STRUCTURE FOR COURSE OF STUDY

POSTGRADUATE PROGRAMME
AS PER

NATIONAL EDUCATION POLICY-2020
&
CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES-2024

M.Sc. (PHYSICS)
(w. e. f. 2026-27)

DEPARTMENT OF PHYSICS
GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)
HARIDWAR-249 404
Year 2026

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)

MISSION

- To create a synthesis of our Indian intellectual tradition with the best of modern education.
- Inculcating national spirit and respect for Indian culture among the students and society in order to contribute to the nation-building.
- Focusing on the personality of the students to be developed by value-based education.
- Enriching and empowering all the beneficiaries through the participative, positive, harmonious teaching-learning environment.
- Developing inter-linkages across teaching, research, and extension.
- Making students employable by imparting holistic education and developing skills.

CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES-2024

GRADUATE ATTRIBUTES OF PG PROGRAMMES

Qualifications that signify completion of the postgraduate degree are awarded to students who have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with the first cycle, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context; ii) can apply their knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study; iii) have the ability to integrate knowledge and handle complexity, and formulate judgments with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments; iv) can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously; v) have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

Accordingly, the NHEQF outlines the statement of learning achievements at a particular level on the basis of the following elements of descriptors:

- Knowledge and understanding
- General, technical, and professional skills required to perform and accomplish tasks
- Application of knowledge and skills
- Generic learning outcomes
- Constitutional, humanistic, ethical, and moral values
- Employability and job-ready skills, and entrepreneurship skills and capabilities/ qualities and mindset.

LEARNING OUTCOMES DESCRIPTORS FOR A HIGHER EDUCATION QUALIFICATION AT LEVEL 6 ON THE NHEQF

The Bachelor's degree (Honours/ Honours with Research) or the Post-Graduate Diploma is awarded to students who have demonstrated the achievement of the outcomes located at appropriate level on the NHEQF.

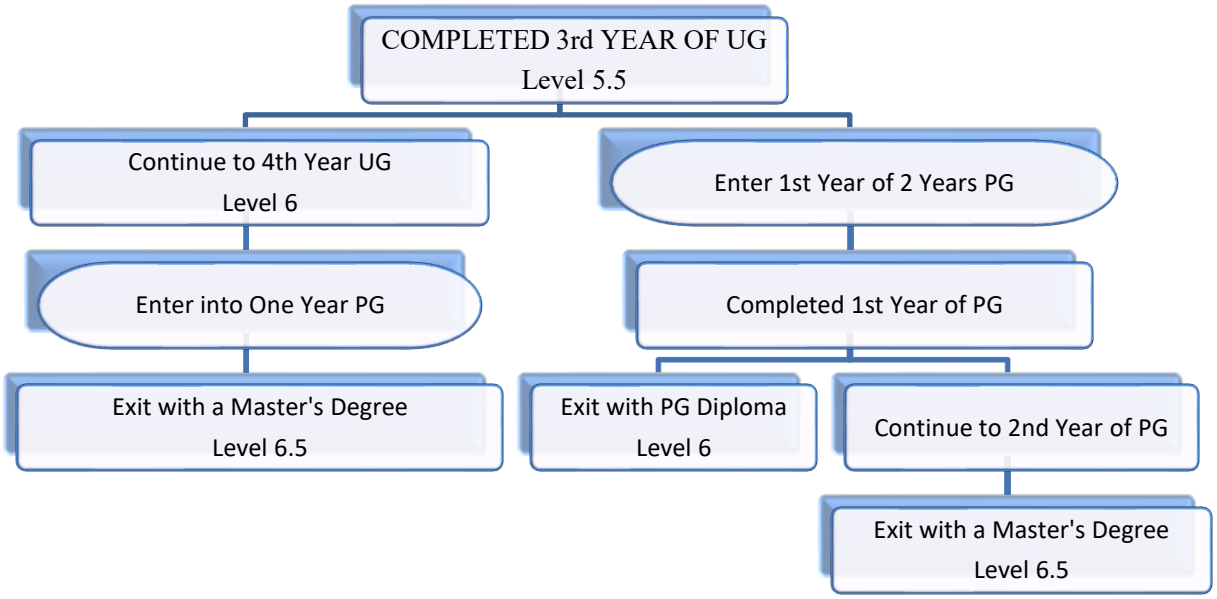
PG CURRICULAR FRAMEWORK-2024 BASED ON NEP 2020

- 2-year PG programme for those who have completed 3-year Bachelor's programme;
- 1-year PG programme for students who have completed a 4-year Bachelor's programme with Honours/Honours with Research

ELIGIBILITY FOR THE PG PROGRAMME:

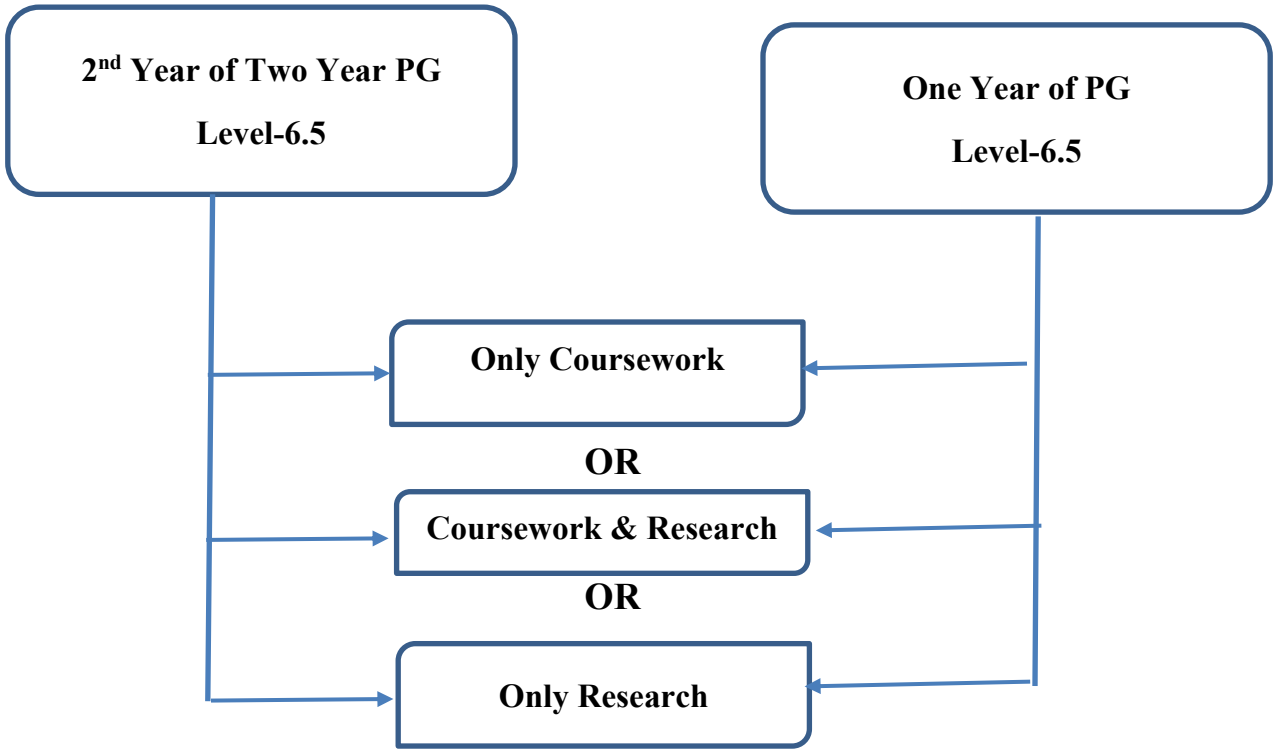
- A student is eligible for a PG programme in a discipline
- Corresponding to **major** discipline in UG programme.
- Corresponding to **minor** discipline in UG programme
- However, irrespective of the major or minor disciplines chosen by a student in a UG programme, a student is eligible for admission in any discipline of PG programmes if the student qualifies the National level or University level entrance examination in the discipline of the PG programme.

PROGRESSION FROM UG TO PG



CURRICULAR COMPONENTS

2ND YEAR (III & IVTH SEMESTER)



MASTER PROGRAM (M.Sc.) In PHYSICS	
Program Learning Outcomes (PLOs)	**Postgraduate Degree in Physics**
After successfully earning the Postgraduate Degree in Physics, the awardee will be able to:	
PLO-01: Knowledge & Understanding	● Demonstrate advanced theoretical and applied knowledge of core and specialized areas in physics and apply this knowledge to analyze natural phenomena.
PLO-02: Experimental & Analytical Skills	● Acquire advanced computational, experimental, and analytical skills to investigate physical phenomena, interpret data, and solve complex problems, including those with interdisciplinary and real-world applications.
PLO-03: Application of Knowledge & Skills	● Integrate theoretical principles and practical methodologies to design experiments, develop models, and propose solutions to research and real-world challenges in physics.
PLO-04: Critical Thinking & Problem-Solving	● Critically evaluate scientific literature across diverse physics domains, analyze complex systems, and formulate evidence-based conclusions using logical and quantitative methods.
PLO-05: Lifelong Learning & Adaptability	● Engage in continuous self-directed learning to stay abreast of advancements in physics and related technologies, adapting to evolving scientific demands. Foster academic and scientific growth.
PLO-06: Digital Literacy & Computational Proficiency	● Utilize information and communication technologies (ICT) for scientific research, collaborative work, and lifelong learning. Conduct literature reviews using digital databases, process and visualize data with programming tools (e.g., Python, MATLAB, Origin. etc.) and develop computational models.
PLO-07: Research & Innovation Aptitude	● Formulate research problems and hypotheses, apply scientific methods, and conduct independent and collaborative research. Demonstrate competence in preparing, submitting, and presenting dissertations or internship reports. Work productively as part of research or project team.

Course Structure

The postgraduate program in Physics is a two-year degree meticulously designed with **Multiple Entry and Exit Points (MEES)**, in alignment with the National Education Policy (**NEP**) **2020**.

Program Structure:

S. No.	Award	Components	Credits Required
1.	PG Diploma	Coursework (CW)	44 Credits
2.	PG with Research	(CW + Research)	88 Credits

Multiple Entry and Exit System (MEES) Details:

The program's MEES framework provides flexibility, as detailed below:

ADMISSION IN PG PROGRAMME:

Entry Points:

1. **First Year Entry (M.Sc. Year 1): Eligibility:** Applicants must hold a 3-three-year Bachelor of Science (B.Sc.) degree or B.E./B. Tech degree with Physics Subject/discipline having at least 12 Credits.
2. **Second Year Direct Entry (M.Sc. Year 2): Eligibility:** Applicants with a 4-year undergraduate degree in Physics (Honors/Research) or B.E./B. Tech degree with having at least 20 Credits.

Note: Students in the PG programme can be admitted based on the student's performance in the UG programme or through National level or University level entrance examination.

Exit Points:

1. **After First Year (PG Diploma):** Students who successfully complete two semesters (totaling 44 credits) are eligible to exit the program with a Postgraduate Diploma in Physics.
2. **After Second Year (PG with Research):** Students who complete all four semesters, which includes a dedicated 20-credit research internship (totaling 88 credits), will earn a Postgraduate Degree with Research in Physics.

Course Structure for One Year PG Diploma in Physics/(Programme Code: MPH)

Two Years PG. in Physics with Coursework

1yr.PGD; 2/1 yr. lateral entry PG(CW+R)

NCrf Credit Level	Semester		Core Papers (Core Course/Elective)		Course Level	Credit	Total Credits		Max. Marks			Credit Distribution
			Course Name	Course Code					Internal	End Sem	Total	L:T:P
6	Sem-I	Core	Mathematical Physics (Core)	MPH26-C101	550	4	20	**22**	30	70	100	3:1:0
			Classical Mechanics (Core)	MPH26-C102	550	4			30	70	100	3:1:0
			Quantum Mechanics (Core)	MPH26-C103	550	4			30	70	100	3:1:0
			Computational Methods & Programming (Core)	MPH26-C104	550	4			30	70	100	3:1:0
			Lab-I (General Physics Lab) (Core)	MPH26-C151	550	4			30	70	100	0:0:4
		Elective – 1 (Select Any One)	Physics of Nanomaterials (Elective)	MPH26-E105	550	2	2		15	35	50	2:0:0
			Lab-II (Computational Lab) (Elective)	MPH26-E152	550	2			15	35	50	0:0:2
			Online SWAYAM Course (Optional)	MPH26-Y106	550	2			15	35	50	2:0:0
	Sem-II	Core	Advanced Quantum Mechanics (Core)	MPH26-C201	600	4	12		30	70	100	3:1:0
			Classical Electrodynamics (Core)	MPH26-C202	600	4			30	70	100	3:1:0
			Statistical Mechanics (Core)	MPH26-C203	600	4			30	70	100	3:1:0
		Elective – 2 (Select Any One)	Electronic Devices & Circuits (Elective)	MPH26-E204	600	4	10		30	70	100	3:1:0
			Solar Photovoltaic Technology (Elective)	MPH26-E207	600	4			30	70	100	3:1:0
		Elective – 3 (Select Any One)	Lab-III (General Electronics Lab) (Elective)	MPH26-E251	600	4			30	70	100	0:0:4
			Physics and Technology of Thin Films (Elective)	MPH26-E208	600	4			30	70	100	3:1:0
		Elective – 4 (Select Any One)	Physics & Vedic Thought (Elective)	MPH26-E206	600	2			15	35	50	2:0:0
			Quantum Information Theory (Elective)	MPH26-E205	600	2			15	35	50	2:0:0
			Online SWAYAM Course (Optional)	MPH26-Y209	600	2			15	35	50	2:0:0
Total Credit (First Year)								**44**				

Exit option with Post-Graduate Diploma in Physics on completion of courses equal to a minimum of 44 credits or Entry to One Year PG in Physics with coursework with Research.

