SYLLABUS

for

Semester V

Program: B. Sc.

Course: Physics

Effective from

Academic Year

2026-27

Board of Studies in Physics

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Prof. Sadanand Sutar	Chairperson	Sir P. T. Sarvajanik College of Science
All Faculty Members of the Department			
1	Prof. Vireshkumar Thakkar	Associate Professor	Sir P. T. Sarvajanik College of Science
2	Dr. Nisha Patel	Assistant Professor	Sir P. T. Sarvajanik College of Science
3	Dr. Dhiraj Shah	Assistant Professor	Sir P. T. Sarvajanik College of Science
4	Prof. Bhupeshkumar Lad	Associate Professor	Sir P. T. Sarvajanik College of Science
5	Dr. Naveen Kumar Singh	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
6	Dr. Jenishkumar Patel	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
Subject Expert nominated by Vice-Chancellor			
1	Dr. Arvind Bajaj	Nominated Member	V. S. Patel College of Arts & Science, College Campus, Morarji Desai Marg, Bilimora
Subject Experts			
1	Prof. Smita L. Survase	Nominated Member	Sant Rawool Maharaj Mahavidyalay, Tal-Kudal, Dist.-Sindhudurg, Maharashtra
2	Prof. Mahesh Shetti	Nominated Member	Wilson College (Autonomous), Mumbai
3	Prof. Debesh R. Roy	Nominated Member	Sardar Vallabhbhai National Institute of Technology, Surat
Representative from Industry/corporate sector/allied area			

1	Mr. Gopal Singh Panwar	Nominated Member	Officer, Human Resources, L & T Defence IC, Hazira, Surat
Meritorious Alumnus			
1	Mr. Darshankumar Jagdishbhai Gabani	Nominated Member	R & D Division, Lucan Techno, Katargam, Surat
Expert from other than the parent University			
1	Prof. Chetan Limbachia	Nominated Member	M. S. University, Vadodara

Acknowledgement

At the outset, I would like to thank our, Principal Dr. Pruthul Desai for his guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Physics for the long and arduous work they have put in during the compiling of the restructured syllabus.

Prof. S. A. Sutar

(Chairperson, Board of Studies in Physics)

Graduate Attributes:

After the successful completion of modules in different courses of B. Sc. PHYSICS, the learner will be able to:

GA 1: Apply Physics concepts and acquired skill sets to novel and unknown problems in order to establish an effective approach or strategy for dealing with them.

GA 2: Explore and derive quantitative data in the realms of Physics.

GA 3: Collect, analyse, and interpret scientific data in the realms of Physics using modern experimental apparatus and research methods.

GA 4: Develop Psycho-motive, analytical, observation skills through lab work

GA 5: Approach any real-life problem with proper assumption, logic and constraints.

GA 6: Prepare for jobs, career development, and lifelong learning in Physics, by using acquired ICT skills, Physics practical skills, and mathematical skills.

Programme Specific Outcomes:

PSO 1: Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PSO 2: Problem solving: Execute a solution process using the first principles of science to solve problems related to respective discipline.

PSO 3: Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in their discipline.

PSO 4: Ethics: Apply the professional ethics and norms in the respective discipline.

PSO 5: Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.

PSO 6: Communication: Communicate effectively with the stake holders and give and receive clear instructions.

