St Joseph's University

#36, Lalbagh Road, Bengaluru – 560027

Department of Physics

Bachelor of Science Honours (B.Sc.(H)) Program

4th Year VII Semester Syllabus

(2025-26)

Course Structure

Course	Paper	Credits
Mathematical Methods of Physics	Theory Paper 1	03
Classical & Quantum Mechanics II	Theory Paper 2	03
Theoretical and Computational Physics	Elective 1	03
Physics Lab 1 (Computational)	Lab 1	02
Advanced Material Science	Elective 2	03
Physics Lab 2 (General)	Lab 2	02
Research Methodology	Research Paper 1	03
Research Proposal Lab	Research Paper 2	04
		Total: 23 Credits

MATHEMATICAL METHODS OF PHYSICS

(3 Credits - 3 Hours/Week)

Course Objectives:

By the end of this course, students should be able to:

CO1	Remember fundamental concepts of linear algebra, complex analysis, Fourier analysis, and partial differential equations.
CO2	Understand the mathematical structures of vector spaces, eigenvalue problems, analytic functions, integral transforms, and PDEs.
CO3	Apply vector calculus, matrix operations, contour integration, and Fourier/Laplace transforms to solve mathematical and physical problems.
CO4	Analyse eigenvalue problems, residue theorems, and PDE solutions using separation of variables and integral transforms.
CO5	Evaluate the correctness and efficiency of different mathematical techniques in solving differential equations and transformations.
CO6	Create solutions to advanced problems in physics and engineering using the mathematical tools covered.

Unit I: Linear Algebra

Vectors and vector spaces: Vector Analysis: Linear Vector Space, Linear independence, Dimension of Vector Space, Basis vectors, Matrix representation of vectors (bra and ket notation), Inner product, Orthonormal basis, differential vector operators, vector integration, curvilinear coordinates, Coordinate Transformations, and Jacobians, Vector Spaces: Gram-Schmidt orthogonalization, self-adjoint operators, unitary operators, transformation of operators, vector spaces.

Eigenvalue Problems: Eigenvalue equations, matrix eigenvalue problems, Cayley-Hamilton theorem, Hermitian eigenvalue problems, Hermitian matrix diagonalization, normal matrices.

(11 hours)

Self-study: vector in 3-d spaces (02 hours)

Unit II: Complex analysis

Functions, Differentiation, Analytic functions, Cauchy-Riemann conditions, Contour integrals, Cauchy's theorem, Cauchy integral formula, Series: Taylor and Laurent series, calculus of residues, contour integrations, introduction to analytic continuation, and Riemann surfaces.

(09 hours)

Self-study: Analytic and harmonic functions (01 hour)

Unit III: Fourier analysis

Fourier series, Fourier integral and transform, Dirac Delta Functions, convolution theorem, Parseval's identity, applications to solving differential equations. (10 hours)

Self-study: The Laplace transform and applications to differential equations. (02 hours)

Unit IV: Partial Differential Equations

Partial Differential Equations: Helmholtz, Laplace, Poisson equations in all three coordinates, Separation of variables, Integral transforms, change of variables, method of characteristics, applications: wave, heat equation. (09 hours)

Self-study: Diffusion equations (01 hour)

Reference Books:

1. Mathematical methods for Physicists - Arfken & Weber - 6 Edition-Academic Press- N.Y.
2. Mathematics for Physical Sciences - Mary Boas, John Wiley & Sons
3. Linear Algebra - Seymour Lipschutz, Schaum Outlines Series- Mc-Graw Hill edition
4. Mathematical Methods of Physics - Mathews & Walker - 2 Edition- Pearson Edition
5. Mathematical Methods in Physics - Butkov Addison Wesley Publishers.
6. Advanced Engineering Mathematics, E. Kreyszig, 7 Edition, New Age International
7. Complex Variables and Applications - J.W.Brown, R.V.Churchill - (7 Edition)- Mc-Graw Hill - Ch. 2 to 7.
8. Complex Variables - Seymour Lipschutz
9. Fourier Series - Seymour Lipschutz, Schaum Outlines Series
10. Laplace Transform - Seymour Lipschutz, Schaum Outlines Series
11. Mathematics of Classical and Quantum Physics - Byron, Fuller Dover (1992)
12. Mathematical physics, applications and problems - V. Balakrishnan (2017)
13. Differential and Integral Calculus - N. Piskunov (1969)