NCrf Credit Level	Semester		Core Papers (Core Course/Elective)		Course Level	Credit	Total Credits		Max. Marks			Credit Distribution
			Course Name	Course Code					Internal	End Sem	Total	L:T:P
6.5	Sem-III	Core	Condensed Matter Physics (Core)	MPH26-C301	650	4	8	22	30	70	100	3:1:0
			Atomic and Molecular Physics (Core)	MPH26-C302	650	4			30	70	100	3:1:0
		Elective – 5 (Select Any One)	Digital Electronics & Microprocessor (Elective)	MPH26-E303	650	4	14		30	70	100	3:1:0
			Quantum Electronics and Laser Applications (Elective)	MPH26-E305	650	4			30	70	100	3:1:0
		Elective – 6 (Select Any One)	Communication Electronics (Elective)	MPH26-E304	650	4			30	70	100	3:1:0
			Computational Techniques (Elective)	MPH26-E306	650	4			30	70	100	3:1:0
		Elective – 7 (Select Any One)	Lab-IV (Digital Electronics & Microprocessor Lab) (Elective)	MPH26-E351	650	2			15	35	50	0:0:2
			Advance Electronic Materials and Devices (Elective)	MPH26-E308	650	2			15	35	50	2:0:0
		Elective – 8 (Select Any One)	Lab-V (Communication Electronics Lab) (Elective)	MPH26-E352	650	2			15	35	50	0:0:2
			Quantum Computation and Information (Elective)	MPH26-E309	650	2			15	35	50	2:0:0
		Elective – 9 (Select Any One)	Elementary Particle Physics (Elective)	MPH26-E307	650	2			15	35	50	2:0:0
			Internship/Academic Attachment (Skill) (Summer Term)	MPH26-I310	650	2			15	35	50	0:0:2
			Online SWAYAM Course (Optional)	MPH26-Y311	650	2			15	35	50	2:0:0
	Sem-IV		Dissertation	MPH26-D471	700	20	22		150	350	500	0:0:20
			Online SWAYAM Course	MPH26-Y401	700	2			15	35	50	2:0:0
	Total Credit (Aggregate)						**44**					
	Post-Graduate Degree in Physics with Research on completion of courses equal to 88 credits.											

Course Selection Guidelines:

- **SWAYAM Courses:** Students need to talk with the Head of the Physics Department (HOD Physics) before choosing any online SWAYAM courses.
- **Mandatory Courses:** All **Core Courses (C)**, **Laboratory Courses (L)** are required. You don't have a choice for these.
- **Elective Courses:** You can choose your **Discipline Elective Courses (E)** from a provided list. The total credits for these chosen electives must be:

Semester-I

Course Type	Course Code	Course Name	**Credits**
Core Course (C)/ Laboratory (L)	MPH26-C101	Mathematical Physics	4
	MPH26-C102	Classical Mechanics	4
	MPH26-C103	Quantum Mechanics	4
	MPH26-C104	Computational Methods & Programming	4
	MPH26-C151	Lab-I (General Physics Lab)	4
		Total Core/Laboratory Credits	**20**
Discipline Centric Elective Course (E)		Elective -1	2
		Total Discipline Centric Elective Credits	**2**
Total Credits Semester-I			**22**

Note: Students will choose online SWAYAM courses in consultation with HOD Physics

- No. of Core Course (C) /Laboratory (L) to be opted = 04 (16 Credits Theory + 04 Credits Lab) = **20** credits
- No. of Discipline Centric Elective Papers to be opted = 01 (02 Credits each) = **02** Credits
- Total No. of Credits = **22** Credits

Semester-II

Course Type	Course Code	Course Name	**Credits**
Core Course (C) /Laboratory (L)	MPH26-C201	Advanced Quantum Mechanics	4
	MPH26-C202	Classical Electrodynamics	4
	MPH26-C203	Statistical Mechanics	4
		Total Core/Laboratory Credits	**12**
Discipline Centric Elective Course (E)		Elective - 2	4
		Elective - 3	4
		Elective - 4	2
		Total Discipline Centric Elective Credits	**10**
Total Credits Semester-II			**22**

Note: Students will choose online SWAYAM courses in consultation with HOD Physics

- No. of Core Course (C) /Laboratory (L) to be opted = 03 (12 Credits Theory) = **12** credits
- No. of Discipline Centric Elective Papers to be opted = 03 (06 Credits Theory+04 Credits Lab) = **10** Credits
- Total No. of Credits = **22** Credits

Summer Term (Evaluation in the III semester) -

Course Type	Course Code	Course Name	**Credits**
Summer Term	MPH26-I310	Internship/Academic Attachment	**2**
Total Credit			**2**

Semester-III

Course Type	Course Code	Course Name	**Credits**
Core Course (C) /Laboratory (L)	MPH26-C301	Condensed Matter Physics	4
	MPH26-C302	Atomic and Molecular Physics	4
		Total Major Core Credits	**8**
Discipline Centric Elective Course		Elective - 5	4
		Elective - 6	4
		Elective - 7	2
		Elective - 8	2
		Elective - 9	2
		Total Discipline Centric Elective Credits	**14**
Total Credits Semester-III			**22**

Note: Students will choose online SWAYAM courses in consultation with HOD Physics

- No. of Core Course (C) = 02 (08 Credits Theory) = **08** credits
- No. of Discipline Centric Elective Papers to be opted = 05 (08 Credits Theory+04 Credits Lab+02 Credits Internship) = **14** Credits
- Total No. of Credits = **22** Credits

Semester-IV (Research)

Course Type	Course Code	Course Name	Credits
Dissertation (D)	MPH26-D471	Dissertation/Internship	**20**
Discipline Centric Elective Course	MPH26-Y401	Online SWAYAM Course (No overlap with running courses)	**02**
Total Credits Semester-IV			**22**

Note: Students will choose online SWAYAM courses in consultation with HOD Physics

- Dissertation (D) = **20** credits
- Online Swayam Course (Y)=**02** Credits
- Total No. of Credits = **22** Credits

Total credit distribution for the Four semesters

CW+R					
	C/L	E	S	I/D	Total credits (semester wise)
Semester-I	20	02	0	0	**22**
Semester-II	12	10	0	0	**22**
Semester-III	08	12	0	2	**22**
Semester-IV	0	0	2	20	**22**
Total credits (Courses type)	40	24	2	22	**88**

Types of Courses:

- C - Core Course (C)
- L - Laboratory (L)
- E - Discipline Centric Elective Course (E)
- S - Skill Enhancement course (S)
- I – Internship (I)
- D – Dissertation (D)

*LIST OF ELECTIVES

Elective – I Sem			
Elective	**Course/Paper Code**	**Course/ Paper Name (02 Credit)**	**Credit**
Elective – 1 (Select Any One)	MPH26-E152	Lab-II (Computational Lab)	2
	MPH26-E105	Physics of Nanomaterials	2
	MPH26-Y106	Online SWAYAM Course (No overlap with running courses)	2
Elective – II Sem			
Elective	**Course/Paper Code**	**Course/ Paper Name (06 Credit Theory + 04 Credit Lab)**	**Credit**
Elective – 2 (Select Any One)	MPH26-E204	Electronic Devices & Circuits	4
	MPH26-E207	Solar Photovoltaic Technology	4
Elective – 3 (Select Any One)	MPH26-E251	Lab-III (General Electronics Lab)	4
	MPH26-E208	Physics and Technology of Thin Films	4
Elective – 4 (Select any One)	MPH26-E206	Physics & Vedic Thought	2
	MPH26-E205	Quantum Information Theory	2
	MPH26-Y209	Online SWAYAM Course (No overlap with running courses)	2
Elective – III Sem			
Elective	**Course/Paper Code**	**Course/ Paper Name (10 Credit Theory + 04 Credit Lab)**	**Credit**
Elective – 5 (Select Any One)	MPH26-E303	Digital Electronics & Microprocessor	4
	MPH26-E305	Quantum Electronics and Laser Applications	4
Elective – 6 (Select Any One)	MPH26-E304	Communication Electronics	4
	MPH26-E306	Computational Techniques	4
Elective – 7 (Select Any One)	MPH26-E351	Lab-IV (Digital Electronics & Microprocessor Lab)	2
	MPH26-E308	Advanced Electronic Materials and Devices	2
Elective – 8 (Select Any One)	MPH26-E352	Lab-V (Communication Electronics Lab)	2
	MPH26-E309	Quantum Computation and Information	2
Elective - 9 (Select Any One)	MPH26-E307	Elementary Particles Physics	2
	MPH26-I310	Internship/Academic Attachment (Summer Term)	2
	MPH26-Y311	Online SWAYAM Course (No overlap with running courses)	2

Semester I

Course Code	Course Title				Type of Course
MPH26-C101	**Mathematical Physics**				**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Understand the theory of complex functions and master the mathematical tools of complex analysis so as to efficiently solve problems in Physics
- **CLO 2:** Understand the utility of Gamma and Beta functions, Dirac Delta function and their applications. Create ad manipulate infinite series along with the convergence tests
- **CLO 3:** Formulate problems in Physics in terms of differential equations and solve the frequently used differential equations in Physics
- **CLO 4:** Develop an understanding of the widely used special mathematical functions in Physics, particularly the Bessel functions, Legendre/associated Legendre, Laguerre/ associate Laguerre, Hermite functions and the likes. Also, derivation and discussion of their properties including orthonormality, recurrence relations, generating functions etc.

UNIT-I

Review of Complex Variable Theory; Laurent Series, Singularities; Calculus of residues, Evaluation of Definite Integrals, Evaluation of Sums. Schwarz Reflection Principle; Conformal Mapping; Rodrigue's Formula; Generating Functions for the commonly used polynomials in Physics. **(15 Lectures)**

UNIT-II

The Gamma Function; Definitions, Simple Properties, Factorial and Double factorial, Di-gamma and Poly-gamma Functions, Stirling's Series. The Beta Function, Legendre duplication formula. Infinite series; Convergence tests, Riemann Zeta Functions. Dirac Delta function and its properties. **(15 Lectures)**

UNIT-III

Partial differential equations (PDEs) and their reduction to ordinary differential equations (ODEs), First and Second order ODEs, Series Solution and its limitations, Other (Wronskian double integral) Solution. Inhomogeneous ODEs, Nonlinear Differential Equations. **(10 Lectures)**

UNIT-IV

Bessel functions of integral order; Recurrence Relations, Integral representation, Orthonormality, non-integer order, Bessel Series. Definitions of the Bessel functions of Second and Third kind; Recurrence relations. Modified Bessel functions. Spherical Bessel functions. Legendre functions; Properties and Recurrence relations, Upper and Lower bound, Orthonormality. Associated Legendre functions. Spherical Harmonics. Angular Momentum. Hermite functions; Recurrence relations, Orthonormality, Simple Harmonic Oscillator. Laguerre and Associated Laguerre Polynomials; Properties, Radial Schrodinger equation. **(20 Lectures)**

Text Books / Reference Books:

1. Mathematical Physics - B.S. Rajput.
2. Mathematical Methods for Physics- G. Arfken.
3. Applied Mathematics for Physicists & Engineer- Pipes & Harvil.
4. Matrices and Tensors for Physicists- A.W. Joshi.
5. Advanced Engineering Mathematics- E. Kreyszig.
6. Mathematics for Physicists- Mary L. Boas.
7. Special functions - E.D. Rainville.
8. Special functions –W. W. Bell.
9. Mathematical Methods for Physicists & Engineers- K.F. Reily, MPH Hobson & SJ Bence.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	2	2	2	2.43
2	3	2	3	3	2	2	2	2.43
3	3	2	3	3	2	2	2	2.43
4	3	2	3	3	2	2	2	2.43
Average PLO	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2.43**

Course Code		Course Title			Type of Course
MPH26-C102		**Classical Mechanics**			**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Apply Lagrangian mechanics to derive equations of motion for various physical systems, including constrained systems and those in electromagnetic fields.
- **CLO 2:** Utilize the principles of variational calculus and Hamiltonian dynamics to solve problems in classical mechanics, understanding concepts like conservation laws, phase space, and Liouville's theorem.
- **CLO 3:** Analyze advanced theoretical mechanics concepts such as canonical transformations, Poisson Brackets, action-angle variables, and the Hamilton-Jacobi equation, applying them to specific problems like central force motion.
- **CLO 4:** Solve problems related to different types of oscillations, including damped and coupled systems, and extend Lagrangian and Hamiltonian formulations to continuous systems.

