Semester IV

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Electromagnetism
COURSE CODE: PHYMJ-S4P8-2CR25 [CREDITS - 02]

CC VIII	COURSE CODE: PHYMJ-S4P8-2CR25
	Course Learning Outcomes

At the end of this course, students will be able to:

- explain the behavior of conductors and dielectrics in the presence of an external electric field, including dielectric polarization and the displacement field.
- analyze the properties of linear dielectrics and apply them to calculate energy and forces in dielectric environments.
- classify materials based on their magnetic properties and analyze the effects of magnetic fields on diamagnetic, paramagnetic, and ferromagnetic substances.
- derive and apply Ampere's law in the context of magnetized materials.

Unit I	Electric fields in Matter	[15L]

Learning Objectives:

This unit is intended to make the learners

- get familiarize with the concept polarization of dielectrics
- learn about bound charges and charge densities in dielectrics and field produced by them
- use expressions for energy and forces in the presence of dielectrics along with the boundary conditions to solve problems of electric fields in matter

Learning Outcomes:

At the end of this unit, learners will be able to:

- explain the behavior of conductors and dielectrics under external electric fields
- explain dielectric polarization and the displacement field, and analyze the properties of linear dielectrics
- derive expressions for energy and forces in systems involving dielectrics.

1.1	**Polarization (4.1):** Dielectrics (4.1.1), Induced Dipoles (4.1.2), Alignments of Polar molecules (4.1.3), Polarization (4.1.4)	**[3L]**
1.2	**The field of a polarized object (4.2):** Bound Charges (4.2.1), Physical interpretation of bound charges (4.2.2), The field inside a Dielectric (4.2.3)	**[4L]**
1.3	**The electric displacement (4.3):** Gauss's law in presence of dielectrics (4.3.1), A deceptive parallel (4.3.2), Boundary Conditions (4.3.3)	**[3L]**
1.4	**Linear dielectrics (4.4):** Susceptibility, permittivity, Dielectric Constant (4.4.1), Boundary value Problems with linear dielectrics (4.4.2), Energy in dielectric systems (4.4.3), Forces on dielectrics (4.4.4)	**[5L]**

Text book:

Introduction to Electrodynamics by David J. Griffiths, Pearson India Education, 4th Ed., 2015

Unit I	Magnetic fields in Matter	[15L]

Learning Objectives:

This unit is intended to help learners:

- classify materials based on magnetic properties and analyze the effects of magnetic fields on various substances
- understand the origin and interpretation of bound currents in magnetic materials
- apply and modify Ampere's law in the presence of magnetized materials.

Learning Outcomes:

At the end of this unit, learners will be able to

- classify materials based on their magnetic properties
- analyze the effect of magnetic fields on diamagnetic, paramagnetic, and ferromagnetic substances
- derive and apply Ampere's law in the context of magnetized materials.

2.1	**Magnetization (6.1):** Diamagnets, Paramagnets, Ferromagnets (6.1.1), Torques and Forces on Magnetic Dipoles (6.1.2), Effect of magnetic field on Atomic orbits (6.1.3), Magnetization (6.1.4).	**[6L]**
2.2	**The field of a magnetized object (6.2):** Bound Currents (6.2.1), Physical interpretation of Bound Currents (6.2.2), The Magnetic Field Inside Matter (6.2.3).	**[4L]**
2.3	**The Auxiliary Field H (6.3):** Ampere's Law in Magnetized Materials (6.3.1), A deceptive parallel (6.3.2), Boundary Conditions (6.3.3).	**[3L]**
2.4	**Linear and Non-linear media (6.4):** Magnetic Susceptibility and Permeability (6.4.1), Ferromagnetism (6.4.2).	**[2L]**

Text book:

Introduction to Electrodynamics by David J. Griffiths, Pearson India Education, 4th Ed., 2015

Reference Books:

- Electricity and Magnetism by Rangwala and Mahajan, Tata McGraw-Hill, Reprint 2001
- Electromagnetics by B. B. Laud, New Age International Publishers, 4th Ed., 2022
- Electricity and Magnetism by D. C. Tayal, Himalaya Publishing House, Revised Ed. 2009

Online Learning resources:

- https://onlinecourses.nptel.ac.in/noc19_ph08/preview
- https://ocw.mit.edu/courses/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/2ccccе322d387cccbc78c3ed65843f49_MITRES_6_002S08_chp03_text.pdf
- https://openlearninglibrary.mit.edu/courses/course-v1:MITx+8.02.1x+1T2019/about
- https://onlinecourses.nptel.ac.in/noc21_ee83/preview
- https://web.mit.edu/sahughes/www/8.022/lec23.pdf
- https://ocw.mit.edu/courses/res-6-001-electromagnetic-fields-and-energy-spring-2008/d4860fdc85d667828060e6d72e49a62f_09.pdf

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total
I	30%	30%	10%	20%	10%	-	100%
II	30%	30%	10%	20%	10%	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• Explain the behavior of conductors and dielectrics in the presence of an external electric field, including dielectric polarization and the displacement field.	√	√	√			
• Analyze the properties of linear dielectrics and apply them to calculate energy and forces in dielectric environments.	√	√			√	√
• Classify materials based on their magnetic properties and analyze the effects of magnetic fields on diamagnetic, paramagnetic, and ferromagnetic substances.	√	√				
• Derive and apply Ampere's law in the context of magnetized materials.	√	√	√		√	√

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Thermodynamics
COURSE CODE: PHYMJ-S4P9-2CR25 [CREDITS - 02]

CC IX	COURSE CODE: PHYMJ-S4P9-2CR25
	Course Learning Outcomes

At the end of this course, students will be able to:

- apply the concepts of free energy to predict reaction mechanisms and interpret the Clausius-Clapeyron relation along with the Van der Waals model.
- identify the steps involved in phase transformations of pure substances and mixtures.
- analyze the physical properties of dilute solutions and their significance in practical contexts.
- apply the concept of chemical equilibrium to explain natural phenomena such as nitrogen fixation and water dissociation.

