

2023 - (T)

RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)

(Reaccredited with 'A' Grade by NAAC)
(Affiliated to Bharathidasan University, Tiruchirappalli)
THANJAVUR – 613 005, TAMIL NADU.

(T)



Department of Physics

DEPARTMENT OF PHYSICS



Curriculum and Syllabus for PG & M.Phil

Learning Outcome – based
Curriculum Frame work (LOCF)
(CO-K, PO mapping adopted and implemented from
2023-24 onwards)

RAJAH SERFOJI GOVT. COLLEGE(AUTONOMOUS)

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(Affiliated to Bharathidasan University, Tiruchirappalli)

Thanjavur – 613 005, Tamil Nadu, India



DEPARTMENT OF PHYSICS



BOARD OF STUDIES IN PHYSICS

Date: 24.07.2023



RAJAH SERFOJI GOVT. COLLEGE (AUTONOMOUS)

*Reaccredited with 'A' Grade by NAAC
(Affiliated to Bharathidasan University, Tiruchirappalli)*

Thanjavur – 613 005, TAMIL NADU, INDIA.

☎04362 226417, Email: physicsrsgc@gmail.com

BOARD OF STUDIES IN PHYSICS

AGENDA

The meeting of the Board of Studies in Physics, for the Academic year 2023-24, is held on 24th July 2023 at 10.00 A.M. in the Department of PHYSICS, Rajah Serfoji Government College (autonomous), Thanjavur-5.

The following agenda will be discussed in the meeting:

1. To implement the TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION (TANSICHE) syllabus for the students admitted from 2023-2024 onwards.
2. To discuss the syllabus designed by TANSICHE, Chennai for U.G and P.G programmes.
3. To discuss and approve the revised Course structure.
4. To discuss and approve the Program Specific Outcomes and Course Outcomes.
5. To discuss and approve the feedback form on Curriculum from stakeholders.
6. To suggest the panel of examiners for 2023 examination onwards.
7. Any other academic affairs.

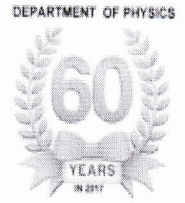
Dr. G. RANI

Chairperson, BOS &

Head, Department of Physics



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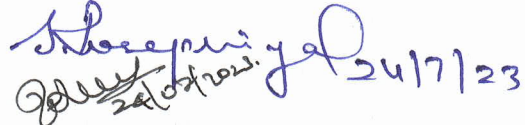





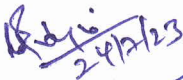


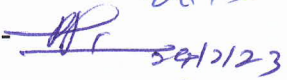

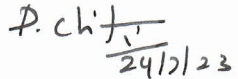


BOARD OF STUDIES MEETING : 24-07-2023

The Board of Studies (BOS) meeting in Physics was held on 24.07.2023 (Monday) at 10.00 A.M. in the Department of Physics, under the chairmanship of Dr. G. Rani, Head, Department of Physics. The following members were present in the meeting.

INTERNAL MEMBERS

SIGNATURE

- | | |
|--------------------------------|--|
| 1. Dr. S. Sakthivel | -  |
| 2. Dr. S. Rosepriya | -  |
| 3. Mrs. S. Senthilkumari | -  |
| 4. Dr. B. Shanmugapriya | -  |
| 5. Dr. S. Nilavazhagan. | - — |
| 6. Dr. C. Kumar | -  |
| 7. Dr.S. Veera Rethina Murugan | -  |
| 8. Dr. T. Ganesh | -  |
| 9. Dr. N. Chidambaram. | -  |
| 10. Dr. D. Anbuselvan | -  |
| 11. Dr. P. Jagdish | -  |
| 12. Dr. P. Paramasivam | -  |
| 13. Dr. M. Sivasubramanian | -  |
| 14. Mrs. P. CHITRA DEVI | -  |

EXTERNAL MEMBERS:**SIGNATURE**

1. Dr.T. C. Sabari Girisun (University Nominee)
Assistant Professor, Department of Physics,
Bharathidasan University, Tiruchirappalli.

T.C. Sabari Girisun
24/07/23

2. Dr. R. S. Sundararajan (Subject Expert)
Associate Professor and
Controller of Examinations,
Government Arts College (Autonomous),
Kumbakonam.

R.S. Sundararajan
24/7/23

3. Dr. S. Valanarasu (Subject Expert)
Assistant Professor, Department of Physics,
Arul Anandar College (Autonomous),
Madurai - 14

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4. Mr. T. Manoharan
(Representative from Industry/ Corporate relating to placement) -
Assistant Director, District Industrial Centre (DIC),
Thanjavur.

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5. Dr. T. Arivudai Nambi (PG Meritorious alumni)
Principal,
A. Govindasamy Government Arts College,
Tindivanam, Villupuram-Dist.

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The syllabus for B.Sc., Physics (Major and Electives), M.Sc., Physics and M.Phil, Physics under CBCS system by TANSICHE was discussed, corrections/changes were made and finalized. The finalized syllabus was approved in the meeting held on 24.07.2023. This syllabus is for the candidates admitted from the academic year 2023-2024.

G. Rani
24/7/23
Dr. G. Rani
(Chairman, BOS-Physics)



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BOARD OF STUDIES IN PHYSICS

MINUTES OF THE MEETING HELD ON 24th July 2023

The meeting of the Board of Studies in Physics, for the Academic Year 2023-24, was held on 24th July 2023 at 10:00 am in Department of Physics, Rajah Serfoji Government College, Thanjavur-5.

Dr. G. RANI, Chairperson, BOS and Head, Department of Physics, Rajah Serfoji Government College, convened the meeting and the following resolutions were transacted.

1. Discussions were made for the implementation of TANSCHÉ syllabus for B.Sc and M.Sc. Programme and 25% modifications were made in the context of local needs and recent developments.

RESOLUTION-1 [No.: BOS/PHY/2023-24/1]

Resolved to implement TANSCHÉ syllabus for B.Sc and M.Sc. Programme and to make 25% modifications in the syllabus, in the context of local needs and recent developments.

2. Discussions were made in the course structure of B.Sc./M.Sc. programme. For UG, it includes CC-15 papers, EC-8 papers, SEC-7 papers, Foundation Course-1 and Professional Competency skill-1 Paper. For PG, it includes CC-16 papers and EC 4 Papers. The necessity of two Elective Courses in the first two years for the implementation of Elective Course Practicals were discussed.

RESOLUTION-2 [No.: BOS/PHY/2023-24/2]

- Resolved to include one Elective Course as running paper between Semester I & II and another Elective Paper as running paper between Semester III & IV in the UG Course Structure given by TANSCHÉ.
- Resolved to approve the modified Course Structure of UG Programme with 10 EC papers and Course Structure of PG Programme.

3. Discussions were made in the syllabus content of UG and PG Programme. Few modifications were carried out in the syllabus content of some papers.

RESOLUTION-3 [No.: BOS/PHY/2023-24/3]

- Resolved to approve the modifications made in the syllabus contents of UG and PG Programme.

4. Discussions were made in the implementation of Summer Internship/Industrial Training in 5.8 semester –V UG syllabus given by TANSICHE. Summer Internship/Industrial Training can be implemented in the summer vacation of Semester -IV and Credits can be given in the Semester-V.

RESOLUTION-4 [No.: BOS/PHY/2023-24/4]

- Resolved to implement, Summer Internship/Industrial Training in the Semester –V of UG programme.

5. Discussions were made in the implementation of Core Course/Project with viva-voce CC-XII in Semester-V. Unanimously decided to implement Core Course Practical-V and not to implement Project with viva-voce in the UG level.

RESOLUTION-5 [No.: BOS/PHY/2023-24/5]

- Resolved to implement Core Course Practical-V in the place of CC-XII given in curriculum structure of TANSICHE syllabus.

6. Discussions were made in the list of Generic Elective Courses designed by the department and Discipline Specific Elective Papers given in the TANSICHE syllabus of UG & PG Programme. Few modifications were made.

RESOLUTION-6 [No.: BOS/PHY/2023-24/6]

- Resolved to implement Generic Elective papers designed by the department in the First year and Second year of UG Programme and Discipline Specific Elective Papers given in the TANSICHE syllabus in the third of UG Programme.
- Resolved to implement the Elective Papers (List-1 & List-2) and Industry oriented Elective Papers IOE (List-3).

7. Discussions were made in the UG and PG Programme on the proposed POs, PSOs and Course Outcomes.

RESOLUTION-7 [No.: BOS/PHY/2023-24/7]

- Resolved to give approval for POs PSOs and COs and the mapping of COs of each course with POs.

The meeting ended with vote of thanks, particularly to the external members of the Board, recollecting their valuable inputs in their tenure.

Chairman:

1. **Dr. G. Rani**
Associate Professor & Head,
Department of Physics.

: 

M.Sc., PHYSICS

Preamble

The curriculum for the P.G. Physics for universities and colleges is revised as per Learning Outcomes- based Curriculum Framework (LOCF). The learner centric courses are designed to enable the students to progressively develop a good understanding of the concepts of various domains in physics. Significant modification is the inclusion of the courses to equip students to face challenges in industries and make them employable. Skill development in different spheres and confidence building are given a special focus.

TANSICHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	M. Sc., Physics
Programme Code	
Duration	PG – 2YEARS
Programme Outcomes (POs)	<p>PO1: Problem Solving Skill Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.</p> <p>PO2: Decision Making Skill Foster analytical and critical thinking abilities for data-based decision-making.</p> <p>PO3: Ethical Value Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.</p> <p>PO4: Communication Skill Ability to develop communication, managerial and interpersonal skills.</p> <p>PO5: Individual and Team Leadership Skill Capability to lead themselves and the team to achieve organizational goals.</p> <p>PO6: Employability Skill Inculcate contemporary business practices to enhance employability skills in the competitive environment.</p> <p>PO7: Entrepreneurial Skill Equip with skills and competencies to become an entrepreneur.</p> <p>PO8: Contribution to Society Succeed in career endeavors and contribute significantly to society.</p> <p>PO 9 Multicultural competence Possess knowledge of the values and beliefs of multiple cultures and a global perspective.</p> <p>PO 10: Moral and ethical awareness/reasoning Ability to embrace moral/ethical values in conducting one's life.</p>

<p>Programme Specific Outcomes (PSOs)</p>	<p>PSO1 – Placement To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.</p> <p>PSO 2 - Entrepreneur To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.</p> <p>PSO3 – 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.</p> <p>PSO4 – Contribution to Business World To produce employable, ethical and innovative professionals to sustain in the dynamic business world.</p> <p>PSO 5 – Contribution to the Society To contribute to the development of the society by collaborating with stakeholders for mutual benefit.</p> <p>PSO 6 Students will utilize e-resources, digital tools and techniques for widening their knowledge base.</p> <p>PSO 7 Students gain exposure to programming language and skills.</p> <p>PSO 8 Student will appreciate the interplay of mathematics, physics and technology.</p> <p>PSO 9 Students will develop adequate knowledge and skills for employment and entrepreneurship.</p> <p>PSO 10 An awareness of civic and ecological duties as good citizens and importance of human values will be inculcated in students</p>
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RAJAH SERFOJI GOVT COLLEGE (AUTONOMOUS), THANJAVUR-5

C.B.C.S PATTERN FOR ALL P.G. COURSES

SUBJECT: PHYSICS

(Applicable to the Students admitted from the academic year 2023-2024 onwards)

Sem	PART	COURSE	CODE	TITLE	CREDIT	HRS / WEEK	EXAM HOURS	MARKS		TOTAL	Page No.
								IA	WE		
				I - SEMESTER							
	III	CC1	T1PPHC1	Mathematical Physics	5	7	3	25	75	100	1
	III	CC2	T1PPHC2	Classical Mechanics and Relativity	5	7	3	25	75	100	4
	III	CC3	T1PPHC3	Practical - I	4	6	4	25	75	100	7
	III	EC-1		Elective Course - I Choose any one from the list I	3	5	3	25	75	100	
		EC-2		Elective Course - II Choose any one from the list II	3	5	3	25	75	100	
		TOTAL			20	30				500	
				II - SEMESTER							
	III	CC4	T2PPHC4	Statistical Mechanics	5	6	3	25	75	100	10
	III	CC5	T2PPHC5	Electromagnetic Theory	5	6	3	25	75	100	13
	III	CC6	T2PPHC6	Practical - II	4	6	4	25	75	100	16
	III	EC3		Elective Course - III Choose any one from the list II	3	4	3	25	75	100	
		EC4		Elective Course - IV Choose any one from the lists III	3	4	3	25	75	100	
	IV	SEC1	T2PPHS1	Skill Enhancement Course - I Entrepreneurial Development	2	4		25	75	100	103
		TOTAL			22	30				600	

Sem	PART	COURSE	CODE	TITLE	CREDIT	HRS / WEEK	EXAM HOURS	MARKS		TOTAL	Page No.
								IA	WE		
				III - SEMESTER							
III	III	CC7	T3PPHC7	Quantum Mechanics	5	6	3	25	75	100	19
	III	CC8	T3PPHC8	Spectroscopy	5	6	3	25	75	100	22
	III	CC9	T3PPHC9	Nuclear and Particle Physics	5	6	3	25	75	100	25
	III	CC10	T3PPHC10	Practical - III	4	6	4	25	75	100	28
	III	EC5		Elective Course - V Choose any one from the lists I, II & III	3	3	3	25	75	100	
	IV	SEC2	T3PPHS2	Skill Enhancement Course - II Cybercrime and its Security	2	3		25	75	100	105
	IV	Internship/ industrial activity		Intenship/ Industrial Activity	2						
		TOTAL			26	30				600	
				IV - SEMESTER							
	III	CC11	T4PPHC11	Condensed Matter Physics	5	6	3	25	75	100	31
	III	CC12	T4PPHC12	Practical - IV	5	6	4	25	75	100	34
	III	CC13	T4PPHC13	Project Work with Viva - voce	7	10		25	75	100	37
	III	EC6		Elective Course - VI Choose any one from the lists I, II & III	3	4	3	25	75	100	
	IV	PCS	T4PPHS3	Professional Competency Skill Employability Skills	2	4	3	25	75	100	107
	V			Extension Activity	1						
		TOTAL			23	30				500	
		GRAND TOTAL			91					2200	

****Intenship will be carried out during the summer vacation of the first year and marks will included in the Third Semester Mark Statement**

Passing Minimum is prescried for Internal and External

a) The Passing minimum for CIA shall be 12 out of 25 Marks

b)The Passing minimum for Autonomous Examinations shall be 38 out of 75 marks

List of Elective Papers

Course Code		Title of the Paper	Page No.
TPPHECA	List I	Energy Physics	39
TPPHECB		Crystal Growth and Thin Films	41
TPPHECC		Analysis of Crystal Structures	44
TPPHECD		Material Science	47
TPPHECE		Physics of Nano Science and Technology	50
TPPHECF		Digital Communication	53
TPPHECG		Communication Electronics	56
TPPHECH		Astrophysics	59
TPPHECI	List II	Plasma Physics	62
TPPHECJ		Bio Physics	65
TPPHECK		Non - Linear Dynamics	68
TPPHECL		Quantum Field Theory	71
TPPHECM		General Relativity and Cosmology	74
TPPHECN		Advanced Optics	77
TPPHECO		Advanced Mathematical Physics	80
TPPHECP	List III	Advanced Spectroscopy	83
TPPHECQ		Microprocessor 8085 and Microcontroller 8051	86
TPPHECR		Characterization of Materials	89
TPPHECS		Medical Physics	92
TPPHECT		Solid Waste Management	95
TPPHECU		Sewage and Waste Water Treatment and Reuse	98
TPPHECV		Solar Energy Utilization	101

(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 1	Semester – I	Course Code: T1PPHC1
Course Title	MATHEMATICAL PHYSICS		
Credits	5	Instruction Hours – 7	Medium : English
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. To help students apply Mathematics in solving problems of Physics		

UNITS	Course Details
Unit – I	LINEAR VECTOR SPACE: Basic concepts – Definitions– examples of vector space – Linear independence – Scalar product– Orthogonality – Gram–Schmidt orthogonalization procedure – linear operators – Dual space– ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation
Unit – II	COMPLEX ANALYSIS: Review of Complex Numbers –de Moivre’s theorem–Functions of a Complex Variable– Differentiability –Analytic functions– Harmonic Functions– Complex Integration– Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy’s Integral Theorem and integral Formula –Taylor’s Series – Laurent’s Expansion– Zeros and poles – Residue theorem and its Application: Potential theory – (1) Electrostatic fields and complex potentials – Parallel plates, coaxial cylinders and an annular region.
Unit – III	MATRICES: Types of Matrices and their properties, Rank of a Matrix –Conjugate of a matrix – Adjoint of a matrix – Inverse of a matrix – Hermitian and Unitary Matrices – Trace of a matrix– Transformation of matrices – Characteristic equation – Eigen values and Eigen vectors – Cayley–Hamilton theorem –Diagonalization
Unit – IV	FOURIER TRANSFORMS & LAPLACE TRANSFORMS: Definitions –Fourier transform and its inverse – Transform of Gaussian function and Dirac delta function –Fourier transform of derivatives – Cosine and sine transforms – Convolution theorem. – Wave equation: Vibration of an infinite string and of a semi – infinite string. Laplace transform and its inverse – Transforms of derivatives and integrals – Differentiation and integration of transforms – Dirac delta functions – Application – Laplace equation: Potential problem in a semi – infinite strip.
Unit – V	DIFFERENTIAL EQUATIONS: Second order differential equation– Sturm–Liouville’s theory – Series solution with simple examples – Hermite polynomials – Generating function – Orthogonality properties – Recurrence relations – Legendre polynomials – Generating function – Rodrigue formula – Orthogonality properties – Dirac delta function– One dimensional Green’s function and Reciprocity theorem –Sturm–Liouville’s type equation in one dimension & their Green’s function.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. George Arfken and Hans J Weber, 2012, <i>Mathematical Methods for Physicists – A Comprehensive Guide</i> (7th edition), Academic press. 2. P.K. Chattopadhyay, 2013, <i>Mathematical Physics</i> (2nd edition), New Age, New Delhi 3. A W Joshi, 2017, <i>Matrices and Tensors in Physics</i>, 4th Edition (Paperback), New Age International Pvt. Ltd., India 4. B. D. Gupta, 2009, <i>Mathematical Physics</i> (4th edition), Vikas Publishing House, New Delhi. 5. H. K. Dass and Dr. Rama Verma, 2014, <i>Mathematical Physics</i>, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
Ref. books	<ol style="list-style-type: none"> 1. E. Kreyszig, 1983, <i>Advanced Engineering Mathematics</i>, Wiley Eastern, New Delhi, 2. D. G. Zill and M. R. Cullen, 2006, <i>Advanced Engineering Mathematics</i>, 3rd Ed. Narosa, New Delhi. 3. S. Lipschutz, 1987, <i>Linear Algebra</i>, Schaum's Series, McGraw – Hill, New York 3. E. Butkov, 1968, <i>Mathematical Physics</i> Addison – Wesley, Reading, Massachusetts. 4. P. R. Halmos, 1965, <i>Finite Dimensional Vector Spaces</i>, 2nd Edition, Affiliated East West, New Delhi. 5. C. R. Wylie and L. C. Barrett, 1995, <i>Advanced Engineering Mathematics</i>, 6 th Edition, International Edition, McGraw–Hill, New York
Web Resources	<ol style="list-style-type: none"> 1. www.khanacademy.org 2. https://youtu.be/LZnRlOA1_2I 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath 4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SIED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSE OUTCOMES:

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

CO1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	K1, K2
CO2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	K2, K3
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	K4
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	K4, K5
CO5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	K2, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	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	3

	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	3

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part-A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)


Part-B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part-C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five–One question from each unit)


HOD

HEAD

PG and Research Department of Physics,
Rajah Serfoji Govt. College (Autonomous),
Thanjavur-613 005.