Sr. No	COURSE NUMBER	COURSE CODE	COURSE NAME
Semester V			
1	CC XI	PHYMJ-S5P11-2CR26	Classical Mechanics
2	CC XII	PHYMJ-S5P12-2CR26	Modern Physics
3	CC XIII	PHYMJ-S5P13-2CR26	Nuclear Physics
4	CC PRACTICAL IX	PHYMJ-S5PR9-2CR26	Physics Practical – IX
5	CC PRACTICAL X	PHYMJ-S5PR10-2CR26	Physics Practical – X
6	CC PRACTICAL XI	PHYMJ-S5PR11-2CR26	Physics Practical – XI
7	MN IV	PHYMN-S5P4-2CR26	Python Programming
8	MN V	PHYMN-S5P5-2CR26	Electronics
9	MN PRACTICAL IV	PHYMN-S5PR4-2CR26	Physics Practical – IV
10	MN PRACTICAL V	PHYMN-S5PR5-2CR26	Physics Practical – V
Semester VI			
1	CC XIV	PHYMJ-S6P14-2CR26	Solid State Physics and Theory of Relativity
2	CC XV	PHYMJ-S6P15-2CR26	Electrodynamics and Optics
3	CC XVI	PHYMJ-S6P16-2CR26	Statistical Mechanics
4	CC PRACTICAL XII	PHYMJ-S6PR12-2CR26	Physics Practical – XII
5	CC PRACTICAL XIII	PHYMJ-S6PR13-2CR26	Physics Practical – XIII
6	CC PRACTICAL XIV	PHYMJ-S6PR14-2CR26	Physics Practical – XIV
7	MN VI	PHYMN-S6P6-2CR26	Nuclear Physics
8	MN PRACTICAL VI	PHYMN-S6PR6-2CR26	Physics Practical – VI
9	INTERNSHIP	PHYINT-S6P1-4CR26	INTERNSHIP

B. Sc. (Physics) SEMESTER V
COURSE NAME: Classical Mechanics
COURSE CODE: PHYMJ-S5P11-2CR26 [CREDITS - 02]

CC XI	Course Code: PHYMJ-S5P11-2CR26
	Course Learning Outcomes

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

- explain the concepts of angular momentum, torque, and rotational motion of particles and rigid bodies
- apply Newton's laws and the work–energy theorem to analyze systems involving translation and rotation
- analyze gyroscopic motion, conservation of angular momentum, and applications of precession
- derive and interpret rotational dynamics using tensor of inertia, principal axes, and Euler's equations
- solve numerical and analytical problems related to rigid body dynamics using mathematical and computational tools and communicate results effectively.

Unit I	Angular Momentum and Fixed Axis Rotation	[15L]

Learning Objectives:

This unit is intended to make the learners

- introduce the concept of angular momentum and its relation to torque and rotational motion
- develop an understanding of rotational dynamics about a fixed axis and pure rotation of rigid bodies
- explain oscillatory systems such as the simple and physical pendulum
- connect classical rotational mechanics with atomic models such as the Bohr atom.

Learning Outcomes:

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

- define and compute angular momentum and torque for particles and rigid bodies
- analyze rotational motion about a fixed axis using Newton's laws and work–energy theorem
- explain the dynamics of simple and physical pendulums and determine their time periods
- describe the Bohr model of the atom using quantization of angular momentum.

1.1	Introduction (6.1), Angular Momentum of A Particle (6.2), Torque (6.3), Angular Momentum and Fixed Axis Rotation (6.4), Dynamics of Pure Rotation About an Axis (6.5), The Physical Pendulum (The Simple Pendulum) (6.6), Motion Involving Both Translation and Rotation (The Work-energy Theorem) (6.7), The Bohr Atom (6.8).	**[15L]**

Text book:

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

Unit II	Rigid Body Motion	[15L]

Learning Objectives:

This unit is intended to make the learners

- emphasize the vector nature of angular velocity and angular momentum
- introduce gyroscopic motion and its physical interpretation
- develop an understanding of conservation laws in rotating systems
- extend rigid body dynamics to advanced topics including tensor of inertia and Euler's equations.

Learning Outcomes:

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

- explain the vector properties of angular velocity and angular momentum in three dimensions
- analyze gyroscopic motion and describe its applications in physical systems
- apply conservation of angular momentum to solve problems involving rotating rigid bodies
- use tensor of inertia, principal axes, and Euler's equations to study advanced rigid body rotation and torque-free precession.

2.1	Introduction (7.1), The Vector Nature of Angular Velocity and Angular Momentum (7.2), The Gyroscope (7.3), Some Applications of Gyroscope Motion (7.4), Conservation of Angular Momentum (7.5), Angular Momentum of a Rotating Rigid Body (Angular Momentum and the Tensor of Inertia, Principal Axes, Rotational Kinetic Energy, Rotation about a Fixed Point) (7.6), Advanced Topics in The Dynamics of Rigid Body Rotation (Introduction, Torque-Free Precession: Why The Earth Wobbles, Euler's Equations.) (7.7).	**[15L]**

Text book:

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

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.