Unit I	Free Energy and Thermodynamics-I	[15L]

Learning Objectives:

This unit is intended to make the learners

- familiarize with the concept of free energy
- learn about phase transformations of pure substances
- aware of the consequences of the Clausius-Clapeyron relation and the Van der Waals model.

Learning Outcomes:

At the end of this unit, learners will be able to

- apply the concepts of free energy to predict the possibilities of reaction mechanisms
- identify the steps involved during the phase transformations of pure substances
- interpret the Clausius-Clapeyron relation and the Van der Waals model.

1.1	Free energy as available work - electrolysis - fuel cells - batteries - thermodynamic identities (5.1), free energy as a force toward equilibrium - extensive and intensive quantities - Gibbs free energy and chemical potential (5.2), phase transformations of pure substances - phase diagram - diamonds and graphite - the Clausius-Clapeyron relation - the Van der Waals model (5.3).	**[15L]**

Text Book:

An Introduction to Thermal Physics by Daniel V. Schroeder, Oxford University Press, 2nd Ed., 2021.

Unit II	Free Energy and Thermodynamics-II	[15L]

Learning Objectives:

This unit is intended to make the learners

- study phase transformations of mixture in terms of free energy
- aware of dilute solution
- learn chemical equilibrium.

Learning Outcomes:

At the end of this unit, learners will be able to • identify the steps involved during the phase transformations of mixture • analyse physical properties of dilute solution • apply the concept of chemical equilibrium to natural phenomena such as nitrogen fixation and the dissociation of water.		
2.1	Phase Transformations of Mixtures (5.4): Free Energy of a Mixture, Phase Changes of a Miscible Mixture; Phase; Phase Changes of a Eutectic System, Dilute Solutions (5.5): Solvent and Solute Chemical Potentials; Osmotic Pressure; Boiling and Freezing Points, Chemical Equilibrium (5.6): Nitrogen Fixation; Dissociation of Water; Oxygen Dissolving in Water; Ionization of Hydrogen.	**[15L]**
Text book: An Introduction to Thermal Physics by Daniel V. Schroeder, Oxford University Press, 2nd Ed., 2021.		
Reference Books: ➢ Thermal Physics Kinetic Theory Thermodynamics and Statistical Mechanics by S.C. Garg, R.M. Bansal and C.K. Ghosh, 2nd Ed., McGraw Hill 2017. ➢ An Introduction to Thermal Physics by C. J. Adkins, 2nd Ed., Cambridge University Press, 1987. ➢ Thermal Physics by Rollen Frantz, Discovery Publishing House, 2024. **Online Learning resources:** • https://onlinecourses.nptel.ac.in/noc24_me63/preview • https://www.youtube.com/watch?v=OjhZYx1FbhI • https://www.youtube.com/watch?v=DPjMPeU5OeM • https://www.youtube.com/watch?v=huKBuShAa1w		

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total
I	30%	30%	10%	20%	10%	-	100%
II	30%	30%	10%	20%	10%	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• Apply the concepts of free energy to predict reaction mechanisms and interpret the Clausius-Clapeyron relation along with the Van der Waals model.	√	√	√			√
• Identify the steps involved in phase transformations of pure substances and mixtures.	√	√	√		√	√
• Analyze the physical properties of dilute solutions and their significance in practical contexts.	√	√			√	
• Apply the concept of chemical equilibrium to explain natural phenomena such as nitrogen fixation and water dissociation.	√	√	√		√	√

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Mechanics, Crystallography and Optoelectronics
COURSE CODE: PHYMJ-S4P10-4CR25 [CREDITS - 04]

CC X	COURSE CODE: PHYMJ-S4P10-4CR25
	Course Learning Outcomes

At the end of this course, students will be able to:

- analyze the behavior of charged particles in crossed electric and magnetic fields and explain the function of particle accelerators, magnetic focusing, and velocity selectors.
- describe the method for obtaining Thomson parabolas and interpret their use in studying charged particles
- explain the concept of central force motion and apply it to planetary systems, using Kepler's Laws and conservation of angular momentum
- use energy diagrams to analyze and solve problems related to the motion of objects under central forces
- define key crystallographic terms and identify various crystal systems, Bravais lattices, and symmetry elements
- describe crystal directions and planes using Miller indices and explain interatomic forces and types of bonding in solids
- apply Bragg's law and understand X-ray scattering techniques to investigate crystal structures
- explain the working principles and applications of optoelectronic devices, and analyze the operational conditions of LASERs.

Unit I	Dynamics of charged particles	[15L]

Learning Objectives:

This unit is intended to make the learners

- explain the fundamental concepts and properties of electric and magnetic fields
- analyze and describe the construction and working principles of particle accelerators, magnetic focusing systems, velocity selectors, and mass spectrographs.