CLASSICAL & QUANTUM MECHANICS II

(3 Credits - 3 Hours/Week)

Course Objectives:

By the end of this course, students should be able to:

CO1	Demonstrate analytical skills to model physical systems using Hamiltonian mechanics.
CO2	Apply problem-solving skills to derive equations of motion using variational principles.
CO3	Develop mathematical proficiency in using linear operators and vector spaces in quantum theory.
CO4	Analyse quantum systems involving angular momentum and indistinguishable particles.
CO5	Employ approximation techniques to solve complex quantum mechanical problems.

Unit I: Hamiltonian Formalisms

Canonical Variables; Cyclic Coordinates and Conservation Theorems in Hamiltonian Formulation; Hamilton's Equations; Examples: Harmonic Oscillator in One and Two Dimensions, Charged Particles in Electromagnetic Field, Hamilton's Equations in Different Coordinate Systems. (05 Hours)

Self-study: Simple Pendulum, Spring-Mass System. (1 Hour)

Unit II: Variational principle

Review of Hamilton's Principle; Modified Hamilton's Principle; Derivation of Hamilton's Equations from the Variational Principle; Canonical Transformations; Legendre Transformations; Generating Functions (Four Standard Types); Conditions for Canonical Transformations with Examples; Poisson Brackets, Lagrange Brackets and Their Relationship with Examples. (08 Hours)

Self-study: Soap bubbles and soap films, Phase Space; Liouville's Theorem (01 Hour)

Unit III: General formalism of QM

Linear vector space, Hilbert space, orthogonal functions, Linear operators, eigenfunctions and eigenvalues, Hermitian operator, Schmidt orthogonalization procedure. Simultaneous measurement of observables, uncertainty relation, Dirac notation, equation of motion (Schrodinger, Heisenberg, and interaction picture), Momentum representation. (7 Hours)

Self-study: Postulates of Quantum mechanics (1 hour)

Unit IV: Angular Momentum

The angular momentum operators, Commutation relations, eigenvalues, and eigenfunctions of L^2 and L_z, general angular momentum, eigenvalues of J^2 and J_z, angular momentum matrices (J_+, J-, J_x, J_y), spin angular momentum, spin vectors for spin-1/2 system. Many-electron atoms:

Indistinguishable particles, symmetric and asymmetric wavefunctions, Pauli's Exclusion principle, inclusion of spin, spin functions of two electrons, Hartree equation. (8 Hours)

Self-study: Hartree-Fock equations. (1 hour)

Unit V: Approximation Methods

Time-independent perturbation: Energy and Wavefunction correction for nondegenerate levels, Application: Stark effect, Energy and Wavefunction correction for degenerate levels, Application: spin-orbit interaction.

Variation method: Principle, for excited states.

WKB approximation: WKB method, Connection formulas, Validity, Barrier penetration problem.

Time-dependent perturbation: First and second-order transition amplitudes, Fermi Golden rule, Dipole approximation, Qualitative discussion on Einstein A and B coefficients. Selection rules for allowed and forbidden transitions. (11 Hours)

Self-study: Application of Variational Method: Ground state of Helium, Application to WKB Approximation: Alpha Decay (02 hours)

Reference Books:

