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DAVANGER UNIVERSITY

Shivagangothri, Davangere- 577007

SYLLABUS and COURSE STRUCTURE

of

PHYSICS

as per the Choice Based Credit System (CBCS) designed in accordance with of State Education Policy (SEP-2024)

Syllabus of V and VI Semester

Bachelor of Science (B.Sc. Physics) SEP V and VI Semester Syllabus

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w.e.f.

Academic Year 2026-27 and onwards

Prof. M. Govindappa
Dean-Sc[illegible] Technology
Dava[illegible]ersity
Shivagangotri, Davangere-577007

Chairman
Board of Studies
Department of Physics
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Shivagangotri, Davangere-07

Registrar
Davangere University
Shivagangotri, Davangere.

Curriculum Structure for Undergraduate Programme for 2024-25

Sl. No.	Course/Paper Code	Title of the Paper	Subject Category	Teaching Hours/ week	Semester End Exam.	Internal Assessment	Total Marks	Credits	Examination Duration
		Semester-I							
1	24SEPPHYT-I	Mechanics and Properties of Matter	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-I	Practical I	MC-P	04	40	10	50	02	3 Hrs.
			Total	08	**120**	**30**	**150**	05	---
		Semester-II							
2	24SEPPHYT-II	Thermal Physics, Waves and Sound	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-II	Practical - II	MC-P	04	40	10	50	02	3 Hrs.
		Total		08	**120**	**30**	**150**	05	---
		Semester-III							
3	24SEPPHYT-III	Geometrical Optics and Electricity	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-III	Practical - III	MC-P	04	40	10	50	02	3 Hrs.
	24SEPPHYE-IIIA 24SEPPHYE-IIIB (Elective Optional–I*)	A) Energy Sources B) Physics for All	OEL/OP-I	02	40	10	50	02	2 Hrs.
			Total	10	**160**	**40**	**200**	07	---
		Semester-IV							
4	24SEPPHYT-IV	Wave Optics and Electromagnetism	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-IV	Practical - IV	MC-P	04	40	10	50	02	3 Hrs.
	24SEPPHYE-IVA 24SEPPHYE-IVB (Optional – II*)	A) Electronic Instrumentation and Sensors B) Elements of Nanoscience	OEL/OP-II	02	40	10	50	02	2 Hrs.
			Total	10	**160**	**40**	**200**	07	---
		Semester-V							
5	24SEPPHYT-V	Foundations of Theoretical Physics	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYT-VI	Atomic, Molecular and Nuclear Physics	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-V	Practical - V	MC-P	04	40	10	50	02	3 Hrs.
	24SEPPHYRM	Elementary Research Methodology		02	40	10	50	02	2 Hrs.
		Total		14	**240**	**60**	**300**	10	---
		Semester-VI							
6	24SEPPHYT-VII	Relativity, Statistical and Astrophysics	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYT-VIII	Condensed Matter Physics and Electronics	MC-T	04	80	20	100	03	3 Hrs.
	24SEPPHYP-VI	Practical - VI	MC-P	04	40	10	50	02	3 Hrs.
	24SEPPHYPr	Project	MC-T	02	40	10	50	02	2 Hrs.
		Total		16	**240**	**60**	**300**	10	---
		Grand total		66	1040	260	1300	44	

MC: *Major Course*; **MC-T:** *Major Course Theory*; ***MC*-P:** *Major Course Practical*; ***MC*-Pr:** Project; **EL/Op:** *Elective/Optional*; ***AEDP***: *Apprenticeship Embedded Degree Programme*. [*In Semester-III and Semester-IV open elective papers are offered. There shall be 02 elective papers offered during each semester (Semester-III and Semester-IV) by every major subject offering Department, where a student shall choose/select/opt 01 elective paper out of two to study in each semester (Semester-III and Semester-IV)].

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15/07/2024
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Shivagangotri, Davangere

Curriculum Structure for B.Sc. Physics V and VI Semester

Sl. No.	Course/Paper Code	Title of the Paper	Subject Category	Teaching Hours/ week	Semester End Exam.	Internal Assessment	Total Marks	Credits	Examination Duration
		Semester-V							
5	24SEPPHYT-V	Foundations of Theoretical Physics	**MC-T**	04	80	20	**100**	03	3 Hrs.
	24SEPPHYT-VI	Atomic, Molecular and Nuclear Physics	**MC-T**	04	80	20	**100**	03	3 Hrs.
	24SEPPHYP-V	Practical - V	**MC-P**	04	40	10	**50**	02	3 Hrs.
	24SEPPHYRM	Elementary Research Methodology	**MC-T**	02	40	10	**50**	02	3 Hrs.
	Total			**12**	**200**	**50**	**250**	**10**	---
		Semester-VI							
6	24SEPPHYT-VII	Relativity, Statistical and Astrophysics	**MC-T**	04	80	20	**100**	03	3 Hrs.
	24SEPPHYT-VIII	Condensed Matter Physics and Electronics	**MC-T**	04	80	20	**100**	03	3 Hrs.
	24SEPPHYP-VI	Practical - VI	**MC-P**	04	40	10	**50**	02	3 Hrs.
	24SEPPHYPr	Project	**MC-T**	02	50	--	**50**	02	2 Hrs.
	Total			**16**	**250**	**50**	**250**	**10**	---
	Grand total			**64**	**1010**	**240**	**1250**	**20**	

Indicative Project Types

Question paper pattern

Scheme of Evaluation for Practical

Scheme of evaluation for Project work

Chairman
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Department of Physics
Davangere University
Shivagangotri, Davangere-07