Learning Outcomes:

At the end of this unit, learners will be able to:

- explain the behavior of charged particles in crossed electric and magnetic fields, including the principles of magnetic focusing and velocity selection
- analyze the construction, working, and significance of particle accelerators and interpret the method of obtaining and studying Thomson parabolas.

1.1	Some definitions and preliminary relations (4.3), Charged particle in a uniform and constant electric field (4.4), Charged particle in an alternating electric field (4.5), Linear accelerator (4.6), Charged particle in a uniform and constant magnetic field (4.7), The Cyclotron (4.8), Magnetic field focussing (4.9), Charged particle in a combined electric and magnetic field (4.10), Electric and magnetic fields in crossed configuration (4.11), Velocity Selector (4.12), Mass spectrographs (4.13), When electric and	**[15L]**

	magnetic fields in parallel configuration – Thomson parabolas (4.14), Determination of e/m for positive rays (4.15), Thomson's parabola method (4.16).	

Text book:

Mechanics by Prof. D. S. Mathur and Dr. P. S. Hemne, Revised Edition, S. Chand & Company Ltd., 2000

Unit II	**Central Force Motion**	**[15L]**

Learning Objectives:

This unit is intended to make the learners:

- understand the fundamental principles of classical mechanics, focusing on central force motion, and apply Kepler's Laws to planetary motion
- apply the concepts of central force motion to analyze real-world problems related to planetary orbits, using energy diagrams to solve related problems effectively.

Learning Outcomes:

At the end of this unit, learners will be able to:

- explain central force motion and its application to planetary systems, describing planetary motion and using Kepler's Laws to analyze the motion of celestial bodies
- apply the law of equal areas and conservation of angular momentum to solve problems, using energy diagrams to analyze and solve problems related to the motion of objects under central forces.

2.1	**Central Force Motion:** Introduction (9.1), Central Force Motion as a One Body Problem (9.2), General Properties of Central Force Motion, The Motion is Confined to a Plane; The Energy and Angular Momentum Are, Constants of the Motion; The Law of Equal Areas (9.3), Finding The Motion in Real Problems (9.4), The Energy Equation and Energy Diagrams (9.5), Planetary Motion (9.6), Kepler's Laws (9.7).	**[15L]**

Text book:

An Introduction To Mechanics by Daniel Kleppner and Robert J. Kolenkow, McGraw Hill Education, 1st Ed., 2017

Unit III	**Crystal Structure**	**[15L]**

Learning Objectives:

This unit is intended to make the learners:

- understand the fundamentals of crystallography, including its significance in material science, the nature of crystalline solids, key crystallographic terminology, and the 14 Bravais lattices and seven crystal systems
- explore crystal structures through Miller indices, interatomic forces, and X-ray generation and absorption, applying Bragg's law and principles of scattering to study crystal structures.

Learning Outcomes:

At the end of this unit, learners will be able to:

• explain key crystallographic terms and understand the basic concepts of crystallography, including crystal systems, Bravais lattices, symmetry elements, and the use of Miller indices to describe crystal directions and planes • explain interatomic forces and bonding types in solids, and apply Bragg's law and X-ray scattering principles to study material structures.		
3.1	**Crystal Structure and Interatomic Forces**: Introduction (1.1), The crystalline state (1.2), Basic definitions (1.3), The fourteen Bravais lattice and the seven crystal systems (1.4), Elements of Symmetry (1.5), Nomenclature of crystal directions and crystal planes, Miller indices (1.6), Examples of simple crystal structures (1.7), Amorphous solids and liquids (1.8), Interatomic forces (1.9), Types of bonding (1.10).	**[10L]**
3.2	**X-ray, Neutron and Electron Diffraction in Crystals**: Introduction (2.1), Generation and absorption of x-rays (2.2), Bragg's law (2.3), Scattering from an atom (2.4), Scattering from a crystal (2.5).	**[5L]**
Text book: Elementary Solid State Physics: Principles and Applications by M. Ali Omar, Addison-Wesley, 1994.		
Unit IV	**Optoelectronic Devices**	**[15L]**
Learning Objectives: This unit is intended to make the learners • study various optoelectronic devices such as photodiodes, LEDs and semiconductor LASERs • understand applications of optoelectronic devices.		
Learning Outcomes: At the end of this unit, learners will be able to • understand the working principles and applications of various optoelectronic devices. • Explain the working principles and illustrate the applications of various optoelectronic devices.		
4.1	**Photodiodes (8.1):** Current and voltage in an Illuminated Junction (8.1.1), Solar Cells (8.1.2), Photodetectors (8.1.3), Gain, Bandwidth, and Signal-to-noise ratio of Photodetectors (8.1.4).	**[4L]**
4.2	**Light-emitting diodes (8.2):** Light-emitting Materials (8.2.1) Fiber-Optic Communications (8.2.2).	**[2L]**
4.3	**Lasers (8.3):** Lasing action, Einstein coefficients.	**[3L]**
4.4	**Semiconductor Lasers (8.4):** Population Inversion at a Junction (8.4.1), emission Spectra for p-n Junction Lasers (8.4.2), The Basic Semi-conductor Laser (8.4.3), heterojunction Lasers (8.4.4), Materials for Semiconductor Lasers (8.4.5) Quantum Cascade Lasers (8.4.6).	**[6L]**
Text book: Solid State Electronic Devices by Ben G. Streetman and Sanjay Kumar Banerjee, 7th Ed., Pearson, 2018.		