UNIT - I

The Lagrangian Approach to Mechanics: degrees of freedom, constraints and generalized coordinates, virtual displacement, virtual work and generalized force, d'Alembert's principle and the generalized equation of motion, the Lagrangian and the Euler Lagrange equation of motion, the Hamiltonian, cyclic coordinates and canonical momenta, applications; double pendulum, spherical pendulum, particle in electromagnetic field. **(15 Lectures)**

UNIT - II

Variational calculus and Hamiltonian dynamics: the variational calculus and the Euler equation, the principle of least action and the Euler Lagrange equation, constraints in variational dynamics. Hamiltonian dynamics: Legendre transformations, Hamilton's equations, conservation laws, phase space and Liouville's theorem. **(15 Lectures)**

UNIT - III

Theoretical Mechanics: canonical transformations and generating functions, symplectic notation, Poisson Brackets (PB); the angular momentum PB relations, invariance of PBs under canonical transformations, action-angle variables and adiabatic invariance, the Hamilton Jacobi (HJ) Equation; HJ equation for Hamilton's characteristic function, separation of variables, particle motion under central force. **(15 Lectures)**

UNIT - IV

Oscillations: the simple harmonic oscillator; the damped harmonic oscillator, the damped simple and damped harmonic oscillator, coupled simple harmonic oscillators; couple pendulum, general method of solution. Lagrangian and Hamiltonian of continuous systems: transition from discrete to continuous systems, the Hamiltonian formulation. **(15 Lectures)**

Text Books/Reference Books:

1. Classical Mechanics by Goldstein, Poole and Safko (Pearson Education).
2. Mechanics by Landau and Lifshitz.
3. Analytical Mechanics by L. N. Hand and J. D. Finch (Cambridge University Press).
4. Classical Mechanics- N .C Rana and P.S. Joag (Tata Mcgraw-Hill, 1991).
5. Mechanics- A. Sommerfeld (Academic Press, 1952).
6. Introduction to Dynamics- I. Perceival and D. Richards (Canbridge Univ. Press).
7. Classical Mechanics – J.C. Upadhyay.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	2	3	1	1	2.14
2	3	2	3	2	3	1	1	2.14
3	3	2	3	3	3	1	1	2.29
4	3	2	3	3	3	2	1	2.43
Average PLO	**3**	**2**	**3**	**2.5**	**3**	**1.25**	**1**	**2.25**

Course Code		Course Title			Type of Course
MPH26-C103		**Quantum Mechanics**			**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO1**: Develop a foundational understanding of quantum mechanics through key experiments, mathematical representations, and operator formalism.
- **CLO2:** Analyze the solutions of the Schrödinger equation for model systems (potential wells, barriers, harmonic oscillator), and interpret physical phenomena like tunneling and classical limits.
- **CLO3:** Apply angular momentum algebra including spin, orbital contributions, and SU(2)/O(3) symmetry; compute eigenvalues, Clebsch-Gordon coefficients, and use symmetry arguments in quantum systems.
- **CLO4:** Solve problems involving motion in central potentials, including the hydrogen atom, and analyze spherical wave functions and associated boundary conditions.

UNIT-I

The Double-Slit Experiment and Stern-Gerlach Experiment. Motion of wave packet, Schrödinger equation, Normalized and orthogonal wave functions, Stationary state solution, Expectation values of dynamical variables, Probability current density, Ehrenfest's theorem, Momentum eigen functions and their applications, Coordinate and momentum representation, Rectangular potential barrier and its applications, Particle in 1-D infinite deep potential well. **(16 Lectures)**

UNIT-II

One dimensional and three dimensional harmonic oscillators, One dimensional finite square well, spherically symmetric systems and potentials, Rigid rotator, Hydrogen atom and its normal state. **(10 Lectures)**

UNIT-III

Algebra of operators, Linear operators, Eigen function and eigen values of operators, Orthogonal and complete set of eigen function, Dirac, Bra and Ket space, Heisenberg's uncertainty relations derived from operators, Hermitian operator and its properties, Matrix representation of operators, Change of basis functions, Unitary and similarity transformations, Equation of motion. Schrödinger, Heisenberg and interaction pictures. **(18 Lectures)**

UNIT-IV

Commutation Algebra, Commutation relation between position and momentum, Commutation relation for orbital angular momentum (L), Spin angular momentum (S) and total angular momentum (J), Eigen value spectrum for J^2 and J_z, Matrix elements of J_x, J_y, J_z, Addition of angular momentum. **(16 Lectures)**

Text Books/Reference Books:

1. Modern Quantum Mechanics, J. J. Sakurai, Third Edition (Cambridge University Press).
2. Non-Relativistic Quantum Mechanics: L. D. Landau and E. M. Lifshitz, Permagon Press.
3. Principles of Quantum Mechanics: R. Shankar, Springer-Verlag.
4. Quantum Mechanics - L. I. Schiff (McGraw-Hill).
5. Quantum Mechanics – Merzbacher.
6. Quantum mechanics - B. Craseman and J D Powell (Addison Wesley).
7. Quantum Mechanics - Mathews and Venkatesan.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	2	2	2	1	2	2
2	3	3	3	3	2	2	2	2.57
3	3	3	3	3	2	3	2	2.86
4	3	3	3	3	2	2	2	2.57
Average PLO	**3**	**2.75**	**2.75**	**2.75**	**2**	**2**	**2**	**2.5**

Course Code		Course Title			Type of Course
MPH26-C104		**Computational Methods & Programming**			**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO1**: Acquire knowledge and apply it to solve simultaneous linear equations. Students will be able to understand the theoretical and practical aspects of the use of numerical analysis in solving different problems those are not possible to solve analytically.
- **CLO2:** The students will become proficient in implementing numerical methods for a variety of multidisciplinary applications such as interpolation, the solution of linear and nonlinear equations, and the solution of differential equations.
- **CLO3:** The student will solve the differentiation and integration problem.
- **CLO4:** The students will understand the logic to make a program. The students will also have expertise to develop the programme using C Language. Acquire knowledge on C programming. Write, Compile, Execute and Troubleshoot programs using C.

UNIT-I

Algebraic & transcendental equations, Numerical solution, Method of bisection, Method of false position, Newton-Raphson iteration, Direct iterative method, Convergence. **(10 Lectures)**

UNIT-II

Errors in polynomial interpolation, Finite differences, Differences of a polynomial, Newton's formula for interpolation, Central differences, Interpolation formulae- Gauss's, Stirling & Bessel formula- Interpolation with unevenly space points- Lagrange's interpolation formula, Errors in Lagrange's interpolation formula, Curve fitting - Least square curve fitting, Weighted least square approximation. **(15 Lectures)**

UNIT- III

Numerical differentiation, Errors in numerical differentiation, Cubic spline method, Numerical integration Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule– use of cubic splines, Newton's cotes integration, Gaussian integration. **(15 Lectures)**

UNIT- IV

Computer languages, Introduction to algorithm, C character set, Identifiers and key words, Data types, Declarations, Expressions, Statements and symbolic constants, #include, #define, Preparing and running a complete C program; Arithmetic, Relational, Logical, Assignments and conditional operators; Precedence rule, Associative law; If-else, Switch, Break, Continue statements; While, Do-while, For statements, Nested loops; Go to statements; One and two dimensional arrays, Basic concept of pointer. Functions: Defining and accessing, Formal and actual parameters, Function prototypes, Recursion, Storage classes (basic concept); Structures: Defining and processing; Data files: Open, Close, Create, Process. **(20 Lectures)**

Text Books / Reference Books:

1. Introductory Methods of Numerical Analysis – Sastry.
2. Numerical Methods in Engg. & Sciences - Grewal B.S., Khanna Pub. N. Delhi.
3. Numerical Analysis – Rajaraman.
4. Computers Today - Byron D.H. Mc Hill.
5. Programming in ANSI C - E. Balaguruswamy, TMH.
6. Numerical Method for Scientific & Engg. Computation - Jain, Iyengar, Wiley, 1987.
7. Mastering C – K.R. Venugopal, B. Rajkumar (TMH).
8. Let Us C – Yashwant Kanitkar (BPB Pub.).

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	2	2	2	1	2	2
2	3	3	3	3	2	2	2	2.57
3	3	3	3	3	2	3	3	2.86
4	3	3	3	3	2	2	3	2.7
Average PLO	**3**	**2.75**	**2.75**	**2.75**	**2**	**2**	**2.5**	**2.53**

Course Code	Course Title				Type of Course
MPH26-C151	**Lab-I (General Physics Lab)**				**Laboratory**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**4**	**4**	**100**	**120**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Apply fundamental experimental techniques and principles to measure physical constants and properties in areas such as quantum mechanics, optics etc.
- **CLO 2:** Design, construct, and characterize the performance of various analog electronic circuits, including operational amplifiers, rectifiers, Zener diode regulators, and function generators.
- **CLO 3:** Conduct experiments to investigate the characteristics and applications of semiconductor devices (LDR, Zener diode) and advanced materials (BaTiO3), interpreting their behavior under varying conditions.
- **CLO 4:** Develop proficient laboratory skills, including systematic data acquisition, accurate error analysis, and clear scientific report writing, while adhering to safety protocols.

LIST OF EXPERIMENTS

1. Michelson Interferometer.
2. Febry-Perot Interferometer.
3. C.D. Spectrometer.
4. Verification of Cauchy's relation.
5. Ultrasonic interferometer.
6. Magnetic Susceptibility.
7. B-H Curve.
8. Planck's constant.
9. Four-Probe method.
10. Lande 'g' factor using E.S.R. Spectrometer.
11. Hall coefficient.
12. Determination of Dielectric Constant.
13. Design and study of different Network theorems.
14. Determination of Hall Life of 'In'.
15. Determination of range of Beta-rays from Ra and Cs.
16. X-ray diffraction by Telexometer.
17. Determination of Ionization Potential of Lithium.
18. Determination of e/m of electron by Zeeman Effect using Febry Perot Etalon.
19. (a) Measurement of wave length of He-Ne Laser light using ruler.
    (b) Measurement of thickness of thin wire with laser.
20. To study Faraday effect using He-Ne Laser.
21. (a) To find the conductivity (Dark and Phtoconductivity) of a thin film semicondutor at room temperature, low temperature and high temperature.
    (b) To study the photointensity and photospectral variation of photoconductivity of a thin film semiconductor.

Note:

1. Students are required to perform at least **15** experiments from the above list.
2. In practical examination the student shall be required to perform **Two** experiments from the list.
3. Experiments shall carry **40 Marks** and **20 Marks** shall be assigned for viva-voce examination. **10** Marks shall be reserved for practical record.
4. No batch for practical class shall consist of more than **20** students.
5. The number of students in a batch allotted to an examiner for practical examination shall not exceed **12-15** students.
6. Addition/deletion in the above list of **some experiments of similar nature** may be made in accordance with the facilities available with the approval of **H.O.D**.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	1	1	2.29
2	3	3	3	3	3	1	2	2.57
3	3	3	3	2	3	1	2	2.43
4	1	3	2	3	3	2	2	2.29
Average PLO	**2.5**	**3**	**2.75**	**2.5**	**3**	**1.25**	**1.75**	**2.40**

Course Code		Course Title			Type of Course
MPH26-E105		**Physics of Nanomaterials**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Understand the fundamental concepts of nanoscience including size-dependent properties, crystal structures, and confinement regimes, and explain their significance in physical phenomena and applications.
- **CLO 2:** Apply quantum mechanics to model low-dimensional systems and analyze their density of states, optical properties, and band engineering in heterostructures.

UNIT I

Introduction to Nanoscience, Definitions, historical context, and societal impact. Key questions in nanoscience: size-dependent properties, synthesis (brief overview), and applications. Crystal Structure and Symmetry, Bravais lattices, unit cells, Miller indices. Common nanostructure crystal systems: FCC, BCC, zinc blende, wurtzite. Surface-to-volume ratio and its implications for catalysis. Length Scales in Nanoscience, de Broglie wavelength, Bohr radius, excitons. Confinement regimes: strong, intermediate, weak. Fermi energy, Fermi velocity, Kubo Gap, mean free path, Drude–Lorentz Model, and charging energy. **(15 Lectures)**

UNIT II

Wave Mechanics and the Schrödinger Equation, Free particles, bound particle (quantum well), and optical absorption in quantum wells. Model problems: particle in a box (1D, 2D, 3D) applied to quantum wells, wires, and dots. Harmonic oscillator and finite potential wells. Density of States (DOS), DOS for bulk, quantum wells, wires, and dots. Joint density of states (JDOS) and optical transitions. Heterostructures and Band Engineering, Band alignment, heterostructures, and their applications. Effective mass approximation and effective mass theory in heterostructures.