1. Classical Mechanics- J.C. Upadhyaya, (2nd edition), 2014, Himalaya Publishing House.
2. Quantum Mechanics Theory and Applications- Ghatak, A. Lokanathan, S, (6th edition), 2012, Trinity Press.
3. Classical Mechanics- Goldstein, H, Safko, Poole, (3rd Edition), 2011, Pearson New International Edition
4. Classical Mechanics- Rana. N, Jog, P, (2nd Edition), 2017, McGraw-Hill Education
5. Fundamentals of Classical Mechanics- Gupta, A.B., 2022, A.B. Book House
6. An Introduction to Mechanics- Kleppner. D, Kolenkov, R, (2nd Edition), 2014, Cambridge University Press
7. Classical Mechanics – Kibble, T, Berkshire F.H, (5th Edition), 2004, Imperial College Press
8. Mechanics: Course of Theoretical Physics- Vol 1- Landau, L.D. Lifshitz, E.M. (3rd Edition), 2010, Elsevier Publishing
9. Feynman Lectures- Vol. 3-Feynman, R. P, Leighton, R. B., Sands, M, (New Millennium Edition), 2013, Pearson Education
10. Introduction to Quantum Mechanics- Griffiths, D.J., (2nd Edition), 2013, Pearson
11. Concepts of Modern Physics- Arthur Beiser, Mahajan, S., Rai Choudhury, S. (7th Edition), 2017, McGraw-Hill Education
12. Quantum Mechanics-Vol.1-Cohen-Tannoudji, C. Diu, B. Laloe, F.1977, John Wiley & Sons
13. Quantum Mechanics – Merzbacher. E, II edition, 1970, John Wiley & Sons.
14. Quantum Mechanics: Concepts and Applications- Neroudin Zettlie,(2nd Edition), 2009, John Wiley & Sons.
15. Quantum Mechanics – Lenov I. Schiff (19__)
16. Demonstrating Science with Soap Films, David Lovett, CRC Press.
17. Science of Soap Films, Cyril Isenberg, Dover Publications

THEORETICAL & COMPUTATIONAL PHYSICS

(3 Credits - 3 Hours/Week)

Course Objectives:

By the end of this course, students should be able to:

CO1	Develop the skill of numerically solving the problems which cannot be solved analytically.
CO2	Develop the skill to formulate algorithms to be used in computers to solve problems.
CO3	Understand the significance of errors and its propagation in numerical calculations and how to minimize the errors, hence improving the accuracy.
CO4	Apply the analytical and computational skills to solve mathematical and physical problems
CO5	Solve research-oriented problems in fields of physics and material sciences

Numerical Techniques in Physics (30 hours)

Unit I: Numerical Algebra

Numerical methods: introduction. IEEE arithmetic: definitions, numbers with decimal and binary conversions. Machine epsilon, errors in numerical computation. (01 hour)

Root finding and Regressions: Newton's method and Bisection method, Secant method and order of convergence. Linear regression, least-square approximation, fitting a straight line, linear combinations. (04 hours)

Interpolation: Meaning of interpolation, types of interpolation. Polynomial interpolation and piecewise interpolations. Linear interpolations, spline interpolations, Lagrange interpolations. (04 hours)

Self-study: Some examples of computer numbers. (01 hour)

Unit II: Numerical Calculus and Monte Carlo Technique

Numerical Differentiation and integration: Finite difference forms of 1^{st} and 2^{nd} order derivatives. Newton's difference method. Elementary techniques: midpoint rule, Simpson's rule (1/3 and 3/8), local vs. global error, adaptive integration. (03 hours)

Monte-Carlo Technique: Introduction, Monte Carlo Evaluation of integrals, Use of Monte Carlo techniques in Physics. (03 hours)

Self-study: Trapezoidal rule of integration (01 hour)

Unit III: Differential Equations

Ordinary Differential Equation: Taylor series method, Euler Method, Runge-Kutta (RK2 and RK4) methods. (05 hours)

Partial Differential Equations: Difference method, accuracy, stability, Two-step Lax-Wendroff method, FTCS application to wave equation, Advective equation, Diffusion equation, Poisson equation, fast Fourier transforms. (06 hours)

Self-study: , Lax method, Lax-Friedrich method. (02 hours)

Density Fucntional Theory (15 hours)