Reference Books:

- Classical Mechanics by J. C. Upadhyaya, 3rd Ed., Himalaya Publishing House, 1999.
- Classical Mechanics by Tai L. Chaw, 2nd Ed., CRC Press, 2013.
- Classical Dynamics of Particles and Systems by J. B. Marion and S. T. Thronton, 5th Ed., Saunders College Publishing, 1995.
- Introduction to Classical Mechanics by Puranik and Takwale, McGraw Hill Education, 1st Ed., 2017
- Introduction to Solid State Physics by C. Kittel, 8th Ed., John Wiley and Sons, 2005.
- Solid State Physics by S.O. Pillai, 8th Ed., New Age International Publishers, 2011.
- Solid State Physics: Structure and Properties of Materials by M. A. Wahab, 2nd Ed., Alpha Science Intl. Ltd., 2005.
- Lasers and Non-linear Optics by B. B. Laud, New Age International Private Limited, 1st Ed., 2011
- Optoelectronics: An Introduction to Materials and Devices by Jasprit Singh, McGraw-Hill Education, 2016.
- Optoelectronic Devices and Systems by S. C. Gupta, PHI Learning, 2nd Ed., 2015

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc24_me148/preview
- https://www.damtp.cam.ac.uk/user/tong/relativity/four.pdf
- https://www.youtube.com/watch?v=YXk-mcS2np4
- https://www.youtube.com/watch?v=d_dasJl8GrA
- https://www.phase-trans.msm.cam.ac.uk/2001/intro.cryst.pdf
- https://shorturl.at/cJGu5

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	30%	30%	10%	20%	10%	-	100%
II	30%	30%	10%	20%	10%	-	100%
III	30%	30%	10%	20%	10%	-	100%
IV	30%	30%	10%	20%	10%	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• Analyze the behavior of charged particles in crossed electric and magnetic fields and explain the function of particle accelerators, magnetic focusing, and velocity selectors.	√	√	√			
• Describe the method for obtaining Thomson parabolas and interpret their use in studying charged particles.	√	√	√		√	√
• Explain the concept of central force motion and apply it to planetary systems, using Kepler's Laws and conservation of angular momentum.	√	√			√	
• Use energy diagrams to analyze and solve problems related to the motion of objects under central forces.	√	√				√
• Define key crystallographic terms and identify various crystal systems, Bravais lattices, and symmetry elements.	√	√	√		√	
• Describe crystal directions and planes using Miller indices and explain interatomic forces and types of bonding in solids.	√	√	√			√
• Apply Bragg's law and understand X-ray scattering techniques to investigate crystal structures.	√	√			√	
• Explain the working principles and applications of optoelectronic devices, and analyze the operational conditions of LASERs.	√	√			√	

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Physics Practical - VII
COURSE CODE: PHYMJ-S4PR7-2CR25 [CREDITS - 02]

Practical VII	**Course Code: PHYMJ-S4PR7-2CR25**
	Course Learning Outcomes

After the successful completion of the course, learners will be able to

- demonstrate practical skills
- correlate the Physics theory concepts through practical

1	To calculate the potential energy, kinetic energy and mechanical energy of the given SHO and to plot the graphs of these quantities versus its displacement.
2	To determine phase angle between voltage and current using voltage vector triangle for an RC circuit.
3	To study oscillations of parallel combination of two springs.
4	To find impedance, inductive reactance and capacitive reactance of an LCR ac series network for two different frequencies.
5	To determine the self-inductance of a coil by Anderson's bridge.
6	To determine the capacitance of a capacitor using Schering bridge.
7	To study parallel resonance in an LCR circuit.
8	To obtain absolute value of capacitance by using a BG.
9	To determine the resistance of a BG.
10	To determine “Y” of a beam by the method of vibration.
11	To study oscillations of a bar pendulum.
12	To study Owen's bridge.
13	To obtain cardinal points of a lens system of two thin lenses.
14	To determine low resistance by using a Carey-Foster’s bridge.

Reference Books:

- Advanced Practical Physics by B. L. Worsnop and H. T. Flint, Asia Publishing House, New Delhi, 3rd Ed., 2021
- B. Sc. Practical Physics by C. L. Arora, S. Chand & Co., Reprint Ed., 2010
- University Practical Physics by D. C. Tayal, Edited by Ila Agarwal, 1st Ed., Himalayan Publishing House, 2000.
- A Laboratory Manual of Physics for Undergraduate Classes by D. P. Khandelwal, Vani Publication House, New Delhi, 1st Ed., 1985.
- B. Sc. Practical Physics by Geeta Sanon, R. Chand & Co., 1st Ed., 2007.