COE
CONTROLLER OF EXAMINATIONS,
RAJAH SERFOJI GOVT. COLLEGE (AUTONOMOUS),
THANJAVUR-613 005.

(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 2	Semester – I	Course Code: T1PPHC2
Course Title	CLASSICAL MECHANICS AND RELATIVITY		
Credits	5	Instruction Hours – 7	Medium : English
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.		

UNITS	Course Details
Unit – I	PRINCIPLES OF CLASSICAL MECHANICS: Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.
Unit – II	LAGRANGIAN FORMULATION: D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.
Unit – III	HAMILTONIAN FORMULATION: Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.
Unit – IV	SMALL OSCILLATIONS: Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.
Unit – V	RELATIVITY: Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1) H. Goldstein, 2002, <i>Classical Mechanics</i> , 3rd Edition, Pearson Edu. 2) J. C. Upadhyaya, <i>Classical Mechanics</i> , Himalaya Publshing. Co. New Delhi. 3) R. Resnick, 1968, <i>Introduction to Special Theory of Relativity</i> , Wiley Eastern, New Delhi. 4) R. G. Takwala and P.S. Puranik, <i>Introduction to Classical Mechanics</i> –Tata – McGraw Hill, New Delhi, 1980.

	5) N. C. Rana and P.S. Joag, Classical Mechanics – Tata McGraw Hill, 2001
Ref. books	1) K. R. Symon, 1971, <i>Mechanics</i> , Addison Wesley, London. 2) S. N. Biswas, 1999, <i>Classical Mechanics</i> , Books & Allied, Kolkata. 3) Gupta and Kumar, <i>Classical Mechanics</i> , Kedar Nath. 4) T.W.B. Kibble, <i>Classical Mechanics</i> , ELBS. 5) Greenwood, <i>Classical Dynamics</i> , PHI, New Delhi.
Web Resources	1) http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf 2) https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html 3) https://nptel.ac.in/courses/122/106/122106027/ 4) https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/ https://www.britannica.com/science/relativistic-mechanics

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of classical mechanics.	K2
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3, K5
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K4, K5
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K2, K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)


Part–B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five–One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 3	Semester – I	Course Code: T1PPHC3
Course Title	PRACTICAL – I		
Credits	4	Instruction Hours – 6	Medium : English
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.		

List of Experiments

(Minimum Twelve Experiments)

1. Determination of Planck Constant – LED Method
2. Measurement of Band gap energy– Thermistor
3. Determination of Specific charge of an electron – Thomson’s method.
4. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
5. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser
6. Determination of Wavelength – Michelson Interferometer
7. Arc spectrum – Iron.
8. FET CS amplifier– Frequency response, input impedance, output impedance
9. V– I Characteristics of different colours of LED.
10. Half adder and Full adder using NAND Gates.
11. Determination of q , η , σ by elliptical fringes method.
12. Planck’s constant Determination.
13. Determination of wavelength and particle size determination– using LASER light.
14. Four probe method – Determination of resistivity of powdered samples.
15. Determination of magnetic susceptibility of liquid by Guoy’s method.
16. Determination of magnetic susceptibility of liquids by Quincke’s method.
17. Determination of specific rotatory power of a liquid using polarimeter.
18. Construction of Dual power supply for IC experiments (9–0–9V)
19. Characteristics of UJT.
20. Characteristics of LDR.
21. Study of MOD counter (7490) and Seven Segment Decoder (7447).

Text books	<ol style="list-style-type: none"> 1. Practical Physics, Gupta and Kumar, Pragati Prakasan. 2. Kit Developed for doing experiments in Physics– Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences. 3. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing. 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
Reference Books	<ol style="list-style-type: none"> 1. Advanced Practical Physics, S.P Singh, PragatiPrakasan. 2. An advanced course in Practical Physics, D. Chattopadhyay, C.R Rakshit, New Central Book Agency Pvt. Ltd 3. Op–Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 4. A course on experiment with He–Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd. 5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

COURSE OUTCOMES:

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

CO1	Understand the strength of material using Young’s modulus.	K2
CO2	Acquire knowledge of thermal behaviour of the matetials.	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1, K3
CO5	Improve the analytical and observation ability in Physics Experiments	K3, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2


	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	


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Course	CC 4	Semester – II	Course Code: T2PPHC4
Course Title	STATISTICAL MECHANICS		
Credits	5	Instruction Hours – 6	Medium : English
Pre-Requisites	Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium, Brownian motion		
Learning Objectives	To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics. To identify the relationship between statistic and thermodynamic quantities. To comprehend the concept of partition function, canonical and grand canonical ensembles. To grasp the fundamental knowledge about the three types of statistics. To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time.		

UNITS	Course Details
Unit – I	STATISTICAL MECHANICS AND THERMODYNAMICS: Foundations of statistical mechanics – Specification of states of a system – Micro canonical ensemble – Phase space – Entropy – Entropy and second law of thermodynamics – Nernst heat theorem of third law – Connection between statistics and thermodynamics – Consequence of third law – Entropy of mixing and Gibb’s paradox.
Unit – II	PHASE TRANSITIONS: Thermodynamic potentials – Phase Equilibrium – Gibb’s phase rule – Phase transitions and Ehrenfest’s classifications –Third law of Thermodynamics – Thermodynamic potential and the reciprocity relations – Transport phenomena – Viscous hydrodynamics. Order parameters – Critical indices – Scale transformations and dimensional analysis.
Unit – III	CANONICAL AND GRAND CANONICAL ENSEMBLES : Entropy of an ideal gas using the micro canonical ensemble – Trajectories and density of states – Canonical and grand canonical ensembles – Partition function – Calculation of statistical quantities – Energy and density fluctuations.
Unit – IV	CLASSICAL AND QUANTUM STATISTICS: Liouville’s theorem – Density matrix – Statistics of ensembles – Statistics of indistinguishable particles – Maxwell–Boltzmann statistics – Fermi–Dirac statistics – Ideal Fermi gas – Degeneracy – Bose–Einstein statistics – Plank radiation formula – Ideal Bose gas – Bose–Einstein condensation.
Unit – V	REAL GAS, ISING MODEL AND FLUCTUATIONS: Cluster expansion for a classical gas – Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion – Landau’s theory of phase transition – Ising model – Mean–field theories of the Ising model in three, two and one dimensions – Exact solutions in one dimension. Correlation of space–time dependent fluctuations – Brownian motion – Langevin’s theory – Fluctuation–dissipation theorem – The Fokker–Planck equation
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits,

	Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1.S. K. Sinha, 1990, <i>Statistical Mechanics</i>, Tata McGraw Hill, New Delhi. 2.B. K. Agarwal and M. Eisner, 1998, <i>Statistical Mechanics</i>, Second Edition New Age International, New Delhi. 3.J. K. Bhattacharjee, 1996, <i>Statistical Mechanics: An Introductory Text</i>, Allied Publication, New Delhi. 4.F. Reif, 1965, <i>Fundamentals of Statistical and Thermal Physics</i>, McGraw – Hill, New York. 5.M. K. Zemansky, 1968, <i>Heat and Thermodynamics</i>, 5th edition, McGraw–Hill New York.
Ref. books	<ol style="list-style-type: none"> 1. R. K. Pathria, 1996, <i>Statistical Mechanics</i>, 2nd edition, Butter WorthHeinemann, New Delhi. 2. L. D. Landau and E. M. Lifshitz, 1969, <i>Statistical Physics</i>, Pergamon Press, Oxford. 3. K. Huang, 2002, <i>Statistical Mechanics</i>, Taylor and Francis, London 4. W. Greiner, L. Neise and H. Stoecker, <i>Thermodynamics and Statistical Mechanics</i>, Springer Verlag, New York. 5. A. B. Gupta, H. Roy, 2002, <i>Thermal Physics</i>, Books and Allied, Kolkata.
Web Resources	<ol style="list-style-type: none"> 1. https://byjus.com/chemistry/third-law-of-thermodynamics/ 2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html 3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics 4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble 5. https://en.wikipedia.org/wiki/Ising_model

COURSE OUTCOMES:

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

CO1	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	K4
CO2	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K5
CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	K1
CO4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	K4, K5
CO5	To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)


Part–B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five–One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 5	Semester – II	Course Code: T2PPHC5
Course Title	ELECTROMAGNETIC THEORY		
Credits	5	Instruction Hours – 6	Medium : English
Pre-Requisites	Different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma		
Learning Objectives	To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables. 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		

UNITS	Course Details
Unit – I	<p>ELECTROSTATICS: Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems.</p> <p>Polarization and displacement vectors – Boundary conditions – Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.</p>
Unit – II	<p>MAGNETOSTATICS: Biot–Savart's Law – Ampere's law – Magnetic vector potential and magnetic field of a localized current distribution – Magnetic moment, force and torque on a current distribution in an external field – Magneto static energy – Magnetic induction and magnetic field in macroscopic media – Boundary conditions – Uniformly magnetized sphere.</p>
Unit – III	<p>MAXWELL EQUATIONS: Faraday's laws of Induction – Maxwell's displacement current – Maxwell's equations – Vector and scalar potentials – Gauge invariance – Wave equation and plane wave solution– Coulomb and Lorentz gauges – Energy and momentum of the field – Poynting's theorem – Lorentz force – Conservation laws for a system of charges and electromagnetic fields.</p>
Unit – IV	<p>WAVE PROPAGATION: Plane waves in non-conducting media – Linear and circular polarization, reflection and refraction at a plane interface – Waves in a conducting medium – Propagation of waves in a rectangular wave guide.</p> <p>Inhomogeneous wave equation and retarded potentials – Radiation from a localized source – Oscillating electric dipole</p>

Unit – V	ELEMENTARY PLASMA PHYSICS: The Boltzmann Equation – Simplified magneto–hydrodynamic equations – Electron plasma oscillations – The Debye shielding problem – Plasma confinement in a magnetic field – Magneto–hydrodynamic waves – Alfvén waves and magnetosonic waves.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. D. J. Griffiths, 2002, <i>Introduction to Electrodynamics</i>, 3rd Edition, Prentice–Hall of India, New Delhi. 2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, <i>Foundations of Electromagnetic Theory</i>, 3rd edition, Narosa Publishing House, New Delhi. 3. J. D. Jackson, 1975, <i>Classical Electrodynamics</i>, Wiley Eastern Ltd. New Delhi. 4. J. A. Bittencourt, 1988, <i>Fundamentals of Plasma Physics</i>, Pergamon Press, Oxford. 5. Gupta, Kumar and Singh, <i>Electrodynamics</i>, S. Chand & Co., New Delhi
Ref. books	<ol style="list-style-type: none"> 1. W. Panofsky and M. Phillips, 1962, <i>Classical Electricity and Magnetism</i>, Addison Wesley, London. 2. J. D. Kraus and D. A. Fleisch, 1999, <i>Electromagnetics with Applications</i>, 5th Edition, WCB McGraw–Hill, New York. 3. B. Chakraborty, 2002, <i>Principles of Electrodynamics</i>, Books and Allied, Kolkata. 4. P. Feynman, R. B. Leighton and M. Sands, 1998, <i>The Feynman Lectures on Physics</i>, Vols. 2, Narosa Publishing House, New Delhi. 5. Andrew Zangwill, 2013, <i>Modern Electrodynamics</i>, Cambridge University Press, USA.
Web Resources	<ol style="list-style-type: none"> 1. http://www.plasma.uu.se/CED/Book/index.html 2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html 3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html 4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/ 5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSE OUTCOMES:

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

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	K1, K5
CO2	Use Biot–Savart’s law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	K2, K3
CO3	Apply Maxwell’s equations to describe how electromagnetic field behaves in different media	K3
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	K3, K4

CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part-B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)


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Course	CC 6	Semester – II	Course Code: T2PPHC6
Course Title	PRACTICAL II		
Credits	4	Instruction Hours – 6	Medium : English
Pre-Requisites	Knowledge and handling 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 observe the applications of FET and UJT. To study the different applications of operational amplifier circuits. To learn about Combinational Logic Circuits and Sequential Logic Circuits		

List of Experiments

(Minimum Twelve Experiments)

1. Measurement of Coefficient of linear expansion– Air wedge Method
2. Determination of Thickness of the enamel coating on a wire by diffraction
3. Determination of Rydberg's Constant – Hydrogen Spectrum
4. Measurement of Conductivity – Four probe method
5. Determination of Thickness of air film. – Solar spectrum – Hartmann's formula. Edser and Butler fringes.
6. Determination of q , n , σ by hyperbolic fringes method.
7. Determination of e / m of an electron by magnetron method
8. Stefan's Law – verification
9. Optical Fibre – measurements of attenuation coefficient and Numerical aperture
10. Determination of carrier concentration and Hall coefficients in semiconductors.
11. Polarizability of liquids by finding the refractive indices at different wavelengths.
12. Determination of bulk modulus of a liquid by ultrasonic wave propagation.
13. Study of a feedback amplifier – Determination of band width, input and output impedances.
14. Characteristics of SCR.
15. Determination of dielectric constant of a liquid by RF oscillator method.
16. Half subtractor and Full subtractor using NAND gate.
17. UJT Relaxation oscillator.
18. Determination of Carrier concentrations and Hall coefficient in semiconductor.
19. FET common Source amplifier.
20. Determination of magnetic susceptibility of powder sample by Quincke's method.

Text Books	<ol style="list-style-type: none"> 1. Practical Physics, Gupta and Kumar, Pragati Prakasan 2. Kit Developed for doing experiments in Physics– Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences 3. Op–Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
Reference Books	<ol style="list-style-type: none"> 1. An advanced course in Practical Physics, D. Chattopadhyay, C.R Rakshit, New Central Book Agency Pvt. Ltd 2. Advanced Practical Physics, S.P Singh, Pragati Prakasan 3. A course on experiment with He–Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd 4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing 5. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi

COURSE OUTCOMES:

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

CO1	Understand the strength of material using Young's modulus	K2
CO2	Acquire knowledge of thermal behaviour of the materials	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1
CO5	Improve the analytical and observation ability in Physics Experiments	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

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


METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	


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Course	CC 7	Semester – III	Course Code: T3PPHC7
Course Title	QUANTUM MECHANICS		
Credits	5	Instruction Hours – 6	Medium : English
Pre-Requisites	Newton's laws of motion, Schrodinger's equation, integration, differentiation.		
Learning Objectives	To develop the physical principles and the mathematical background important to quantum mechanical descriptions. To describe the propagation of a particle in a simple, one-dimensional potential. To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential. To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature. To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.		

UNITS	Course Details
Unit – I	BASIC FORMALISM: Interpretation of the wave function – Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation
Unit – II	ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS: Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator
Unit – III	GENERAL FORMALISM: Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal
Unit – IV	APPROXIMATION METHODS: Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.
Unit – V	ANGULAR MOMENTUM: Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw–Hill, New Delhi, 2010. 2. G. Aruldas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009. 3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011. 4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982. 5. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.
Ref. books	<ol style="list-style-type: none"> 1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970. 2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985. 3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976. 4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999. 5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.
Web Resources	<ol style="list-style-type: none"> 1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf 2. http://www.feynmanlectures.caltech.edu/III_20.html 3. http://web.mit.edu/8.05/handouts/jaffe1.pdf 4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf 5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSE OUTCOMES:

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

CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1, K5
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K3, K4
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	K1
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	K4, K5
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K3, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

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

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 8	Semester – III	Course Code: T3PPHC8
Course Title	SPECTROSCOPY		
Credits	5	Instruction Hours – 6	Medium : English
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 explore various applications of these techniques in R &D. Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds. Understand this important analytical tool		

UNITS	Course Details
Unit – I	<p>MICROWAVE SPECTROSCOPY: Rotational spectra of diatomic molecules – Rigid Rotor (Diatomic Molecules)– reduced mass – rotational constant – Effect of isotopic substitution – Non rigid rotator – centrifugal distortion constant– Intensity of Spectral Lines– Polyatomic molecules – linear – symmetric asymmetric top molecules – Hyperfine structure and quadrupole moment of linear molecules – Instrumentation techniques – block diagram –Information Derived from Rotational Spectra.</p>
Unit – II	<p>INFRA-RED SPECTROSCOPY: Vibrations of simple harmonic oscillator – zero-point energy– Anharmonic oscillator – fundamentals, overtones and combinations– Diatomic Vibrating Rotator–Description of vibrations – Bond stretching – Angle deformation – Rocking – Wagging – out of plane deformation – Twisting and Torsion – Fundamental modes of vibration of H₂O and CO₂ – Introduction to application of vibrations spectra – IR spectrophotometer Instrumentation (Double Beam Spectrometer) – FT Infrared spectroscopy – Interpretation of vibrations spectra.</p>
Unit – III	<p>RAMAN SPECTROSCOPY: Theory of Raman Scattering – Classical theory – molecular polarizability – polarizability ellipsoid – Quantum theory of Raman effect – rotational Raman spectra of linear molecule – symmetric top molecule – Stokes and anti-stokes line– SR branch –Raman activity of H₂O and CO₂ –Mutual exclusion principle–determination of N₂O structure –Instrumentation technique and block diagram.</p>
Unit – IV	<p>RESONANCE SPECTROSCOPY: Nuclear and Electron spin–Interaction with magnetic field – Population of Energy levels – Larmor precession– Relaxation times – Double resonance– Chemical shift and its measurement – NMR of Hydrogen nuclei – Indirect Spin – Spin Interaction – interpretation of simple organic molecules – Instrumentation techniques of NMR spectroscopy –MRI Scan. Electron Spin Resonance: Basic principle – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation – Medical applications of ESR</p>

Unit – V	UV SPECTROSCOPY: Origin of UV spectra – Laws of absorption – Lambert Bouguer law – Lambert Beer law – molar absorptivity – transmittance and absorbance – Color in organic compounds– Absorption by organic Molecule – Choice of Solvent and Solvent effect – Absorption by inorganic systems – Instrumentation – double beam UV– Spectrophotometer –Simple applications
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi. 2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi. 3. D.N. Satyanarayana, 2001, <i>Vibrational Spectroscopy and Applications</i>, New Age International Publication. 4. B.K. Sharma, 2015, <i>Spectroscopy</i>, Goel Publishing House Meerut. 5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition), New Age International Publishers.
Ref. books	<ol style="list-style-type: none"> 1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi. 2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge. 3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York. 4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi. 5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link.
Web Resources	<ol style="list-style-type: none"> 1. https://www.youtube.com/watch?v=0iQhirTf2PI 2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5 3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee 4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

COURSE OUTCOMES:

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

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	K2
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	K2, K3
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	K5

CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	K4
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	K1, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 9	Semester – III	Course Code: T3PPHC9
Course Title	NUCLEAR AND PARTICLE PHYSICS		
Credits	5	Instruction Hours – 6	Medium : English
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 Standard Model of Elementary Particles and Higgs boson.		