Online Learning resources:

- https://fac.iitg.ac.in/saurabh/ph101.html
- https://nptel.ac.in/courses/112104114
- https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-10-rotational-motion/28-1-rigid-bodies/
- https://nptel.ac.in/courses/115107134

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	20%	30%	25%	25%	-	-	100%
II	20%	30%	25%	25%	-	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• explain the concepts of angular momentum, torque, and rotational motion of particles and rigid bodies.	√	√				
• apply Newton's laws and the work–energy theorem to analyze systems involving translation and rotation.	√	√				
• analyze gyroscopic motion, conservation of angular momentum, and applications of precession.	√	√	√			
• derive and interpret rotational dynamics using tensor of inertia, principal axes, and Euler's equations.	√	√				
• solve numerical and analytical problems related to rigid body dynamics using mathematical and computational tools and communicate results effectively.	√	√	√		√	√

B. Sc. (Physics) SEMESTER V
COURSE NAME: Modern Physics
COURSE CODE: PHYMJ-S5P12-2CR26 [CREDITS - 02]

CC XII	Course Code: PHYMJ-S5P12-2CR26	
	Course Learning Outcomes	

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

- analyze the quantum mechanical behaviour of the Hydrogen atom by applying the Schrodinger equation through the separation of variables
- apply the Pauli Exclusion Principle and the concepts of wave function symmetry (symmetric/antisymmetric) to evaluate the electronic configuration of many-electron atoms
- evaluate the effects of internal and external perturbations on atomic energy levels
- analyze the quantum mechanical basis of molecular formation and dynamics.

Unit I	Modern Physics – I	[15L]

Learning Objectives:

This unit is intended to make the learners

- introduce quantum theory of hydrogen atom.
- Introduce quantum numbers and their physical significances
- learn about the concepts of wave function symmetry (symmetric/antisymmetric).

Learning Outcomes:

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

- analyze the quantum mechanical behaviour of the Hydrogen atom by applying the Schrodinger equation through the separation of variables
- apply the Pauli Exclusion Principle and the concepts of wave function symmetry (symmetric/antisymmetric) to evaluate the electronic configuration of many-electron atoms
- evaluate the effects of internal and external perturbations on atomic energy levels
- analyze the quantum mechanical basis of molecular formation and dynamics.

1.1	Schrodinger's equation for the Hydrogen Atom (6.1), Separation of variables (6.2), Quantum numbers (6.3), Principal Quantum Number (6.4), Orbital Quantum Number (6.5), Magnetic Quantum Number (6.6), Electron Probability Density (6.7), Radiative transitions (6.8), Selection rules (6.9), Zeeman effect (6.10).	**[09L]**
1.2	Electron Spin (7.1), Exclusion Principle (7.2), Symmetric and Antisymmetric Wave Functions (7.3), Many-Electron Atoms (7.4), Periodic Table (7.5), Atomic Structures (7.6), Explaining the Periodic Table (7.7).	**[06L]**

Text Books:

Introduction to Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury , 7th Ed., McGraw-Hill Higher Education Reprint 2020.

Unit II	Modern Physics – II	[15L]

Learning Objectives:

This unit is intended to make the learners

- introduce the concepts of perturbations on atomic energy levels
- learn the quantum mechanical basis of molecular formation and dynamics.

Learning Outcomes:

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

- evaluate the effects of internal and external perturbations on atomic energy levels
- analyze the quantum mechanical basis of molecular formation and dynamics.