Online Learning resources:

- https://www.olabs.edu.in/
- https://vlab.amrita.edu/index.php?sub=1
- https://alllabexperiments.com/physics_practical_files/

Note:

- The duration of each experiment is of 2 hours. Two such experiments are to be performed by each student per week.
- In the external exam, a student will have to perform two experiments, one from each group. The experiment will be of 2-hour duration.
- There should be two examiners, one for each group, in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• demonstrate practical skills	√	√		√	√	√
• utilize Physics theory concepts with appropriate practical	√	√			√	

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Physics Practical - VIII
COURSE CODE: PHYMJ-S4PR8-2CR25 [CREDITS - 02]

Practical VIII	**Course Code: PHYMJ-S4PR8-2CR25**
	Course Learning Outcomes

After the successful completion of the course, learners will be able to

- demonstrate practical skills
- correlate the Physics theory concepts through practical

1	To determine refractive index of different transparent liquids using a hollow prism.
2	To determine k_B/e using a power transistor.
3	To determine stopping potential of a metal using photocell.
4	To study characteristics of JFET.
5	To determine the resolving power of a telescope.
6	To determine wavelength of spectral lines of a mercury source by using plane transmission grating. (For normal incidence).
7	To study UJT relaxation oscillator for different frequencies.
8	To determine lattice parameters of a cubic single crystal structure. (From its XRD pattern).
9	To determine spherical aberration due to a plano-convex lens.
10	To study binomial probability distribution.
11	To study phonon dispersion.
12	To study line spectrum of He/Ne source and determine the wavelength of visible lines in the spectrum.
13	To find energy band gap of a semiconducting material.
14	To study exponential decay using random numbers.

Reference Books:

- Advanced Practical Physics by B. L. Worsnop and H. T. Flint, Asia Publishing House, New Delhi, 3rd Ed., 2021
- B. Sc. Practical Physics by C. L. Arora, S. Chand & Co., Reprint Ed., 2010
- University Practical Physics by D. C. Tayal, Edited by Ila Agarwal, 1st Ed., Himalayan Publishing House, 2000.
- A Laboratory Manual of Physics for Undergraduate Classes by D. P. Khandelwal, Vani Publication House, New Delhi, 1st Ed., 1985.
- B. Sc. Practical Physics by Geeta Sanon, R. Chand & Co., 1st Ed., 2007.

Online Learning resources:

- https://www.olabs.edu.in/
- https://vlab.amrita.edu/index.php?sub=1
- https://alllabexperiments.com/physics_practical_files/

Note:

- The duration of each experiment is of 2 hours. Two such experiments are to be performed by each student per week.
- In the external exam, a student will have to perform two experiments, one from each group. The experiment will be of 2-hour duration.
- There should be two examiners, one for each group, in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• demonstrate practical skills	√	√	√	√	√	√
• utilize Physics theory concepts with appropriate practical	√	√			√	

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Rotational and Oscillatory Motions
COURSE CODE: PHYMN-S4P3-2CR25 [CREDITS - 02]

MN III	COURSE CODE: PHYMN-S4P3-2CR25
	Course Learning Outcomes

At the end of this course, students will be able to:

- apply the fundamental concepts of rotational motion, including angular displacement, velocity, acceleration, and vector representations to solve related problems.
- solve problems in rotational dynamics by applying Newton's second law, calculating rotational inertia, and evaluating torque and equilibrium conditions.
- identify the principles of simple harmonic motion, including energy conservation, damped motion, and forced oscillations, with real-world applications.
- analyze the relationship between translational and rotational motion to solve complex motion scenarios.
- apply concepts of rotational dynamics to practical physics problems involving objects in motion.
- evaluate the effects of forces on rotational motion and simple harmonic systems in real-world contexts.

Unit-I	Rotational Motion	[15L]

Learning Objectives:

This unit is intended to make the learners:

- study the key concepts of rotational motion, including the representation of rotational quantities as vectors, the relationship between linear and angular variables, and motion with constant angular acceleration.
- understand torque and its role in generating rotational motion, and explore its applications in equilibrium and non-equilibrium situations for rotational systems.
- learn the relationship between rotational inertia and Newton's second law, and apply these concepts to solve problems involving combined translational and rotational motion.

Learning Outcomes:

At the end of this unit, learners will be able to:

- describe key concepts and variables in rotational motion, including the representation of rotational quantities as vectors and the application of vector relationships to solve problems.
- apply Newton's second law to rotational dynamics, calculate rotational inertia, and solve problems related to torque, including torque due to gravity.
- analyze combined translational and rotational motion and apply these principles to solve real-world problems involving both types of motion.

1.1	**Rotational Kinematics** Rotational Motion (8.1), The Rotational Variables (8.2), Rotational Quantities as Vectors (8.3), Rotation with Constant Angular Acceleration	[07L]

	(8.4), Relationships between Linear and Angular Variables (8.5), Vector Relationships between Linear and Angular Variables (8.6)	
1.2	**Rotational Dynamics** Torque (9.1), Rotational Inertia and Newton's Second Law (9.2), Rotational Inertia of Solid Bodies (9.3), Torque due to Gravity (9.4), Equilibrium Applications of Newton's Laws for Rotation (9.5), Non-equilibrium Applications of Newton's Laws for Rotation (9.6), Combined Rotational and Translational Motion (9.7)	**[08L]**
Text book: Physics by Halliday, Resnik and Krane, Vol. 1, 5th Ed., Wiley. 2017		
Unit II	**Oscillatory Motion**	**[15L]**

Learning Objectives:

This unit is intended to make the learners:

- study the concept of oscillatory systems and simple harmonic motion (SHM), including the principles of energy and conservation in SHM.
- understand damped harmonic motion and analyze the effects of damping on oscillatory systems.
- learn about forced oscillations and resonance, exploring practical examples of these phenomena in real-world systems.