UNITS	Course Details
Unit – I	NUCLEAR MODELS: Liquid drop model – Weizacker mass formula – Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrupole moment – Bohr and Mottelson collective model.
Unit – II	NUCLEAR FORCES: Nucleon – nucleon interaction – properties of nuclear forces – ground state of deuteron – Exchange Forces – Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces – charge independence and charge symmetry.
Unit – III	NUCLEAR REACTIONS: Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Nuclear Chain reaction – four factor formula.
Unit – IV	NUCLEAR DECAY: Beta decay – Continuous Beta spectrum – Fermi theory of beta decay – Comparative Half-life – Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay – neutrino physics – Gamma decay – multipole radiations – internal conversion – nuclear isomerism.
Unit – V	ELEMENTARY PARTICLES: Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks – SU (2) and SU (3) groups – Gell Mann matrices – Gell Mann Okuba Mass formula – Quark Model. Standard model of particle physics – Higgs boson.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011) 2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)

	<ol style="list-style-type: none"> 3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996) 4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011) 5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc., U.S. – 3rd Revised edition (1968)
Ref. books	<ol style="list-style-type: none"> 1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973) 2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974). 3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002) 4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001) 5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.
Web Resources	<ol style="list-style-type: none"> 1. http://bubl.ac.uk/link/n/nuclearphysics.html 2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdf http://www.scholarpedia.org/article/Nuclear_Forces 3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/ 4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html 5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

COURSE OUTCOMES:

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

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	K1, K5
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	K2, K3
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	K3
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	K3, K4
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 10	Semester – III	Course Code: T3PPHC10
Course Title	PRACTICAL – III		
Credits	4	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge in digital electronics, microprocessor and microcontroller Basic knowledge of operating system and computer fundamentals.		
Learning Objectives	To equip the computational skill using various mathematical tools. To apply the software tools to digital electronics, microprocessor and microcontroller. To use microprocessor and Microcontroller in different applications		

List of Experiments

(Minimum Twelve Experiments)

1. Operational Amplifier–Parameters –Open loop gain, closed loop gain, Input impedance, Output impedance, CMRR.
2. Operational Amplifier– Sign changer, Adder, Subtractor, Differentiator and Integrator.
3. Operational Amplifier– Low pass, High pass and Band pass filters.
4. Operational Amplifier–Clipping and Clamping Circuits.
5. Simplification of Boolean expression (any 4 expression) using Boolean theorems.
6. Shift Register–SISO, SIPO (Shift left and right).
7. Synchronous Counter–Up Counter and Down Counter.
8. Study of MOD counter (7490) and Seven Segment Decoder (7447).
9. BCD– Adder.
10. One– bit comparator using gates and Four– bit digital Comparator using IC (7485) .
11. D/A Conversion– R–2R Binary ladder– Weighted Resistor Network
12. Multiplexer (4 to 1, 8 to 1, 16 to 1).
13. Microprocessor 8085– 8 bit Addition, Subtraction, Multiplication and Division.
14. Microprocessor 8085– Conversion from Decimal to Hexa Decimal and Octal Number.
15. Microprocessor 8085– Traffic Control System.
16. Microcontroller 8051 – 8 bit Addition and Subtraction.
17. Microcontroller 8051– 8 bit Multiplication and Division.
18. Microcontroller 8051 – Square root of a given number.
19. C–Program– Solving equations by Newton – Raphson method.
20. C–Program– Solving equations by Successive Approximation method.
21. C–Program– Solving equations by Gauss Elimination method.
22. C–Program– Numerical Differentiation by Euler’s method.

Text Books	<ol style="list-style-type: none"> 1. Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey 2006 2. Numerical methods in Science and Engineering – M.K. Venkataraman, National Publishing Co. Madras, 1996 3. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice–Hall, New Delhi. 4. M.K. Jain, S.R. Iyengar and R.K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Ed. New Age International, New Delhi. 5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, New Delhi.
Reference Books	<ol style="list-style-type: none"> 1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw–Hill). 2. B.F. Gerald and P.O. Wheatley, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA. 3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York. 4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison – Wesley, London. 5. V. Rajaraman, Programming in FORTRAN/ Programming in C, PHI, New Delhi.

COURSE OUTCOMES:

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

CO1	Program with the C Program/ FORTRAN with the C or any other high level language	K1
CO2	Use various numerical methods in describing/solving physics problems.	K4
CO3	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.	K5
CO4	To enhance the problem–solving aptitudes of students using various numerical methods.	K5
CO5	To apply various mathematical entities, facilitate to visualise any complicate tasks.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

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


METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 11	Semester – IV	Course Code: T4PPHC11
Course Title	CONDENSED MATTER PHYSICS		
Credits	5	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.		
Learning Objectives	To describe various crystal structures, symmetry and to differentiate different types of bonding. To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. To critically assess various theories of electrons in solids and their impact in distinguishing solids. Outline different types of magnetic materials and explain the underlying phenomena. Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.		

UNITS	Course Details
Unit – I	CRYSTAL PHYSICS: Types of lattices – Miller indices – Symmetry elements and allowed rotations – Simple crystal structures – Atomic Packing Factor– Crystal diffraction – Bragg's law – Scattered Wave Amplitude – Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions – Laue equations – Brillouin zone.
Unit – II	LATTICE DYNAMICS: Lattice with two atoms per primitive cell – First Brillouin zone – Group and phase velocities – Quantization of lattice vibrations – Phonon momentum – Inelastic scattering by phonons – Debye's theory of lattice heat capacity – Thermal Conductivity – Umklapp processes.
Unit – III	THEORY OF METALS AND SEMICONDUCTORS: Free electron gas in three dimensions – Electronic heat capacity – Wiedemann–Franz law – Band theory of metals and semiconductors – Bloch theorem – Kronig–Penney model – Semiconductors – Intrinsic carrier concentration – Temperature Dependence – Mobility – Impurity conductivity – Impurity states – Hall effect – Fermi surfaces and construction.
Unit – IV	MAGNETISM: Diamagnetism – Quantum theory of paramagnetism – Rare earth ion – Hund's rule – Quenching of orbital angular momentum – Adiabatic demagnetization – Quantum theory of ferromagnetism – Curie point – Exchange integral – Heisenberg's interpretation of Weiss field – Ferromagnetic domains – Bloch wall – Spin waves – Quantization – Magnons – Thermal excitation of magnons – Curie temperature and susceptibility of ferrimagnets – Theory of antiferromagnetism – Neel temperature.
Unit – V	SUPERCONDUCTIVITY EXPERIMENTAL FACTS: Occurrence – Effect of magnetic fields – Meissner effect – Critical field – Critical current – Entropy and heat capacity – Energy gap – Microwave and infrared properties – Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition – London equation – Coherence length – Isotope effect – Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime– Nature of pairing and condensation of Fermions. Single particle tunneling – Josephson tunneling – DC and AC Josephson effects – High temperature Superconductors – SQUIDS.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. C. Kittel, 1996, <i>Introduction to Solid State Physics</i>, 7th Edition, Wiley, New York. 2. Rita John, <i>Solid State Physics</i>, Tata Mc–Graw Hill Publication. 3. A. J. Dekker, <i>Solid State Physics</i>, Macmillan India, New Delhi. 4. M. Ali Omar, 1974, <i>Elementary Solid State Physics – Principles and Applications</i>, Addison – Wesley 5. H. P. Myers, 1998, <i>Introductory Solid State Physics</i>, 2nd Edition, Viva Book, New Delhi.
Ref. books	<ol style="list-style-type: none"> 1. J. S. Blakemore, 1974 , <i>Solid state Physics</i>, 2nd Edition, W.B. Saunder, Philadelphia 2. H. M. Rosenburg, 1993, <i>The Solid State</i>, 3rd Edition, Oxford University Press, Oxford. 3. J. M. Ziman, 1971, <i>Principles of the Theory of Solids</i>, Cambridge University Press, London. 4. C. Ross–Innes and E. H. Rhoderick, 1976, <i>Introduction to Superconductivity</i>, Pergamon, Oxford. 5. J. P. Srivastava, 2001, <i>Elements of Solid State Physics</i>, Prentice–Hall of India, New Delhi.
Web Resources	<ol style="list-style-type: none"> 1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html 2. http://www.cmmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html 3. https://www.britannica.com/science/crystal 4. https://www.nationalgeographic.org/encyclopedia/magnetism/ 5. https://www.brainkart.com/article/Super-Conductors_6824/

COURSE OUTCOMES:

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

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	K1
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	K1, K2
CO3	Student will be able to comprehend the heat conduction in solids	K3
CO4	Student will be able to generalize the electronic nature of solids from band theories.	K3, K4
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

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

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 12	Semester – IV	Course Code: T3PPHC12
Course Title	PRACTICAL – IV		
Credits	5	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge in digital electronics, microprocessor and microcontroller Basic knowledge of operating system and computer fundamentals.		
Learning Objectives	To equip the computational skill using various mathematical tools. To apply the software tools to digital electronics, microprocessor and microcontroller. To use microprocessor and Microcontroller in different applications		

List of Experiments
(Minimum Twelve Experiments)

1. Operational Amplifier–Sine Wave Generator– Wien’s Oscillator.
2. Operational Amplifier–Square, Triangular and Ramp Wave Generator.
3. Operational Amplifier–Solving Simultaneous equations.
4. Operational Amplifier– Schmidt triggers (IC 555 Timer).
5. Study of Flip Flops using NAND gates.
6. Simplification of Boolean expressions by Karnaugh Map method.
7. D/A Conversion– Resolution Linearity and Dual Slope.
8. Asynchronous Counter– Up Counter and Down Counter.
9. Study of 0–9 and 0–99 Counter (IC 7490 and 7447).
10. Demultiplexer–(1 to 4, 1 to 8, 1 to 16).
11. Microprocessor 8085– 16 bit Addition, 1’s complements Subtraction.
12. Microprocessor 8085– Conversion from Octal, Hexa decimal to Decimal number system.
13. Microprocessor 8085 – Searching a number from the given list.
14. Microprocessor 8085 – DAC interfacing (DAC 0800).
15. Microprocessor 8085– Interfacing of Stepper Motor.
16. Microcontroller 8051 – Factorial of a given number.
17. Microcontroller 8051– Smallest and Biggest number in an array of data.
18. Microcontroller 8051– Arranging an array of data in Ascending and Descending order.
19. C–Program– Numerical Integration by Simpson’s method.
20. C–Program– Numerical Integration by Trapezoidal rule.
21. C–Program– Numerical Differentiation by Runge– Kutta (II Order) method

TEXT BOOKS	<ol style="list-style-type: none"> 1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008) 2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008). 3. V. Vijayendran, 2005, Fundamentals of Microprocessor–8085”, 3rd Edition S. Visvanathan Pvt, Ltd. 4. The 8085 Microprocessor, Architecture, Programming and Interfacing – K. Udaya Kumar, S. Uma Shankar, Pearson 5. Fundamentals of Microprocessors and Microcontrollers – B. Ram, Dhanpat Rai Publications
REFERENCE BOOKS	<ol style="list-style-type: none"> 1. W. A. Tribel, Avtar Singh, “The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi. 2. Microprocessor and Its Application – S. Malarvizhi, Anuradha Agencies Publications 3. Microprocessor Architecture, Program And Its Application With 8085 – R.S. Gaonkar, New Age International (P) Ltd 4. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice– Hall of India, New Delhi. 5. J. Uffrenbeck, “The 8086/8088 Family–Design, Programming and Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi.

COURSE OUTCOMES:

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

CO1	Develop the programming skills of Microprocessor	K5
CO2	Appreciate the applications of Microprocessor programming	K3
CO3	Understand the structure and working of 8085 microprocessor and apply it.	K1, K3
CO4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.	K1, K4
CO5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.	K1, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2


METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	


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(For the candidates admitted from 2023 – 2024 onwards)

Course	CC 13	Semester – IV	Course Code: T3PPHC13
Course Title	PROJECT WORK WITH VIVA – VOCE		
Credits	7	Instruction Hours – 10	Medium : English
Learning Objectives	To develop the innovative thinking in project to make application oriented working models for theoretical concepts.		

PROJECT WORK

OUTCOME

- This will bring out innovative ideas from the students


EVALUATION

Viva Voce Examination: 75 Marks


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Elective Papers

(For the candidates admitted from 2023 – 2024 onwards)

Elective – List 1

Course	EC	Course Code: TPPHECA	
Course Title	1. ENERGY PHYSICS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Knowledge of conventional energy resources		
Learning Objectives	To learn about various renewable energy sources. To know the ways of effectively utilizing the oceanic energy. To study the method of harnessing wind energy and its advantages. To learn the techniques useful for the conversion of biomass into useful energy. To know about utilization of solar energy.		

UNITS	Course Details
Unit – I	INTRODUCTION TO ENERGY SOURCES: Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution.
Unit – II	ENERGY FROM THE OCEANS: Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.
Unit – III	WIND ENERGY SOURCES: Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) – Energy storage–Applications of wind energy.
Unit – IV	ENERGY FROM BIOMASS: Biomass conversion Technologies– wet and dry process– Photosynthesis – Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas– bio gas from waste fuel– properties of biogas–utilization of biogas.
Unit – V	SOLAR ENERGY SOURCES: Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi. 2. S. Rao and Dr. Paru Lekar, Energy technology. 3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983). 4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2 nd edition, Tata McGraw–Hill Publishing Co. Lt., New Delhi (1997). 5. Energy Technology by S. Rao and Dr. Parulekar.

Ref. books	1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York. 2. Applied solar energy, A. B. Meinel and A. P. Meinal 3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York.
Web Resources	1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1 2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/ 3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy 4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/ 5. https://www.acciona.com/renewable-energy/solar-energy/

COURSE OUTCOMES:

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

CO1	To identify various forms of renewable and non-renewable energy sources	K1
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	K2
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	K3
CO4	Distinguish aerobic digestion process from anaerobic digestion.	K3, K4
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	K2, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

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

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)


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Elective – List 1

Course	EC	Course Code: TPPHECB	
Course Title	2. CRYSTAL GROWTH AND THIN FILMS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Fundamentals of Crystal Physics		
Learning Objectives	To acquire the knowledge on Nucleation and Kinetics of crystal growth. To understand the Crystallization Principles and Growth techniques. To study various methods of Crystal growth techniques. To understand the thin film deposition methods. To apply the techniques of Thin Film Formation and thickness Measurement		

UNITS	Course Details
Unit – I	CRYSTAL GROWTH KINETICS: Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium – super saturation – Types of Nucleation – Formation of critical Nucleus – Classical theory of Nucleation – Homo and heterogeneous formation of 3D nuclei – rate of Nucleation.
Unit – II	CRYSTALLIZATION PRINCIPLES: Crystallization Principles and Growth techniques Classes of Crystal system – Crystal symmetry – Solvents and solutions – Solubility diagram – Super solubility – expression for super saturation – Metastable zone and introduction period – Miers TC diagram – Solution growth – Low and high temperatures solution growth – Slow cooling and solvent evaporation methods – Constant temperature bath as a Crystallizer.
Unit – III	GEL, MELT AND VAPOUR GROWTH: Gel, Melt and Vapour growth techniques Principle of Gel techniques – Various types of Gel – Structure and importance of Gel – Methods of Gel growth and advantages – Melt techniques – Czochralski growth – Vapour phase growth – Physical vapour deposition – Chemical vapour deposition.
Unit – IV	THIN FILM DEPOSITION METHODS; Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.
Unit – V	THIN FILM FORMATION: Thin Film Formation and thickness Measurement Nucleation, Film growth and structure – Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement – Interferometry.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition 2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008) 3. M. Ohora and R. C. Reid, “Modeling of Crystal Growth Rates from Solution” 4. D. Elwell and H. J. Scheel, “Crystal Growth from High Temperature Solution” 5. Heinz K. Henish, 1973, “Crystal Growth in Gels”, Cambridge University Press. USA.
Ref. books	<ol style="list-style-type: none"> 1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986) 2. P. Ramasamy and F. D. Gnanam, 1983, “UGC Summer School Notes”. 3. P. Santhana Raghavan and P. Ramasamy, “Crystal Growth Processes”, KRU Publications. 4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York 5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.
Web Resources	<ol style="list-style-type: none"> 1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp 2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcY7KeTLUuBu3WF 3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m 4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xll_KQFs_R_oky3Yd1Emw 5. https://www.electrical4u.com/thermal-conductivity-of-metals/

COURSE OUTCOMES:

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

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
CO2	Understand the Crystallization Principles and Growth techniques	K2, K4
CO3	Study various methods of Crystal growth techniques	K3
CO4	Understand the Thin film deposition methods	K2
CO5	Apply the techniques of Thin Film Formation and thickness Measurement	K3, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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Elective – List 1

Course	EC	Course Code: TPPHECC	
Course Title	3. ANALYSIS OF CRYSTAL STRUCTURES		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Fundamentals of crystal structures, symmetry and X-Ray Diffraction techniques		
Learning Objectives	To teach the concept of crystal structures and symmetry, and diffraction theory. To provide students with a background to X-ray generation, scattering theory and experimental diffraction from single crystals. To provide instruction on the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography. To give the students a background to the instrumentation used for powder diffraction and structure refinement using Rietveld method. To teach the different levels of structure exhibited by proteins and nucleic acids and methods used in protein crystallography.		

UNITS	Course details
Unit – I	CRYSTAL LATTICE: Unit cell and Bravais lattices – crystal planes and directions – basic symmetry elements operations – translational symmetries – point groups – space groups – equivalent positions – Bragg's law – reciprocal lattice concept – Laue conditions – Ewald and limiting spheres – diffraction symmetry – Laue groups.
Unit – II	DIFFRACTION: X-ray generation, properties – sealed tube, rotating anode, synchrotron radiation – absorption – filters and monochromators Atomic scattering factor – Fourier transformation and structure factor – anomalous dispersion – Laue, rotation/oscillation, moving film methods– interpretation of diffraction patterns – cell parameter determination – systematic absences – space group determination.
Unit – III	STRUCTURE ANALYSIS: Single crystal diffractometers – geometries – scan modes – scintillation and area detectors –intensity data collection – data reduction – factors affecting X-ray intensities – temperature and scale factor – electron density – phase problem – normalized structure factor – direct method fundamentals and procedures – Patterson function and heavy atom method – structure refinement – least squares method – Fourier and difference Fourier synthesis – R factor – structure interpretation – geometric calculations – conformational studies – computer program packages.
Unit – IV	POWDER METHODS: Fundamentals of powder diffraction – Debye Scherrer method – diffractometer geometries – use of monochromators and Soller slits – sample preparation and data collection – identification of unknowns – powder diffraction files (ICDD) – Rietveld refinement fundamentals – profile analysis – peak shapes – whole pattern fitting – structure refinement procedures – auto-indexing – structure determination from powder data – new developments. Energy dispersive X-ray analysis – texture studies – crystallite size determination – residual stress analysis – high and low temperature and high pressure crystallography (basics only).