SEMESTER-V

Curriculum Structure

Sl. No.	Course/Paper Code	Title of the Paper	Subject Category	Teaching Hours/ week	Semester End Exam.	Internal Assessment	Total Marks	Credits	Examination Duration
1	2	3	4	5	6	7	8	9	10
1	24SEPPHYT-V	Foundations of Theoretical Physics	MC-T	04	80	20	100	03	3 Hrs.
2	24SEPPHYT-VI	Atomic, Molecular and Nuclear Physics	MC-T	04	80	20	100	03	3 Hrs.
3	24SEPPHYP-V	Practical - V	MC-P	04	40	10	50	02	3 Hrs.
4	24SEPPHYRM	Elementary Research Methodology		02	40	10	50	02	2 Hrs.
	Total			14	240	50	250	10	---

24SEPPHYT-V: Foundations of Theoretical Physics

TOTAL HOURS -56

Course Learning Objectives :

a) Understand the fundamental principles of classical mechanics including Newtonian mechanics, constraints, generalized coordinates and Lagrangian formulation.

b) Explain the variational principles and Hamiltonian formulation of mechanics and their significance in theoretical physics.

c) Understand the limitations of classical physics and the development of quantum theory to explain microscopic phenomena.

d) Describe the wave nature of matter, matter waves and their experimental verification.

e) Understand the Heisenberg uncertainty principle and its implications in microscopic systems.

f) Explain the probabilistic interpretation of the wave function and the formulation of the Schrödinger equation.

g) Understand the postulates of quantum mechanics and apply them to simple systems such as the particle in a potential well.

h) Develop mathematical tools including vector calculus, differential equations and matrices required for solving physical problems.

i) Apply mathematical methods to analyze and solve problems in classical and quantum physics.

j) Develop analytical and problem-solving skills required for advanced studies in theoretical physics.

Learning Outcomes (Course Outcomes):

After successful completion of this course, students will be able to:

a) Explain the basic principles of classical mechanics, frames of reference, conservation laws and the role of constraints in mechanical systems.

b) Formulate equations of motion using Lagrangian and Hamiltonian approaches and understand the significance of variational principles.

c) Discuss the experimental failures of classical physics and explain phenomena such as blackbody radiation, photoelectric effect and Compton scattering.

d) Explain the wave nature of particles, de Broglie hypothesis and experimental verification through the Davisson–Germer experiment.

e) Interpret the Heisenberg uncertainty principle and apply it to physical situations such as electron diffraction and atomic stability.

f) Interpret the probabilistic nature of quantum mechanics, including normalization, expectation values and the Schrödinger equation.

g) Apply the postulates of quantum mechanics to analyze simple systems such as the particle in a one-dimensional potential well.

h) Apply vector calculus operations such as gradient, divergence and curl in physical contexts.

i) Solve ordinary differential equations and matrix eigenvalue problems that arise in physical systems.

j) Develop the ability to solve numerical and conceptual problems in classical mechanics, quantum mechanics and mathematical physics.

24SEPPHYT-V: Foundations of Theoretical Physics

Unit I

Classical Mechanics **14 Hrs**

Chapter 1: Introduction to Newtonian Mechanics and Lagrangian formulation: Frames of references, Newton s laws of motion, Conservation of linear momentum and angular momentum, Conservative force and energy. Constraints – Holonomic and non-holonomic constraints. Generalized coordinates, D'Alembert's principle and Lagrange's equation. Examples(qualitative)

Chapter 2: Variational principle and Hamiltonian mechanics: Hamilton's equation, Lagrange's equation from Hamilton's principle. Hamiltonian of a system and Hamilton's equation of motion. Hamilton's equations of motion from variational principle.

Solving Problems

Unit II

Quantum Mechanics I **14 Hrs**

Chapter 3: Brief discussion on failure of classical physics to explain black body radiation, Photoelectric effect, Compton effect, Compton scattering, Expression for Compton shift(with derivation), stability of atoms and spectra of atoms.

Chapter 4: Matter waves: deBroglie hypothesis of matter waves, experimental evidence for matter waves, Davisson Germer experiment and G P Thomson's experiment and their significance. Electron microscope, wave description of particles by wave packets, group and phase velocities and relation between them.

Chapter 5: Heisenberg's uncertainty principle: Elementary proof of Heisenberg's relation between momentum and position, energy and time. Illustration of uncertainty principle by gamma ray microscope thought experiment. Consequences of uncertainty relations: Diffraction of electrons at a single slit, nonexistence of electron in the nucleus, zero-point energy of a linear harmonic oscillator

Solving Problems

Unit III

Quantum Mechanics II **14 Hrs**

Chapter 6: Probabilistic interpretation of wave function, normalization and orthogonality of wave function, admissibility conditions on a wave function. Schrodinger equation: Equation of motion of matter waves, Schrodinger wave equation for a free particle in one-and three-dimension, time dependent and time independent wave equation, probability current density, equation of continuity and its physical significance.

Chapter 7: Postulates of quantum mechanics: States as normalized wave functions, dynamical variables as linear Hermitian operators (position, momentum, energy and angular momentum as examples), Expectation values of operators and their time evolution, Ehrenfest theorem (no derivation), Commutator relations: position, momentum and angular momentum operators. Applications: Particle in one-dimensional infinite potential well(derivation), particle in a finite potential well(qualitative).

Solving Problems

Unit IV

Mathematical Physics **14 Hours**

Chapter 8: Vector Analysis: Scalar and vector fields, Gradient, divergence and curl. Physical significance of grad, div and curl. Line, surface and volume integrals. Gauss divergence theorem and Stokes theorem (statements and simple applications).