Unit IV: Introduction to Density Functional theory (DFT)

Introduction to DFT: The Schrödinger equation, Systems of non-interacting electrons Hartree potential, Self-consistent field, Exchange potential, Correlation potential, Hohenberg-Kohn theorem, Kohn-Sham equation, Relationship between Kohn-Sham energy and total energy, Exchange-correlation functional, Total energy calculation. (06 hours)

Unit V: Solid-State Physics for DFT

Reciprocal Space and k Points, Plane Waves and the Brillouin Zone, Integrals in k Space, Summary of k Space, Plane wave expansion, Cut-off energy and pseudopotential, Energy bands and density of states, Experiments for E(k) and DOS, Phonon dispersion, Electron-phonon interaction, Optical properties of solid, Transport properties of solid. (04 hours)

Unit VI: DFT Calculations for Simple Solids

Periodic Structures, Supercells, and Lattice Parameters, Face-Centred Cubic Materials, Hexagonal Close-Packed Materials, Crystal Structure Prediction, Phase Transformations (03 hours)

Self-study: Phonon-phonon interaction, Heat conduction in a solid. (02 hours)

Reference books:

1. Computer oriented numerical methods, V. Rajaraman, PHI
2. Numerical Analysis, S. S. Sastry, PHI
3. Numerical Methods for Scientific and Engineer Computation, M. K. Jain, S.R.K. Iyengar & R. K. Jain, Wiley Eastern, Indian Journal of Physics
4. Numerical Recipes in C, W.H Press, S.A. Tenkolsky, W. Vetterling and B.P Flannery, Cambridge University Press
5. Density Functional Theory: A Practical Introduction, David S. Sholl, Janice A. Steckel, Wiley, 2009
6. Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, Errol G. Lewars, Springier, 2016
7. Computational Physics, by P.K. Ahluwalia, R.C. Verma and K.C. Sharma

PHYSICS LAB I: COMPUTATIONAL PHYSICS LAB

(30 hours, 02 credits)

(Any 09 experiments from the following list or any other experiments decided by the Department)

1. Numerical Integration of equations of motion using Simpson's one-third rule
2. Numerical differentiation of equations of motion using Newton's forward difference rule
3. Linear interpolation of data of a given function.
4. Root finding of square root of 2 and formation of Newton's fractals.
5. Solution of SHM equations using Euler method: Error analysis: forward, backward and hybrid approach.
6. Simulation of 1D classical random walk.
7. Determination of value of π using Monte-Carlo experiment.
8. DFT calculation of Optimized geometry, DoS and Bandgap of elementary materials using Quantum Espresso. Semiconductors
9. DFT calculation of Optimized geometry, DoS and Bandgap of elementary materials using Quantum Espresso. Metals
10. DFT calculation of Optimized geometry, DoS and Bandgap of elementary materials using Quantum Espresso. Insulators
11. Motion under drag force
12. Rocket equation numerical simulation.

ADVANCED MATERIALS SCIENCE

(03 credits – 3 Hours/week)

Course Objectives

By the end of this course, students should be able to:

Level	**Course Objective (Based on Bloom's Taxonomy)**
CO1	Remember fundamental concepts of materials science, including classification, processing-structure-property relationships, and modern material needs.
CO2	Understand various synthesis techniques (top-down, bottom-up) and thin-film deposition methods, explaining their principles and applications.
CO3	Apply characterization techniques (XRD, SEM, TEM, UV-Vis, electrical measurements) to analyse material properties.
CO4	Analyse the structural, optical, morphological, and electrical properties of materials using experimental data.
CO5	Evaluate different quantum mechanical approaches and their implications in low-dimensional structures (quantum wells, dots, wires).
CO6	Design device structures (heterostructures, superlattices, MQWs) for applications in solar cells, LEDs, supercapacitors, and MEMS/NEMS

Unit I: Introduction to Materials:

Historical Perspective, Materials Science and Engineering, Why Study Materials Science and Engineering. Advanced Materials – Soft matter, Shape Memory Alloys, Energy materials, metamaterials and photonic crystals, Quantum Materials. Processing/ Structure/ Properties/ Performance Correlation. Phase-diagrams (TTT). (4 hours)

Self-study: Classification of Materials and Modern Materials' Needs. (1 hour)

Unit II: Synthesis, Preparation and Fabrication Techniques:

Synthesis: Successive Ionic Layer Absorption and Reactions (SILAR), chemical precipitation, sol-gel, and hydrothermal approaches.