2.1	Spin-Orbit Coupling (7.8), Total Angular Momentum (7.9), X-Ray Spectra (7.10), Orbitals and Quantum Chemistry (7.11), Approximation Methods (7.12), Paschen-Back Method (7.13), The Stark Effect (7.14).	**[08L]**
2.2	The Molecular Bond (8.1), Electron Sharing (8.2), The H_2^+ Molecular Ion (8.3), The Hydrogen Molecule (8.4), Complex Molecules (8.5), Rotational Energy Levels (8.6), Vibrational Energy Levels (8.7), Electronic Spectra of Molecules (8.8), Raman Effect (8.9).	**[07L]**

Text Books:

Introduction to Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury , 7th Ed., McGraw-Hill Higher Education Reprint 2020

Reference Books:

- Quantum Mechanics: Concepts and Applications: Nouredine Zettili, 2nd Ed., John Wiley and Sons Ltd., 2004
- Introduction to Quantum Mechanics: David Griffiths, 2nd Ed., Pearson Education; 2015

Online Learning resources:

- https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/
- https://onlinecourses.nptel.ac.in/noc25_ph07/preview
- https://www.youtube.com/playlist?list=PLCvpYrhOPdiX6-GqRU3eVMKScNP4jedGi

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	-	30%	25%	20%	25%	-	100%
II	-	30%	25%	20%	25%	-	100%

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• analyze the quantum mechanical behavior of the Hydrogen atom by applying the Schrodinger equation through the separation of variables	√	√		√	√	
• apply the Pauli Exclusion Principle and the concepts of wave function symmetry (symmetric/antisymmetric) to evaluate the electronic configuration of many-electron atoms	√	√		√	√	
• evaluate the effects of internal and external perturbations on atomic energy levels	√				√	√
• analyze the quantum mechanical basis of molecular formation and dynamics	√	√		√	√	

B. Sc. (Physics) SEMESTER V
COURSE NAME: Nuclear Physics
COURSE CODE: PHYMJ-S5P13-2CR26 [CREDITS - 02]

CC XIII	COURSE CODE: PHYMJ-S5P13-2CR26
	Course Learning Outcomes

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

- explain nuclear structure and properties, including composition, binding energy, and models such as liquid-drop and shell models
- analyze radioactive decay processes (alpha, beta, gamma) and compute decay constants, half-life, and nuclear stability
- apply concepts of nuclear reactions, including cross-sections, fission, and fusion, in both laboratory and astrophysical contexts
- interpret nuclear magnetic properties, including spin, magnetic moment
- understand elementary particle physics, including classification of particles, quark model, fundamental interactions, and the Standard Model.

Unit I	Nuclear Structure	[15L]

Learning Objectives:

This unit is intended to make the learners

- develop a conceptual understanding of nuclear composition, atomic masses, and stability criteria
- learn to derive and apply mathematical relations such as binding energy, decay laws, and reaction cross-sections
- gain knowledge of nuclear models (liquid-drop and shell model) and their physical significance.

Learning Outcomes:

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

- understand nuclear structure and properties, including composition, stability, binding energy, and nuclear models
- explain radioactive decay processes and perform calculations related to half-life and decay laws.

1.1	Nuclear Composition (11.1), Atomic Masses (11.1.1), Some Nuclear Properties (11.2), Spin and Magnetic Moment (11.2.1), Nuclear Magnetic Resonance (11.2.2), Stable Nuclei (11.3), Nuclear Decay (11.3.1), Binding Energy (11.4), Binding Energy per Nucleon (11.4.1), Liquid-Drop Model (11.5), Corrections to the formula (11.5.1), Shell Model (11.6), How magic numbers arise (11.6.1), Reconciling the models (11.6.2), Meson Theory of Nuclear Forces (11.7), Discovery of the Pion (11.7.1).	**[12L]**
1.2	Radioactive Decay (12.1), Half-Life (12.2), Radioactive Series (12.3)	**[03L]**

Text book:

Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury, 7th Ed., McGraw Hill Education Pvt. Ltd. Reprint 2020.

Unit II	Nuclear Transformations and Elementary Particles	[15L]

Learning Objectives:

This unit is intended to make the learners

- understand the mechanisms of nuclear decay and reactions, including practical applications in energy and medicine
- explore modern physics concepts, including particle classification, quarks, bosons, and cosmological implications.

Learning Outcomes:

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

- analyze nuclear reactions, including fission, fusion, and their applications in energy and astrophysics
- interpret nuclear magnetic properties such as spin, magnetic moment, and NMR principles
- describe elementary particles and fundamental interactions, including quarks, leptons, and the Standard Model.