Chapter 9: Differential Equations in Physics: Ordinary differential equations (ODEs): first and second order. Solution of first order differential equations (separable and linear forms). Second

order linear differential equations with constant coefficients. Applications to simple physical problems (harmonic oscillator, exponential decay, LCR circuits-growth and decay).
Chapter 10: Matrices and Eigenvalue Problems: Types of matrices (square, diagonal, symmetric). Addition and multiplication of matrices Determinants and inverse of a matrix. Eigenvalues and eigenvectors (basic idea).Applications in physical systems (normal modes, quantum mechanics).
Solving Problems

Reference Books

1. Classical Mechanics, N.C. Rana and P.S. Joag - Tata Mc-Graw Hill, 1991.
2. Classical Mechanics, J.C. Upadyaya - Himalaya Publishing House, 2005.
3. Classical Mechanics, Gupta, Kumar and Sharma –Pragathi Prakashan, 2012.
4. Introduction to Classical Mechanics, R.G. Takwale and P.S. Puranic -Tata McGraw-Hill, 1989.
5. Principles of Quantum Mechanics, R Shankar, Springer, 2012.
6. Introductory Quantum Mechanics, Richard L. Liboff, 4th Edition, Pearson Education
7. Quantum Mechanics, Ajoy Ghatak and S. Lokanathan, 5th Edition, Macmillan Publishers, 2004.
8. Introduction to Quantum Mechanics, David J Griffiths, 2nd Edition, Pearson Education.
9. Quantum Mechanics: Concepts and Applications, 2nd Edition, Zettili, Wiley.
10. Mathematical Physics with Classical Mechanics, Satya Prakash, published by Sultan Chand and Sons.
11. Mathematical Physics, Gupta B.D., 4th Edition,Vikas Publishing House

24SEPPHYT-VI: ATOMIC MOLECULAR PHYSICS AND NUCLEAR PHYSICS

TOTAL HOURS -56

Course Learning Objectives:

a) Understand the development of atomic models and the experimental evidence leading to the modern atomic theory.
b) Explain the Bohr atomic model and vector atom model, including quantum numbers, spatial quantization and electron spin.
c) Understand spectroscopic phenomena such as optical spectra, Zeeman effect and Stark effect.
d) Analyze the structure and spectra of molecules, including rotational, vibrational and electronic spectra.
e) Understand the Raman effect and laser principles, including stimulated emission, population inversion and applications of lasers.
f) Explain the general properties of atomic nuclei including nuclear size, binding energy, magnetic moments and nuclear stability.
g) Describe the mechanisms of radioactive decay including alpha, beta and gamma decay.
h) Understand the interaction of radiation with matter and the energy loss of charged particles.
i) Explain the working principles of radiation detectors such as GM counters, ionization chambers and scintillation detectors.
j) Understand the principles and operation of particle accelerators used in nuclear physics research.
k) Develop the ability to apply theoretical concepts to solve problems in atomic, molecular and nuclear physics.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

a) Explain the historical development of atomic models including Thomson, Rutherford and Bohr models and interpret atomic spectra.
b) Describe the vector atom model, quantum numbers, spin, coupling schemes and Pauli's exclusion principle.
c) Analyze atomic spectra, spectral terms and selection rules and explain the Zeeman and Stark effects.
d) Explain the rotational, vibrational and electronic spectra of molecules using the rigid rotator and harmonic oscillator models.
e) Describe the Raman effect and laser principles, including stimulated emission, Einstein coefficients and applications of lasers.
f) Explain the general properties of atomic nuclei such as nuclear size, binding energy and nuclear moments.
g) Describe the mechanisms of radioactive decay including alpha, beta and gamma decay and their associated theories.

h) Explain the interaction of nuclear radiation with matter and the processes of energy loss by charged particles.
i) Describe the working principles of radiation detectors such as ionization chambers, proportional counters, GM counters and scintillation detectors.
j) Explain the principles and operation of particle accelerators such as linear accelerators, cyclotrons, betatrons and synchrotrons.
k) Apply theoretical concepts and mathematical relations to solve conceptual and numerical problems in atomic, molecular and nuclear physics.

24SEPPHYT-VI: ATOMIC AND MOLECULAR PHYSICS, NUCLEAR PHYSICS

Unit I

ATOMIC PHYSICS **14 Hrs**

Chapter 1: Basic atomic models: Thomson's atomic model, Rutherford atomic model, Alpha particle scattering - Rutherford scattering formula(Derivation). Bohr atomic model: postulates, expression for radius, total energy of electron (Qualitative). Effect of nuclear motion on atomic spectra – derivation. Qualitative discussion on Sommerfeld's atomic model.

Chapter 2:Vector atom model: Spatial quantization, electron spin. Quantum numbers associated with vector atomic model, Coupling schemes: L-S and j-j. Pauli's exclusion principle, Magnetic dipole moment due to orbital motion of electron (derivation) and spin motion of an electron. Lande's g-factor and its calculation for different states, Stern-Gerlach experiment with theory, Spin-Orbit Interaction (qualitative).

Chapter 3: Optical spectra: spectral terms, spectral notations, selection rules, intensity rules, and fine structure of sodium D-line. Zeeman effect: Types, Experimental study and quantum theory of normal Zeeman effect - Zeeman shift expression, Theory of Anomalous Zeeman effect, Stark effect.

Solving Problems

Unit II

MOLECULAR PHYSICS **14 Hrs**

Chapter 4: Types of molecules based on their moment of inertia; Types of molecular motions and energies; Born Oppenheimer approximation; Origin of molecular spectra; Nature of molecular spectra; Theory of rigid rotator: energy levels and spectrum, Qualitative discussion on non-rigid rotator and centrifugal distortion; Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum; Electronic spectra of molecules – fluorescence and phosphorescence

Chapter 5: Raman effect: Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical (Qualitative) and quantum theory, experimental study of Raman effect, applications of Raman effect.