Unit – V	PROTEIN CRYSTALLOGRAPHY: Globular and fibrous proteins, nucleic acids – primary, secondary, tertiary and quaternary structures – helical and sheet structures – Ramachandran map and its significance – crystallization methods for proteins – factors affecting protein crystallization – heavy atom derivatives – methods used to solve protein structures – anomalous dispersion methods.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.
Text Books	<ol style="list-style-type: none"> 1. Azaroff, L.V., "Elements of X-Ray Crystallography", Techbooks, New York, 1992. 2. Blundell, T.L. and Johnson, L., "Protein Crystallography", Academic Press, New York, 1986. 3. Cullity, B.D. and Stock, S.R. "Elements of X-ray Diffraction", Pearson, 2014. 4. H.L. Bhat, Introduction to Crystal Growth Principles and Practice CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015. 5. B.R. Pamplin, Crystal Growth, Pergamon Press, Oxford, 1975.
Ref. books	<ol style="list-style-type: none"> 1. Glusker, J.P. and Trueblood, K.N. Crystal Structure Analysis: A Primer", Oxford University Press, New York, 1994. 2. Ladd, M.F.C. and Palmer, R.A., "Structure Determination by X-ray Crystallography", Plenum Press, New York, 3rd Edition, 1993. 3. Stout, G.H. and Jensen, L. "X-ray Structure Determination, A Practical Guide", Macmillan, New York, 1989. 4. Woolfson, M.M. "An Introduction to X-ray Crystallography" Cambridge University Press, New York, 1997. 5. Sam Zhang, Lin Ki, Ashok Kumar, Materials Characterization Techniques, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009
Web Resources	<ol style="list-style-type: none"> 1. https://archive.nptel.ac.in/courses/112/106/112106227/ 2. https://archive.nptel.ac.in/courses/104/108/104108098/ 3. https://www.digimat.in/nptel/courses/video/102107086/L11.html 4. https://onlinecourses.nptel.ac.in/noc19_cy35/previewhttps://onlinecourses.nptel.ac.in/noc19_cy35/preview 5. https://nptel.ac.in/courses/104/104/104104011/

COURSE OUTCOMES:

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

CO1	Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	K2
CO2	Gain a working knowledge of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination	K1, K3
CO3	Get an exposure to crystal structure determination using program packages	K1, K4
CO4	Understand the instrumentation used for powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method	K2, K4
CO5	Get an insight into the structural aspects of proteins and nucleic acids, crystallization of proteins and methods to solve protein structures	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	3	2	1	2	2	2
CO2	3	3	3	2	2	2	1	2	2	2
CO3	3	3	2	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	2	1	2	2	2
CO2	3	3	3	2	2	2	1	2	2	2
CO3	3	3	2	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	2	2

Question Paper Pattern**Maximum Marks -75****Exam Duration: 3 Hours**

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Elective – List 1

Course	EC	Course Code: TPPHECD	
Course Title	4. MATERIALS SCIENCE		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Basic knowledge on different types of materials		
Learning Objectives	To gain knowledge on optoelectronic materials. To learn about ceramic processing and advanced ceramics. To understand the processing and applications of polymeric materials. To gain knowledge on the fabrication of composite materials. To learn about shape memory alloys, metallic glasses and nanomaterials		

UNITS	Course details
Unit – I	OPTOELECTRONIC MATERIALS: Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.
Unit – II	CERAMIC MATERIALS: Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, alumina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics
Unit – III	POLYMERIC MATERIALS: Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.
Unit – IV	COMPOSITE MATERIALS: Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.
Unit – V	NEW MATERIALS: Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications – bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior – nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007 2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.

	<ol style="list-style-type: none"> 3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice–Hall India, New Delhi(For units 2,3,4 and 5) 4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw–Hill 5. M. Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha Agencies
Ref. books	<ol style="list-style-type: none"> 1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer–Verlag, 2012. 2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011. 3. Lawrence H. Van Vlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison–Wesley. 4. H. Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer. 5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.
Web Resources	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview 2. https://nptel.ac.in/courses/112104229 3. https://archive.nptel.ac.in/courses/113/105/113105081 4. https://nptel.ac.in/courses/113/105/113105025/ https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSE OUTCOMES:

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

CO1	Acquire knowledge on optoelectronic materials	K1
CO2	Be able to prepare ceramic materials	K3
CO3	Be able to understand the processing and applications of polymeric materials	K2, K3
CO4	Be aware of the fabrication of composite materials	K5
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	K1
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)


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Elective – List 1

Course	EC	Course Code: TPPHECE
Course Title	5. PHYSICS OF NANOSCIENCE AND TECHNOLOGY	
Credits	3	Instruction Hours – 4/5 Medium : English
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.	

UNITS	Course Details
Unit – I	FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY: Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology — Classification of Nanomaterials – Metal and Semiconductor Nanomaterials – 2D, 1D, 0D nanostructured materials – Quantum dots – Quantum wires – Quantum wells – Surface effects of nanomaterials.
Unit – II	PROPERTIES OF NANOMATERIALS: Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant – Mechanical behavior: Elastic properties – strength – ductility – superplastic behavior – Optical properties: – Surface Plasmon Resonance – Quantum size effects – Electrical properties – Conductivity, Ferroelectrics and dielectrics – Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
Unit – III	SYNTHESIS AND FABRICATION: Physical vapour deposition – Chemical vapour deposition – sol-gel – Wet deposition techniques – electrochemical deposition method – Plasma arching – Electrospinning method – ball milling technique – pulsed laser deposition – Nanolithography: photolithography – Nanomanipulator.
Unit – IV	CHARACTERIZATION TECHNIQUES: Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) – UV-visible spectroscopy – Photoluminescence – Scanning electron microscopy (SEM) – Transmission electron microscopy (TEM) – Scanning probe microscopy (SPM) – Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.
Unit – V	APPLICATIONS OF NANOMATERIALS: Sensors: Nanosensors based on optical and physical properties – Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots – display screens – GMR read/write heads – Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification –Medicine: Imaging of cancer cells – biological tags – drug delivery – photodynamic therapy – Energy: fuel cells – rechargeable batteries – supercapacitors – photovoltaics.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill

	Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw–Hill Publishing Co. (2012). 2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010). 3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012). 4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002). 5. Nanotechnology and Nanoelectronics, D.P. Kothari, V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi. (2018)
Ref. books	<ol style="list-style-type: none"> 1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004). 2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007) 4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012) 5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV – Nanoelectronics Pentagon Press, New Delhi.
Web Resources	<ol style="list-style-type: none"> 1. www.its.caltec.edu/feyman/plenty.html 2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm 3. http://www.understandingnano.com 4. http://www.nano.gov 5. http://www.nanotechnology.com

COURSE OUTCOMES:

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

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	K1, K2
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	K1
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	K2, K3
CO4	Analyze the various characterization of Nano–products through diffraction, spectroscopic, microscopic and other techniques.	K4
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

Question Paper Pattern**Maximum Marks -75****Exam Duration: 3 Hours****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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Elective – List 1

Course	EC	Course Code: TPPHECF
Course Title	6. DIGITAL COMMUNICATION	
Credits	3	Instruction Hours – 4/5 Medium : English
Pre-Requisites	Exposure to Fourier transform, pulse modulation, multiplexing, noises in communication signals	
Learning Objectives	To understand the use of Fourier, transform in analyzing the signals. To learn about the quanta of transmission of information. To make students familiar with different types of pulse modulation. To have an in depth knowledge about the various methods of error controlling codes. To acquire knowledge about spread spectrum techniques in getting secured communication.	

UNITS	Course Details
Unit – I	SIGNAL ANALYSIS: Fourier transforms of gate functions, delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting – Convolution –Graphical representation – Convolution theorem – Time Convolution theorem –Frequency Convolution theorem –Sampling theorem.
Unit – II	INFORMATION THEORY: Communication system – Measurement of information – Coding – Bandot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel– Effects of noise– Capacity of noise in a channel – Shannon Hartley theorem – Redundancy.
Unit – III	PULSE MODULATION: Pulse amplitude modulation – natural sampling – Instantaneous sampling – Transmission of PAM Signals –Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM –Effects of noise –Companding – Advantages and application
Unit – IV	ERROR CONTROL CODING: Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RS Coding, Convolutional Coding, Coding Grain Viterbi Coding
Unit – V	SPREAD SPECTRUM SYSTEMS: Pseudo Noise sequences, generation and Correlation properties, direct sequence spread spectrum systems, frequency HOP Systems, processing gain, anti-jam and multipath performance
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. B.P. Lathi, <i>Communication system</i> , Wiley Eastern. 2. George Kennedy, <i>Electronic Communication Systems</i> , 3 rd Edition, Mc Graw Hill. 3. Simon Haykin, <i>Communication System</i> , 3 rd Edition, John Wiley & Sons.

	<ol style="list-style-type: none"> 4. George Kennedy and Davis, 1988, <i>Electronic Communication System</i>, Tata McGraw Hill 4th Edition. 5. Taub and Schilling, 1991, "<i>Principles of Communication System</i>", Second edition Tata McGraw Hill.
Ref. books	<ol style="list-style-type: none"> 1. John Proakis, 1995, <i>Digital Communication</i>, 3rd Edition, McGraw Hill, Malaysia. 2. M. K. Simen, 1999, <i>Digital Communication Techniques, Signal Design and Detection</i>, Prentice Hall of India. 3. Dennis Roddy and Coolen, 1995, <i>Electronics communications</i>, Prentice Hall of India IV Edition. 4. Wave Tomasi, 1998, "<i>Advanced Electronics communication System</i>" 4th Edition Prentice Hall, Inc. 5. M.Kulkarni, 1988, "<i>Microwave and Radar Engineering</i>", Umesh Publications.
Web Resources	<ol style="list-style-type: none"> 1. http://nptel.iitm.ac.in/ 2. http://web.ewu.edu/ 3. http://www.ece.umd.edu/class/enee630.F2012.html 4. http://www.atcourses.com/Advanced%20Topics%20in%20Digital%20Signals 5. http://nptel.iitm.ac.in/courses/117101051.html

COURSE OUTCOMES:

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

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	K1, K3
CO2	Apply different information theories in the process of study of coding of information, storage and communication	K3
CO3	Explain and compare the various methods of pulse modulation techniques	K4
CO4	Apply the error control coding techniques in detecting and correcting errors—able to discuss, analyze and compare the different error control coding	K3, K4
CO5	Apply, discuss and compare the spread spectrum techniques for secure communications	K3, k5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)


Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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Elective – List 1

Course	EC	Course Code: TPPHECG
Course Title	7. COMMUNICATION ELECTRONICS	
Credits	3	Instruction Hours – 4/5 Medium : English
Pre-Requisites	Knowledge of Regions of electromagnetic spectrum and its characteristics	
Learning Objectives	To comprehend the transmission of electromagnetic waves through different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth. To gain knowledge in the generation and propagation of microwaves. To acquire knowledge about radar systems and its applications and also the working principle of colour television. To learn the working principle of fiber optics and its use in telecommunication. To understand the general theory and operation of satellite communication systems.	

UNITS	Course Details
Unit – I	ANTENNAS AND WAVE PROPAGATION: Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Eccles and Larmor theory- Magneto ionic theory-ground wave propagation
Unit – II	MICROWAVES: Microwave generation—multi cavity Klystron-reflex klystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR)
Unit – III	RADAR AND TELEVISION: Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes- Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV
Unit – IV	OPTICAL FIBER: Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres – fibre losses and dispersion-applications
Unit – V	SATELLITE COMMUNICATION: Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites
Unit – VI	Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<ol style="list-style-type: none"> 1. Handbook of Electronics by Gupta and Kumar, 2008 edition. 2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988. 3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill (1991). 4. M. Kulkarani, Microwave and radar engineering, Umesh Publications, 1998. 5. Mono Chrome and colour television, R. R. Ghulathi
Ref. books	<ol style="list-style-type: none"> 1. Electronic communications – Dennis Roddy and Coolen, Prentice Hall of India, IV edition, 1995. 2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998 3. Dennis Roddy and Coolen, 1995, <i>Electronics communications</i>, Prentice Hall of India IV Edition. 4. Wayne Tomasi, 1998 “<i>Advanced Electronics communication System</i>” 4th edition, Prentice Hall of India, 1998 5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, <i>Electronic Devices and Circuits</i>, Tata McGraw–Hill Publishing Company Limited, New Delhi, Second Edition.
Web Resources	<ol style="list-style-type: none"> 1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/ 2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/ 3. http://nptel.iitm.ac.in/ 4. http://web.ewu.edu/ 5. http://nptel.iitm.ac.in/

COURSE OUTCOMES:

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

CO1	Discuss and compare the propagation of electromagnetic waves through sky and on earth’s surface Evaluate the energy and power radiated by the different types of antenna	K1, K5
CO2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides– discuss and compare the different methods of generation of microwaves	K4
CO3	Classify and compare the working of different radar systems– apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military– elaborate and compare the working of different picture tube	K3
CO4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it–discover the use of optical fiber as wave guide	K1, K3
CO5	Explain the importance of satellite communication in our daily life–distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)

Part-B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five-One question from each unit)

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Elective – List 1

Course	EC	Course Code: TPPHECH
Course Title	8. ASTROPHYSICS	
Credits	3	Instruction Hours – 4/5 Medium : English
Pre-Requisites	Fundamental knowledge about electromagnetic spectrum, wave nature of light and about the universe and the galaxy where we live in.	
Learning Objectives	To impart knowledge on the physical universe and its evolution. To make the student to understand fundamental principles and techniques of astronomy and astrophysics. To make the student to study electromagnetic radiation from stars, atomic spectra and classification of stars. To provide information about the properties and the evolution of stars. To render information about astronomical instrumentation.	
UNITS	Course Details	
Unit – I	OBSERVATIONAL ASTRONOMY: The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multiwavelength)	
Unit – II	PROPERTIES OF STARS: Brightness (luminosities, fluxes and magnitudes); colours (black body radiation, the Planck, Stefan–Boltzmann and Wien’s laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman & Balmer series etc, Doppler effect); Hertzsprung–Russell diagram; the main sequence (stellar masses ,binary systems, Kepler’s laws, mass–luminosity relations); distances to stars (parallax, standard candles, P–L relationships, ms–fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).	
Unit – III	THE LIFE AND DEATH OF STARS: Energy source (nuclear fusion, p–pchain, triple–alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure hydro static equilibrium, equation of state); evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants(white dwarfs, neutron stars, black holes, degeneracy pressure, Swarschild radius, escape velocities).	
Unit – IV	GALAXIES: Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter ; active galaxies and quasars.	
Unit – V	COSMOLOGY: Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (black body radiation);big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox); cosmological models (critical density, geometry of space, the fate of the Universe); dark energy and the accelerating Universe.	
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

Text Books	<p>1. Zeilik & Gregory, Introductory Astronomy & Astrophysics, 4th edition (Saunders College Publishing)</p> <p>2. Morison, I., Introduction to Astronomy and Cosmology, (Wiley)</p> <p>3. Kutner, M.L., Astronomy: A Physical Perspective (Cambridge University Press)</p> <p>4. Green, S.F. & Jones, M.H., An Introduction to the Sun and Stars (Cambridge University Press)</p>
Ref. books	<p>5. Jones, M.H. & Lambourne, R.J.A., An Introduction to Galaxies & Cosmology (Cambridge University Press)</p> <p>6. Carroll, B.W. & Ostlie, D.A., An Introduction to Modern Astrophysics (Pearson)</p> <p>7. Shu, F.H., The Physical Universe, An Introduction to Astronomy, (University Science Books)</p> <p>8. Motz, L. & Duveen, A., The Essentials of Astronomy, (Columbia University Press)</p>
Web Resources	<p>1. https://www.coursera.org/courses?query=astrophysics</p> <p>2. https://www.space.com</p> <p>3. https://www.britanica.com</p> <p>4. https://science.nasa.gov</p> <p>5. https://merriam-webster.com</p>

COURSE OUTCOMES:

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

CO1	Recall and understand the electromagnetic radiation from celestial objects. Analyze the wave nature of light in the form of ray diagram. Apply the knowledge of phenomenon of diffraction and assess, how diffraction limits the resolution of any system having a lens or mirror. Distinguish between reflecting and refracting telescopes and their usage.	K1 K2 K3 K4 K5
CO2	Correlate luminosity, flux and magnitude, related to the brightness of a star. Analyze the evolution of stars using HR diagram. Apply and examine the various laws related to temperature of a star. Assess the distance of stars, measured using trigonometric parallax method. Understand the position of star in the celestial sphere. Distinguish between sidereal and universal time.	K1 K2 K3 K4 K5
CO3	Define nuclear fusion, which is the fundamental energy source of stars. Analyze, how neutrinos are born during the process of nuclear fusion in the sun. Recall and explain the CNO cycle – the main source of energy of hotter stars. Comprehend stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories	K1 K2 K3 K4
CO4	Remember and illustrate the structure of our Milky way galaxy. Classify the types of galaxies. Understand the presence of dark matter in the universe. Explain, how quasars and active galaxies are powered by supermassive black holes which produce copious luminosity.	K1 K2 K3 K4
CO5	Explain cosmology, a branch of astronomy that involves the origin and evolution of the universe, from the Big Bang to today and on into the future. Define Hubble's law of cosmic expansion. Analyze and assess the big bang nucleosynthesis universe that explains the relative	K1 K2 K3 K4 K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	1	3	2	1	2
CO2	3	2	3	1	2	1	3	2	1	2
CO3	3	2	3	1	2	1	3	2	1	2
CO4	3	2	3	1	2	1	3	2	1	2
CO5	3	2	3	1	2	1	3	2	1	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	1	2	1	3	2	1	2
CO2	3	2	3	1	2	1	3	2	1	2
CO3	3	2	3	1	2	1	3	2	1	2
CO4	3	2	3	1	2	1	3	2	1	2
CO5	3	2	3	1	2	1	3	2	1	2

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Elective – List 2

Course	EC	Course Code: TPPHECI	
Course Title	9. PLASMA PHYSICS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Fundamentals of Electricity and Magnetism, Electromagnetic theory, Maxwell's equation, Basic knowledge of electrical and electronics instrumentation.		
Learning Objectives	To explore the plasma universe by means of in-site and ground-based observations. To understand the model plasma phenomena in the universe. To explore the physical processes which occur in the space environment.		

UNITS	Course Details
Unit – I	FUNDAMENTAL CONCEPTS OF PLASMA: Kinetic pressure in a partially ionized – mean free path and collision cross section – Mobility of charged particles – Effect of magnetic field on the mobility of ions and electrons–Thermal conductivity– Effect of magnetic field– Quasi-neutrality of plasma Debye shielding distance – Optical properties of plasma.
Unit – II	MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD: Particle description of plasma– Motion of charged particle in electrostatic field– Motion of charged particle in uniform magnetic field – Motion of charged particle in electric and magnetic fields– Motion of charged particle in inhomogeneous magnetic field – Motion of charged particle in magnetic mirror confinement – motion of an electron in a time varying electric field– Magneto-hydrodynamics – Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour.
Unit – III	PLASMA OSCILLATIONS AND WAVES: Introduction, theory of simple oscillations – electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation – Ion oscillation and waves in a magnetic field – thermal effects on plasma oscillations – Landau damping – Hydro magnetic waves – Oscillations in an electron beam.
Unit – IV	PLASMA DIAGNOSTICS TECHNIQUES: Single probe method – Double probe method – Use of probe technique for measurement of plasma parameters in magnetic field – microwave method – spectroscopic method – laser as a tool for plasma diagnostics–X-ray diagnostics of plasma – acoustic method – conclusion.
Unit – V	APPLICATIONS OF PLASMA PHYSICS: Magneto hydrodynamic Generator – Basic theory – Principle of Working–Fuel in MHD Generator – Generation of Microwaves Utilizing High Density Plasma – Plasma Diode.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<ol style="list-style-type: none"> 1. Plasma Physics– Plasma State of Matter – S. N. Sen, Pragati Prakashan, Meerut. 2. Introduction to Plasma Physics–M. Uman 3. Krall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley, CA: San Francisco Press, 1986. ISBN: 9780911302585. Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw–Hill, 1967. ISBN: 9780070628120. 4. Goldston, R. J., and P. H. Rutherford. Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995. ISBN: 9780750301831. 5. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK: Cambridge University Press, 2005. ISBN: 9780521675741.
Ref. books	<ol style="list-style-type: none"> 1. Chen, F. F. Introduction to Plasma Physics. 2nd ed. New York, NY: Springer, 1984. ISBN: 9780306413322. 2. Introduction to Plasma Theory–D.R. Nicholson 3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507. 4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139. 5. Huddleston, R. H., and S. L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965
Web Resources	<ol style="list-style-type: none"> 1. https://fusedweb.llnl.gov/Glossary/glossary.html 2. http://farside.ph.utexas.edu/teaching/plasma/lectures1/index.html 3. http://www.plasmas.org/ 4. http://www.phy6.org/Education/whplasma.html 5. http://www.plasmas.org/resources.htm

COURSE OUTCOMES:

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

CO1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	K1, K2
CO2	Understand the plasma and learn the magneto–hydrodynamics concepts applied to plasma.	K2
CO3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell’s equation to quantitative analysis of plasma.	K1, K3
CO4	Analyze the different principle and techniques to diagnostics of plasma.	K2, K5
CO5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

Question Paper Pattern**Maximum Marks -75****Exam Duration: 3 Hours****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Elective – List 2

Course	EC	Course Code: TPPHECJ	
Course Title	10. BIO PHYSICS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Fundamental concepts of Physics and Biology		
Learning Objectives	To understand the physical principles involved in cell function maintenance. To understand the fundamentals of macromolecular structures involved in propagation of life. To understand the biophysical function of membrane and neuron. To understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions. To understand the physical principles behind the various techniques available for interrogating biological macromolecules..		