Learning Outcomes:

At the end of this unit, learners will be able to:

- explain the fundamental characteristics of oscillatory systems and simple harmonic motion (SHM), including energy calculations and the concept of energy conservation.
- analyze damped harmonic motion and understand the role of damping forces in oscillatory systems.
- describe forced oscillations and resonance, and identify practical examples of these phenomena in real-world systems.

2.1	**Oscillatory Motion**: Oscillating systems (17.1), The simple harmonic Oscillator (17.2), Simple harmonic Motion (17.3), Energy in simple Harmonic motion (17.4), Applications of simple Harmonic motion (17.5), Simple harmonic Motion and uniform circular Motion (17.6), Damped harmonic Motion (17.7), Forced oscillations and resonance (17.8)	**[15L]**
Text book: Physics by Halliday, Resnik and Krane, Vol. 1, 5th Ed., Wiley. 2017		

Reference Books:

- Concepts of Physics by H C Verma, vol. 1 and 2, Bharati Bhawan, 2016.
- University Physics with Modern Physics by Young Hugh D. and Freedman Roger A., 14th Ed., Pearson Education, 2017.

Online Resources:

- https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-10-rotational-motion/
- https://pages.physics.ua.edu/staff/fabi/ph101/classnotes/8RotD101.pdf

- https://ocw.mit.edu/courses/8-03sc-physics-iii-vibrations-and-waves-fall-2016/pages/part-i-mechanical-vibrations-and-waves/lecture-1/

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	40%	40%	20%	-	-	-	100%
II	40%	40%	20%	-	-	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• Apply the fundamental concepts of rotational motion, including angular displacement, velocity, acceleration, and vector representations to solve related problems.	√	√	√			
• Solve problems in rotational dynamics by applying Newton's second law, calculating rotational inertia, and evaluating torque and equilibrium conditions.	√	√	√		√	√
• Identify the principles of simple harmonic motion, including energy conservation, damped motion, and forced oscillations, with real-world applications.	√	√	√		√	√
• Analyze the relationship between translational and rotational motion to solve complex motion scenarios.	√	√	√		√	
• Apply concepts of rotational dynamics to practical physics problems involving objects in motion.	√	√			√	√
• Evaluate the effects of forces on rotational motion and simple harmonic systems in real-world contexts.	√	√			√	

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Physics Practical - III
COURSE CODE: PHYMN-S4PR3-2CR25 [CREDITS - 02]

Practical VIII	Course Code: PHYMN-S4PR3-2CR25
	Course Learning Outcomes

After the successful completion of the course, learners will be able to

- demonstrate practical skills
- utilize Physics theory concepts through practical

1	To determine moment of inertia of a circular disc using torsional pendulum (η to be given).
2	To determine k_B/e using a power transistor.
3	To determine moment of inertia of a flywheel.
4	To determine resolving power of a telescope.
5	To verify the perpendicular axes theorem of moment of inertia for a laminar body.
6	To verify the parallel axes theorem of moment of inertia.
7	To determine self-inductance of an inductor using Maxwell' s bridge.
8	To determine spherical aberration of a plano-convex lens.
9	To study simple harmonic motion.
10	To study bar pendulum.
11	To determine moment of inertia of different specimen using bifilar suspension method.
12	To determine Young's modulus of a beam by the method of elevation.
13	To study characteristics of LDR.
14	To study ballistic pendulum. (Amrita Lab.).

Reference Books:

- Advanced Practical Physics by B. L. Worsnop and H. T. Flint, Asia Publishing House, New Delhi, 3rd Ed., 2021
- B. Sc. Practical Physics by C. L. Arora, S. Chand & Co., Reprint Ed., 2010
- University Practical Physics by D. C. Tayal, Edited by Ila Agarwal, 1st Ed., Himalayan Publishing House, 2000.
- A Laboratory Manual of Physics for Undergraduate Classes by D. P. Khandelwal, Vani Publication House, New Delhi, 1st Ed., 1985.
- B. Sc. Practical Physics by Geeta Sanon, R. Chand & Co., 1st Ed., 2007.

Online Learning resources:

- https://www.olabs.edu.in/
- https://vlab.amrita.edu/index.php?sub=1
- https://alllabexperiments.com/physics_practical_files/

Note:

- The duration of each experiment is of 2 hours. Two such experiments are to be performed by each student per week.
- In the external exam, a student will have to perform two experiments, one from each group. The experiment will be of 2-hour duration.
- There should be two examiners, one for each group, in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• demonstrate practical skills	√	√	√	√	√	√
• utilize Physics theory concepts with appropriate practical	√	√			√	

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Programming in "C" Language - IV
COURSE CODE: PHYSEC-S4P7-2CR25 [CREDITS - 02]

SEC VII	Course Code: PHYSEC-S4P7-2CR25
	Course Learning Outcomes

At the end of this unit, learners will be able to

- understand how to use if-else statements to control program flow based on conditions.
- apply array operations and conditional statements to real-world problems, such as data analysis and processing.
- apply how to read the data from file and dump data into file
- apply to read and write files using functions like fscanf(), fprintf(), fread(), and fwrite().

Learning outcomes:

At the end of this unit, learners will be able to

- use conditional statements to control program flow based on conditions.
- design and implement file-based data storage systems using C.