Chapter 6: Lasers: Spontaneous and stimulated emission, Einstein's A and B co-efficient (qualitative), Characteristics of Laser (Directionality, Monochromaticity, Intensity, Coherence - Spatial and Temporal), Population Inversion, Pumping – different methods (brief). Construction and working of Ruby Laser. Applications of Lasers.

Solving Problems

Unit III

Nuclear Physics I **14 Hrs**

Chapter 7: General Properties of Nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about – mass, radii, charge density (matter density), binding energy (main features of binding energy versus mass number curve), angular momentum, parity, magnetic moment, electric quadrupole moments.

Chapter 8: Radioactive decay: Definition of radioactivity, half-life, mean life, Theory of successive disintegration- Bateman's equations (Derivation)-radioactivity equilibrium (Transient and secular). Alpha decay: basics of α-decay processes, theory of α emission (brief), Gamow factor, Geiger-Nuttall law. Beta decay: Types, Pauli neutrino hypothesis. Gamma decay (qualitative). Gamma ray interaction with matter, photoelectric effect, Compton scattering, pair production.

Solving Problems

Unit IV

Nuclear Physics II **14 Hrs**

Chapter 09: Qualitative discussion on mechanisms of charged particle interaction with matter (Ionization, excitation and radiation). Nuclear Radiation Detectors: Gas filled detectors-estimation of electric field, mobility of particle in ionization chamber. Qualitative discussion on proportional counter and ionization chamber, Construction and working of GM Counter, dead time. Basic principle of scintillation, construction and working of scintillation detector.

Chapter 10: Particle accelerators: Linear Accelerator- Energy expression, Betatron-construction, betatron condition and energy expression. Cyclotron-construction and cyclotron condition, Synchrotron (Qualitative).

Chapter 11: Elementary particles- classification- fundamental interactions-their comparison-Symmetries and conservation laws (momentum, energy, charge, parity, lepton number, baryon number, isospin, strangeness)- Brief introduction to quarks.

Solving Problems

Reference books

1. Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2. Atomic & Molecular spectra: Laser, Raj Kumar, 5th Edition, 2019, Kedar Nath Ram Nath Publishers, Meerut.
3. Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.
4. Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.
5. Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
6. College Physics (Volume III),Sundararajan N, George Thomas & Syed Azeez, United Publishers (2006).
7. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition, 2008, Tata McGraw-Hill Publishers.
8. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill)
9. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
10. Introduction to High Energy Physics, D.H. Perkins, 4th Edition, Cambridge Univ. Press
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
12. Nuclear physics, S.N. Ghoshal S. Chand and Company, Delhi, 1994
13. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
14. Nuclear radiation detectors, S.S. Kapoor and V. Ramamoorthy s Wiley Eastern, Bangalore,2nd Edition, 2007.
15. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007)

24SEPPHYP-V: Practical-V

LIST OF EXPERIMENTS FOR 5TH SEM (Students have to perform a minimum of TEN Experiments from the list below)

1. Determination of Planck's constant using LED. **(Compulsory)**
2. Determination of fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.**(Compulsory)**
3. Study the characteristics of Geiger-Müller Tube and hence determine the threshold voltage, plateau region and operating voltage. **(Compulsory)**
4. Study the absorption of beta particles in Aluminium foils using GM counter and hence determine mass attenuation coefficient of Aluminium. **(Compulsory)**
5. Determination of wavelength of laser by single slit diffraction method.**(Compulsory)**
6. Determination of wavelength of laser by multi slit diffraction method.
7. Determination of particle size by laser diffraction.
8. Determination of wavelength of spectral lines of mercury source using spectrometer.
9. Determination of the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
10. Determination of the ionization potential of mercury.
11. Determination of the absorption lines in the rotational spectrum of Iodine vapour.
12. Determination of the force constant and vibrational constant for the iodine molecule from its absorption spectrum.

10\. Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.

11\. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.

12\. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium foils.

13\. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source and G M counter

14\. Studying the effect of amplitude of oscillation on the time period of the simple pendulum.

15\. Determine the acceleration of gravity is to use an Atwood's machine.

16 Study the conservation of energy and momentum using projectile motion.

17\. Verification of the Principle of Conservation of Linear Momentum.

18\. Determination of Planck constant and work function of the material of the cathode using Photoelectric cell.

19\. Study the spectral characteristics of a photo-voltaic cell (Solar cell).

20\. Determination of the value of e/m for an electron by Thomson's method using bar magnets.

21\. Determination of the value of e/m for an electron by magnetron method.

22\. Write and implement C/C++/Scilab code to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrödinger equation.

23\. Write and implement C/C++/Scilab code to plot and analyse the wavefunctions for particle in an infinite potential well.

NOTE:- ***Any additional relevant experiment may be added with prior approval of the Board of Studies (BOS).***

24SEPPHYRM: Elementary Research Methodology

Total Hours: 32 hrs

Course Objectives

a) Introduce students to the fundamentals of scientific research.

b) Develop skills in problem identification, literature survey, and hypothesis formulation.

c) Train students in basic data analysis and scientific writing.

d) Prepare students for project work and higher studies.

Course Outcomes

After completion, students will be able to:

a) Understand the process of scientific research in physics.

b) Conduct basic literature surveys using journals and online databases.

c) Formulate research problems and hypotheses.

d) Analyze experimental data using simple statistical tools.

e) Write basic scientific reports and presentations.

24SEPPHYRM: Elementary Research Methodology

Unit 1

Introduction to Research **6 hrs**

Meaning and objectives of research, Types of research: Fundamental, Applied, Experimental Research in Physics: Examples from condensed matter, nuclear, materials science, Research ethics and scientific integrity (plagiarism, citation)

Unit 2

Research Problem & Literature Survey **6 hrs**

Identification of research problem, defining objectives and hypothesis, Literature survey: journals, books, online databases, Use of tools: Google Scholar, ResearchGate, arXiv, Referencing styles (APA/IEEE basics).