2.1	Alpha Decay (12.4), Beta Decay (12.5), Gamma Decay (12.6), Cross Section (12.7), Nuclear Reactions (12.8), Nuclear Fission (12.9), Nuclear Reactors (12.10), Nuclear Fusion in Stars (12.11), Fusion Reactors (12.12).	**[08L]**
2.2	Interactions and Particles (13.1), Leptons (13.2), Hadrons (13.3), Elementary Particle Quantum Numbers (13.4), Quarks (13.5), Field Bosons (13.6), The Standard Model and Beyond (13.7), History of the Universe (13.8), The Future (13.9), Cosmic Rays (13.10).	**[07L]**

Text book:

Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury, 7th Ed., McGraw Hill Education Pvt. Ltd. Reprint 2020.

Reference Books:

- Nuclear and Particle Physics by Brian R. Martin, Graham Shaw 2019
- Introductory Nuclear Physics by Kenneth S. Krane. John Wiley & Sons Inc., 1987
- Nuclear Physics by S.N. Ghoshal S Chand Publishing, 2019
- Introduction to Nuclear and Particle Physics by V.K. Mittal, R.C. Verma, and S.C. Gupta. PHI Learning 2018.

Online Resources:

- http://digimat.in/nptel/courses/video/115104043/115104043.html
- https://nptel.ac.in/courses/115104043
- https://ocw.mit.edu/courses/22-02-introduction-to-applied-nuclear-physics-spring-2012/

Question Paper Template

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

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• explain nuclear structure and properties, including composition, binding energy, and models such as liquid-drop and shell models.	√	√			√	
• analyze radioactive decay processes (alpha, beta, gamma) and compute decay constants, half-life, and nuclear stability.	√	√				√
• apply concepts of nuclear reactions, including cross-sections, fission, and fusion, in both laboratory and astrophysical contexts.	√	√			√	√
• interpret nuclear magnetic properties, including spin, magnetic moment.	√	√			√	
• understand elementary particle physics, including classification of particles, quark model, fundamental interactions, and the Standard Model.	√	√		√		√

B. Sc. (Physics) SEMESTER V
COURSE NAME: Physics Practical - IX
COURSE CODE: PHYMJ-S5PR9-2CR26 [CREDITS - 02]

Practical IX	Course Code: PHYMJ-S5PR9-2CR26
	Course Learning Outcomes

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

- demonstrate practical skills
- utilize Physics theory concepts with practical

1	Study of normal modes of coupled pendulum.
2	To study the effective potential for a particle moving under a central force field, plot the graph of $V_{\text{eff}}(r) \rightarrow r$ using Excel, and analyze the conditions for stable and unstable circular orbits.
3	To verify Kepler's three laws of planetary motion using computational simulation of a particle moving under gravitational central force.
4	To study mechanical resonance and determine the resonant length (or frequency) of a pendulum using a resonance pendulum setup.
5	To study Lissajous figures formed by two mutually perpendicular simple harmonic motions (SHMs) and determine the frequency ratio between them.
6	To determine acceleration due to gravity using Kater's pendulum.
7	To study double mass-spring system.
8	To study forced oscillation and damped oscillation.
9	To study coupled oscillator using SEELab.

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.
- 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, Himalayan Publishing House, 1st Ed., 2000.

Online Learning resources:

- https://expeyes.in/software.html
- https://www.myphysicslab.com/

- https://phet.colorado.edu/
- 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 V
COURSE NAME: Physics Practical - X
COURSE CODE: PHYMJ-S5PR10-2CR26 [CREDITS - 02]

Practical X	Course Code: PHYMJ-S5PR10-2CR26
	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 set up the differential equations for Hydrogen wave function in spherical polar coordinates.
2	To study the normalized wave functions for Hydrogen atom for $n = 1$ and $n = 2$.
3	To study the normalized wave functions for Hydrogen atom for $n = 3$.
4	To understand the space quantization.
5	To study the principal quantum numbers.
6	To study the orbital quantum numbers.
7	To solve the problems based on probability of finding the electron in Hydrogen atom.
8	To solve the problems based on Zeeman effect.
9	To determine the inverse of a matrix by Gauss elimination method.
10	To apply Gauss-Jordan elimination method to solve the system of linear equations.
11	To find the dimension of the space spanned by the given vectors and a basis for the space.
12	To evaluate the eigenvalues and eigenvectors for the given matrix.
13	To apply the method of similarity transformation to diagonalize the given matrix.