(15 Lectures)

Text Books/Reference Books:

1. Masaru Kuno, Introductory Nanoscience: Physical and Chemical Concepts, Garland Science.
2. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press.
3. S.K. Kulkarni, Nanotechnology: Principles and Practices, Springer.
4. C. P. Poole Jr. and F. J. Owens – *Introduction to Nanotechnology*, Wiley.
5. G. Cao and Y. Wang – Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific.
6. K. K. Chattopadhyay and A. N. Banerjee – *Introduction to Nanoscience and Nanotechnology*, PHI Learning.
7. M. A. Ratner and D. Ratner – Nanotechnology: A Gentle Introduction to the Next Big Idea, Pearson.
8. C. Binns – Introduction to Nanoscience and Nanotechnology, Wiley
9. B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and J. Murday – *Textbook of Nanoscience and Nanotechnology*, Springer.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	2	2	2	2	2.28
2	3	2	3	2	3	2	2	2.43
Average PLO	**3**	**2**	**3**	**2**	**2.5**	**2**	**2**	**2.36**

Course Code		Course Title			Type of Course
MPH26-E152		**Lab-II (Computational Lab)**			**Laboratory**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**2**	**2**	**50**	**60**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Make C programs of algebraic and transcendental equations, interpolations, Bisections, Newton's, Stirling, Bessel, Lagrange etc.
- **CLO 2:** Make C programs and **c**an solve an equation and find the roots by using bisection, Secant, Newton-Raphson method and can-do integration and differentiation using trapezoidal and simpson's rule.
- **CLO 3:** Make C programs for curve fitting and interpolation and extrapolation.
- **CLO 4:** Develop C programs for solving physics problems like spring attached to a body, freely falling body, Oscillation in LCR circuit, Damped Harmonic Oscillator etc.

LIST OF PROGRAMMES

LIST-A SOLUTION OF NA PROBLEMS THROUGH C PROGRAMMING:

1. To deduce errors involved in polynomial interpolation.
2. Algebraic and transcendental equations using bisection, iterative method of false position.
3. To implement Bessel's function, Newtons, Stirling, Lagrange's.
4. Implement numerical differential using trapezoidal, Simpson 3/8 rules.
5. Integration by trapezoidal rule and midpoint rule.
6. Quadratic interpolation using Newton's forward difference formula.
7. To find roots of f(x)=0 using Bisection method.
8. To find roots of f(x)=0 using Newton-Raphson method.
9. To find roots of f(x)=0 using Secant method.
10. To show frequency chart, regression analysis, Linear square fit and Polynomial fit.
11. To implement method of least square fitting.

LIST-B SOLUTION OF PHYSICS PROBLEMS THROUGH C PROGRAMMING:

1. Motion of object that falls freely.
2. Motion of projectile in horizontal direction.
3. Motion of satellite around a planet.
4. Motion of body attached to spring.
5. Motion of damped harmonic oscillator.
6. Fourier sum of harmonic waves.
7. Diffraction in N-slits grating.
8. Electric field due to N point charges.
9. Motion of a charge particle in a uniform magnetic field.
10. Growth of current in LR circuit.
11. Oscillations in LCR circuit.

Note:

1. Students are required to perform at least **ten** programmes from list A and B.
2. In practical examination the student shall be required to perform **One** programme each from the list A and B.
3. Programs shall carry **20** Marks and **05** Marks shall be assigned for viva-voce examination, **05** Marks shall be reserved for record.
4. No batch for practical class shall consist of more than 20 students.
5. The number of students in a batch allotted to an examiner for practical examination shall not exceed 12-15 students.
6. Addition/deletion in the above list of **some experiments of similar nature** may be made in accordance with the facilities available with the approval of H.O.D.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	2	2	2.57
2	3	3	3	3	3	2	2	2.71
3	3	3	3	2	3	2	2	2.57
4	1	3	2	3	3	2	2	2.29
Average PLO	**2.5**	**3**	**2.75**	**2.5**	**3**	**2**	**2**	**2.54**

Semester II

Course Code	Course Title				Type of Course
MPH26-C201	**Advanced Quantum Mechanics**				**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Apply Approximation Methods in Quantum Systems, utilize time-independent and time-dependent perturbation theory, variational methods, and WKB approximation to analyze systems such as oscillators, atomic transitions, and tunneling phenomena.
- **CLO 2:** Analyze Quantum Scattering Phenomena, Interpret and compute scattering processes using partial wave analysis, Lippmann-Schwinger equations, Born approximation, and understand bound states, resonances, and cross-sections in different frames.
- **CLO 3:** Understand Quantum Statistics and Field Formalisms, Apply the principles of identical particles, spin-statistics, and second quantization to bosonic and fermionic systems; use density matrix formalism and describe quantum transitions under semi-classical radiation theory.
- **CLO 4:** Explore Relativistic Quantum Mechanics, Formulate and interpret the Klein-Gordon and Dirac equations, analyze relativistic effects including spin, probability
current, and negative energy solutions, and derive their non-relativistic limits.

UNIT-I

Time-independent perturbation theory: Non-degenerate & degenerate cases, Applications such as linear harmonic oscillator, Zeeman effect, Stark effect, Perturbation of the type X^2, X^3, X^4. Variational method and its applications, WKB approximation: Solution of bound state and Tunnelling problems. Time-dependent perturbation theory: Harmonic perturbation, Fermi's golden rule, Adiabatic and sudden approximation. **(15 Lectures)**

UNIT-II

Scattering Matrix: Bound States and Resonances. Collision in 3-D and scattering, Laboratory and CM reference frames, Scattering amplitude, differential and total scattering cross sections. Lippman-Schwinger Equation. Born and Eikonal Approximation. Partial Wave Analysis: Low energy Scattering, Bound states and Resonance scattering. Complex potential and absorption. **(15 Lectures)**

UNIT-III

Identical particles, Symmetric and antisymmetric wave functions, Spin and Statistics. Collision of identical particles; Spin angular momentum. Second Quantization: Weakly interacting Bosonic and Fermionic systems. Semi classical theory of radiation, Transition probability for absorption and induced emission, Electric dipole and forbidden transitions. **(15 Lectures)**

UNIT-IV

Relativistic QM: The Klein-Gordon equation, Free particle solutions, probability density & probability current density, interpretation of negative energy solutions of the K-G equation. The Dirac equation, Free particle solutions, Probability density and probability density current for the free particle Dirac equation, Spin of an electron, Interpretation of negative energy states. Non-relativistic limit of KG and Dirac Equations. **(15 Lectures)**

Text Books / Reference Books:

1. Quantum Mechanics - L. I. Schiff (McGraw-Hill).
2. Quantum mechanics - B. Craseman and J.D. Powell (Addison Wesley).
3. Quantum Mechanics - Mathews and Venkatesan.
4. Principles of Quantum Mechanics - I.S. Tyagi (Pearson).
5. Modern Quantum Mechanics - J.J. Sakurai.
6. Introduction to Quantum Field Theory - Paul Roman (John Wiley).
7. Quantum Fields - N.N. Bigollubov & D.V. Shrikov.
8. Introduction to Quantum Fields Theory- Paul Roman.
9. W. Greiner, Relativistic Quantum Mechanics, Springer-Verlag.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	3	2	2	3	2.7
2	3	3	3	3	2	2	3	2.7
3	3	3	2	3	2	2	3	2.57
4	3	3	2	3	2	2	3	2.57
Average PLO	**3**	**3**	**2.5**	**3**	**2**	**2**	**3**	**2.64**

Course Code		Course Title			Type of Course
MPH26-C202		**Classical Electrodynamics**			**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Apply advanced mathematical techniques, including Poisson's and Laplace's equations, boundary conditions, Green's functions, and the method of images, to solve complex electrostatic problems in various coordinate systems.
- **CLO 2:** Analyze the behavior of electromagnetic fields in dielectric media and at interfaces, formulate and solve boundary value problems, and apply Maxwell's equations to understand energy and momentum conservation, including Poynting's theorem.
- **CLO 3:** Characterize electromagnetic wave propagation in various media and waveguides, understand the concept of electromagnetic potentials and gauge transformations, and calculate radiation fields and power from accelerating charges and dipoles.
- **CLO 4:** Formulate and solve relativistic electrodynamics problems using four-vector and tensor notation, apply Lorentz transformations to electromagnetic fields, and analyze the motion of relativistic charged particles in external electromagnetic fields using Lagrangian and Hamiltonian formalisms.

UNIT-I

Electrostatics: Gauss Law and Scalar Potential. Poisson's and Laplace's equation, Boundary Conditions. Green's theorem, Uniqueness theorem, Formal solution of boundary-value problem, Green's functions, Electrostatic potential energy. Method of images: Point-charge and grounded conducting sphere, Point charge and conducting sphere in uniform field, Method of inversion, Green's function for sphere, Conducting sphere with hemi-spheres at different potentials. Boundary value problems in cylindrical co-ordinates, Expansion of Green's function in spherical co-ordinates, Mixed boundary conditions, charged conducting disc. **(16 Lectures)**

UNIT-II

Multipole expansion and energy of charge distribution. Gauss Law in dielectrics. Induced and bound charges. Boundary Value problems in presence of linear dielectrics. Vector potential and multipole expansion. Boundary conditions and calculation of vector field. Maxwell's equations in free space and linear isotropic media, Boundary conditions on the fields at interfaces, Charge and energy, Poynting's theorem and Conservation of Energy and momentum. **(15 Lectures)**

UNIT-III

Electromagnetic waves: Waves in one-dimension, Electromagnetic waves in vacuum and matter, Energy and momentum in electromagnetic waves, Wave Guides and modes in a rectangular wave guide. Scalar and Vector potentials, Gauge transformations, Coulomb and Lorentz Gauge, Maxwell's equations in terms of potentials, Retarded potentials, Lienard-Wiechert potentials, fields of a moving point charge, Electric and Magnetic dipole radiation, power radiated by a point charge. **(14 Lectures)**

UNIT-IV

Four-Vectors in Electrodynamics, Transformation of electric and magnetic fields under Lorentz transformations, Field Tensor, Electrodynamics in tensor notation, Relativistic potentials, Covariant form of Maxwell's equations, Lorentz force on a relativistic charged particle. Lagrangian and Hamiltonian for a relativistic charge particle in external electromagnetic fields. Motion in uniform, static, magnetic field, Motion in combined uniform, static, electric and magnetic fields, Particle drifts in non-uniform magnetic fields. **(15 Lectures)**

Text Books/Reference Books:

1. Classical Electrodynamics: J. D. Jackson, Wiley Press.
2. Introduction to Electrodynamics: D. J. Griffiths, Pearson Edition.
3. Classical Theory of Fields: L. D. Landau and E. M. Lifshitz, Permagon Press.
4. Classical Electrodynamics: J. Schwinger, John Wiley Press.
5. Modern Electrodynamics: A. Zhangwll, Cambridge University Press.
6. Classical Electricity and Magnetism - Panofsky & Phillips.
7. Classical Electrodynamics -Bittencourt.
8. Electricity & Magnetism - A. Kip, McGraw Hill.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	1	2	2.43
2	3	2	3	3	3	1	2	2.43
3	3	2	3	3	3	1	2	2.43
4	3	2	3	3	3	2	2	2.57
Average PLO	**3**	**2**	**3**	**3**	**3**	**1.25**	**2**	**2.47**

Course Code	Course Title				Type of Course
MPH26-C203	**Statistical Mechanics**				**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Explain and apply fundamental concepts of statistical distributions and ensembles (microcanonical, canonical, grand canonical) to derive statistical quantities and understand fluctuations.
- **CLO 2:** Utilize the Gibbs distribution to derive thermodynamic relations and analyze various physical systems, including rotating bodies and systems with a variable number of particles.
- **CLO 3:** Differentiate and apply Fermi-Dirac and Bose-Einstein statistics to analyze degenerate electron and Bose gases, including their properties under various conditions and phenomena like black-body radiation and virial coefficients.
- **CLO 4:** Analyze conditions for phase equilibrium and various types of phase transitions (first and second order), applying concepts like the Clapeyron-Clausius formula, critical point phenomena, and critical indices.