Unit 3

Experimental & Data Handling Methods 6 hrs

Basic experimental design, Measurement, errors, and uncertainty, Data collection and tabulation, Graph plotting and interpretation, Introduction to software tools (Excel, Origin, Python basics).

Unit 4

Data Analysis & Statistics **7 hrs**

Mean, median, standard deviation, Curve fitting and interpolation, Error propagation (basic idea), Representation of data (tables, graphs), Introduction to regression (linear fitting)

Unit 5

Scientific Writing & Presentation **7 hrs**

Structure of research paper (Abstract, Introduction, Methodology, Results, Conclusion), Writing reports and project dissertations, Preparing posters and presentations, Basics of LaTeX and Word formatting, Oral presentation skills.

Reference Books

1. Research Methodology: Methods and Techniques-C.R. Kothari, 2nd Revised Edition.
2. Research Methodology and Statistical Techniques-S. K. Gupta, 2002.
3. Scientific Research and Methodology – Peter K. Dunn, Taylor & Francis.
4. Research Methodology and Techniques in Physics-Arun Kumar Singh

SEMESTER-VI

Curriculum Structure

Sl. No.	Course/Paper Code	Title of the Paper	Subject Category	Teaching Hours/ week	Semester End Exam.	Internal Assessment	Total Marks	Credits	Examination Duration
1	2	3	4	5	6	7	8	9	10
1	24SEPPHYT-VII	Relativity, Statistical and Astrophysics	**MC-T**	04	80	20	**100**	03	3 Hrs.
2	24SEPPHYT-VIII	Condensed Matter Physics and Electronics	**MC-T**	04	80	20	**100**	03	3 Hrs.
3	24SEPPHYP-VI	Practical - VI	**MC-P**	04	40	10	**50**	02	3 Hrs.
4	24SEPPHYPr	Project	**MC-Pr**	~~04~~	50	--	**50**	02	3 Hrs.
	Total			**14**	**240**	**50**	**250**	**10**	---

24SEPPHYT-VII: Relativity, Statistical and Astrophysics
Total Hours 56

Course Learning Objectives:

a) Understand the limitations of classical mechanics and the necessity for Einstein's theory of relativity.
b) Explain the fundamental postulates of special relativity and the Lorentz transformations connecting different inertial frames.
c) Understand the relativistic effects such as time dilation, length contraction and relativity of simultaneity.
d) Apply relativistic principles to relativistic mechanics, including relativistic mass, energy–momentum relation and Doppler effect.
e) Understand the basic concepts of statistical physics such as microstates, macrostates, ensembles, phase space and thermodynamic probability.
f) Explain the Maxwell–Boltzmann statistics and partition function, and relate statistical mechanics to thermodynamic quantities.
g) Understand the quantum statistical distributions such as Bose–Einstein and Fermi–Dirac statistics and their physical applications.
h) Explain the statistical behaviour of photon gas, electron gas and degenerate gases in physical systems.
i) Understand the basic observational properties of stars, including stellar distances, magnitudes, spectral classification and the Hertzsprung–Russell diagram.
j) Explain the basic principles governing stellar structure, including hydrostatic equilibrium and energy transport.
k) Understand the stages of stellar evolution and the formation of compact objects such as white dwarfs, neutron stars and black holes.
l) Develop the ability to analyze and solve conceptual and numerical problems related to relativity, statistical physics and astrophysics.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

a) Explain the limitations of Galilean relativity and describe the Michelson–Morley experiment that led to the development of special relativity.
b) Derive and interpret the Lorentz transformations and explain relativistic phenomena such as time dilation, length contraction and relativity of simultaneity.
c) Apply the principles of relativistic mechanics, including relativistic velocity transformation, relativistic mass and mass–energy equivalence.
d) Explain the fundamental concepts of classical statistical mechanics, including microstates, macrostates, entropy and Maxwell–Boltzmann distribution.
e) Use the partition function to obtain thermodynamic properties and explain the equipartition theorem and its applications.
f) Describe the Bose–Einstein and Fermi–Dirac distribution laws and their applications to photon gas and electron gas systems.
g) Explain physical phenomena such as Bose–Einstein condensation, degenerate Fermi gas behaviour and properties of white dwarf stars.
h) Describe stellar observational properties such as stellar distances, magnitudes, spectral classification and the Hertzsprung–Russell (HR) diagram.
i) Explain the basic equations of stellar structure and the concept of hydrostatic equilibrium in stars.
j) Describe the life cycle of stars, including formation, main sequence evolution and the formation of compact objects such as white dwarfs, neutron stars and black holes.
k) Apply theoretical principles to solve conceptual and numerical problems in relativity, statistical physics and astrophysics.

24SEPPHYT-VII: Relativity, Statistical and Astrophysics

UNIT-I

Relativity **14 Hrs**

Chapter 1: The Special Theory of Relativity: Limitations of classical (Galilean) Relativity, The Michelson-Morley Experiment (Theory), Postulates of the Special Theory of Relativity, Lorentz Transformation (derivation), Relativity of Simultaneity, Length Contraction, Time dilation (derivation).

Chapter 2: Relativistic Mechanics: Relativistic transformation of velocity (derivation), relativistic variation of mass (derivation), Einstein's mass energy equivalence ($E=mc^2$-derivation) with illustrations, Energy-momentum relation, Relativistic Doppler Effect (derivation).

Solving Problems

Unit-II

Statistical Physics: Classical Statistics **14 Hrs**

Chapter 3: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law.

Chapter 4: Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression (no derivation) , Gibbs Paradox, Sackur Tetrode equation (derivation), Law of Equipartition of Energy (with proof)-applications to Specific Heat and its Limitations.