Reference Books:

- Introduction to Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury , 7th Ed., McGraw-Hill Higher Education Reprint 2020.
- Mathematical Methods in the Physical Sciences by M L Boas, 3rd Ed. Wiley 2006.
- Advanced Engineering Mathematics, 10th Edition, Erwin Kreyszig Wiley 2011
- 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, Himalayan Publishing House, 1st Ed., 2000.
- .

Online Learning resources:

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

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- 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 V
COURSE NAME: Physics Practical - XI
COURSE CODE: PHYMJ-S5PR11-2CR26 [CREDITS - 02]

Practical XI	Course Code: PHYMJ-S5PR11-2CR26
	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 study characteristics of a GM tube and determine its operating voltage, plateau length and slope.
2	To verify inverse square law for γ-rays using a GM detector.
3	To study nuclear counting statistics using a GM detector.
4	To find the dead time of a GM detector using single source method.
5	To measure the half-value thickness and evaluate mass-absorption coefficient.
6	To estimate the efficiency of a GM detector using γ-source.
7	To study Cs-137 spectrum, and calculate FWHM and resolution for a Scintillation detector.
8	To calibrate spectrometer to establish linearity between energy and channel number using a single channel analyser.
9	To determine the energy of an unknown γ-source using a Scintillation detector.
10	To determine the energy of an unknown gamma source with the help of a scintillation detector using an MCA.
11	To calculate the binding energy per nucleon using liquid drop model.

Reference Books:

- Introduction to Modern Physics by Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury , 7th Ed., McGraw-Hill Higher Education Reprint 2020
- Introduction to Special Relativity, Robert Resnick, John Wiley & Sons, Inc.
- University Practical Physics by D. C. Tayal, Edited by Ila Agarwal, Himalayan Publishing House, 1st Ed., 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 V
COURSE NAME: Python Programming
COURSE CODE: PHYMN-S5P4-2CR26 [CREDITS - 02]

MN IV	COURSE CODE: PHYMN-S5P4-2CR26	
	Course Learning Outcomes	

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

- recall Python basics, including variables, data types, modules and key commands for scientific programming
- interpret Python data structures, input-output operations and module usage for scientific and engineering applications
- apply Python conditionals and loops to solve scientific and engineering problems.

Unit I	Strings, Lists, Array and Dictionaries	[15L]

Learning Objectives:

This unit is intended to make the learners

- describe variables and some python modules
- describe string, lists, arrays and dictionaries.

Learning Outcomes:

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

- remember Python basics, including variables, data types, modules and key commands for scientific programming
- use different data types, modules and key commands in scientific programming.

1.1	The Ipython Pane (2.4), Magic commands (2.4.1), System shell commands (2.4.2), Variables (2.6), Names and assignment operator (2.6.1), Legal and recommended variable names (2.6.2), Python Modules (2.8), Python modules and functions: A first look (2.8.1), Some Numpy functions (2.8.2), Strings (3.1), Lists (3.2), Slicing lists (3.2.1), The "range" function: Sequence of numbers (3.2.2), Tuples (3.2.3), Multidimension lists and tuples (3.2.4), NumPy Arrays (3.3), Creating arrays (1-d) (3.3.1), Mathematical Operations with arrays (3.3.2), Slicing and addressing arrays (3.3.3), Fancy indexing: Boolean masks (3.3.4), Differences between lists and arrays (3.3.6), Dictionaries (3.4), Objects (3.5).	**[15L]**

Text book:

Introduction to Python for Science and Engineering by David J. Pine, CRC Press Taylor & Francis Group 2019.