UNIT - I

Statistical Distributions; Statistical independence, Liouvilles theorem, Significance of energy, Statistical Matrix, Statistical Distributions in quantum Statistics, Microcanonical, Canonical and Grand Canonical ensemble, Partition Function, Calculation of Statistical Quantities, Energy and Density Fluctuations. **(15 Lectures)**

UNIT - II

Gibbs distribution, Maxwellian distribution, Probability distribution for an Oscillator, Free energy in the Gibbs distribution, Gibbs distribution for rotating bodies and for a variable number of particles, Derivation of thermodynamics relations from the Gibbs distribution. **(15 Lectures)**

UNIT - III

Fermi distribution, Bose distribution, Fermi and Bose gases of elementary particles, Degenerate electron gas, Specific heat of degenerate electron gas, Weak fields, Strong fields, Relativistic degenerate electron gas, Degenerate Bose gas, Black body Radiation. Deviation of gases from the ideal state, Expansion in powers of density, Relationship of the virial coefficients. **(15 Lectures)**

UNIT - IV

Conditions for phase equilibrium; the Clapeyron-Clausius formula, Critical point, Law of Corresponding states, Phase transitions of the second kind, Discontinuity of Specific heat, Effect of an external field on a phase transition, Change in symmetry in a phase transition of the second kind, Fluctuations of the order parameter, Critical indices, scale invariance. **(15 Lectures)**

Text Books/Reference Books:

1. Statistical Mechanics by K Huang.
2. Statistical and Thermal Physics by F. Reif.
3. Fundamentals of Statistical Mechanics by B. B. Laud.
4. Statistical Mechanics – R. K. Pathria.
5. Statistical Physics - E.S. R. Gopal.
6. Theoretical Chemistry – Glasstone.
7. Statistical Mechanics - S.K. Sinha.
8. Statistical Mechanics - Landau & Lifshitz.
9. Introduction to Statistical Physics – Pointon.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	2	2	1	1	2
2	3	2	3	3	2	1	1	2.14
3	3	2	3	3	3	1	2	2.43
4	3	2	3	3	3	1	2	2.43
Average PLO	**3**	**2**	**3**	**2.75**	**2.5**	**1**	**1.5**	**2.25**

Course Code		Course Title			Type of Course
MPH26-E204		**Electronic Devices & Circuits**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Presents the basic principles of circuit analysis and design, the basic concepts and characteristics of the FET electronic devices and circuits.
- **CLO 2:** Provides information to the students about the electronic components like OP-AMP Theory with negative feedback etc. in detail
- **CLO 3:** Various interesting features associated with the OP-AMP theory and their circuits as well as oscillators and voltage regulators are also an important part of this course.
- **CLO 4:** The course provides an opportunity to students to practice in the experimental setup, measurement, and analysis of basic electronic devices and circuits along with the knowledge of switching circuit, Oscillators, UJT, SCR etc.

UNIT -I

Network & network theorems, Diode Circuits-Rectifiers & smoothing circuits, Voltage multipliers, Limiters & clampers, Photodiode and LED, Zener diode, Varactor diode and tunnel diode, Transistor fundamentals, Transistor biasing, CE and CC amplifier and their small signal equivalent circuits. FET and MOSFET device characteristics, FET biasing, FET amplifier, Lead and lag networks, Miller's theorem, High frequency FET and BJT analysis, Bode frequency response plots, Amplifier frequency response. **(16 Lectures)**

UNIT-II

The differential amplifier, DC and AC analysis of a differential amplifier, CMMR, The OP-AMP, OP-AMP DC offset characteristics, Frequency response, Slew rate and power bandwidth, Types of negative feedback: Non–inverting voltage feedback, Effect on input and output impedances, Non–inverting current feedback, Inverting voltage and current feedback, Band width, Closed loop gain and BW. **(15 Lectures)**

UNIT-III

Inverting amplifier, Non-inverting amplifier, Summing amplifier, Active filters, Comparators, The Schmitt trigger, Integrator, Differentiator, Waveform conversion, Waveform generator, Current to voltage and voltage to current converters, Low pass, band pass and band reject filters, Brief study of timer 555. **(14 Lectures)**

UNIT-IV

The positive feedback and oscillations, Wein bridge oscillator, RC and LC oscillators, The unwanted oscillations and stability, Multivibrators. Zener diode regulators, transistor series voltage regulators, Negative feedback voltage regulators, Transistor shunt voltage regulator, The SCR and its applications, UJT and its applications. **(15 Lectures)**

Text Books / Reference Books:

1. Solid State Electronics - Ben G. Streetman, PHI.
2. Semiconductor Devices-Physics and Technology- S.M. Sze Wiley (1985).
3. Introduction to Semiconductor devices - M.S. Tyagi, John Wiley & Sons.
4. Electronic Devices & Circuits- G.K. Mithal.
5. Electronic Principles (3/e)- A.P. Malvino, TMH.
6. Op-Amps & Linear integrated circuits - Ramakanth A. Gayakwad, PHI, Second Edition, 1991.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	1	2	2.43
2	3	2	3	3	3	1	2	2.43
3	3	2	3	3	3	1	2	2.43
4	3	2	3	3	3	2	3	2.71
Average PLO	**3**	**2**	**3**	**3**	**3**	**1.25**	**2.25**	**2.50**

Course Code		Course Title			Type of Course
MPH26-E251		**Lab-III (General Electronics Lab)**			**Laboratory**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**4**	**4**	**100**	**120**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Design and Study of CC, CE amplifier, BJT amplifier
- **CLO 2:** Design and Study of FET, MOSFET amplifier etc.
- **CLO 3:** Design and Study of various circuits of OP-AMP as subtractor, integrator, differentiator
- **CLO 4:** Design and Study of different oscillator phase shift, Wien bridge etc. and different multi-vibrator.

LIST OF EXPERIMENTS

1. Design and study of a CE transistor amplifier and study its frequency response, Input and output impedance.
2. Design and study of a CC transistor amplifier and estimate its input, output impedances and frequency response.
3. Design and study of Network Theorems.
4. Design a two stage RC coupled BJT amplifier with and without feedback and study frequency response for two different gains.
5. Design and study of junction diode limiter & clamper.
6. Study of FET characteristics, Load line, Calculation of I_{DSS} and pinch off voltage.
7. Study of MOSFET characteristics, Load line, Calculation of I_{DSS} and pinch off voltage.
8. Design and study of FET & MOSFET amplifier.
9. Study and construction of a Push-Pull amplifier.
10. Study and draw V-I characteristics of SCR, its design and application circuit using SCR.
11. Design and study of UJT relaxation oscillator. To study wave form generation and storage oscilloscope.
12. Study of real OP-AMP; The maximum slew rate, Input offsets, Frequency compensation.
13. Design and study of OP-AMP as inverting, Non-inverting and summing amplifier.
14. Design and study of OP-AMP as subtracter, integrator and differentiator.
15. Design and study of OP-AMP as Schmitt trigger and measure its hysteresis characteristics.
16. Design and study of astable, monostable and bistable multivibrator using OP-AMP.
17. Design and study of phase shift oscillator using OP-AMP.
18. Design and study of a Wein bridge oscillator using OP-AMP.
19. Study of IC timer 555 as; (a) Astable multivibrator (b) A monostable multivibrator (c) Time delay.
20. Design and study of high pass, low pass, band pass and band reject filters using OP-AMP.
21. Design and test a Logarithmic amplifier.
22. Study of function generator using OP-AMP.
23. Study of an instrumentation amplifier using OP-AMP.

Note:

1. Students are required to perform at least **10** experiments from the above list.
2. In practical examination the student shall be required to perform **one** experiment from the list and **one Minor Project** on the design of Electronic Circuits.
3. Experiments/Minor Project shall carry **20 Marks each** and **10 Marks each** shall be assigned for viva-voce examination. **05** Marks shall be reserved for practical/minor project (each) record.
4. No batch for practical class shall consist of more than **20** students.
5. The number of students in a batch allotted to an examiner for practical examination shall not exceed **12-15** students.
6. Addition/deletion in the above list of **some experiments of similar nature** may be made in accordance with the facilities available with the approval of **H.O.D**.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	1	1	2.29
2	3	3	3	3	3	1	2	2.57
3	3	3	3	2	3	1	2	2.43
4	1	3	2	3	3	2	2	2.29
Average PLO	**2.5**	**3**	**2.75**	**2.5**	**3**	**1.25**	**1.75**	**2.40**

Course Code		Course Title			Type of Course
MPH26-E205		**Quantum Information Theory**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1**: Explain the postulates of quantum mechanics, quantum entanglement, Bell inequalities, and the density operator formalism, including Bloch sphere representation and measurement techniques. Utilize operator sum representation, purification techniques, and distance measures such as trace distance and fidelity to quantify quantum states and entanglement.
- **CLO2**: Understand key quantum communication protocols such as quantum teleportation, superdense coding, and entanglement distribution, along with the implications of the No-Cloning theorem. Implement quantum algorithms such as Deutsch-Jozsa and Quantum Fourier Transform, analyze Shannon and von Neumann entropies, and evaluate quantum channel capacities using mutual information.

UNIT-I

Postulates of quantum mechanics, qubits, composite quantum systems, Quantum entanglement, Bell Inequality. Density Operator: General properties, Bloch sphere representation, projective measurement, POVM, Schmidt decomposition, reduced density operator. Operator sum representation and its applications. Distance Measures: Norms, Trace Distance and its properties, Fidelity and its properties, relation between Trace Distance and Fidelity. Entanglement measures. Purification: Purification of a density operator, isometric extension of single qubit channels. **(15 Lectures)**

UNIT-II

No-Cloning theorem. Quantum Circuits. Entanglement distribution, super dense coding, quantum teleportation, optimality of these protocols, unit source capacity region. Shannon and von Neumann Entropies: Basic properties, Data Processing Inequalities, coding theorems, channel capacities. Mutual Information. Quantum Algorithms: Parallelism, Deustch-Jozsa, Quantum Fourier Transform and its applications. **(15 Lectures)**

Text Book/Reference Books:

1. Quantum Computation and Quantum Information: M. A. Nielson and I. Chaung, Cambridge University Press.
2. Quantum Information, Second Edition (Cambridge University Press): Mark Wilde.
3. Quantum Information: An Introduction – S.M. Barnett.
4. Quantum Information Theory and Quantum Statistics – D. Petz.
5. An Introduction to Quantum Computing – P. Kaye, M. Mosca, R. Laflamme.
6. The Theory of Quantum Information – J. Watrous.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	2	2	2	1	1	1.86
2	3	3	2	3	2	2	2	2.43
Average PLO	**3**	**2.5**	**2**	**2.5**	**2**	**1.5**	**1.5**	**2.15**

Course Code		Course Title			Type of Course
MPH26-E206		**Physics & Vedic Thought**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1:** Explains the nature, structure and classification of Vedic literature. Concept of Panch Mahabhutas, Spirituo-Materialistic view of the universe.
- **CLO2:** Vedic Cosmology is described using Nasadiya Sukta, Hiranya Garbha Sukta etc. Understands the Vedic Rashmi theory, its classification & properties. Oum as fundamental Rashmi, formation of elementary particles etc.

UNIT – I

Scientific Understanding of Vedas: Introduction to the four Vedas; Concept of Rishi, Chandas and Devata; Six Vedangas; Symbolism in Vedas; The Vedic Gods; Spirituo-materialistic view of the universe; Concept of Prakriti and Purusha; Panch Mahabhutas and their physical significance, Fire Altars (Sulba Sukta and Yajna), Nature of Prakriti (Sat, Raj and Tam Guna). **(12 Lectures)**

UNIT – II

Vedic Cosmology: The birth of Sun, Matter composing the sun, The Earth, Hiranya Garbha Sukta (The Golden Womb: Origin of the universe), Vishvakarma Sukta (The Architect of the Universe), Nasadiya Sukta (The Big Bang Theory), Cyclic creation and dissolution of universe.

Vedic Rashmi Theory (VRT): Veda Mantra as Rashmis; Classification and Properties of Rashmis; Oum as the fundamental Rashmi; Elementary & Primary Rashmi; Formation of elementary particles; Concept of Time, Mass, Energy, Force, Dark Matter and Dark Energy (Introduction only). **(18 Lectures)**

Text Books / Reference Books:

1. The Call of Vedas - Abinash Cahndra Bose.
2. Cosmology of the Rigvedas (London 1887) - W. Wallis.
3. Physics in ancient India - Narayen Gopal Dongre.
4. Sciences in the Vedas - Acharya V.N. Shastri.
5. The Vedas - Jeanire Miller, Rider & Co., London.
6. Vedas: The Source of Ultimate Science, S.R. Verma, Nag Publishers (2005 Ed.).
7. Ved Vigyan Alok – Agnivrat Naishthik, Jalore (2017).
8. Introduction to Vaidic Physics – Vishal Arya (2021), Bhinmal.
9. Vaidic Rashmi Viganam – Agnivrat Naishtik (2024), Ved Science Pub.
10. Vedarth Viganam -Agnivrat Naishtik (2024), Ved Science Pub.
11. Energy Science in Vedas, R.K. Menaria, V. Priya, (2016) Parimal Pub.
12. Katayana Sulba Sutra, S.D. Khadilkar, (2003), Vaidic Samsodhana Mandala, Pune.
13. An Introduction to Commentary on Vedas, S. Arya, (2018) Parimal Pub.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	2	2	2	1	1	1.86
2	3	3	2	3	2	2	2	2.43
Average PLO	**3**	**2.5**	**2**	**2.5**	**2**	**1.5**	**1.5**	**2.15**

Course Code		Course Title			Type of Course
MPH26-E207		**Solar Photovoltaic Technology**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1:** Understand the need for renewable solar-based technologies.
- **CLO2:** Appreciate various material properties which are used in photovoltaic.
- **CLO3:** Learn about Semiconductor material for solar cell.
- **CLO4:** Appreciate the science and technology of solar cells, their design and characterization, understand various upcoming technologies in this area.