Solving Problems

Unit-III

Statistical Physics: Quantum Statistics **14 Hrs**

Chapter 5: Bose-Einstein distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Chapter 6: Fermi-Dirac distribution law, thermodynamic functions of a completely and strongly degenerate fermi gas, fermi energy, electron gas in a metal, specific heat of metals, relativistic fermi gas, white dwarf stars, Chandrasekhar mass limit.

Solving Problems

Unit-IV

Astrophysics **14 Hrs**

Chapter 7: Stellar Properties: Stellar Parallax – Parallax method of determining the stellar distance, units of stellar distance (light year and parsec), Stellar Magnitude (Hipparchus magnitude Scale -apparent and absolute magnitudes & their relations). Distance-modulus Relationship, Stellar Colour – Colour (Surface) temperature of star using UBV photometry, Spectral Spectra – Harvard Classification Scheme for stars, Stellar Mass and size, HR Diagram and its importance.

Chapter 8: Stellar Structure: Gravitational potential energy of a star using linear density model, Hydrostatic equilibrium, Basic Equations of stellar structure (Mention of equations for mass conservation & momentum conservation), Virial Theorem, Linear density model of a star - Expression for internal pressure and temperature of a star, Mass-Luminosity Relation (Qualitative), Photon diffusion Time (Qualitative).

Chapter 9: Stellar Evolution: Gravitaional potential energy of a star using linear density model,Block diagram of Stellar Evolution – Qualitative discussion of different stages of Stellar Evolution (Formation, main sequence stage, red giant stage and death stage), super dense remnants-White dwarf- Chandrasekhar limit, neutron star and black hole (qualitative- mass limits and expression for radius).
Solving Problems

Reference Books

1. Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
2. Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
3. Astrophysics : A Modern Perspective, K.S. Krishnaswamy, New Age International (2006)
4. Introduction to Special Theory of Relativity, Robert Resnick, John Wiley & Sons (1968)
6. Special Relativity, A P French, W W Norton & Company (1968)
7. A Primer of Special Relativity, P L Sardesai, New Age International (2004)
8. Relativistic Mechanics, Satyaprakash, Pragati Prakashan.
9. College Physics (Volume III), Sundararajan N, George Thomas & Syed Azeez, United Publishers (2006).
10. An Introduction to Modern Astrophysics (Second Edition), Bradley W Carroll & Dale A Ostlie, , Pearson Education (2007)
11. Heat Thermodynamics and Statistical Physics, Brij Lal N Subrahmanyam PS Hemne, Revised Edition, S Chand And Co.x

12 Fundamentals of Statistical Mechanics by B B Laud, Second Edition, New Age International Lid.

13. Statistical Mechanics, Srivastava, R. K., Ashok, J., Phi Learning.
14. Statistical Mechanics, Gupta K, Elementary PRAGATI PRAKASHAN-MEERUT, 2005.
15. Stellar Evolution, Stein R F & A G W Cameron, Plenum (1966)
16. Astrophysics of Stars and Galaxies, Abhyankar K D, Universities Press, 2001
17. Astrophysics I:Stars, Richard Bowers and Terry Deeming, Jones and Bartlett, Boston 1st Edition (1984)

PAPER VIII: Condensed Matter Physics and Electronics

Total 56 Hours

Course Learning Objectives:

a) Understand the fundamental concepts of crystal structures, including lattice, unit cells, Bravais lattices and crystal planes.
b) Explain the principles of X-ray diffraction and analyze crystal structures using Bragg's law.
c) Understand the theories of specific heat of solids, including classical and quantum models.
d) Describe the free electron theory of metals and its role in explaining electrical conductivity.
e) Explain the band theory of solids and its application to conductors, semiconductors and insulators.
f) Understand the electrical properties of semiconductors, including intrinsic and extrinsic conduction and Hall effect.
g) Describe the phenomenon of superconductivity and its important properties and applications.
h) Understand the magnetic properties of materials, including diamagnetism, paramagnetism and ferromagnetism.
i) Explain the basic principles of electronic instrumentation and digital electronics, including CRO, logic gates and digital circuits.
j) Understand electronic filters and voltage regulation techniques used in electronic circuits.
k) Describe the interaction of light with semiconductors and the basic principles of photonics.
l) Explain the working principles of optoelectronic devices such as LEDs and photodiodes and their applications.
m) Develop the ability to analyze and solve conceptual and numerical problems related to condensed matter physics, electronics and photonics.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

a) Explain the crystal structure of solids, including lattice systems, Miller indices and Bravais lattices.
b) Apply Bragg's law of X-ray diffraction to determine crystal structures.
c) Describe the classical and quantum theories of specific heat of solids, including Einstein and Debye models.
d) Explain the free electron theory of metals and derive expressions for electrical conductivity.
e) Describe the band theory of solids and explain electrical conduction in intrinsic and extrinsic semiconductors.
f) Explain the Hall effect and its applications in determining charge carrier properties.

g) Describe the phenomenon of superconductivity, its experimental features and technological applications.
h) Explain the magnetic behavior of materials using classical theories of diamagnetism, paramagnetism and ferromagnetism.
i) Explain the working principle and applications of CRO, logic gates and digital electronic circuits.
j) Design and analyze basic electronic circuits such as filters and voltage regulators.
k) Explain the interaction of light with semiconductors and the principles of photoconductivity and recombination.
l) Describe the construction, working and applications of LEDs and photodiodes used in photonics and optical communication.
m) Apply theoretical concepts to solve conceptual and numerical problems in condensed matter physics, electronics and photonics.