Unit II	Reading/Writing Data, Conditionals and Loops	[15L]

Learning Objectives:

This unit is intended to

- familiarize the students reading and writing data in Python
- explain the students conditionals and loops in Python.

Learning Outcomes:

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

- write and read data in Python

• apply conditionals in Python to solve scientific and engineering problems • apply loops in Python to solve scientific and engineering problems.		
2.1	Keyboard Input (4.1), Screen Output (4.2), Formatting output with str. format () (4.2.1), Printing arrays (4.2.2), File Input (4.3), Reading data from a text file (4.3.1), Reading data from excel file: CSV file (4.3.2), File Output (4.4), Writing data to a text file (4.4.1), Writing data to a CSV file (4.4.2).	**[08L]**
2.2	Conditionals (5.1), **if, elif** and **else** statements (5.1.1), Logic operators (5.1.2), Loops (5.2): **for** loops (5.2.1), **while** loops (5.2.2), Loops and array operations (5.2.3), List Comprehensions (5.3), Exercises (5.4).	**[07L]**

Text book:

Introduction to Python for Science and Engineering by David J. Pine, CRC Press Taylor & Francis Group 2019.

Reference Books:

- Computational Physics, Problem solving with Python: R. H. Landau, Manuel J. Páze and Cristian C. Bordeianu, 3rd Ed., Wiley-VCH, 2015.

Online Learning resources:

- https://archive.nptel.ac.in/courses/115/104/115104095/
- https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/
- https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
• recall Python basics, including variables, data types, modules and key commands for scientific programming	√	√	√	√	√	
• interpret Python data structures, input-output operations and module usage for scientific and engineering applications	√	√	√	√	√	
• apply Python conditionals and loops to solve scientific and engineering problems	√	√	√	√	√	

B. Sc. (Physics) SEMESTER V
COURSE NAME: Analog and Digital Electronics
COURSE CODE: PHYMN-S5P5-2CR26 [CREDITS – 02]

MN V	Course Code: PHYMN-S5P5-2CR25	
Course Learning Outcomes		
After the successful completion of the course, learners will be able to • interpret the analogue and digital signals • understand active devices • convert numbers from one number system to another.		
Unit I	**Analog Electronics**	**[15L]**
Learning objectives: This unit is intended to make the learners • understand and learn active devices • understand the digital logics.		
Learning outcomes: After the successful completion of the unit, learners will be able to • design transistor's different configurations • design transistor as an amplifier • design digital logic and combinational circuits • know different number systems.		
1.1	Transistor (8.1), Naming the transistor terminals (8.2), Some facts about the transistor (8.3), Transistor action (8.4), Transistor symbols (8.5), Transistor circuit as an Amplifier (8.6), Transistor connections (8.7), Common base connection (8.8), Characteristics of common base connection (8.9), Common emitter connection (8.10), Measurement of leakage current (8.11), Characteristics of Common emitter connection (8.12), Common collector connection (8.13), Comparison of transistor connections (8.14), Commonly used transistor connection (8.15), Transistor as an Amplifier in CE Arrangement (8.16), Transistor Load Line Analysis (8.17), Operating Point (8.18).	**[15L]**
Unit II	**Digital Electronics**	**[15L]**
2.1	Digital Logic: The Basic gates-NOT, OR, AND (2.1), Universal logic gates (2.2), AND–OR invert gates (2.3), Combinational Logic Circuit: Boolean law and theorems (3.1), Sum of product method (3.2), Truth table to Karnaugh map (3.3), Pairs, quads and octets (3.4), Karnaugh simplifications, (3.5), Don't care conditions (3.6), Product of sum method (3.7), Product of sum simplification (3.8), Binary number system (5.1), Binary to decimal conversion (5.2), Decimal To binary conversion (5.3), Octal number (5.4), Hexadecimal numbers (5.5).	
Textbook: 1. Principles of Electronics by V. K. Mehta and R. Mehta, S. Chand & Co., 11th Ed. 2020.		

2. Digital Principles and Applications by D. Leach, A Malvino and G. Saha, McGraw Hill Edu. (India) Pvt. Ltd. 7th ed., 2010.