UNIT – I

World Energy scenario – Advantages and challenges of solar energy harnessing - Source of radiation – solar constant– solar intensity at earth's surface – direct and diffuse radiation – apparent motion of sun-solar insolation data –solar charts – measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder. **(15 Lectures)**

UNIT – II

Crystals' structures, atomic bonding, energy band diagram – direct & indirect band gap –p & n doping and carrier concentration – intrinsic & extrinsic semiconductor – compound semiconductors– diffusion and drift of carriers, continuity equation – optical absorption – carrier recombination – effect of temperature – p-n junction in equilibrium conditions – p-n junction in non-equilibrium condition – p-n junction under illumination. **(10 Lectures)**

UNIT- III

Silicon: preparation of metallurgical, electronic and solar grade silicon -Production of single crystal silicon: Czokralski (CZ) and Float Zone (FZ) method– imperfections – carrier doping and lifetime – Germanium –compound semiconductors – growth & characterization– amorphous materials – transparent conducting oxides – anti-reflection principles and coatings – organic materials. **(15 Lectures)**

UNIT- IV

Device isolation & analysis – ideal cell under illumination – solar cell parameters short circuit current, open circuit voltage, fill factor, efficiency; optical losses, electrical losses, surface recombination velocity, quantum efficiency – measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal quantum yield measurements – effects of series and parallel resistance and temperature.

Upper limits of solar cell parameters – losses in solar cells – Solar Cell design: Design for High Isc – Design for High Voc – Design for High FF – Si-based solar cell Technology: process flow of commercial Si Cell Technologies – high-efficiency Si Solar cells. Thin film solar cell technologies: Common features of thin film Technologies – aSi technology – CdTe, CIGS, Epitaxial Si. Other technologies: DSSC. **(20 Lectures)**

Text Books/Reference Books:

1. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications 2nd ed., Prentice Hall of India, New Delhi (2011).
2. H. J. Moller, Semiconductors for solar cells, Artech House Inc., MA, USA (1993).
3. Martin Green, Solar Cells: Operating principles, Technology and Systems Applications, UNSW, Australia (1997).
4. Solar Cells and their Applications, Larry D. Partain (ed.), John Wiley and Sons, New York (1995).
5. J. Nelson, The Physics of Solar Cells, Imperial College Press (2006).
6. Photovoltaic Materials, Richard H. Bube, Imperial College Press (1998).

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	1	1	2.29
2	3	3	3	3	3	1	2	2.57
3	3	3	3	2	3	1	2	2.43
4	1	3	2	3	3	2	2	2.29
Average PLO	**2.5**	**3**	**2.75**	**2.5**	**3**	**1.25**	**1.75**	**2.39**

Course Code		Course Title			Type of Course
MPH26-E208		**Physics and Technology of Thin Films**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1:** Have clear exposure and knowledge of different thin film growth techniques.
- **CLO2** Have thorough knowledge on the fundamental concept of thin films.
- **CLO3:** Earn good knowledge on the characterization of thin films to investigate its properties.
- **CLO4:** Be molded to do high-level research in thrust areas like LEDs, Laser, solar cells, storage devices etc.

UNIT-I

Classifications of vacuum ranges –Vacuum pumps - Rotary, Diffusion, Turbomolecular and Ion Pumps –Thin film (epitaxy) – definition & advantages – Types of epitaxy. Different Growth Techniques: Liquid Phase Epitaxy, Vapour Phase Epitaxy, Molecular Beam Epitaxy, Metal Organic Vapour Phase Epitaxy, Sputtering (RF & DC), Pulsed Laser Deposition. Thickness Measurement: Microbalance technique, Photometry, Interferometry (MBI, FECO). **(15 Lectures)**

UNIT-II

Nucleation Kinetics: types of nucleation – kinetic theory of nucleation – energy formation of a nucleus – critical nucleation parameters; spherical and non-spherical nucleus (cap, disc and cubic shaped) on the substrates.

Growth Kinetics: Kinetics of binary (GaAs, InP, etc.), ternary ($Al_{1-x}Ga_xAs$, $Ga_{1-x}In_xP$, $InAs_{1-x}P_x$, etc.) and quaternary ($Ga_{1-x}In_xAs_{1-y}P_y$, etc.) semiconductors – derivation of growth rate and composition expressions. **(15 Lectures)**

UNIT-III

X-ray diffraction –Photoluminescence –UV-Vis-IR spectrophotometer – Atomic Force Microscope –Scanning Electron Microscope – Hall effect – Vibrational Sample Magnetometer – Secondary Ion Mass Spectrometry. **(10 Lectures)**

UNIT-IV

Dielectric properties – Important parameters, Measurement of dielectric properties- Effect of annealing and film thickness. Optical properties – Optical constants, determination of optical constants by Brewster angle method, Normal incidence method and graphical method. Mechanical properties – Concept and origin of stress and strain, Lattice misfit, Thermal misfit, Hardness test and Bulge test. Optoelectronic devices: LED, LASER and Solar cell – Micro Electromechanical Systems (MEMS)–Fabrication of thin film capacitor – application of ferromagnetic thin films; Data storage, Giant Magnetoresistance (GMR). **(20 Lectures)**

Text Books/Reference Books:

1. A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi (1996).
2. K. L. Chopra, Thin Film Phenomena, McGraw- Hill book company New York, (1969).
3. Ludminla Eckertova, Physics of Thin Films, Plenum press, New York (1977).
4. Hari Singh Nalwa (ed.), Hand Book of Thin Films, Vol. 1 – 5, Academic Press (2002).
5. Milton Ohring, Material Science of Thin films, 2nd Edition Academic Press (2002).
6. R.F. Vossen, W. Ken, Thin Film Processes.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	1	1	2.29
2	3	3	3	3	3	1	2	2.57
3	3	3	3	2	3	1	2	2.43
4	1	3	2	3	3	2	3	2.42
Average PLO	**2.5**	**3**	**2.75**	**2.5**	**3**	**1.25**	**2**	**2.42**

Semester III

Course Code		Course Title			Type of Course
MPH26-C301		**Condensed Matter Physics**			**C**
L	T	P	Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Demonstrate advanced understanding of crystal structures, symmetry operations, and reciprocal lattice theory, and apply these principles to analyze wave diffraction patterns using Fourier techniques.
- **CLO 2:** Apply quantum mechanical models—such as the free electron model, Bloch-Floquet formalism, and tight binding approximation—to analyze the origin of energy bands and gaps in solids. Interpret the electronic structure of semiconductors and metals using band theory concepts like constant energy surfaces, Fermi surfaces, and effective mass. Demonstrate understanding of experimental methods such as cyclotron resonance for probing electronic properties.
- **CLO 3:** Evaluate the quantum behavior of electrons in low-dimensional systems, including 1D/2D electron gases and nanostructures, and apply formal models such as Landauer's theory and quantum Hall effect to interpret experimental phenomena.
- **CLO 4:** Critically examine models of ferromagnetism and ferroelectricity—including Weiss theory, spin wave theory, and Landau theory—to describe phase transitions, domain formation, and their technological implications.

UNIT-I

Crystal lattice; crystal planes and directions. Crystal symmetry, crystallographic point groups, non-centrosymmetric points, and their applications. Space groups, diffraction of waves by crystals, scattered wave amplitude, Fourier Analysis of a crystal. Reciprocal lattice and its applications to diffraction techniques, Bragg's law in reciprocal space. Diffraction condition in reciprocal space, Brillouin zones, Crystal Structure Factor, and Atomic Scattering Factor. Calculation of atomic scattering factor for the ground state hydrogen. **(15 Lectures)**

UNIT-II

The quantum mechanical free electron model, electrons in a periodic lattice, the origin of energy gaps. Bloch-Floquet functions, Bloch's theorem, Bloch modes, the Schrödinger wave equation in reciprocal space; Tight binding approximation. Band structure of semiconductors (Si, Ge, GaAs) and metals (Cu, Al), Constant Energy Surface, Fermi surface of solids; Concept of effective mass and its experimental determination; the cyclotron resonance method. **(15 Lectures)**

UNIT-III

Low-dimensional electron systems: One-dimensional systems; density of states (DOS), 1D sub-bands, Van Hove singularities and their applications; electron motion in a uniform magnetic field; Landau levels; the electronic structure of a two-dimensional electron gas and the integral quantum Hall effect (IQHE). Conductance quantization and the Landauer formalism. Resonant tunnelling, two potential barriers in the series. Zero-dimensional systems: quantized energy levels of semiconductor nanocrystals. **(15 Lectures)**

UNIT-IV

Ferromagnetism: Weiss's theory of ferromagnetism, the Curie-Weiss law for susceptibility, Heisenberg model and molecular field theory. Ising model in one-dimensions. Spin waves and magnons, Dispersion relation. Specific heat of ferromagnets at low temperature, Bloch $T^{3/2}$ law. Formation of domains, Bloch wall energy. Ferroelectricity: Classification of ferroelectric crystals, Landau's theory of the ferroelectric phase transition. Phonon softening and ferroelectricity, Soft-mode theory. Applications of ferroelectric materials. **(15 Lectures)**

Text Books/Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons.
2. Elementary solid-state physics by Ali Omer, Pearson Publications.
3. The physics of low dimensional semiconductors: An introduction by John H. Davis, Cambridge University Press.
4. Quantum Mechanics for Nanostructure by Dmitry I. Sementsov, Nizami Z. Vagidov, and V. V. Mitin, Cambridge University Press.
5. Modern course in quantum theory of solids by Fuxuang Han, Wiley Scientific.
6. Solid state physics by Neil W. Ashcroft and N. David Mermin, Black Well Pub.
7. Solid State Physics - A.J. Dekker.
8. Crystallography for Solid State Physics- Verma & Srivastava.
9. Introduction to Solids – Azaroff.
10. Solid State Physics- S.O. Pillai.
11. Principle of Condensed Matter Physics- Chaikim & Lubensky.
12. Introduction to Solid State Physics – Paterson.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	2	2	1	2	1	1.86
2	3	3	3	2	1	2	2	2.29
3	3	3	3	3	1	2	2	2.43
4	3	2	2	3	1	1	2	2.0
Average PLO	**3.0**	**2.5**	**2.5**	**2.5**	**1.0**	**1.75**	**1.75**	**2.14**

Course Code		Course Title			Type of Course
MPH26-C302		**Atomic and Molecular Physics**			**C**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Interpret fine and hyperfine structure in atomic spectra based on quantum mechanical principles including relativistic and magnetic interactions.
- **CLO 2:** Analyze and apply selection rules and transition probabilities to atomic and molecular systems.
- **CLO 3:** Examine vibrational and rotational spectra of diatomic molecules and understand the basis of Raman and electronic transitions.
- **CLO 4:** Understand the quantum mechanical and classical description of the Raman effect and apply it in spectroscopic structure analysis & basics of Lasers.

UNIT I

Review of Solution of Schrodinger's equation for Coulomb field and Hydrogen atom. Quantum states of an electron atoms, Pauli's exclusion principle, Different series in alkali spectra, Term values and quantum defect, Ritz combination principle, Penetrating and non-penetrating orbits, Energy state of Helium atom, Spectra of Helium and Mercury, Characteristics of X-ray spectra, Fine structure of X-ray levels, Auger effect. **(14 Lectures)**

UNIT II

Spin-Orbit coupling, Lamb shift and Rutherford experiment, LS and JJ coupling schemes, Term values in equivalent and non-equivalent electron systems, Energy level diagrams and selection rules in complex spectra, Regularities in complex spectra, Fine and Hyperfine structure of spectral lines, normal Zeeman effect, Paschan-Back effect and Stark effect. Normal and specific mass shifts, Anomalous Zeeman effect, Applications of Resonance Spectroscopy: ESR and NMR. **(14 Lectures)**

UNIT III

Born and Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Molecular orbital method, Hydrogen molecular ion, Rotational spectra of diatomic molecule as a rigid and non-rigid rotator, Vibrational spectra of a diatomic molecule as a harmonic and anharmonic oscillator, Selection Rules, Isotope effects in vibrational spectra. **(12 Lectures)**

UNIT IV

Electronic spectra of diatomic molecules, Frank-Condon principle, Vibrational coarse structure, Rotational fine structure of electronic-vibration transition, Raman spectra: Classical and quantum explanation of Raman Effect, Vibrational and rotational Raman spectra of diatomic molecules. Structure determination of molecules by Raman spectroscopy.