UNITS	Course Details
Unit – I	CELLULAR BIOPHYSICS: Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix – Molecular mechanisms of Vesicular traffic – Electrical activities of cardiac and neuronal cells.
Unit – II	MOLECULAR BIOPHYSICS: Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins. Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation. Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.
Unit – III	MEMBRANE AND NEURO BIOPHYSICS: Models membranes – Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels. Nervous system: Organization of the nervous system – Membrane potential – Origins of membrane potential – Electrochemical potentials – Nernst equation – Goldman equation.
Unit – IV	RADIATION BIO PHYSICS: X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.
Unit – V	PHYSICAL METHODS IN BIOLOGY: Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. The cell: A molecular approach, Geoffrey M. Cooper, ASM Press, 2013. 2. Biophysics, VasanthaPattabhi, N. Gautham, Narosa Publishing, 2009 3. Biophysics, P. S. Mishra VK Enterprises, 2010. 4. Biophysics, M. A Subramanian, MJP Publishers, 2005. 5. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.
Ref. books	1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008). 2. Essential cell biology by Bruce Albert et al (Garland Science) 3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983). 4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media). 5. Biological spectroscopy by Iain D. Campbell, Raymond A. Dwek
Web Resources	1. General Bio: http://www.biology.arizona.edu/DEFAULT.html 2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm 3. Electrophoresis: http://learn.genetics.utah.edu/content/labs/gel/ 4. Online biophysics programs: http://mw.concord.org/modeler/ 5. https://blanco.biomol.uci.edu/WWWResources.html

COURSE OUTCOMES:

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

CO1	Understand the structural organization and function of living cells and should be able to apply the cell signaling mechanism and its electrical activities.	K2, K3
CO2	Comprehension of the role of biomolecular conformation to function.	K1
CO3	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	K2, K5
CO4	To know the effects of various radiations on living systems and how to prevent ill effects of radiations.	K1, K5
CO5	Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	1	3	3	2
CO2	3	3	3	2	1	2	1	3	3	2
CO3	3	3	3	3	1	1	2	3	3	2
CO4	3	3	3	2	1	1	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	1	2	1	3	3	2
CO2	3	3	3	2	1	2	1	3	3	2
CO3	3	3	3	3	1	1	2	3	3	2
CO4	3	3	3	2	1	1	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	3

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Elective – List 2

Course	EC	Course Code: TPPHECK
Course Title	11. NONLINEAR DYNAMICS	
Credits	3	Instruction Hours – 4/5
Pre-Requisites	Basics of Numerical methods and Differential equations, Fundamentals of linear and nonlinear waves, and Basics of communication systems	
Learning Objectives	To school the students about the analytical and numerical techniques of nonlinear dynamics. To make the students understand the concepts of various coherent structures. To train the students on bifurcations and onset of chaos. To educate the students about the theory of chaos and its characterization. To make the students aware of the applications of solitons, chaos and fractals.	

UNITS	Course Details
Unit – I	GENERAL: Linear waves–ordinary differential equations(ODEs)–Partial differential equations(PDEs)– Methods to solve ODEs and PDEs.– Numerical methods – Linear and Nonlinear oscillators–Nonlinear waves–Qualitative features
Unit – II	COHERENT STRUCTURES: Linear and Nonlinear dispersive waves – Solitons – KdB equation – Basic theory of KdB equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis – Perturbation methods– Solitons in Optical fibres – Applications.
Unit – III	BIFURCATIONS AND ONSET OF CHAOS: One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dynamical system – Strange attractors – Routes to chaos.
Unit – IV	Nonlinear dynamical systems –Integrable systems –Solitary waves –The Scott Russell Phenomena—Soliton – Kortewig– deVries (Kdv) equation (no derivation) Non Integrable systems –Chaos –Bifurcation theory –Period doubling cascades – Strange attractions– Controlling of Chaos– applications – Tsunamis (basic idea)
Unit – V	APPLICATIONS: Soliton based communication systems – Soliton based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns. Springer, 2003. 2. A. Hasegawa and Y. Kodama, Solitons in Optical Communications. Oxford Press, 1995. 3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455. 4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and

	Chaos. Springer, 2003. ISBN: 9780387001777. 5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.
Ref. books	1. G. Drazin and R. S. Johnson. Solitons: An Introduction. Cambridge University Press, 1989. 2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific, 1989. 3. S. Strogatz. Nonlinear Dynamics and Chaos. Addison Wesley, 1995. 4. Hao Bai-Lin, Chaos (World Scientific, Singapore, 1984). 5. Kahn, P. B., Mathematical Methods for Scientists & Engineers (Wiley, NY, 1990)
Web Resources	1. https://www.digimat.in/nptel/courses/video/108106135/L06.html 2. http://digimat.in/nptel/courses/video/115105124/L01.html 3. https://www.digimat.in/nptel/courses/video/108106135/L01.html 4. http://complex.gmu.edu/neural/index.html 5. https://cnls.lanl.gov/External/Kac.php

COURSE OUTCOMES:

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

CO1	Gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	K1, K4
CO2	Understand the concepts of different types of coherent structures and their importance in science and technology.	K2
CO3	Learn about simple and complex bifurcations and the routes to chaos	K1, K2
CO4	Acquire knowledge about various oscillators, characterization of chaos and fractals.	K1
CO5	To analyze and evaluate the applications of solutions in telecommunication, applications of chaos in cryptography, computations and that of fractals.	K3, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)


Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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Elective – List 2

Course	EC	Course Code: TPPHECL	
Course Title	12. QUANTUM FIELD THEORY		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Prior exposure on fundamentals of Quantum mechanics and Special Relativity will be essential.		
Learning Objectives	To school the students about the analytical and numerical techniques of nonlinear dynamics. To make the students understand the concepts of various coherent structures. To train the students on bifurcations and onset of chaos. To educate the students about the theory of chaos and its characterization. To make the students aware of the applications of solitons, chaos and fractals.		

UNITS	Course Details
Unit – I	SYMMETRY PRINCIPLES: Relativistic kinematics, relativistic waves, Klein–Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of energy–momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and the associated conserved current.
Unit – II	QUANTIZATION OF KLEIN–GORDAN FIELD: Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N–particle eigenstates of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum.
Unit – III	QUANTIZATION OF DIRAC FIELD: Review of Dirac equation and its quantization, use of anti–commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta.
Unit – IV	QUANTIZATION OF ELECTROMAGNETIC FIELDS: Review of free Maxwell's equations, Lagrangian, gauge transformation and gauge fixing, Hamiltonian, quantization in terms of transverse delta functions, expansion in terms of creation operators, spin, statistics and propagator of the photon.
Unit – V	PERTURBATIVE INTERACTION AT TREE LEVEL: Introduction to interacting quantum fields, Wick's Theorem, Feynman Diagram, Examples from quantum electrodynamics at the tree level: positron–electron and electron–electron scattering.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<ol style="list-style-type: none"> 1. J. D. Bjorken and S. D. Drell, Relativistic Quantum Fields David 2. An Introduction to Quantum Field Theory by M. Peskin and D. V. Schroeder 3. Quantum Field theory: From Operators to Path Integrals, 2nd edition by Kerson Huang 4. Quantum Field Theory by Mark Srednicki 5. Quantum Field Theory by Claude Itzykson and Jean Bernard Zuber.
Ref. books	<ol style="list-style-type: none"> 1. V. B. Berestetskii, E. M. Lifshitz and L. P. Pitaevskii, <i>Quantum Electrodynamics</i> 2. Introduction to the Theory of Quantized Fields by N. N. Bogoliubov and D. V. Shirkov (1959) 3. Quantum Field Theory by L. H. Ryder (1984) 4. Quantum Field Theory by L. S. Brown (1992) 5. Quantum Field Theory: A Modern Introduction by M. Kaku (1993)
Web Resources	<ol style="list-style-type: none"> 1. https://homepages.dias.ie/ydri/QFTNOTES4v2.pdf 2. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/referencespapers.aspx?referenceid=2605249 3. https://archive.nptel.ac.in/courses/115/106/115106065/ 4. http://www.nhn.ou.edu/~milton/p6433/p6433.html 5. https://plato.stanford.edu/entries/quantum-field-theory/

COURSE OUTCOMES:

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

CO1	Understand the interconnection of Quantum Mechanics and Special Relativity	K1
CO2	Enable the students to understand the method of quantization to various field	K2
CO3	Employ the creation and annihilation operators for quantization	K5
CO4	Summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	K1, K3
CO5	Understand the concept of Feynman diagram	K2
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	3	2	3	3	2	3
CO2	3	3	3	2	3	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	2	3

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

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)

Part-B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five-One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)
Elective – List 2

Course	EC	Course Code: TPPHECM	
Course Title	13. GENERAL RELATIVITY AND COSMOLOGY		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Skill in mathematics and mechanics.		
Learning Objectives	To give an introduction to students in the areas of general relativity and cosmology.		

UNITS	Course Details
Unit – I	TENSORS: Tensors in index notation – Kronecker and Levi Civita tensors – inner and outer products – contraction – symmetric and antisymmetric tensors – quotient law – metric tensors – covariant and contravariant tensors – vectors – the tangent space – dual vectors – tensors – tensor products – the Levi-Civita tensor – tensors in Riemann spaces
Unit – II	TENSORS FIELD: Vector-fields, tensor-fields, transformation of tensors – gradient and Laplace operator in general coordinates – covariant derivatives and Christoffel connection – Elasticity: Field tensor – field energy tensor – strain tensor – tensor of elasticity– curvature tensor
Unit – III	GENERAL RELATIVITY: The space time interval – the metric – Lorentz transformations – space-time diagrams – world-lines – proper time – energy-momentum vector – energy-momentum tensor – perfect fluids – energy-momentum conservation – parallel transport – the parallel propagator – geodesics – affine parameters – the Riemann curvature tensor – symmetries of the Riemann tensor – the Bianchi identity
Unit – IV	TENSOR IN RELATIVITY: Ricci and Einstein tensors – Weyl tensor – Killing vectors – the Principle of Equivalence – gravitational redshift – gravitation as space-time curvature – the Newtonian limit – physics in curved space-time – Einstein's equations – the Weak Energy Condition – causality – spherical symmetry – the Schwarzschild metric – perihelion precession
Unit – V	COSMOLOGY: Expansion of the Universe – thermal history – and the standard cosmological model – Friedmann – Robertson-Walker type models of the Universe – Primordial inflation and the theory of cosmological fluctuations – Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe – Dark matter and dark energy – theoretical questions and observational evidence – inflation – origin of galaxies and other open problems
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.

Text Books	<ol style="list-style-type: none"> 1. M. R. Spiegel, <i>Vector Analysis, Schaum's outline series</i>, McGraw Hill, New York, 1974. 2. James Hartle, <i>Gravity: An introduction to Einstein's general relativity</i>, San Francisco, Addison-Wesley, 2002 3. Sean Carroll, <i>Spacetime and Geometry: An Introduction to General Relativity</i>, (Addison-Wesley, 2004). 4. Jerzy Plebanski and Andrzej Krasinski, <i>An Introduction to General Relativity and Cosmology</i>, Cambridge University Press 2006 5. Meisner, Thorne and Wheeler: <i>Gravitation</i> W. H. Freeman & Co., San Francisco 1973
Ref. books	<ol style="list-style-type: none"> 1. Robert M. Wald: <i>Space, Time, and Gravity: the Theory of the Big Bang and Black Holes</i>, Univ. of Chicago Press. 2. J. V. Narlikar, <i>Introduction to Cosmology</i>, Jones & Bartlett 1983 3. Steven Weinberg, <i>Gravitation and Cosmology</i>, New York, Wiley, 1972. 4. Jerzy Plebanski and Andrzej Krasinski, <i>An Introduction to General Relativity and Cosmology</i>, Cambridge University Press 2006 5. R Adler, M Bazin & M Schiffer, <i>Introduction to General Relativity</i>
Web Resources	<ol style="list-style-type: none"> 1. http://www.fulviofrisone.com/attachments/article/486/A%20First%20Course%20In%20General%20Relativity%20-%20Bernard%20F.Schutz.pdf 2. https://link.springer.com/book/9780387406282 3. https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/resources/lecture-18-cosmology-i/ 4. https://arxiv.org/abs/1806.10122 5. https://uwaterloo.ca/applied-mathematics/future-undergraduates/what-you-can-learn-applied-mathematics/relativity-and-cosmology

COURSE OUTCOMES:

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

CO1	Skillfully handle tensors	K1
CO2	Understanding of the underlying theoretical aspects of general relativity and cosmology	K2
CO3	Gain knowledge on space time curvature	K1
CO4	Equipped to take up research in cosmology	K3, K4
CO5	Confidently solve problems using mathematical skills	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)

Part-B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five-One question from each unit)

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Elective – List 2

Course	EC	Course Code: TPPHECN	
Course Title	14. ADVANCED OPTICS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Knowledge of ray properties and wave nature of light.		
Learning Objectives	To know the concepts behind polarization and could pursue research work on application aspects of laser. To impart an extensive understanding of fiber and non-linear optics. To study the working of different types of LASERS. To differentiate first and second harmonic generation. Learn the principles of magneto-optic and electro-optic effects and its applications.		

UNITS	Course Details
Unit – I	POLARIZATION AND DOUBLE REFRACTION: Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu’s law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity
Unit – II	LASERS: Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and laser action – Types of lasers and its applications – Solid state lasers: Ruby laser – Nd:YAG laser – Gas lasers: He-Ne laser – CO ₂ laser – Chemical lasers: Semiconductor laser.
Unit – III	FIBER OPTICS: Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor
Unit – IV	NON-LINEAR OPTICS: Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light
Unit – V	MAGNETO-OPTICS AND ELECTRO-OPTICS: Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<ol style="list-style-type: none"> 1. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd. 2. Ajoy Ghatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd. 3. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York 4. J. Peatros, Physics of Light and Optics, a good (and free!) electronic book 5. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley–Interscience,
Ref. books	<ol style="list-style-type: none"> 1. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition. 2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH. 3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011. 4. Y. B. Band, Light and Matter, Wiley and Sons (2006) 5. R. Guenther, Modern Optics, Wiley and Sons (1990)
Web Resources	<ol style="list-style-type: none"> 1. https://www.youtube.com/watch?v=WgzynzPiyC 2. https://www.youtube.com/watch?v=ShQWwobpW60 3. https://www.ukessays.com/essays/physics/fiber-optics-and-it-applications.php 4. https://www.youtube.com/watch?v=0kEvr4DKGRI 5. http://optics.byu.edu/textbook.aspx

COURSE OUTCOMES:

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

CO1	Discuss the transverse character of light waves and different polarization phenomenon	K1
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K2
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	K3, K4
CO4	Identify the properties of nonlinear interactions of light and matter	K4
CO5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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Elective – List 2

Course	EC	Course Code: TPPHECO	
Course Title	15. ADVANCED MATHEMATICAL PHYSICS		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Good knowledge in basic mathematics.		
Learning Objectives	To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.		

UNITS	Course Details
Unit – I	DISCRETE GROUPS: Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.
Unit – II	CONTINUOUS GROUPS: Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D-matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.
Unit – III	SPECIAL UNITARY GROUPS: Definition of unitary, unimodular groups SU (2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)–Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the irreducible representations 3, 3*, 6, 6, 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G. coefficients for 3 x 3* and 3 x 6 representations. SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.
Unit – IV	TENSORS: Cartesian vectors and tensors illustration with moment of inertia, conductivity, dielectric tensors. Four vector in special relativity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.
Unit – V	TENSOR CALCULUS: Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming $Dg = 0$). Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation $G=0$.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<ol style="list-style-type: none"> 1. A. W. Joshi, Group Theory for Physicists 2. D. B. Lichtenberg, Unitary Symmetry and Elementary Particles 3. E. Butkov, Mathematical Physics 4. J. V. Narlikar, General Relativity & Cosmology 5. R. Geroch, Mathematical Physics, The University of Chicago press (1985).
Ref. books	<ol style="list-style-type: none"> 1. M. Hamermesh <i>Group Theory</i> 2. M. E. Rose: Elementary Theory of Angular Momentum 3. Georgi : Lie Groups for Physicists 4. E. A. Lord: Tensors, Relativity & Cosmology 5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.
Web Resources	<ol style="list-style-type: none"> 1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0 2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf 3. https://www.hindawi.com/journals/amp/ 4. https://projecteuclid.org/journals/advances-in-theoretical-and-mathematical-physics 5. https://www.springer.com/journal/11232

COURSE OUTCOMES:

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

CO1	Gained knowledge of both discrete and continuous groups	K1
CO2	Apply various important theorems in group theory	K3
CO3	Construct group multiplication table, character table relevant to important branches of physics.	K5
CO4	Equipped to solve problems in tensors	K4, K5
CO5	Developed skills to apply group theory and tensors to peruse research	K2, K3

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;

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	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)
Elective – List 3

Course	EC	Course Code: TPPHECP	
Course Title	16. ADVANCED SPECTROSCOPY		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Basic knowledge of group theory, abstract thinking ability, lasers, chemical bonds and molecular structures.		
Learning Objectives	Helps students understand and appreciate spectroscopy as a sufficiently broad field in which many sub disciplines exist. Make them appreciate each of these specific techniques with numerous implementations. To realize the progress in this field that is rapid, resulting in improved instrument capabilities and an ever-widening range of applications. To apply group theory in spectroscopy to shed light on molecular symmetry and determine important physical parameters.		