	Programming in "C" Language - IV	[60L]

To formulate algorithm, draw a flow chart and write a program for the following:	
1	Numerical Integration using Simpson 1/3 method
2	Numerical Integration using Simpson 3/8 method
3	Runge-Kutta second order method to solve the differential equation.
4	Runge-Kutta fourth order method to solve the differential equation.
5	Two dimensional dynamics of a body moving under gravity (projectile motion) with drag force.
6	Rutherford scattering experiment
7	Trajectory of an electron in H^{2+} ion
8	Decay of charge in R-C circuit.
9	Current in L-R circuit.
10	Project work (equivalent to 5 experiments)

Reference Books:

➢ Computer Programming in C by V. Rajaraman, 2nd Ed., PHI Learning Pvt. Ltd., 1994.

Online Learning resources:

- https://ocw.mit.edu/courses/6-087-practical-programming-in-c-january-iap-2010/
- https://www.coursera.org/specializations/c-programming
- https://www.learn-c.org/

Note:

➢ The duration of each experiment is of 2 hours. Two experiments are to be

performed by each student per week.

- In the external exam, a student will have to perform one experiment and also needs to appear for project viva. The experiment will be of 2-hour duration.
- The batch for external examination shall have maximum 20 students.
- There should be two examiners in the external examination.
- There should not be more than 10 students per examiner per session in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
• understand how to use if-else statements to control program flow based on conditions.		√	√		√	√
• apply array operations and conditional statements to real-world problems, such as data analysis and processing.		√			√	
• apply how to read the data from file and dump data into file		√	√		√	√
• apply to read and write files using functions like fscanf(), fprintf(), fread(), and fwrite().		√	√		√	√

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Basic Electronic Circuits and Designing - II
COURSE CODE: PHYSEC-S4P8-2CR25 [CREDITS - 02]

SEC VIII	COURSE CODE: PHYSEC-S4P8-2CR25
	Course Learning Outcomes

At the end of this course, students will be able to

- design PCB with the skills necessary for effective bread board design, leading to successful project implementation in various applications
- use software to design the circuit
- design a prototype electronic circuit for rectifier, filter and regulators

	Printed Circuit Design and Techniques (Practical)	**[60L]**

Learning objectives:

This unit is intended to make the learners

- design a small project based on basic electronics.
- design logic gates using diodes and transistor.

Learning outcomes:

At the end of this unit, learners will be able to

- design, build and test and troubleshoot a circuit design built on Bread-board.
- use software to design the circuit.

1. Design an AND gate using diodes. 2. Design an OR gate using diodes. 3. Design a NOT gate using transistors. 4. Design an AND gate using transistors. 5. Design an OR gate using transistors. 6. Design temperature to frequency convertor using IC-555 and a thermistor. 7. Design, build and test CB amplifier. 8. Design, build and test CE amplifier. 9. Design Ex-OR gate using NAND gates. 10. Design Ex-OR gate using basic logic gates. 11. Design seven segment using LEDs. 12. Determine the Plank's constant using LEDs. 13. Project work (Equivalent to 5 Experiment).	**[60L]**

Reference Books:

➢ Electrical Technology by B L Theraja, Vol. 1, S. Chand Co., 24th Ed., 2024.

Online Learning Resources:

- https://be-iitkgp.vlabs.ac.in/
- https://de-iitr.vlabs.ac.in/

Note:

➢ The duration of each experiment is of 2 hours. Two experiments are to be performed by each student per week.

- In the external exam, a student will have to perform one experiment and also needs to appear for project viva. The experiment will be of 2-hour duration.
- The batch for external examination shall have maximum 20 students.
- There should be two examiners in the external examination.
- There should not be more than 10 students per examiner per session in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• design PCB with the skills necessary for effective bread board design, leading to successful project implementation in various applications	√	√	√		√	√
• use software to design the circuit	√	√	√		√	
• design a prototype electronic circuit for rectifier, filter and regulators	√	√	√		√	√

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Instrumentation Laboratory Skills – II
COURSE CODE: PHYSEC-S4P9-2CR25 [CREDITS - 02]

SEC IX	COURSE CODE: PHYSEC-S4P9-2CR25	
	Course Learning Outcomes	

At the end of this course, students will be able to

- design, build and test instrument which pick up the physical parameter to be converted to measurable electrical parameter
- use software to design the circuit

	Instrumentation (Practical)	**[60L]**

Learning objectives:

This unit is intended to make the learners

- design how "pick up" materials work, i.e., transducer
- learn about amplifies and microprocessor

Learning outcome:

At the end of this unit, learners will be able to

- design, build and test instrument which pick up the physical parameter to be converted to measurable electrical parameter.
- use software to design the circuit.