Lasers: Requisites for producing laser light, Multilevel rate equations and saturation, Rabi frequency, Laser pumping and population inversion, Solid state Laser (Ruby), Gas Lasers (Helium-Neon and Carbon dioxide), Semiconductor laser (GaAs), Free electron Laser, Nonlinear phenomenon, Harmonic generation, Laser accelerator, Laser Applications: Distance measurement, Laser interferometry, Holography. **(20 Lectures)**

Text Books / Reference Books:

1. Introduction to Atomic spectra- H.E. White.
2. Fundamentals of molecular spectroscopy - C. N. Banwell.
3. Molecular spectroscopy - J.M. Brown.
4. Introduction to Molecular Spectroscopy - G.M. Barrow.
5. Lasers- B.B. Laud.
6. Principles of Lasers- O. Svelto. Physics of Atoms and Molecules by B. H. Bransden and C. J. Joachain, 2nd Ed.
7. Spectra of Atoms and Molecules by Peter F. Bernath, Oxford University Press.
8. Atoms and Molecules by Mitchel Weissbluth.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	2	1	2	2.29
2	3	3	3	3	2	2	2	2.57
3	2	3	3	3	2	2	3	2.57
4	2	2	2	2	2	2	3	2.14
Average PLO	**2.5**	**2.75**	**2.75**	**2.5**	**2**	**1.75**	**2.5**	**2.39**

Course Code		Course Title			Type of Course
MPH26-E303		**Digital Electronics & Microprocessor**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Understanding basic knowledge of Boolean algebra. define basic logical circuits, minimization methods, methods for writing Boolean functions, combinational and sequential circuits, flip-flops, register, counter, A/D, D/A, digital automaton, programmable structures.
- **CLO 2:** Describe operation methods of combinational and sequential circuits, similarities and differences of writing the Boolean functions and minimizations.
- **CLO 3:** Synthesis of appropriate combinational and sequential logic circuits.
- **CLO 4:** To understand the working of a microprocessor/controller. To learn to program a processor using assembly language. Describe the architectures of 8085 microprocessors.

UNIT-I

Number systems - Decimal, Binary, Octal, Hexa decimal and their interconversions, The ASCII code, EXCESS-3 code, Gray code and BCD code, Binary addition and subtraction, 2's complements arithmetic, Half adder and full adder, Binary multiplication and division, Transistor as a switch, OR, AND, NOT and NAND logic gates, Boolean algebra: Boolean laws and theorem, Demorgan's theorem, Logic families : RTL, DTL, TTL, ECL, Sum of product and product of sum methods, K-Map; pairs, quads and octets, K-map simplification, Min-term and max- term analysis. **(15 Lectures)**

UNIT-II

Multiplexer and demultiplexer, Decoder, BCD to decimal decoders, Encoders, Parity generators, Checker, Seven segment display, RS, JK, M/S JK, T & D clocked and edge triggered flip-flop and their timing diagrams. Buffer register, Shift register, Controlled shift register, Ripple counter, Frequency counters, Ring counters, Up and down counters, Electronic counters: Counting unit, Gate generator, Universal counter and its modes of operation.

(15 Lectures)

UNIT-III

A/D converters: Successive approximation A/D converters, Voltage to time A/D converter, Voltage to frequency A/D converters and dual-slope integrator A/D converters, D/A conversion techniques, Digital voltmeter, Accuracy and consideration, Memory addressing, ROMS, RAMS, DRAMS. **(15 Lectures)**

UNIT-IV

8085 Microprocessor: Architecture & Operations: Microprocessor architecture and its operations, Memory, Input/output (I/O), The 8085 MPU, Instructions classification, instruction format, How to write and execute a simple programme, Instruction timings and operation status, Data transfer (copy) Instructions, Arithmetic operations, Logic operations, Branch operations, Writing assembly language programs, Debugging a program. **(15 Lectures)**

Text Books / Reference Books:

1. Digital Principles and Application- A.P. Malvino and Donald P. Leach, TMH, New Delhi
2. Digital Design - M. Morris Mano, PHI, 1998
3. Microprocessor Architecture, Programming and Applications with8085/8086 by Ramesh
4. S. Gaonkar, Wiley-Eastern Ltd., 1987
5. Microprocessor, Interfacing, Programming and Hardware -Douglas V. Hall, second edition, Mcgraw Hill International Edition, 1992.
6. Fundamentals of Digital Circuits – A. Anand Kumar.
7. Modern Digital Electronics – R.P. Jain
8. Advanced Microprocessors and Peripherals – A.K. Ray, K.M. Bhurchandi.
9. Microprocessor and Microcontrollers – N. Senthil Kumar.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	2	1	2	2.29
2	3	3	3	3	2	2	2	2.57
3	2	3	3	3	2	2	3	2.57
4	2	2	2	2	2	2	3	2.14
Average PLO	**2.5**	**2.75**	**2.75**	**2.75**	**2**	**1.75**	**2.5**	**2.39**

Course Code		Course Title			Type of Course
MPH26-E304		**Communication Electronics**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Appraise about AM, DSB/SSB modulation.
- **CLO 2:** Interpret frequency modulation and modulation factor.
- **CLO 3:** Determine the characteristics of long transmission line, Antenna.
- **CLO 4:** Determine the characteristics of AM and F.M. radio receiver & Antennas.

UNIT-I

Communication systems, Modulation, Bandwidth requirements, Noise: External noise, Internal noise, Noise calculation, Noise figure, Amplitude modulation: Theory, Generation of AM, Basic requirement, Modulated transistor amplifiers, Single side band (SSB) techniques: Evolution of SSB, Suppression of carrier and unwanted side band, Demodulation: Envelop detection, Product detector. **(10 Lectures)**

UNIT-II

Theory of frequency and phase modulation- Mathematical representation of FM, Frequency spectrum of FM wave, Phase modulation, Intersystem comparisons, Noise and frequency modulation- Effects of noise on carrier, Preemphasis de-emphasis, Comparison of wide band and narrow band FM, Stereo Phonic FM multiplex system, Generation of FM- FM methods, Direct methods, AFC. **(10 Lectures)**

UNIT-III

Fundamentals of transmission lines, Characteristics impedance, Losses, Standing waves, Reactance properties of transmission lines, The Smith chart and its applications, Ground (surface) waves, Sky wave propagation- The ionosphere, Space waves, Tropospheric scatter propagation, Extraterrestrial communications. **(10 Lectures)**

UNIT-IV

ANTENNAS: The elementary doublet, Wire radiator in space, Antenna gain and effective radiated power, Antenna resistance, Bandwidth, Beamwidth and polarization, Ungrounded antennas, Grounded antennas, Grounding systems, Effects of antenna height, Antenna coupling at medium frequency, Directional antennas- dipole arrays, Folded dipole and applications, The Yagi antenna.

RADIO RECEIVERS: Receiver types- TRF receiver, Superheterodyne receiver, AM receiver- RF section and characteristic, Frequency changing and tracking, intermediate frequency and IF amplifiers, AGC, Extension of superheterodyne principle, FM receivers- comparison with AM receiver, Amplitude limiting, Basic FM demodulators. **(20 Lectures)**

Text Books / Reference Books:

1. Principles of communication systems - Taub and Schilling, TMH, 1994.
2. Electronic Communication System - G. Keneddy.
3. Communication systems, Third Edition -Simon Haykin, John Wiley & Sons, Inc. 1994.
4. Digital and Communication system - Roden H.S., PHI.
5. Analog and Digital Communication - Chakraborty, Dhanpat Rai.
6. Advanced Electronics Communication Systems- Wayne Tomasi, PHI. Edn.
7. Digital and Analog Communication System- K. San Shanmugam, John Wile & Sons.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	2	1	2	2.29
2	3	3	3	3	2	1	2	2.43
3	2	3	3	3	2	1	2	2.29
4	2	2	3	2	2	1	2	2
Average PLO	**2.5**	**2.75**	**3**	**2.5**	**2**	**1**	**2**	**2.25**

Course Code	Course Title				Type of Course
MPH26-E305	**Quantum Electronics and Laser Applications**				**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45 L+15T)**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1**: Have understanding of Quantum theory of radiation.
- **CLO2**: Have knowledge of cavity optics and high power lasers.
- **CLO3**: Have understanding Holography and fiber optics.
- **CLO4**: Have knowledge of application of laser in industry.

UNIT-I

Wave particle dualism, Concept of wave packet, Boltzmann distribution law- Atoms –molecules energy transition, Spontaneous and stimulated emission Einstein's coefficients –Lifetime of excited state – Line Broadening mechanisms – Condition for producing laser – population inversion, gain and gain saturation – saturation intensity. **(15 Lectures)**

UNIT-II

Requirements for resonator –gain and loss in a cavity -characterization of resonator –resonator stability for Gaussian beams –common cavity configurations. Q switching-Mode locking- Types: ruby laser, helium-neon laser, CO_2 laser, semiconductor lasers. **(10 Lectures)**

UNIT – III

Construction –reconstruction-inline, off axis holography applications of holography –HNDT (Holographic Non-Destructive Testing). Fibre Optics: Optical fibre principle – types of fibres – properties–fiber optical communication– fibre amplifiers. Fiber-optic sensors: intensity-phase polarization and frequency dependent techniques. **(15 Lectures)**

UNIT-IV

Nonlinear optics, basics SHG –THG – excited state spectroscopy – time domain and its applications – Laser induced fluorescence spectroscopy, stimulated Raman emission –medical applications, photo-chemical applications. Materials processing, Lasers in 3D Machining –drilling, cutting, welding –hardening, alloying – annealing –Lasers in Non-destructive Evaluations: Ultrasonics, Laser Profilometry, Digital shearography. **(20 Lectures)**

Text Books / Reference Books:

1. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, Mcmillan (1981).
2. K. Koebner (ed.), Industrial Applications of Lasers, Wiley (1984).
3. J.T. Cuxon and D.E. Parker, Industrial Lasers and their Applications, Prentice Hall (1985).
4. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
5. 3.F.C. Appard, Fiber Optics Handbook, McGraw-Hill (1989).

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	2	1	2	2.14
2	3	3	3	3	2	2	2	2.57
3	2	3	3	3	2	2	3	2.57
4	2	2	2	2	2	2	3	2.43
Average PLO	**2.5**	**2.75**	**2.75**	**2.75**	**2**	**1.75**	**2.5**	**2.43**

Course Code	Course Title				Type of Course
MPH26-E306	**Computational Techniques**				**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
3	**1**	**0**	**4**	**100**	**60 (45L+15T)**

Course Learning Objectives (CLOs): Upon successful completion of this course, students will be able to:

- **CLO1:** Identify and describe the syntax of MATLAB, solve different mathematical problems and demonstrate basic machine learning techniques in MATLAB.
- **CLO2:** identify and describe the different applications of MATLAB.
- **CLO3:** solve different physical problems using FEM.
- **CLO4:**describe and explain the finite element method principle and its different variants.

UNIT- I

MATLAB environment – working with data sets – data input/output – logical variables and operators – array and X-Y Plotting – simple graphics – data types: matrix, string, cell and structure– file input and output – MATLAB files – simple programs. **(18 Lectures)**

UNIT- II

Matrices and array operation – elemental matrix functions – file functions – application of MATLAB – solving linear algebraic equations – curve fitting – interpolation – numerical integration – basic 2D Plots – overlay plots – specialized 2D plots – 3D plots – view. **(15 Lectures)**

UNIT-III

Fast Fourier Transform - Fuzzy Logic - Artificial Neural Network (ANN): Neural Net Fitting, Neural Net Pattern Recognition, Neural Net Time Series. **(12 Lectures)**

UNIT-IV

Introduction to FEM: Method of Weighted Residuals – Galerkin's Finite Element Formulation – Variational Method – Rayleigh-Ritz Finite Element Method. Structural mechanics and wave propagation problems in 2D - solving ordinary and partial differential equations - Fluid-structure interaction. **(15 Lectures)**

Text Books / Reference Books:

1. R. Pratap, Getting Started with MATLAB: A Quick Introduction for Scientist and Engineers, Oxford University Press (2010).
2. D. W. Pepper and J. C. Heinrich, The Finite Element Method: Basic Concepts and Applications with MATLAB, MAPLE, and COMSOL, 3rd edition, CRC Press (2017).
3. H. Bang and Y. W. Kwon, The Finite Element Method Using MATLAB, CRC Press (2018).
4. Introduction to COMSOL Multiphysics – © 1998–2020 COMSOL.
5. MATLAB Programming Fundamentals – © 1984–2021 by The MathWorks, Inc.
6. An Introduction to Computational Physics – T. Pang.
7. Computational Physics- J. Giordano, H. Nakanishi.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	2	3	2	2.71
2	3	3	3	3	2	3	2	2.71
3	2	3	3	3	2	3	3	2.57
4	2	2	2	2	2	2	3	2.43
Average PLO	**2.5**	**2.75**	**2.75**	**2.75**	**2**	**2.75**	**2.5**	**2.60**

Course Code		Course Title			Type of Course
MPH26-E307		**Elementary Particle Physics**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Understand and articulate the properties and quantum numbers of elementary particles, including charge, spin, parity, isospin and strangeness, and apply the Gell-Mann Nishijma formula to classify baryons and mesons, and analyze the implications of symmetry principles, including parity violation and CP invariance, in particle interactions and collisions. and Standard Model to particle physics scenarios.
- **CLO 2:** Apply Feynmann calculus methodologies to analyze particle decay processes, compute cross sections, and understand the implications of the Golden Rule in quantum field theories, with a specific focus on the interactions described by quantum electrodynamics (QED) and quantum chromodynamics (QCD), including concepts such as asymptotic freedom and Higgs mechanism.