UNITS	Course Details
Unit – I	MOLECULAR SPECTROSCOPY AND GROUP THEORY: Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class– Lagrange’s theorem statement and proof – Symmetry operations and symmetry elements – Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations– Unitary representations – Schur’s lemmas – Great orthogonality theorem – point group –Simple applications : Symmetry operations of water and ammonia– Construction of character table for C _{2v} (water) and C _{3v} (ammonia) molecules
Unit – II	LASER SPECTROSCOPY: Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission– ultra short pulses– laser cooling –Single and multi–mode lasers– Laser tenability– Fluorescence spectroscopy with lasers– Laser Raman Spectroscopy – Non–linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research
Unit – III	MOSSBAUER SPECTROSCOPY: Basic idea of Mossbauer spectroscopy – Principle– Mossbauer effect– Recoilless emission and absorption– Chemical shift –Effect of electric and magnetic fields – hyperfine interactions– instrumentation–Applications: understanding molecular and electronic structures
Unit – IV	XRAY PHOTOELECTRON SPECTROSCOPY: Principle – XPS spectra and its interpretation– ECSA–EDAX– other forms of XPS – chemical shift – Applications : – stoichiometric analysis– electronic structure– XPES techniques used in astronomy, glass industries, paints and in biological research
Unit – V	MOLECULAR MODELLING: Determination of force constants– force field from spectroscopic data–normal

	coordinate analysis of a simple molecule (H ₂ O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data– molecular modelling using data from various spectroscopic studies
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. William Kemp, 2019, Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition. 2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi. 3. D.N. Satyanarayana, 2001, <i>Vibrational Spectroscopy and Applications</i>, New Age International Publication. 4. B.K. Sharma , 2015, <i>Spectroscopy</i>, Goel Publishing House Meerut. 5. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
Ref. books	<ol style="list-style-type: none"> 1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink. 2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol.I., Chapman and Hall, New York. 3. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi. 4. David. L. Andrews, Introduction to Laser Spectroscopy, Springer, 2020 5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition) New Age International Publishers.
Web Resources	<ol style="list-style-type: none"> 1. Fundamentals of Spectroscopy – Course (nptel.ac.in) 2. http://mpbou.edu.in/slm/mscche1p4.pdf 3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 4. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu 5. https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html

COURSE OUTCOMES:

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

CO1	Comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations. Apply mathematical theory while working with symmetry operations. To use group theory as a tool to characterize molecules.	K1, K2
CO2	Align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	K3
CO3	Understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	K2, K3

CO4	Assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	K3, K4
CO5	Employ IR and Raman spectroscopic data along with other data for structural investigation of molecules. Analyze thermodynamic functions and other parameters to evolve molecular models.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	3	3	3	3	3	2
CO2	2	2	2	3	3	3	2	3	3	2
CO3	2	2	3	3	3	3	3	2	3	3
CO4	3	2	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	3	3	3	3	3

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)


Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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Elective – List 3

Course	EC	Course Code: TPPHECQ
Course Title	17. MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	
Credits	3	Instruction Hours – 4/5 Medium : English
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	

UNITS	Course Details
Unit – I	8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING: Memory mapped I/O scheme– I/O mapped I/O scheme – Memory and I/O interfacing– Data transfer schemes – Interrupts of 8085 – Programmable peripheral interface (PPI) – Control group and control word– Programmable DMA controller – Programmable interrupt controller – Programmable communication interface – Programmable counter /interval timer.
Unit – II	8085 INTERFACING APPLICATIONS: Seven segment display interface – Interfacing of Digital to Analog converter and Analog to Digital converter – Stepper motor interface – Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature an strain).
Unit – III	8051 MICROCONTROLLER HARDWARE: Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin–out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.
Unit – IV	8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING: Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.
Unit – V	INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD: 8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. A. NagoorKani, Microprocessors & Microcontrollers, RBA Publications (2009). 2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009). 3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013). 4. B. Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi (2016). 5. V. Vijayendran, 2005, Fundamentals of Microprocessor–8085”, 3rd Edition S.Visvanathan Pvt, Ltd.
Ref. books	<ol style="list-style-type: none"> 1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008) 2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008). 3. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice– Hall of India, New Delhi. 4. J. Uffrenbeck, “The 8086/8088 Family–Design, Programming and Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi. 5. W. A. Tribel, Avtar Singh, “The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi.
Web Resources	<ol style="list-style-type: none"> 1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html 2. http://www.electronicengineering.nbcafe.in/peripheral-mapped-io-interfacing/ 3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/ 4. http://www.circuitstoday.com/8051-microcontroller 5. https://www.elprocus.com/8051-assembly-language-programming/

COURSE OUTCOMES:

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

CO1	Gain knowledge of architecture and working of 8085 microprocessor.	K1
CO2	Get knowledge of architecture and working of 8051 Microcontroller.	K1
CO3	Be able to write simple assembly language programs for 8085A microprocessor.	K2, K3
CO4	Able to write simple assembly language programs for 8051 Microcontroller.	K3, K4
CO5	Understand the different applications of microprocessor and microcontroller.	K3, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)


Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

HOD



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Elective – List 3

Course	EC	Course Code: TPPHECR
Course Title	18. CHARACTERIZATION OF MATERIALS	
Credits	3	Instruction Hours – 4/5 Medium : English
Pre-Requisites	Fundamentals of Heat and Thermodynamics, Basics of Optical systems, Microscopic systems, Electrical measurements and Fundamentals of Spectroscopy.	
Learning Objectives	To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA. To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes. To make the students understand some important electrical and optical characterization techniques for semiconducting materials. To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.	

UNITS	Course details
Unit – I	THERMAL ANALYSIS: Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)– cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.
Unit – II	MICROSCOPIC METHODS: Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy – phase contrast microscopy –differential interference contrast microscopy – fluorescence microscopy – confocal microscopy – digital holographic microscopy – oil immersion objectives – quantitative metallography – image analyzer.
Unit – III	ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY: SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis– Scanning tunneling microscopy (STEM) – Atomic force microscopy (AFM) – Scanning new field optical microscopy.
Unit – IV	ELECTRICAL METHODS AND OPTICAL CHARACTERISATION: Two probe and four probe methods– van der Pauw method – Hall probe and measurement – scattering mechanism – C–V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C–V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.
Unit – V	X–RAY AND SPECTROSCOPIC METHODS: Principles and instrumentation for UV–Vis–IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS–proton induced X–ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis–application – Powder diffraction – Powder diffractometer –interpretation of diffraction patterns – indexing – phase identification – residual stress analysis – Particle size, texture studies – X–ray fluorescence spectroscopy – uses.

Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990. 2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979. 3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991 4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002. 5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
Ref. books	<ol style="list-style-type: none"> 1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001). 2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001). 3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009). Volumes 49 – 51, (2009). 4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986). 5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)
Web Resources	<ol style="list-style-type: none"> 1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf 2. http://www.digimat.in/nptel/courses/video/113106034/L11.html 3. https://nptel.ac.in/courses/104106122 4. https://nptel.ac.in/courses/118104008 5. https://www.sciencedirect.com/journal/materials-characterization

COURSE OUTCOMES:

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

CO1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	K1, K3
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	K2
CO3	The working principle and operation of SEM, TEM, STM and AFM.	K2, K3
CO4	Understood Hall measurement, four –probe resistivity measurement, C–V, I–V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	K3, K4
CO5	The theory and experimental procedure for x– ray diffraction and some important spectroscopic techniques and their applications.	K4, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

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

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A $10 \times 2 = 20$ Marks Answer ALL Questions (Two questions from each unit)

Part-B $5 \times 5 = 25$ Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C $3 \times 10 = 30$ Marks Answer ALL Questions (Three out of Five-One question from each unit)

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Elective – List 3

Course	EC	Course Code: TPPHECS	
Course Title	19. MEDICAL PHYSICS		
Credits	3	Instruction Hours – 4/5	Medium : English
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, gamma camera, accelerator and nuclear magnetic resonance. To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics. To introduce the ideas of Radiography. To form a good base for further studies like research.		

UNITS	Course Details
Unit – I	X-RAYS AND TRANSDUCERS: Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer
Unit – II	BLOOD PRESSURE MEASUREMENTS: Introduction –□sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).
Unit – III	RADIATION PHYSICS: Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter
Unit – IV	MEDICAL IMAGING PHYSICS: Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)
Unit – V	RADIATION PROTECTION: Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	<p>Dr. K. Thayalan , <i>Basic Radiological Physics</i>, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.</p> <p>Curry, Dowdey and Murry, <i>Christensen's Physics of Diagnostic Radiology: – LippincotWilliams and Wilkins</i>, 1990.</p> <p>FM Khan, <i>Physics of Radiation Therapy</i>, William and Wilkins, 3rd ed, 2003.</p> <p>D. J. Dewhurst, <i>An Introduction to Biomedical Instrumentation</i>, 1st ed, Elsevier Science, 2014.</p> <p>R.S. Khandpur, <i>Hand Book of Biomedical Instrumentations</i>, 1st ed, TMG, New Delhi, 2005.</p>
Ref. books	<p>Muhammad Maqbool, <i>An Introduction to Medical Physics</i>, 1st ed, Springer International Publishing, 2017.</p> <p>Daniel Jiráč, FrantišekVítek, <i>Basics of Medical Physics</i>, 1st ed, Charles University, Karolinum Press, 2018</p> <p>Anders Brahme, <i>Comprehensive Biomedical Physics</i>, Volume 1, 1st ed, Elsevier Science, 2014.</p> <p>K. Venkata Ram, <i>Bio–Medical Electronics and Instrumentation</i>, 1st ed, Galgotia Publications, New Delhi, 2001.</p> <p>John R. Cameron and James G. Skofronick, 2009, <i>Medical Physics</i>, John Wiley Interscience Publication, Canada, 2nd edition.</p>
Web Resources	<p>https://nptel.ac.in/courses/108/103/108103157/</p> <p>https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692</p> <p>https://www.technicalsymposium.com/alllecturenotes_biomed.html</p> <p>https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78</p> <p>https://www.modulight.com/applications-medical/</p>

COURSE OUTCOMES:

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

CO1	Learn the fundamentals, production and applications of X-rays.	K1
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	K2
CO3	Apply knowledge on Radiation Physics	K3
CO4	Analyze Radiological imaging and filters	K4
CO5	Assess the principles of radiation protection	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

Question Paper Pattern

Maximum Marks -75

Exam Duration: 3 Hours

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer ALL Questions (Three out of Five-One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)
Elective – List 3

Course	EC	Course Code: TPPHECT	
Course Title	20. SOLID WASTE MANAGEMENT		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Basic knowledge of solid waste and its type		
Learning Objectives	To gain basic knowledge in solid waste management procedures. To gain industry exposure and be equipped to take up a job. To harness entrepreneurial skills. To analyze the status of solid waste management in the nearby areas. To sensitize the importance of healthy practices in waste managements		

UNITS	Course Details
Unit – I	SOLID WASTE MANAGEMENT: Introduction – Definition of solid waste – Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.
Unit – II	SOLID WASTE CHARACTERISTICS: Solid Waste Characteristics: Physical and chemical characteristics – SWM hierarchy – factors affecting SW generation
Unit – III	TOOLS AND EQUIPMENT: Tools and equipment – Transportation – Disposal techniques – Composting and land filling technique
Unit – IV	ECONOMIC DEVELOPMENT: SWM for economic development and environmental protection Linking SWM and climate change and marine litter.
Unit – V	INDUSTRIAL VISIT: SWM Industrial visit – data collection and analysis – presentation
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> 1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002). 2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006). 3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS BSP /ations PublicBooks (.(2020 4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014). 5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private

	limited, 2016
Ref. books	<ol style="list-style-type: none"> 1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012 2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2 3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237 4. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 2006 ISBN-13: 978-8131709122 5. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693
Web Resources	<ol style="list-style-type: none"> 1. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648 2. https://testbook.com/learn/environmental-engineering-solid-waste-management/ 3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28 5. https://amzn.eu/d/5VUSTDI

COURSE OUTCOMES:

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

CO1	Gained knowledge in solid waste management	K1
CO2	Equipped to take up related job by gaining industry exposure	K5
CO3	Develop entrepreneurial skills	K3
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	K4
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)


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(For the candidates admitted from 2023 – 2024 onwards)
Elective – List 3

Course	EC	Course Code: TPPHECU	
Course Title	21. SEWAGE AND WASTE WATER TREATMENT AND REUSE		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Basic knowledge of classification of sewage and solid waste and its harmful effects.		
Learning Objectives	To gain basic knowledge in sewage and waste water Treatment procedures. To gain industry exposure and be equipped to take up job. To harness entrepreneurial skills. To analyze the status of sewage and waste water management in the nearby areas. To sensitize the importance of healthy practices in waste water management.		

UNITS	Course Details
Unit – I	RECOVERY & REUSE OF WATER: Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation – Sedimentation – sedimentation with coagulation – Filtration – sand filters – pressure filters – horizontal filters – vector control measures in industries – chemical and biological methods of vector eradication
Unit – II	DISINFECTION: Disinfection: Introduction to disinfection and sterilization: Disinfectant – UV radiation – Chlorination – Antisepsis – Sterilant – Aseptic and sterile – Bacteriostatic and Bactericidal – factors affecting disinfection.
Unit – III	CHEMICAL DISINFECTION: Chemical Disinfection: Introduction – Theory of Chemical Disinfection – Chlorination Other Chemical Methods – Chemical Disinfection Treatments Requiring – Electricity – Coagulation/Flocculation Agents as Pretreatment – Disinfection By-Products(DBPs)
Unit – IV	PHYSICAL DISINFECTION: Physical Disinfection: Introduction – Ultraviolet Radiation – Solar Disinfection – Heat Treatment – Filtration Methods – Distillation – Electrochemical Oxidation Water Disinfection by Microwave Heating.
Unit – V	INDUSTRIAL VISIT: Industrial visit – data collection and analysis – presentation
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. Drinking water and disinfection technique, Anirudhha Balachandra. CRC press (2013) 2. Design of Water and Wastewater Treatment Systems (CV-424/434), Shashi Bushan,(2015) Jain Bros 3. Integrated Water Resources Management, Sarbhukan M M, CBS

	<p>PUBLICATION (2013)</p> <p>4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007</p> <p>5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.</p>
Ref. books	<p>1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020</p> <p>2. Wastewater Treatment Technologies, Mritunjay Chaubey, Wiley, 2021.</p> <p>3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002.</p> <p>4. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989</p> <p>5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.</p>
Web Resources	<p>1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en</p> <p>2. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?</p> <p>3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB</p> <p>4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB</p> <p>5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=&hvrnd=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmld=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi</p>

COURSE OUTCOMES:

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

CO1	Gained knowledge in solid waste management	K1
CO2	Equipped to take up related job by gaining industry exposure	K5
CO3	Develop entrepreneurial skills	K3
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	K4
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)


Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)



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(For the candidates admitted from 2023 – 2024 onwards)
Elective – List 3

Course	EC	Course Code: TPPHECV	
Course Title	22. SOLAR ENERGY UTILIZATION		
Credits	3	Instruction Hours – 4/5	Medium : English
Pre-Requisites	Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types		
Learning Objectives	To impart fundamental aspects of solar energy utilization. To give adequate exposure to solar energy related industries. To harness entrepreneurship skills. To understand the different types of solar cells and channelizing them to the different sectors of society. To develop an industrialist mindset by utilizing renewable source of energy.		

UNITS	Course Details
Unit – I	HEAT TRANSFER & RADIATION ANALYSIS: Conduction, Convection and Radiation – Solar Radiation at the earth’s surface – Determination of solar time – Solar energy measuring instruments.
Unit – II	SOLAR COLLECTORS: Physical principles of conversion of solar radiation into heat flat plate collectors – General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.
Unit – III	SOLAR HEATERS: Types of solar water heater – Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.
Unit – IV	SOLAR ENERGY CONVERSION: Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo – electric conversion – process flow of silicon solar cells–different approaches on the process– texturization, diffusion, Antireflective coatings, metallization.
Unit – V	NANOMATERIALS IN FUEL CELL APPLICATIONS: Use of nanostructures and nanomaterials in fuel cell technology – high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage. Industrial visit – data collection and analysis – presentation
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	<ol style="list-style-type: none"> Solar energy utilization –G.D. Rai –Khanna publishers – Delhi 1987. Maheshwar Sharon, Madhuri Sharon, Carbon “Nano forms and Applications”, Mc Graw–Hill, 2010. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems“, Academic Press, London, 2009 Tiwari G.N, “Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
Ref. books	<ol style="list-style-type: none"> Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976) Solar energy thermal processes – John A.Drife and William. (1974)

	3. John W. Twidell & Anthony D. Weir, 'Renewable Energy Resources, 2005 4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, John Wiley and Sons, 2013 5. Duffie, J.A., Beckman, W.A., "Solar Energy Thermal Process", John Wiley and Sons, 2007.
Web Resources	1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb 2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read 3. www.nptel.ac.in/courses/112105051 4. www.freevideolectures.com 5. http://www.e-booksdirectory.com

COURSE OUTCOMES:

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

CO1	Gained knowledge in fundamental aspects of solar energy utilization	K1
CO2	Equipped to take up related job by gaining industry exposure	K3
CO3	Develop entrepreneurial skills	K5
CO4	Skilled to approach the needy society with different types of solar cells	K4
CO5	Gained industrialist mindset by utilizing renewable source of energy	K2, K3

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;

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	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

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

Question Paper Pattern

Maximum Marks –75

Exam Duration: 3 Hours

Part–A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part–B 5×5=25 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–C 3×10=30 Marks Answer ALL Questions (Three out of Five–One question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Course	SEC1	Course Code: T2PPHS1	
Course Title	ENTREPRENEURIAL DEVELOPMENT		
Credits	2	Instruction Hours – 4	Medium : English
Learning Objectives	To instruct the characteristics essential for entrepreneurial and the role of entrepreneurial in economic development. To encourage rural entrepreneurs. To know the special schemes offered by the government.		

UNITS	Course Details
Unit – I	CONCEPT OF ENTREPRENEURSHIP: Meaning – Definition – characteristics – functions – role of entrepreneurs in economic development – classification of entrepreneurs – factors affecting entrepreneurial growth – entrepreneurship development programmes.
Unit – II	PROJECT: Project appraisal – Project formulation – Project identification – sources of ideas – preliminary evaluation and testing of ideas. Entrepreneurial opportunities for physical science: Microprocessor – crystal – solar panels – semiconductor devices – mobile servicing – computer servicing.
Unit – III	LICENSING: Licensing procedures to start an industrial unit – procedures to start small and women entrepreneurs – import and export substitutions oriented items – new procedures.
Unit – IV	GOVERNMENT SUBSIDISED LOAN SCHEMES: District industrial centre (DIC) – Definition of MSME– Classification – Types of Schemes, Objectives , Key Benefits and How to apply – Unemployed Youth Employment Generation Programme UYEGP – Prime Minister Employment Generation Programme PMEGP – New Entrepreneur Cum Enterprise Development Programme NEEDS, Ineligibility list for NEEDS. Centre for Entrepreneurship Development and Incubation (CEDI), NIT, Tiruchirapalli, Indian Institute of Food Processing Technology (IIFPT), Thanjavur.
Unit – V	GOVERNMENT MSME INCENTIVE SCHEMES Objectives and Key Benefits – Capital subsidy – Additional Capital subsidy: Thrust Sector Enterprises, List of thrust sectors, Micro Manufacturing Enterprises, select category of entrepreneurs and scaling up – Operational Improvement: Low Tension Power Tariff(LTPT) subsidy, Payroll subsidy, generator subsidy, Promotion of Energy Audit and Conservation of Energy(PEACE) – Skill training and employment scheme. Statutory: Reimbursement of stamp duty and registration charges – Value Addition: Scheme for acquiring Quality certification (Q– Cert), Subsidy for Asset creation for intellectual property, Reimbursement of Hall Rent.
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books	1. Entrepreneurial development – C. Gupta, N. P. Srinivasan, Sultan Chand and sons 2. Dynamics of entrepreneurial development and Management – Vasant Desai, Himalaya Publishing House. 3. Scheme Booklet for MSMEs in Government of Tamil Nadu – with effect from 16 th February 2021.
Ref. books	1. Entrepreneurship development principles, policies and programme – P. Saravanavel.

COURSE OUTCOMES:

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

CO1	Understand the concept of entrepreneurship.	K1
CO2	Get awareness about the source of project appraisal	K2
CO3	Understand the legal requirements for licensing procedures.	K3
CO4	Know the incentives and subsidies of state and central governments	K4
CO5	Get the idea of entrepreneurial opportunities of physical science	K5

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;

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

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

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 5x6=30 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part-B 3x15=45 Marks Answer Any Three Questions (Three out of Five–one question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Course	SEC2	Course Code: T3PPHS2	
Course Title	CYBERCRIME AND ITS SECURITY		
Credits	2	Instruction Hours – 3	Medium : English
Learning Objectives	To acquire general awareness about the cybercrime and its security. To understand about cyber attacks. To acquire the knowledge about Types of Hacking. To acquire the knowledge about cyber law and IT act.		

