and advantages. Solution growth – Low and high temperatures solution growth – Slow cooling and solvent evaporation methods – Constant temperature bath as a crystallizer.

Unit III: Melt and Vapor Growth Techniques

Growth from melt – Crucible selection - Zone refining melt technique – Czochralski growth – Bridgman method – Flux growth – Hydrothermal growth – Vapour phase growth – Physical vapour deposition – Chemical vapour deposition.

Unit IV: Thin Film Deposition Techniques

Vacuum evaporation - Hertz - Knudsen equation - Evaporation from a source and film

thickness uniformity - E - beam, pulsed laser and ion beam evaporations - Glow discharge and plasmas - Mechanisms and yield of sputtering processes – DC sputtering, rf sputtering, reactive sputtering – Spray pyrolysis – Electro deposition.

Unit V: Characterization Techniques

X–ray diffraction – Powder and single crystal – Fourier transform infrared analysis – Elemental dispersive X - ray analysis – Transmission and scanning electron microscopy – UV - vis - NIR spectrometer – Chemical etching – Vickers micro hardness – Basic principles and operations of AFM and STM - X - ray photoelectron spectroscopy for chemical analysis – Photoluminescence – Thermoluminescence.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the basic concepts of nucleation and nucleation theories.

CO2: Understand the low temperature crystal growth techniques.

CO3: Learn about the high temperature crystal growth methods.

CO4: Acquire the knowledge on various deposition techniques.

CO5: Acquire the knowledge about diverse characterization techniques.

TEXT BOOKS :

1. **Crystal Growth Process and Methods - P. Santhanaraghavan and P. Ramasamy, (KRU Publications, Kumbakonam, 2001).** *UNIT I:* ***2.1, 2.2 - 2.2.3.2;*** *UNIT II:* ***4.1.1 - 4.2.2,5.4.1 – 5.4.6.5*** *Unit III:* ***3.2, 3.3, 3.3.1, 3.4.4, 3.9.***
2. Crystallization - JW Mullin 4th Edition, 2001 Butterworth Heinmann. **UNIT I:** 3.2, 3.9, 3.12, 5.3.
3. Materials Science of Thin Films - M. Ohring, (Academic Press, Boston, 2002) 2nd Edition. **UNIT IV:** 3.3.2; 3.4.2; 3.5.2; 3.5.4; 4.5.2; 5.2; **UNITS III:** 6.1. **UNIT V:** 10.3.5.2, 10.3.5.4
4. Instrumental Methods of Analysis - H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, (CBS Publishers, New Delhi, 1986).

REFERENCE BOOKS:

1. Crystal Growth Process - J.C. Brice, (John Wiley, New York, 1986).
2. Thin Film Fundamentals - A. Goswami, (New Age, New Delhi, 2008).
3. Materials Characterization Techniques- S. Zhang, L. Li and A. Kumar, (CRC Press, Bota Racon, 2009).
4. Characterization of Materials - E. N. Kaufmann, Volume - I John Wiley Publication - 2003, New Jersey.

WEB SOURCES:

https://www.elsevier.com/books/handbook-of-crystal-growth/levy/978-0-444-82070-7

https://link.springer.com/search?facet-sub-discipline=%22Crystal+Growth%22

https://aip.scitation.org/action/doSearch?AllField=crystal+growth

https://www.cambridge.org/core/membership/mrs/journals/journal-of-materials-research/mrs-thin-film-growth-and-deposition-focus-issue

https://www.sciencedirect.com/search?qs=thin+films

https://journals.aps.org/search/advanced?terms=crystal+growth+thin+films

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	2	2	2
CO2	2	2	3	3	2	2	3	3	3	3
CO3	2	3	2	3	2	3	2	3	2	2
CO4	2	3	3	2	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	2	3
CO2	2	2	3	3	3	3	3	3	2	3
CO3	3	3	2	2	3	3	2	2	3	3
CO4	3	3	3	2	2	2	2	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Course Title	**NON – CONVENTIONAL ENERGY RESOURCES**	Core Course	**NME I**	
Course Code	23PPH2N1	Credits	2	
Semester	II	Marks	25	75

(To be offered to the students of other departments)

Pre-Requisites
Knowledge on different types of energy
Learning objectives
• To introduce renewable energy sources. • To study the solar energy fundamentals. • To study the wind energy systems • To understand the different forms of energy. • To introduce basic knowledge on future energy systems.