PAPER VIII: Condensed Matter Physics and Electronics

UNIT-I

Condensed Matter Physics I **14 hrs.**

Chapter 1: Crystal Structure: Concept of Lattice, unit cell, Bravis Lattice, crystal plane, crystal systems and Miller indices. X-ray diffraction- Bragg's Law, Bragg's Spectrometer, Crystal structure of NaCl

Chapter 2: Specific heat of solids: Dulong and Petit's law. Einstein's theory of specific heat of solids, Debye's theory.

Chapter 3: Free electron theory: The free electron gas theory of metals- Drude-Lorenz model-expression of electrical conductivity (derivation) -Limitations of classical theory, Quantum free electron theory-Energy states of free electrons in metals - Statement of density of states. Expression for Fermi energy and average energy (at zero Kelvin).

Solving Problems

UNIT-II

Condensed Matter Physics II **14 hrs.**

Chapter 4: Band theory of solids: Origin of bands in solids, intrinsic semiconductors-statement of density of energy states- Derivation of expression for Electrical conductivity. Fermi level in case of intrinsic and extrinsic semiconductors (qualitative), Hall effect - expression for Hall coefficient, experimental determination of it and application.

Chapter 5: Superconductivity: Experimental facts (Transition temperature, persistent current, Isotope effect, Meissner effect), Critical magnetic field, BCS theory (qualitative), Josephson's effect, Type I & Type II superconductors - Applications of Superconductors.

Chapter 6: Magnetic materials: Classical Langevin's theory of Diamagnetism and paramagnetism, Curie Law, Domain theory of Ferromagnetism (Qualitative).

Solving Problems

UNIT III

Electronics 14 hrs

Chapter 7: Introduction to CRO: Block diagram of Cathode Ray Oscilloscope (CRO). Electron gun, electrostatic deflection system, time base. Deflection sensitivity. Applications of CRO: Study of waveforms, Measurement of voltage and current, Measurement of frequency, Measurement of phase difference.

Chapter 8 : Boolean Algebra and Logic Gates: Boolean algebra, Boolean laws. De Morgan's theorems. Simplification of logic expressions using Boolean algebra. Basic logic gates: AND, OR, NOT. Realization using diodes and transistors.

Chapter 9: Digital Circuits: Difference between analog and digital circuits. Examples of linear and digital ICs. Binary number system. Decimal to binary and binary to decimal conversion. BCD, octal and hexadecimal number systems. Universal gates: NAND and NOR. Exclusive gates: XOR and XNOR. Application of XOR/XNOR as parity checkers.

Chapter 10: Electronic Filters and Voltage Regulation: Capacitor and inductor filters. L-section and π-section filters. Ripple factor. Electronic voltage regulators. Stabilization factor. Voltage regulation using IC regulators.

Solving Problems

UNIT IV

Photonics **14 hrs**

Chapter 10: Introduction to Photonics: Interaction of light with semiconductors. Optical absorption in semiconductors. Photoconductivity. Radiative and non-radiative recombination. Direct and indirect band gap semiconductors. Internal and external quantum efficiency.

Chapter 11: Light Emitting Diodes (LEDs): Principle of electroluminescence. Construction and working of LED. Energy band diagram of LED. Materials used for LEDs (GaAs, GaP, GaAsP, InGaN). V–I characteristics and efficiency of LEDs. Advantages and limitations. Applications: displays, indicators, solid-state lighting and optical communication.

Chapter 12: Photodiodes: Principle of photodetection. Construction and working of PN photodiode. PIN photodiode. Avalanche photodiode (APD) – basic idea. Photodiode characteristics. Responsivity and quantum efficiency. Dark current and noise. Applications in optical communication, sensors and detectors.

Solving Problems

Reference Books

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications,1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S.Saxena,P.N. Saxena,Pragatiprakashan Meerut(2017).
1. Introduction to solid State Physics, Charles Kittel, VII edition, (1996)
2. Solid State Physics- A J Dekker, MacMillan India Ltd, (2000)
3. Essential of crystallography, M A Wahab, Second Edition (2015)
4. Solid State Physics-S O Pillai-New 10^{th} Edition, Age Int. Publishers
5. Solid State Physics, M Ali Omer, , Pearson Education
6. Principles of Electronics, V K Mehta and Rohit Mehta, , S Chand & Company
7. Elements of Electronics, R S Sedha, , S Chand.
8. A Textbook of Digital Electronics - RS Sedha
9. Fundamental Principles of Electronics by Dr. Basudev Ghosh
10. Physics for Degree students (Third Year) – C.L. Arora and P.S. Hemne, 2014, S, Chand (For Unit-1, Power supplies)
11. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, 2011, McGraw Hill Education India Pvt. Ltd. (For rest of the syllabus)
12. Instrumentation – Devices and Systems (2nd Edition)– C.S. Rangan, G.R. Sarma, V.S.V. Mani, 2009, Tata McGraw Hill Education Pvt. Ltd. (Especially for circuitry and analysis of signal generators and filters).
13. **Semiconductor Optoelectronic Devices**, Pallab Bhattacharya, 2^{nd} Edition, Pearson Education, (Singapore, pvt.ltd.), Printed in India by Tan Prints(I), Pvt. Ltd., 2004.
14. Optoelectronics an Introduction, John Wilson, John Hawkes, , Third edition, PHI EUROPE.
15. **Lasers and Optoelectronics,** Anil K. Maini,, **2013 John Wiley and Sons Ltd**
16. **Introduction to Fiber Optics**, Ajoy Ghatak and K. Thayagarajan, Cambridge university press, First South Asian Edition, Rerint 2009.