UNITS	Course Details
Unit – I	Cyber crime: definition–Types –History of cybercrime–Reasons for cyber crime–Effects of cybercrime against individual, business, society, & Nation
Unit – II	Cyber security – Security goals – Types of cyber–attacks – Types of cyber attackers – Cyber security tools– Cyber security challenges –Advantages of cyber security
Unit – III	Hacking–Definition–Types of hacking– Advantages and disadvantages of hacking –Purpose of hacking –Types of hackers – Ethical hacking – Ethical hacking tools
Unit – IV	Computer Security – overview – Security Terminologies – Securing through operating system – Security through Antivirus – Managing malware – Securing through backup: Backup devices– Types of back ups
Unit – V	Cyber law – Meaning of cyber law – Advantages of cyber law – objective of cyber law – Areas of cyber law – IT act 2000 – Offences and penalties
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1. Over view of cyber crime and security by Akash Mishra
Web Resources	1. https://u-next.com/blogs/cyber-security/history-of-cybercrime/ 2. https://www.javatpoint.com/cyber-security-tutorial 3. https://www.tutorialspoint.com/computer_security/index.htm 4. https://www.javatpoint.com/ethical-hacking 5. https://www.tutorialspoint.com/ethical_hacking/index.htm 6. https://www.tutorialspoint.com/information_security_cyber_law/index.htm 7. https://www.javatpoint.com/what-is-cyber-law

COURSE OUTCOMES:

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

CO1	Students acquire knowledge about cyber attacks and cyber attackers.	K1
CO2	Students acquire the knowledge of types of Hacking and types of Hackers.	K2
CO3	Students acquire the knowledge about the cyber law and IT act.	K3
CO4	Acquire knowledge about cyber law acts.	K4

CO5	By the end of the course the students acquire general awareness about the cybercrime and its security.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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

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

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part–A 5x6=30 Marks Answer ALL Questions (Either or Type–Two questions from each unit)

Part–B 3x15=45 Marks Answer Any Three Questions (Three out of Five–one question from each unit)

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(For the candidates admitted from 2023 – 2024 onwards)

Course	PCS	Course Code: T4PPHS3	
Course Title	EMPLOYABILITY SKILLS		
Credits	2	Instruction Hours – 4	Medium : English
Learning Objectives	To develop the personality development and to improve the skills needed for the employment opportunities.		

UNITS	Course Details
Unit – I	PERSONALITY DEVELOPMENT: Knowing yourself – Positive thinking – Physical fitness – Emotional Intelligence – Skills to develop emotional intelligence.
Unit – II	RESUME WRITING: Resume writing – purpose of a resume – How long should my resume job? – Types of Resume – Chronological Resume, Functional Resume, Combination Resume, Infographic Resume, Resume with profile, Targeted Resume, mini Resume, Non-traditional resume – Things to do – Formats of Resume – Job Application or covering letter.
Unit – III	GROUP DISCUSSION: Introduction – Types of Group discussions – Difference between group discussion and panel discussion debate – personality traits – Advantages of Group discussion – Dos and Don'ts.
Unit – IV	INTERVIEW SKILLS: Introduction – Types of interviews – Preparatory steps for job interview – Interview skills – punctuality – Think before you speak – clarity – being confident – Listening – Expressing optimism – Body language – Showing interest – Communication skills – Expressing gratitude.
Unit – V	PROFESSIONAL SKILLS: Creativity at work place – Ethical values – Capacity building, Developing interpersonal relationship – Leadership and team building – Decision making – Stress and Time management
Unit – VI	PROFESSIONAL COMPONENTS: Expert Lectures, Online Seminars – Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
Text Books	1) ICTACT – Soft skills and Industry awareness – Tamil Nadu state council for Higher Education, Department of Higher Education – ICT Academy of Tamil Nadu, Chennai. 2) Soft Skills: An integrated approach to maximize personality, Gajendra S.Chauhan, Sangeetha Sharma, Wiley India.

COURSE OUTCOMES:

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

CO1	Acquire the knowledge about the personality development.	K2
CO2	Gain the knowledge about various types of resumes and resume writing.	K2
CO3	Able to face the first step of interview on gaining the group discussion skills	K3
CO4	Acquire interview skills and understand about body language.	K4
CO5	Gain the professional skills for employability and leadership.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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


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

Question Paper Pattern**Maximum Marks: 75 Marks****Exam Duration: 3 Hrs****Part–A** 5x6=30 Marks Answer ALL Questions (Either or Type–Two questions from each unit)**Part–B** 3x15=45 Marks Answer Any Three Questions (Three out of Five–one question from each unit)

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M.Phil. PHYSICS COURSE STRUCTURE

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

PART	CODE	COURSE	TITLE	MARKS		TOTAL	EXAM HOURS	CREDIT	Page No.
				IA	WE				
I SEMESTER							3		
III		CC1	Research Methodology	25	75	100	3	4	1
III		CC2	Advanced Physics	25	75	100	3	4	3
III		CC3	Teaching and Learning Skills	25	75	100	3	4	5
III		CC4	Guide Paper*	25	75	100	3	4	
		TOTAL				400		16	
II SEMESTER									
				V.V	Dis	TOTAL			
III		CC5	Dissertation and viva voce	50	150	200		8	
GRAND TOTAL						600		24	
Guide Paper*									
	A1MPH4A	Crystal Growth and Application to Nano Materials							
	A1MPH4B	Thin Film Physics							
	A1MPH4C	Physics of Dielectric Materials							
	A1MPH4D	Chemical Physics							
	A1MPH4E	Nano-Materials							
	A1MPH4F	Nano Materials and Applications							

No of papers

Core course 4 (each of 4 credits)

Project 1 (8 credits)

Total 5 (24 credits)

Passing Minimum is prescribed for Internal and External

a) The Passing minimum for CIA shall be 50% out of 25 Marks (ie 12 Marks)

b) The Passing minimum for Autonomous Examinations shall be 50% out of 75 marks (ie 38 Marks)

Course: CC1

Credits :4

Code:

RESEARCH METHODOLOGY

(For Students admitted from 2023-2024)

OBJECTIVE

- To have the knowledge on literature survey on research fields

UNIT: 1 RESEARCH TECHNIQUES

Problem identification – Determining the mode of approach-literature survey-various sources-current status of the problem –impact and usefulness of the research topic-role of guide and scholar – Use of internet e-mail and www browsing-use of software packages MS office –Introduction to MATLAB.

UNIT: 2 PREPARATION AND PRESENTATION OF SCIENTIFIC REPORTS

Writing a paper and preparing a poster-art of writing synopsis, dissertation and thesis Illustrations and analysis of results.

UNIT: 3 NUMERICAL ANALYSIS

Curve fitting –Least squares method –solution of equations Graphical Method , simple iterative method-Jacobi's method-Gauss Serial method- Regula falsi method-Newton-Raphson method-Numerical Integration: Simpson's rule - Gaussian's integration- Differential equation: Taylor's series solution- Predictor corrector method-Eulers method - Runge-Kutta method.

UNIT: 4 BASICS OF C PROGRAMMING

Introduction to C –Character set– Identifiers and keywords – Data types – constants symbolic constants –Expressions – statements –Arithmetic, Relational, Logical and assignment operators, increment and decrement operators, conditional operators – Bitwise operator, special operator, library functions- input and output functions Control statements – while, do-while, for, nested for, if – else, switch, break, continue and go to statements- arrays.

UNIT: 5 RESEARCH EQUIPMENTS

Working principles and applications of UV, VIS, IR, FTIR, XRD, SEM, TEM, STEM, ESR, and NMR.

OUTCOME

By the end of the course the students will be able to

1. Analyze about various research techniques.
2. Acquire information about the preparation and presentation of scientific reports.
3. Have knowledge on various research fields to proceed in a systematic and in scientific methodologies.

4. Explain about various methods adopted in numerical analysis.
5. Comprehend about the instrumental analysis.

BOOKS FOR STUDY

1. J. Anderson and M. Poole. Assignment and Thesis Writing. 4th Edition. John Wiley and Sons Inc. (2002)
2. M.K. Venkataraman. Numerical Methods in Science and Engineering. The National Publishing Company, Madras. (1999).

BOOKS FOR REFERENCE

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation. 4th Edition. New Age International Publishers. New Delhi, India. (2005).
2. E. Balagurusamy. Programming in ANSI C. 6th Edition. Tata McGraw Hill Education Private Limited, New Delhi, India. (2012).
3. K. Ravichandran, K. Swaminathan, and B. Sakthivel. Introduction to Thin Films.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	3	2	2	3	2	2	2	2	2.5
CO2	3	3	2	2	2	3	2	2	2	2	2.2
CO3	3	3	3	2	2	3	2	2	2	2	2.3
CO4	3	3	3	2	2	3	2	2	2	2	2.4
CO5	3	3	3	2	2	3	3	2	2	2	2.4
Mean Overall Score (High Level Relationship Between COs and POs)											2.36 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)


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Course: CC2
CODE:

Credits :4

ADVANCED PHYSICS

(For students admitted from 2023-2024)

OBJECTIVE

- To know about defects and solids, high vacuum technology, ultrasonic and non conventional energy sources

UNIT 1: IMPERFECTION IN ATOMIC PACKING

Defects in solids-point defects-plane defects-dislocation-diffusion and ionic conductivity-color centers-photoconductivity-luminescence-types of luminescence-thermo and electroluminescence Glow curve-absorbption and emission spectra.

UNIT 2: PREPARATION TECHNIQUES

CHEMICAL METHODS: Electroplating-ion plating-Chemical reduction plating-vapourphase growth. Anodisation-Vacuum evaporation-Evaporation theory-Sputtering methods-Reactive sputtering-RRF Sputtering-preparation technique of semiconducting Chalcogenide binary compounds.

HIGH VACUUM TECHNOLOGY: Vacuum Pump-Oil-sealed rotary pumps-Diffusion pump pressure measurement-Thermal conductivity-Gauge-pressure gauges for high to ultra high vacuum.

UNIT 3: ULTRASONICS

Ultrasonic waves-different methods of production-behaviour - reflection and transmission at normal incidence-stationary waves and resonance. Detection of Ultrasonic waves-Measurment technique of ultrasound-pulse echo overlap method –cross correlation method-phase slope method.

UNIT 4: ELECTRONICS AND CONTROL CIRCUITS

Electronics control circuits-Introduction to automatic control system open loop control system-closed loop control system-basic elements of servo mechanism-advantages of electronic control of devices-dc motor speed control-temperature control-illumination control-automatic water level indicator using SCR-Battery operated inverter circuit using power transistor.

UNIT5: NON CONVENTIONAL ENERGY

Principle of conversion of solar radiation into heat-Green house effect-flat plate collectors- general characteristics-solar concentrators- parabolic and spherical systems-solar cells-characteristics –peak power point photovoltaic cell-types of solar cell applications - indirect sources of solar energy conversion- wind energy-Horizontal axis type wind mill.

OUTCOME

By the end of the course the students will be able to

1. Infer fundamentals of imperfections of solids.
2. Explain about various preparation techniques.
3. Gather information about the production of ultrasonics.
4. Understand about various non conventional energy sources.
5. Learn about electronics and control circuits.

BOOKS FOR REFERENCES

1. Introduction to Solid state physics, Charles Kittel, Wiley International,6th Edition,(1986)
2. Ultrasonics-Benson Carlin Tata McGraw Hill Company,3rd Edition,(1949)
3. Hand Book of Thin film technology, L.T. Maissel and Glang McGraw Hill, (1970)
4. Thin film Phenomena, K.L.Chopra, Krieger Publishing Company, (1979) .
5. Solar energy utilization-G.D.Rai Khanna Publishers, (1987)

BOOKS FOR REFERENCES

1. Fundamentals of Microprocessor 8085: Architecture Programming, and Interfacing, Viswanathan, S. Printers & Publishers Pvt Ltd,(2009)
2. Fundamentals of Microprocessor and computers by Badri Ram, Dhanpat Rai and sons, New Delhi,(1995.)
3. Industrial Electronics and Control S.K.Battarcharya,S.Chatterjee, Tata McGraw Hill,(2001)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	2	3	2	2	2	2	2	2	3	2.3
CO2	3	2	2	2	3	2	2	3	2	2	2.3
CO3	2	2	2	2	2	3	2	2	2	2	2.1
CO4	3	3	3	2	3	2	2	2	2	3	2.5
CO5	2	2	3	2	3	3	2	2	2	2	2.3
Mean Overall Score (High Level Relationship Between COs and POs)											2.3 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

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THANJAVUR-613 005.

Course :CC3

Credit: 4

Code :

TEACHING AND LEARNING SKILLS

(Common Paper for All M.Phil. Courses)

(For Students admitted from 2023 -2024)

UNIT I

Computer Application Skills. Computer system: Characteristics, Parts and their functions. Different generations of Computer. Information and Communication Technology (ICT): Definition, Meaning, Features, Trends–Integration of ICT in teaching and learning – ICT applications: Using word processors, spread sheets, Power point slides in the classroom– ICT for Research: On-line journals, e-books, Courseware, Tutorials, Technical reports, Theses and Dissertations.

UNIT II

Communication Skills. Communication: Definitions. Elements of Communication: Sender, Message, Channel, Receiver, Feedback and Noise–Types of Communication: Spoken and written; Non-verbal communication–Intrapersonal, Interpersonal, Group and Mass communication–Barriers to communication: Mechanical, Physical, Linguistic & Cultural – Skills of communication: Listening, Speaking, Reading and writing –Methods of developing fluency in oral and written communication –style, Diction and Vocabulary –Classroom communication and dynamics.

UNIT III

Communication Technology: Bases, Trends and Developments –Skills of using Communication Technology. Computer Mediated Teaching: Multimedia, E-content –Satellite based communication: EDUSAT and ETV channels, Communication through web: Audio and Video applications on the Internet, interpersonal communication through the web.

UNIT IV

Pedagogy. Instructional Technology: Definition, Objectives and Types–Difference between Teaching and Instruction–Lecture Technique: Steps, Planning of a Lecture, Delivery of a lecture–Narration in tune with the nature of different disciplines –Lecture with power point presentation –Versatility of lecture technique –Demonstration, Characteristics, Principles, Planning Implementation and Evaluation –Teaching –Learning Techniques: Team Teaching, Group discussion, Seminar, Workshop, Symposium and Panel Discussion –Models of teaching: CAI, CMI and WBI.

UNIT V

Teaching Skills. Teaching skill: Definition, Meaning and Nature –Types of Teaching skills: Skill of Set Induction, Skill of Stimulus Variation, Skill of Explaining, Skill of Probing Questions, Skill of Black Board writing and Skill of Closure –Integration of Teaching Skills–Evaluation of Teaching Skills.

BOOKS FOR REFERENCE

1. Bela Rani Sharma (2007), Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi .
2. Don Skinner (2005), Teacher Training, Edinburgh University Press Ltd., Edinburgh.
3. Information and Communication Technology in Education: A Curriculum for Schools and programme of Teacher development, Jonathan Anderson and Tom Van Weart, UNESCO, 2002
4. Kumar K.I (2008) Educational Technology, New Age International Publishers, New Delhi
5. Mangal, S.K. (2002) Essential of Teaching –Learning and Information Technology, Tandon Publications, Ludhiana.
6. Michael D. and William (2000), Integrating Technology into Teaching and Learning: Concepts and Applications, Prentice Hall, New York.

OUTCOME

By the end of the course the students will be able to

- 1) Acquire knowledge about the computer application.
- 2) Understand knowledge about communication skills.
- 3) Infer knowledge about communication technology.
- 4) Gather information about pedagogy.
- 5) Comprehend about the teaching skills.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO3	PSO 4	PSO 5	Mean Score of COs
CO1	3	3	2	3	2	3	2	2	3	2	2.5
CO2	3	3	2	3	2	3	3	3	3	2	2.7
CO3	3	3	3	3	2	3	3	3	3	2	2.8
CO4	3	3	3	2	2	3	3	3	2	2	2.6
CO5	3	3	3	3	2	3	3	2	3	2	2.7
Mean Overall Score (High Level Relationship Between COs and POs)											2.66 (high)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hour

Part – A – 10 X 2=20 Marks (Two Question from Each Unit)

Part – B – 5 X 5=25 Marks (Either or type – Two Questions from Each Unit)


Part – C – 3 X 10=30 Marks (Three out of five and One Question from Each Unit)



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Course: CC4

Credits: 4

Code:

CRYSTAL GROWTH AND APPLICATIONS TO NANOMATERIALS
(For Students admitted from 2022-2023)

OBJECTIVE

- To have the knowledge on literature survey on research fields

UNIT: 1 CLASSICAL THEORY OF NUCLEATION

Gibbs Thomson equation – theory of nucleation – energy of formation of a nucleus – different possible shapes of nucleus - homogenous nucleation of binary system – heterogeneous nucleation - free energy of formation of critical heterogeneous – cap shaped – disc shaped nucleus – secondary nucleation.

UNIT: 2 THEORY OF CRYSTAL GROWTH

Surface energy theory – diffusion theory – absorption layer theory – Volmer theory – Bravais theory – Kossel theory – Straski's treatment – two dimensional nucleation theory.

UNIT: 3 GROWTH OF CRYSTAL FROM MELT

Growth of III-V materials – growth of oxide materials – growth crystal from flux – slow cooling method- temperature difference method – high pressure method – solvent evaporation method – electro crystallization – crystal growth by thermal, hydrothermal method.

UNIT: 4 CRYSTAL CHARACTERIZATION

Single crystal diffraction techniques – power diffraction – indexing – least square refinement – X-ray fluorescence – X-ray topography – SEM and TEM studies – electron probe microanalysis – secondary ion mass spectroscopy (SIMS) – electron spectroscopy for chemical analysis (ESCA) – electrical conductivity – measurement of electrical conductance – measurement of dielectric constant – micro hardness – etching studies.

UNIT: 5 PROPERTIES OF NANOMATERIALS

Nanomaterials – method used to produce nanomaterials – Sol-Gel synthesis – applications of nanomaterials – Automobiles with greater fuel efficiency – Aero space components with enhanced performed characteristics – better and future weapons platforms – longer lasting satellites – longer lasting medical implants – ductile, machinable ceramics – largeelectrochromic display devices.

OUTCOME

By the end of the course the students will be able

1. Explain about classical theory of nucleation.
2. Understand the theories of crystal growth.
3. Analyze characterization techniques involved in crystal growth.
4. Acquire knowledge on properties of nanomaterials.
5. Comprehend about crystal growth and applications to nanomaterials.

BOOKS FOR STUDY

1. Modeling crystal growth rates from solution by Makoto Oharo and Robert C.Reid PHI Pvt. Ltd., New Delhi, 1973
2. Crystal Growth Process by J. C. Brice . John Wily and sons., NY 1986.

BOOKS FOR REFERENCE

- 1.Synthesis, crystal growth and characterization – Krishnan Lal, North Holland Amerstdam (1982).
2. A Guide to materials characterization and chemical analysis – John P. Sibilila, Wiley VCH(1996)
3. Introduction to Nano Technology – Charles P. Pool Jr. and Frank J. Owens , John Wiley Sons., New Delhi 2006.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	2	3	2	3	2	2	3	2	2.5
CO2	3	3	2	3	2	3	3	3	3	2	2.7
CO3	3	3	3	3	2	3	3	3	3	2	2.8
CO4	3	3	3	2	2	3	3	3	2	2	2.6
CO5	3	3	3	3	2	3	3	2	3	2	2.7
Mean Overall Score (High Level Relationship Between COs and POs)											2.66 (high)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

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Course: CC4

Credits: 4

Code:

THIN FILM PHYSICS
(For Students admitted from 2023-2024)

OBJECTIVE

- To have the knowledge on Thin Film Physics.