UNIT - I

Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Eight folded ways, Gellmann- Nishijima formula. baryons and mesons, Quark model, Standard model. Parity (non-conservation in weak interaction), charge conjugation and CPT invariance, CP violation. Application of symmetry arguments to particle reactions. Relativistic collisions, classical collisions, Examples and applications. **(15 Lectures)**

UNIT - II

Feynman calculus: Decays and scattering, Decay rates, Cross sections, The Golden Rule (for decays), Two particle decays. Feynman rules for a Toy Theory, Muon decay and pion decay. Electrodynamics and Chromodynamics of Quarks: Quark-Quark, Quark-Antiquark, Pair annihilation in QCD, Asymptotic Freedom, Spontaneous symmetry breaking, Higgs mechanism. **(15 Lectures)**

Text Books/Reference Books:

1. Introduction to elementary particles by David J. Griffiths, John Wiley and Sons.
2. Introduction to Nuclear Physics by Samuel S. M. Wong.
3. Introduction to high energy physics by D. H. Perkins
4. Introductory Nuclear Physics by David Halliday and Robert Resnick.
5. The Standard Model of Particle Physics by David Griffiths.
6. Nuclear Physics - I. Kalplan, Narosa, Madras
7. Atomic nucleus - R. D. Evans, McGraw Hill, N York
8. Concepts of Nuclear Physics - B.L. Cohen, MGH, Bombay, 1971
9. Nuclear Physics - R.R. Roy and B.P. Nigam, Wiley- Eastern Ltd., 1983

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	1	1	2.29
2	3	2	3	3	3	1	1	2.29
Average PLO	**3**	**2**	**3**	**3**	**3**	**1**	**1**	**2.29**

Course Code		Course Title			Type of Course
MPH26-E308		**Advanced Electronic Materials and Devices**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs):

- **CLO 1:** choose suitable materials and emphasize the need for modern materials for specific applications. appreciate the fundamentals of advanced materials and their preparation/processing methods.
- **CLO2:** acquire knowledge about the sensors, wearable and flexible devices. formulate devices for electronic and biological applications.

UNIT – I

Materials considerations: Overview, inorganics, semiconductors, dielectrics, ferroelectrics, conductors - Electronic properties and quantum effects, organic molecules- Electronic structures, properties and reactions, polymers-conducting polymers. Synthesis, purification of organic, inorganic and hybrid materials, processing, film deposition methods, lithography, etching, chemical and mechanical polishing, analysis by direct and indirect methods.

(10 Lectures)

UNIT – II

Chemical, Bio Sensors, Information Display Materials and Technology

Introduction – systems design- challenges in chemical and biochemical sensing- Sensors and materials-obtained parameters -application areas and future scope. Principles of liquid crystal display, organic light emitting diodes, field emission, plasma display-materials –challenges and opportunities.

Flexible and Wearable Electronics

History of flexible electronics - Materials for flexible electronics: degrees of flexibility, Substrates-Materials and Technologies - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to-Roll processing - Additive printing. Wearable haptics- attributes of wearables – examples, challenges and opportunities. **(20 Lectures)**

Text Books/Reference Books:

1. Pradeep Fulay, Electronic, Magnetic and Optical Materials, CRC Press, Boca Raton (2010).
2. William S. Wong, Alberto Salleo, "Flexible Electronics: Materials and Applications",1st Edition, Springer, New York (2011).
3. Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 1st Edition, Academic Press, Cambridge (2014).
4. Rainer Waser, "Nanoelectronics and Information Technology Advanced Electronic Materials and Novel Devices", WILEY-VCH Verlag GmbH & Co. Weinheim, Germany (2003).
5. Gregory P. Crawford, "Flexible Flat Panel Displays", John Wiley & Sons Ltd., England (2005).
6. Yury Gogotsi, "Carbon Nanomaterials", CRC Press, Taylor & Francis group, Boca Raton,London, New York (2006).

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	1	2	2.42
2	3	3	3	3	3	3	2	2.85
Average PLO	**3**	**2.5**	**3**	**3**	**3**	**2**	**2**	**2.63**

Course Code		Course Title			Type of Course
MPH26-E309		**Quantum Computation and Information**			**E**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
2	**0**	**0**	**2**	**50**	**30**

Course Learning Objectives (CLOs):

- **CLO 1:** density operator, tensor product and state of composite systems, the importance of basic quantum gates.
- **CLO2:** tools for quantum information, possible physical realization of qubits.

UNIT – I

Postulates of quantum mechanics – qubit – Bloch sphere presentation – density operator – measurement – tensor product – composite system – reduced state – Schmidt decomposition – Bell's inequality. Models for computation – computational complexity – energy and computation – single qubit gates – two-qubit gates – toffoli gate – universal quantum gates – no cloning theorem. **(15 Lectures)**

UNIT – II

Super-dense coding – teleportation – quantum parallelism – Deutsch-Jozsa algorithm – Grover's quantum search. Environment and quantum operations – operator sum representation – examples of quantum noise – distance measures – trace distance – fidelity – Shannon entropy and properties – Von Neumann entropy and properties. **(15 Lectures)**

Text Books/Reference Books:

1. M.A. Neilsen, I.L Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Cambridge (2000).
2. J.Preskill, Lecture notes for Physics, Quantum computation (1999) . http://theory.caltech/edu/~preskill/ph229.
3. A. Peres, Quantum Theory: Concepts and Methods, Kluwer Academic Publishers, New York (2002).
4. P. Kaye, R. Laflamme and M. Mosca, An Introduction to Quantum Computing, Oxford University Press (2007).

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	1	3	2.57
2	3	3	3	3	3	3	3	3.0
Average PLO	**3**	**2.5**	**3**	**3**	**3**	**2**	**3**	**2.78**

Course Code	Course Title				Type of Course
MPH26-E351	**Lab-IV (Digital Electronics & Microprocessor Lab)**				**Laboratory**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**2**	**2**	**50**	**60**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Design and Study of multiplexer, flip-flops.
- **CLO 2:** Study of different ICs.
- **CLO 3:** Study the A/D, D/A converter.
- **CLO 4:** Study of basic instructions and programming for simple application of 8085 Microprocessor.

LIST OF EXPERIMENTS:

1. Construction and study of logic gates using diode and transistors
2. Study of pin connection, power supply requirement and truth tables of various digital IC's
3. Design and study of control combinational logic network
4. Design and study of different shift registers using IC's
5. Design and study of multiplexer for different modes using IC's
6. Design and study of demultiplexer for different modes
7. Design and study of decoders
8. Design and study of encoders
9. Design and study of different counter modes
10. Design and study of RS, D, JK and T flip-flops
11. Design and study of A/D converter
12. Design and study of D/A converter
13. Study of ITL 742121 as monostable Schmitt trigger
14. Design and study of decode and display circuit using 7448 and FND 507 or other LED 15. Study of basic instructions and programming for simple application of 8085 Microprocessor
15. Study of interfacing of 8251,8255, 8253, 8257 etc.
16. Study of addition, subtraction, multiplication & division using 8085/8086
17. Study of motor speed control, temperature control using 8085/8086
18. Design and study of active filters
19. Study of an experiment using various types of memory elements

Note:

1. Students are required to perform **10** experiments from the list.
2. In practical examination the student shall be required to perform **one** experiment.
3. Addition or deletion in the above lists may be made in accordance with the facilities available with the approval of H.O.D. Physics.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	2	2	2.57
2	3	3	3	3	3	2	2	2.71
3	3	3	3	2	3	2	2	2.57
4	3	3	3	3	3	2	2	2.71
Average PLO	**3**	**3**	**3**	**2.5**	**3**	**2**	**2**	**2.64**

Course Code		Course Title			Type of Course
MPH26-E352		**Lab-V (Communication Electronics Lab)**			**Laboratory**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**2**	**2**	**50**	**60**

Course Learning Objectives (CLOs): By the end of this course, students will be able to:

- **CLO 1:** Study of modulation and demodulation.
- **CLO 2:** Study of FM and radio receiver.
- **CLO 3:** Study of Antenna.
- **CLO 4:** Study of broadcast transmitter.

LIST OF EXPERIMENTS

1. Study of amplitude modulation & demodulation
2. Study of SSB modulation & demodulation
3. Study of frequency modulation & demodulation
4. Study of AGC and AVC
5. Study of simple radio receiver circuits using IC
6. Study of the characteristics of a superhetrodyne broadcast radio receiver
7. Study of FM receivers
8. Study of the sweep generator using SCR and UJT
9. Determination of antenna constants
10. Study of half wave antenna
11. Study of Marconi antenna
12. An elementary study of antenna array
13. Study of Yagi antenna
14. An elementary study of broadcast transmitter
15. An elementary study of coaxial and parallel transmission lines
16. Ionospheric study (i) critical frequency (ii) virtual height (iii) signal strength

Note:

1. Students are required to perform **ten** experiments from the list.
2. In practical examination the student shall be required to perform **one** experiment.
3. Addition or deletion in the above lists may be made in accordance with the facilities available with the approval of H.O.D. Physics.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	3	3	2	3	2	2	2.57
2	3	3	3	3	3	2	2	2.71
3	3	3	3	2	3	2	2	2.57
4	3	3	3	3	3	2	2	2.71
Average PLO	**3**	**3**	**3**	**2.5**	**3**	**2**	**2**	**2.64**

Semester-IV

(Research)

Course Code		Course Title			Type of Course
MPH26-D471		**Dissertation**			**D**
L	T	P	Total Credits	Max. Marks	Total Contact Hrs.
0	**0**	**20**	**20**	**500**	**720**

Course Learning Outcomes (CLOs): After successfully completing this course, students will be able to:

- **CLO1 (Formulate and Plan Research):** Identify an original research problem in physics, conduct a critical literature review, and develop a clear proposal with well-defined objectives and methodology.
- **CLO2 (Design and Apply Research Methodology):** Select and justify suitable experimental, theoretical, or computational approaches, ensuring rigor and reproducibility.
- **CLO3 (Execute Research Independently):** Carry out the planned research, operating relevant instruments, software, or analytical techniques while demonstrating initiative and autonomy.
- **CLO4 (Collect, Analyze, and Interpret Data**): Acquire and process data systematically, apply appropriate statistical and computational tools, and critically evaluate findings against theoretical expectations.
- **CLO5 (Develop Problem-Solving and Critical Thinking Skills):** Identify challenges, assess limitations, and propose evidence-based solutions or future research directions.
- **CLO6 (Communicate Scientific Work Effectively** – Prepare a well-structured dissertation with high academic writing standards, proper citations, and clear data presentation; confidently present and defend findings in oral examinations.
- **CLO7 (Exhibit Professionalism and Ethical Research Practices):** Demonstrate integrity, time management, responsible conduct of research, and effective collaboration with mentors and peers.
- **CLO8 (Discuss Broader Impacts of Research):** Articulate the significance of research outcomes for scientific advancement, industry applications, or addressing societal challenges.

CLO-PLO Matrix for the Course:

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	Average CLO
1	3	2	3	3	3	2	3	2.71
2	2	3	3	3	2	3	3	2.71
3	2	3	3	2	3	3	3	2.71
4	2	3	3	3	2	3	3	2.71
5	2	2	3	3	2	2	3	2.43
6	2	2	3	3	2	2	3	2.43
7	2	2	2	2	3	2	3	2.29
8	2	2	2	3	3	2	3	2.43
Average PLO	**2.125**	**2**	**2**	**3**	**3**	**2**	**3**	**2.55**

EVALUATION OF DISSERTATION (RESEARCH):

(i) The Research (Dissertation/Project/Patent) in IVth Semester of PG Programme carries 20 Credits which will carry 500 marks.

(ii) There will be only ESA for research (Dissertation/Project/Patent) in IVth semester. The research (Dissertation/project/patent) will be jointly evaluated by Internal Examiner and One External Examiner appointed by the Controller of Examinations. The obtained marks by the student will be forwarded by Head of the Department to the Controller of Examinations.

(iii) The Distribution of marks will be as follows for this component:

Dissertation/Project/Patent Report	**Presentation & Viva-Voce**	**Total Marks**
300 Marks (60% ESA)	200 Marks (40% ESA)	**500**