	1. To find absorption coefficient of liquid. 2. To verify inverse square law of radiation for a photo-electric cell. 3. To find figure of merit of a BG. 4. To design voltage divider bias amplifier using transistor. 5. To find nodal points of a two lens system. 6. To study LVDT transducer for displacement measurement. 7. To study resistance temperature detector for temperature measurement. 8. To calibrate thermistor for temperature measurement. 9. To study displacement measurement using a capacitor transducer. 10. To measure pressure using a pressure gauge. 11. To calibrate strain gauge for temperature measurement. 12. To convert digital signals to analogue signals using R-2R network. 13. To convert analogue signals to digital signals using ADC 0804 IC. 14. To write programs of addition and subtraction using 8085 simulators. 15. To study integrator and differentiator amplifiers using 741 Op Amps. 16. To study summing and subtracting amplifiers using 741 Op Amps. 17. To study instrument amplifier using 741 Op-Amps.	**[60L]**

Reference Books:

- Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar, 5th Ed., Prentice Hall, 2002
- A Course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, Dhanpat Rai & Co. Publication 2023

Online Learning Resources:

- https://sil-coep.vlabs.ac.in/
- https://nptel.ac.in/courses/108105064

Note:

- The duration of each experiment is of 2 hours. Two experiments are to be performed by each student per week.
- In the external exam, a student will have to perform two experiments. The experiment will be of 2-hour duration.
- The batch for external examination shall have maximum 20 students.
- There should be two examiners in the external examination.
- There should not be more than 10 students per examiner per session in the external examination.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• design, build and test instrument which pick up the physical parameter to be converted to measurable electrical parameter	√	√	√		√	√
• use software to design the circuit	√	√	√		√	√

B. Sc. (Physics) SEMESTER IV
COURSE TITLE: Vedic Perspectives of Astronomy
COURSE CODE: PHYBKS-S4P2-2CR25 [CREDITS - 02]

BKS II	COURSE CODE: PHYBKS-S4P2-2CR25	
	Course Learning Outcomes	

At the end of this course, students will be able to

- describe the key contributions of ancient Indian civilization to the field of astronomical observation and time measurement.
- explain the astronomical concepts from the Vedic period, including the calculation of time units, Yugas and the understanding of comets, meteors and planets
- identify and define the basic features and terminologies of Vedanga Jyotisha, including the division of the year and the significance of Nakshatras and the Moon's motion.
- analyze the contributions of ancient scholars like Parasara and Garga and understand their influence on Vedic and Vedanga astronomical knowledge.

Unit I	Ancient Indian Civilization and Astronomical Observation	[15L]

Learning Objectives:

This unit is intended to:

- introduce learners to the history of ancient Indian civilization and its contributions to astronomical observation.
- explore the development of astronomy during the Vedic period, including the concepts of time, Yugas and celestial phenomena like comets, meteors and planets.

Learning Outcomes:

At the end of this unit, learners will be able to:

- describe the key contributions of ancient Indian civilization to the field of astronomical observation and time measurement.
- explain the astronomical concepts from the Vedic period, including the calculation of time units, Yugas, and the understanding of comets, meteors, and planets.

1	Brief Introduction to Ancient Indian Civilization and Astronomical Observation, Astronomy During the Vedic Period, Antiquity of Rigveda: Day and Month; Five Year Yuga, Ayanas; Month and Year; Seasons; Vedic Altars; Time Units; Comets, Meteors and Planets.	**[15L]**

Text book:

History of Science in India, Vol. I : Part II, Astronomy by Prof. Amitabha Ghosh, The National Academy of Sciences, India and The Ramkrishna Mission institute of Culture, Kolkata. 2017

Unit II	Astronomy During Vedanga Period	[15L]

Learning Objectives:

This unit is intended to:

- examine the basic features and terminologies of Vedanga Jyotisha, including the division of the year, Nakshatras and the Moon's motion.
- discuss key astronomical texts from the Mahabharata, and the contributions of scholars like Parasara and Garga to the understanding of celestial bodies.

Learning Outcomes:

At the end of this unit, learners will be able to:

- identify and define the basic features and terminologies of Vedanga Jyotisha, including the division of the year and the significance of Nakshatras and the Moon's motion.
- analyze the contributions of ancient scholars like Parasara and Garga, and understand their influence on Vedic and Vedanga astronomical knowledge.

2	Astronomy During Vedanga Period: Antiquity and The Location of Vedanga Jyotisha Composition; Basic Features of Vedanga Jyotisha; Terminologies in Vedanga Jyotisha; Division of Year; Nakshatra Part (BH-AMSA); the measure of division; The Moon's motion; Mahabharata, Parasara and Garga.	**[15L]**

Text book:

History of Science in India, Vol. I : Part II, Astronomy by Prof. Amitabha Ghosh, The National Academy of Sciences, India and The Ramkrishna Mission institute of Culture, Kolkata. 2017

Reference Books:

- Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat. PHI Learning 2022.
- Indian Knowledge Systems: Vol. 1 & Vol. 2 by Kapil Kapoor and Awadhesh Kumar Singh. 1st Ed., D.K. Print World Ltd 2005.
- Introduction to Indian Knowledge System by Dr. Rohidas Nitonde, Notion Press 2024.

Online Learning Resources:

- https://archive.nptel.ac.in/courses/121/104/121104006/

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	40%	40%	20%	-	-	-	100%
II	40%	40%	20%	-	-	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• describe the key contributions of ancient Indian civilization to the field of astronomical observation and time measurement.	√	√				
• explain the astronomical concepts from the Vedic period, including the calculation of time units,	√	√				

Yugas and the understanding of comets, meteors and planets						
• identify and define the basic features and terminologies of Vedanga Jyotisha, including the division of the year and the significance of Nakshatras and the Moon's motion.	√	√				
• analyze the contributions of ancient scholars like Parasara and Garga and understand their influence on Vedic and Vedanga astronomical knowledge.	√	√				