UNIT: 1 NUCLEATION THEORY AND DEPOSITION METHODS

Theories of nucleation- Four stages of film growth incorporation of defects during growth-Chemical methods: Liquid phase epitaxy- electrodeposition-Ion plating- Chemical reduction plating-Vapour phase growth - Anodisation-Vacuum evaporation- Evaporation theory-Sputtering methods- Reactive sputtering-RF sputtering- Preparation technique of semiconducting- Chalcogenide binary compounds - Molecular beam epitaxy (MBE).

UNIT 2: PRESSURE AND THICKNESS MEASUREMENTS

High vacuum Technology: Vacuum pump- Oil sealed Rotary pumps-Diffusion pump- pressure measurement- Thermal conductivity -Gauge -Pressure gauges for high to ultra high vacuum.Thickness measurements: Electrical methods -microbalance monitors-optical interference methods multiple beam interferometry- Fizeau and FECO methods- Quartz crystal thickness monitor.

UNIT 3: INSULATING AND DIELECTRIC FILMS

Metal insulator contact -Ohmic-neutral, blocking contacts -two electrode system conduction mechanism in insulator film- Photoconduction -Experimental techniques. Dielectric properties -dielectric constant -dielectric loss capacitance - breakdown voltage - polarization - effect of temperature and frequency on dielectric properties.

UNIT 4: ELECTRICAL, OPTICAL AND MAGNETIC PROPERTIES

Sources of resistivity in metallic conductors - sheet resistance - TCR influence of thickness on the resistivity -Hall effect- influence of heat treatment - optical characterization by spectrophotometer (refractive index, Absorption Edge - Transmission and absorbance) - Energy band gap - Magneto resistance - Ferromagnetic Domain studies -Meissner effect - super conducting stage.

UNIT: 5 THIN FILM APPLICATIONS

Thin film passive components -Thin film battery -Thin film for Gas sensors and photovoltaic applications -Thin film flexible LED -CNT and its applications - Field Emission Display - Decorative and Barrier Coatings.

OUTCOME

By the end of the course the students will be able to

1. Understand about the theory of nucleation.
2. Explain about deposition methods involved in thin film fabrication.
3. Gain knowledge about high vacuum technology and thickness measurements.
4. Learn about insulating, dielectric films and its properties.
5. Acquire knowledge on Thin Film Physics and applications.

BOOKS FOR STUDY

1. Hand Book of Thin Film Technology –L.T. Maissel and Glang McGraw Hill, NY (1983).
2. Thin film Fundamentals –A.Goswami New Age International ,New Delhi (2003).

BOOKS FOR REFERENCE

1. Thin film Phenomena –K.L.Chopra McGraw Hill NY (1969).

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	2	3	2	3	3	3	2	2	2.6
CO2	3	3	2	3	2	3	3	3	2	2	2.6
CO3	3	3	3	3	2	3	2	3	2	2	2.6
CO4	3	3	3	2	2	3	3	3	2	2	2.6
CO5	3	3	3	2	2	3	3	2	3	2	2.6
Mean Overall Score (High Level Relationship Between COs and POs)											2.6 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

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THANJAVUR-613 005. 10

Course: CC4

Credits :4

Code:

PHYSICS OF DIELECTRIC MATERIALS

(For Students admitted from 2023-2024)

OBJECTIVE

- To have the knowledge on Physics of dielectric materials.

UNIT 1: THEORIES OF STATIC PERMITTIVITY

The molecular origins of permittivity and loss – Polarization types Debye's theory of static permittivity – Onsager's theory of the internal field and permittivity – Kirkwood's theory and Frohlich's theory for non-polarizable dipoles – relation between Kirkwood's and Frohlich's theory.

UNIT 2: DIPOLE MOMENT STUDIES

Dipole moment – Experimental determination – Debye's method and Onsager's method – application to molecular structure – dipole moment of molecular complexes – Few and Smyth method- Huyskens method.

UNIT 3: DIELECTRICS

Dielectrics and insulators – various polarization mechanisms – polarization and relaxation in solid and liquid dielectrics – Ceramics and Plastic dielectrics – power and distribution equipments – electronic equipments – Capacitors – Dielectric rectifiers and piezo electric transducers – Memory devices.

UNIT4: MICROWAVE FREQUENCY TECHNIQUES

X-band microwave bench – Principle – Von Hippel Method Experimental arrangement – Determination of dielectric parameters-Dielectric and conductivity measurements at microwave frequencies – Microwave devices fabrication - Dielectric relaxation – Higasi's and Cole-Cole plot methods – Rate theory of dielectric relaxation and viscosity –Time domain Reflectometry – Principle, Experimental arrangement Procedure-Dynamic permittivity – Davidson – Cole model, Havariliak – Nagami model – Applications.

UNIT 5: POLYMER

Monomers – Polymers classification – Chain and step polymerization – Thermo plastic and thermosetting polymers – Mol.wt and degree of polymerization – Glassy solids and glass transition temperature with copolymers — Polymer dielectrics in power equipments – Conducting polymers –charge transfer complexes – Effect of doping on polymers and its techniques – Optical properties of polymers –Effect of polymer Structure on optical properties-clarity, transparency, haze, transmittance, reflectance and gloss-refractive indices of polymers by group contributions – polymer solar panels.

OUTCOME

By the end of the course the students will be able to

1. Analyse about theories of static permittivity.
2. Learn about experimental determination of dipole moments.
3. Understand the principles involved in microwave frequency techniques.
4. Acquire knowledge on Physics of dielectric materials.
5. Infer knowledge about polymer and its optical properties.

BOOKS FOR STUDY

- 1) Dielectric properties and molecular behaviour – Nora E Hill – Van Nostrand Co.London(1969).
- 2) Dielectric behaviour and molecular structure – C.P Smyth –McGraw Hill publication(1955).
- 3) Electric dipole moments – J.W.Smyth – Butterworth publications(1955).
- 4) Microwave Techniques and Laboratory manual – M.L Sisodia and G.S. Raguvanshi – Wiley Eastern Limited – (1987).

BOOKS FOR REFERENCE

- 1) Polymer Science V.R. Gowariker, N.V. Viswanathan and Jayadev Sreedhar – New Age International (P) Ltd (1986).
- 2) Dielectric materials and applications – Von – Hippel A.R., John wiley and Sons Inc., New York (1974).
- 3) Dielectric Relaxation – Daniel V. E., Academic Press., London (1967).

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	2	2	1	3	3	2	2	2	2.3
CO2	3	3	2	2	1	3	3	2	2	2	2.3
CO3	3	3	2	2	1	3	3	2	2	2	2.3
CO4	3	3	2	2	1	3	3	2	2	2	2.3
CO5	3	3	2	2	2	3	3	2	2	2	2.4
Mean Overall Score (High Level Relationship Between COs and POs)											2.32 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

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THANJAVUR-613 005.

Course: CC4

Credits: 4

Code:

CHEMICAL PHYSICS
(For Students admitted from 2023-2024)

OBJECTIVE

- To have the knowledge on Chemical Physics.

Unit 1: THEORIES OF STATIC PERMITTIVITY

Molecular origins of permittivity and laws – polarization types – Debye's theory of static permittivity – Onsager's theory of the internal field and permittivity – Kirkwood's theory and Frolich theory for non-polarizable dipoles – Relation between and Kirkwood's and Frohlich theory.

Unit 2: DIPOLE MOMENT STUDIES

Dipole moment – Experimental determination – Debye's method and Onsager's method – application to - molecular structure – dipole moment of molecular complexes – Fewand Symth method Huyskens method.

Unit 3: FREQUENCY DOMAIN AND TIME DOMAIN TECHNIQUES

X-band microwave bench – principle – experimental arrangement – dielectric relaxation – Higasi and Cole-Cole plot method – Rate theory of dielectric relaxations and viscosity – Time Domain Reflectometry - principle – Experimental arrangement – procedure –dynamic permittivity – Davidson –Cole method - Havariliak – Negami model – applications.

Unit 4: FUNDAMENTALS OF H - BONDING STUDIES

Nature of H-bonding – Model of Hydrogen bonding (Electrostatic model, (Quantum mechanical models) – potential energy curves and symmetrical hydrogen bonds – proton transfer and ion pair formation – thermodynamics of H-bonding – equilibrium constants.

Unit 5: IR SPECTRA AND H – BONDING

Applications of IR spectra in the study of H-bonding - determination of equilibrium constants – Nash method – Whetsal and Kagarise method - thermodynamic properties – dipolemoment derivatives – enhancement of intensity in H-bonding system.

OUTCOME

By the end of the course the students will be able to

1. Analyze about theories of static permittivity.
2. Learn about experimental determination of dipole moments.

- Understand the concepts adopted in X-band microwave bench.
- Gather information regarding IR spectra in the study of H-bonding.
- Acquire knowledge on Chemical Physics.

BOOKS FOR STUDY

- Dielectric properties and molecular behaviour – Nora E Hill – Van Nostrand Reinhold London.Ny-(1969).
- Dielectric behaviour and molecular structure – C.P Smyth –McGraw Hill publication-(1955).
- Electric dipole moments – J.W.Smyth – Butterworth publications London –(1955).
- The IR spectra of complex molecules – L.J. Bellamy-Publisher-2nd edition, London, Chagman and Hall-(1980).
- Hydrogen bond – G.C.Pimental and A.L.McClellan-Annual review of Physical Chemistry-(1971).

BOOKS FOR REFERENCE

- Hydrogen bonding - S.N. Vinogradov and R.H.Linnell- Van Nostrand Reinhold Co. London.(1971)
- Microwave techniques and laboratory manual – M.L Sisodhia and G.S. Raguvanshi – WileyEastern Limited – (1987).
- Molecular interactions Vol.(2) –H. Ratajczak and J.Orville –Thomas – Wiley InterscienceNY-(1982).
- Dielectric materials and applications – VonHippel A.R., John Wiley and Sons. NY (1954).
- Dielectric Relaxation – DanielVera., Academic Press.,1st Edition London (1967).

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Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	2	2	1	3	3	2	2	2	2.3
CO2	3	3	2	2	1	3	3	2	2	2	2.3
CO3	3	3	2	2	1	3	3	2	2	2	2.3
CO4	3	3	2	2	1	3	3	2	2	2	2.3
CO5	3	3	2	2	2	3	3	2	2	2	2.4
Mean Overall Score (High Level Relationship Between COs and POs)											2.32 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)


Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

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THANJAVUR-613 005.

Course: CC4

Credits :4

Code:

NANOMATERIALS

(For Students admitted from 2023-2024)

OBJECTIVE

- **To have the knowledge on Nano materials**

UNIT 1: NANOMATERIALS SYNTHESIS – AN OVERVIEW

Classification based on dimensionality – Quantum Dots, Wells and Wires – Metal based nano materials (nanogold, nanosilver, metal oxides and sulphides) – Top-Down and Bottom-Up approaches – Wet chemical – Sol-gel synthesis – Hydrothermal and solvothermal Synthesis - Metal Nanocrystals by Reduction – Photochemical Synthesis – Sonochemical Routes – Ball Milling – Combustion – Nanocomposites - Nanopolymers – Nanoglasses – Nanoceramics - Biological nanomaterials.

UNIT 2: CHARACTERIZATION TECHNIQUES

X-ray diffraction – Energy Dispersive Analysis of X-rays – X-ray fluorescence – UV-vis absorption and diffuse reflectance spectroscopy – Fluorescence spectroscopy – Fourier Transform-Infrared Spectroscopy – Thermogravimetric Analysis – Differential Thermal Analysis – Differential Scanning Calorimetry - Field Emission Scanning Electron Microscopy – High Resolution Transmission Electron Microscope - Scanning Tunneling Microscope – Surface Enhanced Raman Spectroscopy – X-ray Photoelectron Spectroscopy – Auger Electron Spectroscopy – Rutherford Backscattering Spectroscopy – Vibrating Sample Magnetometer.

UNIT 3: CARBONACEOUS MATERIALS

Fullerenes – Synthesis (CVD and Arc Discharge) – fullerene functionalization - Single-walled carbon nanotubes and multiwalled carbon nanotubes – Synthesis - Graphene Oxide structure and properties – Hummers method – reduced Graphene Oxide – Graphene and graphene oxide functionalization.

UNIT 4: NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY

Nanotechnology in Agriculture – Precision farming – Insecticides using nanotechnology –Potential of nano-fertilizers – Nanotechnology in Food industry – Packaging, Food processing –Food safety and biosecurity – Contaminant detection – Smart packaging.

UNIT 5: APPLICATIONS OF NANOMATERIALS

Solar energy conversion and catalysis – Electrode material for super capacitor – Energy storage (Graphite) – Hydrogen Storage (CNT, Aerogels) – Fuel cells – Chemical and biosensors – Anti-bacterial agents – Nanoparticles for Delivery of Drugs – Nanoparticles in Cancer Therapy – Detection of viruses by Nanowires.

OUTCOME

By the end of the course the students will be able to

- 1) Know the salient features of nano structures and nano materials.

- 2) Learn about the carbonaceous materials and their properties.
- 3) Acquire knowledge about nanotechnology in agriculture and food technology.
- 4) Learn about the types of nanostructures and nanomaterials.
- 5) Acquire knowledge on Nano materials.

BOOKS FOR STUDY

1. Rao C. N., A. Muller, A. K. Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007.
2. Introduction to Nanotechnology, Charles P Poole Jr, Frank J Ownes, John Wiley Sons, Inc., 2003.
3. Instrumental Methods of Analysis, Willard. Merritt, Dean and Settle, CBS Publications, 6th Edition, 2000.
4. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, 2006.

BOOKS FOR REFERENCE

5. Lynn J. Frewer, Willehm Norde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, 2011.
6. Niemeyer C. M., and Mirkin, C. A., Nanobiotechnology: Concepts, applications, and perspectives. Weinheim: Wiley-VCH, 2004.
7. Schmid, G., Nanoparticles: From theory to application. Weinheim:Wiley-VCH, 2004.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes(PSO)					Mean Scores
	PO1	PO2	PO3	PO 4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	Mean Score of COs
CO1	3	3	3	2	2	3	2	2	2	2	2.5
CO2	3	3	2	2	2	3	2	2	2	2	2.2
CO3	3	3	3	2	2	3	2	2	2	2	2.3
CO4	3	3	3	2	2	3	2	2	2	2	2.4
CO5	3	3	3	2	2	3	3	2	2	2	2.4
Mean Overall Score (High Level Relationship Between COs and POs)											2.36 (High)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

Part-A 10x2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5x5=25 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3x10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD


HEAD

PG and Research Department of Physics,
Rajah Serfoji Govt. College (Autonomous),
Thanjavur-613 005.


COE

CONTROLLER OF EXAMINATIONS,
RAJAH SERFOJI GOVT. COLLEGE (AUTONOMOUS),
THANJAVUR-613 005.

Course: CC4

Credits: 4

Code:

NANO MATERIALS AND APPLICATIONS

(For Students admitted from 2023-2024)

OBJECTIVE

- **To have the knowledge on** nano materials and applications.

UNIT 1: BACKGROUND TO NANOTECHNOLOGY

Types of nano-structures and nano-crystals - Classification: of bulk Nanostructured materials, 0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms – Specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States - Particles, Quantum dots, Nano-wires, Ultra-thin films, Multi-layered materials.

Top-down and bottom-up approaches - self assembly process - grain boundary volume in nanocrystals - defects in nanocrystals - surface effects on the properties - Metals (Au, Ag) - Metal oxides (TiO₂, CeO₂, ZnO, SnO₂, WO₃, MoO₃) - Ceramics and Composites.

UNIT 2: SYNTHESIS TECHNIQUES

Solution growth techniques of 1D-2D nano structures - Synthesis of metallic, semiconducting and oxide nanoparticles – homo and hetero-nucleation growth methods - Template-based synthesis (electrochemical, electrophoretic, Melt and solution, CVD, ALD) - Gas Phase Synthesis of Nanopowders: Vapor (or solution) – liquid – solid (VLS or SLS) growth – Self assembly technique - Sol-gel method - Spray pyrolysis.

UNIT-3: CHARACTERIZATION OF NANOMATERIALS

Fundamentals of the techniques – Experimental approaches - Sample preparation and data interpretation – applications/limitations of Microscopic equipments: SEM, EDAX, STM, TEM and AFM. UV-VIS Spectroscopy – XRD - RAMAN Spectroscopy - XPS – SIMS - NMR - DLS (Dynamic Light Scattering or photon correlation spectroscopy) - DPI (Dual Polarisation Interferometry), FTIR - Photoluminescence.

UNIT-4: NANO GRAPHENE & CARBON-DOTS

Nano-Graphene Structure, Properties and fabrication (Physical & Chemical methods) - Carbon dots: Structures - Properties (Optical, Photocatalytic, Chemical Inertness & Water Solubility. Synthesis of carbon dots by: Chemical, Electrochemical, Combustion, Thermal, Hydrothermal and Acidic Oxidation of Carbon Precursors, Pulsed Laser Irradiation, Laser Ablation of Graphite, Arc Discharge, Plasma Treatment, Opening of Fullerene Cage, Ultrasonic-/Microwave-Assisted and Biogenic methods.

UNIT 5: APPLICATIONS OF NANOMATERIALS

Molecular electronics and nanoelectronics – Quantum electronic devices - CNT based transistor and Field Emission Display - Biological applications - Biochemical sensor - Membrane based water purification.

Hydrogen Fuel Cell: types of fuel cell and their merits & demerits, Hydrogen Storage: as liquid and gaseous form - Super Capacitors –Lithium batteries and application of Carbon and Nano-carbon in Lithium batteries.

OUTCOME

By the end of the course the students will be able to

1. Understand the basic classification of nano structured materials.

- Analyse about various synthesis techniques of 1D-2D nano structures.
- Explain characterization of nanomaterials.
- Learn about nano graphene & carbon-dots.
- Acquire knowledge on nano materials and applications.

BOOKS FOR STUDY

- C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag GmbH&Co, Weinheim, 2004.
- Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, Inc, 2001.
- G.Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.
- Zhong Lin Wang, Handbook of Nanophase and Nanomaterials (Vol 1 and II) Springer
- Roland Wiesendanger, Scanning Probe Microscopy and Spectroscopy: Methods and Applications, Cambridge Univ press

BOOKS FOR REFERENCE

- Willard, "Instrumental Methods of Analysis", Van Nostrand, 2000
- J. Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lyman et.al, Scanning Electron Microscopy and X-ray Microanalysis, Springer Publications, 2003.
- Francois Leonard, The Physics of Carbon Nanotube Devices, William Andrew Inc., 2009.

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CO2	3	3	2	3	2	3	3	3	3	2	2.7
CO3	3	3	3	3	2	3	3	3	3	2	2.8
CO4	3	3	3	2	2	3	3	3	2	2	2.6
CO5	3	3	3	3	2	3	3	2	3	2	2.7
Mean Overall Score (High Level Relationship Between COs and POs)											2.66 (high)

Question Paper Pattern

Maximum Marks: 75 Marks

Exam Duration: 3 Hrs

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THANJAVUR-613 005.

Course: CC5
Code :

Credits: 8

OBJECTIVE

- To develop the innovative thinking in project to make application oriented working models for theoretical concepts.

DISSERTATION AND VIVA VOCE

OUTCOME

- This will bring out innovative ideas from the students

EVALUATION

Viva Voce Examination: 50 Marks

Dissertation: 150 Marks

HOD



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