Additional References:

1. Functional Electronics by K.V. Ramanan – McGraw Hill Edu. (India) Pvt. Ltd Publication 1984
2. Electronics Devices and Circuits by Allen Mottershed – PHI Publication 1979
3. Modern Digital Electronics by R. P. Jain, McGraw Hill Education, New Delhi, 2009.

Online Resources:

- https://onlinecourses.nptel.ac.in/noc21_ee55/preview
- https://www.coursera.org/courses”query=electronics
- https://www.udemy.com/course/electronic-circuits-part3-bipolar -junction-transistors/
- https://www.udemy.com/course/digitalelectronics/
- https://onlinecourses.nptel.ac.in/”oc20_ee32/preview

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes					
	1	2	3	4	5	6
• interpret the analog and digital signals	√	√			√	
• understand the active device	√	√			√	
• convert numbers from one number system to another	√	√			√	

B. Sc. (Physics) SEMESTER V
COURSE NAME: Physics Practical - IV
COURSE CODE: PHYMN-S5PR4-2CR26 [CREDITS - 02]

MN Practical IV	Course Code: PHYMN-S5PR4-2CR26
	Course Learning Outcomes

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

- demonstrate practical skills
- utilize Physics theory concepts through practical

Write algorithm, draw flow chart and prepare program to study the following:

1	Install and configure IDE and write simple Python program to display messages.
2	Write a Python program to calculate the solar mass.
3	Write a Python program to convert 1 AU in meter and 1 parsec in AU.
4	Write a simple Python program to check whether a given number is a Fibonacci term or not.
5	If Initial Velocity of an object is “u”, acceleration is “a”, and elapsed time spent by the object is “t”, then find the displacement “s” of the object using a python code.
6	Write a Python program to demonstrate Percentage Discount Calculator.
7	Write a Python program to create a tuple and find the minimum and maximum number from it.
8	Write a Python program to find common wavelengths and unique wavelengths from two different experiments.
9	Write a Python program to combine two dictionaries adding values for common keys. a. d1 = {'a': 100, 'b': 200, 'c':300} b. d2 = {'a': 300, 'b': 200, 'd':400}.
10	Write a Python program to find surface area and volume of a sphere using math library.
11	Write a Python function that accepts a string and calculate the number of upper case letters and lower-case letters.
12	Write a Python program to find the solution of a quadratic equation.
13	Write a Python program to study the damped oscillation and draw necessary plots.
14	Write a Python program to find charge of a capacitor that discharges in an RC circuit and draw necessary plots.
15	Write a Python program to plot sine and cosine over the range of { 0, 2π}.

Reference Books:

- Introduction to Python for Science and Engineering by David J. Pine, CRC Press Taylor & Francis Group 2019

- Computational Physics, Problem solving with Python: R. H. Landau, Manuel J. Páze and Cristian C. Bordeianu, 3rd Ed., Wiley-VCH, 2015.

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 V
COURSE NAME: Physics Practical - V
COURSE CODE: PHYMN-S5PR5-2CR26 [CREDITS - 02]

MN Practical V	Course Code: PHYMN-S5PR5-2CR26
	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 study characteristics of CE configuration of transistor.
2	To study characteristics of CB configuration of transistor.
3	To determine e/k_B using CE configuration of transistor.
4	To determine e/k_B using CB configuration of transistor.
5	To determine current gain in common emitter transistor circuit.
6	To determine DC operating point of common emitter transistor circuit.
7	To design an AND gate using diodes.
8	To design an OR gate using diodes.
9	To design a NOT gate using transistors.
10	To design an AND gate using transistors.
11	To design an OR gate using transistors.
12	To design Ex-OR gate using NAND gates.
13	To design Ex-OR gate using basic logic gates.
14	To design and build Half Adder and Full Adder.
15	To design, build and test Half Subtractor and Full Subtractor.

Reference Books:

- Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, Goutam Shah, 8th Ed., Tata McGraw Hill Edu. Pvt. Ltd. 2013
- Digital Fundamentals Floyd and Jain 8th Ed., Pearson Education 2005
- 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, Himalayan Publishing House, 1st Ed., 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/
- https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html

Note:

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