Unit I: RENEWABLE ENERGY SOURCES

Conventional energy sources: Electricity production by water, radioactive materials and fossil fuel – Energy resources and their availability – Need for alternative energy resources – Types of renewable energy resources – Advantages.

Unit II: SOLAR ENERGY FUNDAMENTALS

Physical principle of conversion of solar radiation into heat – Basic idea of solar collectors – Applications of solar energy – Solar water heating – Solar electric power generation – Solar cooker – Solar energy in space.

Unit III: WIND ENERGY

Basic principle of wind conversion – Types of wind mills – Advantages and disadvantages of wind energy conversion (WECs) – Applications of wind energy.

Unit IV: OTHER FORMS OF ENERGY

Energy from biomass – Biogas generation – KVIC biogas plant – Biogas from plant waste – Main applications of biogas – Basic ideas of ocean thermal electric conversion (OTEC).

Unit V: ENERGY FOR THE FUTURE

Basic principle for tidal power – Advantages and limitations of tidal power generation – Use of hydrogen as an energy sources – Production of hydrogen by solar method - Hydrogen as a fuel in future.

Course outcomes:

At the end of the course students will have the

CO1: Ability to understand renewable energy sources.

CO2: Ability to gain knowledge on conversion of solar radiation into heat and solar electric power generation.

CO3: Ability to understand wind energy conversion systems.

CO4: Knowledge about bio mass ocean thermal energy conversion system.

CO5: Ability to explain the various forms of energy.

TEXT BOOKS:

1. Solar energy Utilization – G. D. Rai, Khanna publications, New Delhi, 1993.
2. Principle and practices of Solar Energy – C. P. Anantha Krishnan and Sethu Rao.

REFERENCE BOOKS:

1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)

WEB SOURCES:

1. www.freevideolectures.com

2. www.nptel.ac.in/courses/112105051
3. http://www.e-booksdirectory.com
4. https://www.renewableenergyworld.com/

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	3	2	3	3	2	3	2	2
CO2	2	2	2	2	2	2	3	2	3	2
CO3	3	2	2	2	3	3	2	2	2	3
CO4	3	3	2	3	2	2	3	2	3	2
CO5	2	2	2	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	2	3	3	3	2	2	3
CO2	2	2	3	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2	3	2
CO4	3	3	3	2	2	3	2	3	2	2
CO5	3	2	2	3	2	3	3	2	2	2

Course Title	**SOLAR ENERGY UTILIZATION**	Core Course	**NME II**	
Course Code	23PGE3N2	Credits	2	
Semester	III	Marks	25	75

Pre-Requisites
Knowledge of conventional energy resources
Learning Objectives
• To learn about various renewable energy sources. • To acquire the knowledge about solar collectors. • To understand solar energy conversion techniques and fuel cell applications. • To know about utilization of solar 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 ofnano technology in hydrogen production and storage.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Understand the basic concepts solar energy and solar energy measurement instrumentation.

CO2: Acquires the knowledge about solar collectors

CO3: Understand the fundamentals principles of solar energy conversion.

CO4: Learn about the solar water heaters.

CO5: Acquire the knowledge of fuel cell applications.

TEXT BOOKS:

1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.
2. Solar energy – principles of thermal collection & storage – S.P. Sukhatme, TMH Delhi 1984.
3. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", McGraw-Hill, 2010.

REFERENCE BOOKS:

1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)
2. Principle and practices of Solar Energy – C. P. Anantha Krishnan and Sethu Rao.

WEB SOURCES:

1. https://www.wwindea.org/
2. https://www.hydropower.org/
3. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb
4. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	2	3	3	2	3	2	2
CO2	3	3	2	2	2	2	3	2	3	2
CO3	3	2	2	3	2	2	3	3	3	2
CO4	3	3	2	3	2	2	3	2	3	2
CO5	2	2	2	3	2	2	2	3	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	2	2	3	3	3	2	2	3
CO2	2	2	3	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2	3	2
CO4	3	3	3	2	2	3	2	3	2	2
CO5	3	2	2	3	2	3	3	2	2	2