24SEPPHYP-VI: Practical - VI

*List of experiments for **6th semester** (students have to perform a minimum of ten experiments from the list below)*

1. Plot Maxwell–Boltzmann, Fermi–Dirac and Bose–Einstein distribution functions as a function of energy at different temperatures. **(Compulsory)**
2. Determination of the energy gap of a Thermistor **(Compulsory)**
3. Analysis of X-ray diffraction spectra and calculation of lattice parameter. **(Compulsory)**
4. Measurement of voltage, frequency, and phase difference of AC signal using CRO.**(Compulsory)**
5. Measurement of photodiode response to light intensity.**(Compulsory)**
6. Mapping of H-R diagrams. **(Compulsory)**
7. Construct a DC power supply using a bridge rectifier and a capacitor filter. Use a Zener diode or a 3- pin voltage regulator and study the load and line regulation characteristics. Measure ripple factor with and without filter and compare with theoretical values. **(Compulsory)**
8. Fermi Energy of Copper **(Compulsory)**
9. Verification of Logic gates using ICs or Diodes OR Transistors.
10. Study of LED V–I characteristics and hence find threshold voltage.
11. Hall Effect in semiconductor: determination of mobility, hall coefficient.
12. Energy gap of semiconductor (diode/transistor) by reverse saturation method
13. Specific Heat of Solid by Electrical Method
14. Determination of Dielectric Constant of polar liquid.
15. Determination of dipole moment of organic liquid
16. Study of B-H Curve Using CRO.
17. Spectral Response of Photo Diode and its I-V Characteristics.
18. Determination of particle size from XRD pattern using Debye-Scherrer formula.
19. Measurement of susceptibility of paramagnetic solution (Quincke's Tube Method).
20. Measurement of susceptibility of paramagnetic solid (Goey's Method)

*NOTE:- **Any additional relevant experiment may be added with prior approval of the Board of Studies (BOS).***

24SEPPHYPr: Project

Course Objectives of the Project

The project work aims to:

- Introduce students to basic research methodology in physics.
- Develop experimental, computational, or theoretical skills.
- Train students in data collection, analysis, and interpretation.
- Improve scientific writing and presentation skills.
- Encourage independent learning and problem-solving ability

Indicative types of projects; however, they are not limited to these

Students may undertake any one of the following types of projects:

1. Experimental Physics Projects

Examples:

- Measurement of thermal conductivity of materials
- Study of magnetic hysteresis loop
- Optical experiments using laser diffraction or interference
- Raman spectrum analysis (if facility available)

2. Computational Physics Projects

Examples:

- Synthesis and decomposition square wave using Fourier analysis
- Simulation of particle in a potential well using Python
- Simulation of radioactive decay using Monte Carlo method
- Numerical solution of Schrödinger equation
- Simulation of planetary motion
- Modelling of harmonic oscillator or chaotic systems
- Simulation of Maxwell-Boltzmann distribution
- Basic quantum computing experiments using Qiskit

(This may interest students since computational physics is becoming important.)

3. Electronics / Instrumentation Projects

Examples:

- Design of temperature sensor using thermistor
- Construction of LED-based optical communication system
- Design of digital counter using logic gates
- Construction of regulated power supply
- Design of light intensity meter
- Arduino-based data acquisition system

4. Literature / Review Projects

Suitable where experimental facilities are limited.

Examples:

- Applications of superconductivity
- Graphene and its electronic properties
- Physics of solar cells
- Quantum computing basics
- Nanomaterials for energy storage
- Astrophysical compact objects

Students review 20–30 research papers/books and prepare a report.

Scheme of Valuation for Practicals

Maximum Marks: 50

Internal (To be assessed by the in-charge faculty):	10
During practical Exam	
Formula and explanation of terms with units:	05
Figure and setting of experiments:	05
Reading and Tabulation:	08
Calculations with graph if any:	10
Result reporting and accuracy:	02
Practical Record:	05
Viva:	05
Total	**40**

Scheme of Valuation for Project

Internal (To be assessed by the in-charge faculty):	10
During Project Viva-Voce Examination	
Project Report :	20
Presentation :	10
Viva:	10
Total	**40**

10/03/2026

Shivagangotri, Davangere-07

THEORY EXAMINATION QUESTION PAPER PATTERN FOR MAJOR SUBJECTS (Semesters V –VI)

B. Sc. Semester-V-VI Degree Examination; 2025-26
(Semester Scheme; New Syllabus: 2024-25)

SUBJECT: SCIENCE COURSES

Paper –______: ________________________________
Paper Code: ___________________

Time: 3 Hours **Max. Marks: 80**

Instructions to candidates:

1) All sections are compulsory
2) Draw neat and labelled diagrams wherever necessary.

SECTION-A

I. Answer **all** the following questions: **(2×10=20)**

1
2
3
4
5
6
7
8
9
10

SECTION-B

II. Answer any **SIX** of the following: **(5×6=30)**

11.
12.
13.
14.
15.
16.
17.
18.

SECTION -C

III. Answer **Any Three** of the following: **(10×3=30)**

19. From Unit-I
20. From Unit-II
21. From Unit-III
22. From Unit-IV

*****

10/03/26
Chairman
Board of Studies
Department of Physics
Shivagangotri, Davangere-07

Registrar
Davangere University
Shivagangotri, Davangere

THEORY EXAMINATION QUESTION PAPER PATTERN FOR ELEMENTARY RESEARCH METHODOLOGY

(Semesters V)

B.Sc. Semester-V Degree Examination; 2025-26

(Semester Scheme; New Syllabus: 2024-25)

SUBJECT: SCIENCE COURSES

Paper – : Elementary Research Methodology

Paper Code: _______________

Time: 2 Hours **Max. Marks: 40**

Instructions to candidates:

1) All sections are compulsory
2) Draw neat and labelled diagrams wherever necessary.

SECTION-A

Answer **all** the following questions: **(2×5=10)**

1.
2.
3.
4.
5.

SECTION-B

Answer any **SIX** of the following: **(5×6=30)**

6.
7.
8.
9.
10.
11.
12.
13.

____

10/03/2026

Chairman
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