Thin films deposition: thermal evaporation, Sputtering, e-beam evaporation, pulsed laser deposition, and molecular beam epitaxy, nanolithography. (8 hours)

Self-study: concept of Top-down and bottom-up approach, nanolithography. (2 hours)

Unit III: Characterization and Analytical Techniques

Structural properties: X-ray diffraction - determination of grain size, micro strain, dislocation density, stacking fault, texture coefficient, XRD pattern for amorphous, nanocrystals, polycrystals, and single crystals.

Optical properties: UV-Visible spectroscopy - Beer-Lambert's Law, determination of optical band gap - thin films & nanomaterials (Kubelka Munk Function).

Morphological properties: Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) – morphology, topology, and Selected Area electron diffraction pattern, particle size determination.

Electrical Properties: Van-der Pauw technique - measuring resistivity in thin sheets, four probe method - measuring resistivity of semiconducting films. Hall effect. (09 hours)

Self-study: to determine the Hall coefficient for P and N-type semiconductors. (1 hour)

Unit IV: Theoretical Understanding of the Quantum Mechanics Approach, Device Structure and Applications

Quantum mechanical approach: low-dimensional structures, concept of quantum well structure, Formation of quantum well, Quantum dots, and quantum wires. Quantum tunnelling effect, Quantum confinement effect, confined states in quantum wells, wires, and dots.

Device structure: Heterostructure, double heterostructure, Superlattice, Multilayer, multi-junction, multiband, Triple junction, and Multiple Quantum well (MQWs), substrate and superstrate structures.

Applications: Solar cells: device structure and characteristics: CIGS and CdTe thin film, Perovskite and Si based Solar cells, Light emitting diode: device structure, power loss and characteristics: surface and edge light emitting diodes, Organic Light emitting diodes and Blue LED, Supercapacitor, Lithium-Ion Batteries, Micro electromechanical system (MEMS).

(18 hours)

Self-study: Density of states in quantum wells, wires, and dots, and nanoelectronics mechanical system (NEMS). (02 hours)

Reference books:

1. Textbook on Nanoscience and Nanotechnology by T. Pradeep, 2012. McGraw-Hill Education (India) Private Limited.
2. NANO: The Essentials: Understanding Nanoscience and Nanotechnology, 1st Edition by T. Pradeep. McGraw-Hill Education (India) Private Limited.
3. Materials science of Thin films: deposition and structure. Milton Ohring. Academic Press. 2016.
4. Materials Science and Engineering – An Introduction (10^{th} Edition) by William Callister. Wiley.

5. Material Science & Engineering, V. Raghavan, Prentice-Hall of India, New Delhi (2001).
6. Experimental Physics: R.A. Dunlap, Oxford University Press, 1988.

PHYSICS LAB II: GENERAL PHYSICS LAB

(30 hours, 02 credits)

(Any 09 experiments from the following list or any other experiments decided by the Department)

1. Determination of e/m ratio by Helium Arc Method
2. Resistivity determination using four-probe method
3. Thermal relaxation of bulb
4. Cu-Constantan Thermocouple and Si diode
5. Hall effect
6. High Resistance by leakage
7. Absorption spectrum of various dyes
8. Rigidity Modulus of Brass
9. Verification of Beer-Lambart's Law: Study of intensity variation from different concentration dyes using Spectrophotometer Absorption (cross-section)
10. Dielectric Constant of polar liquids
11. Resistivity using Vander Pauw method
12. Piezo-electric constant of PVDF Film

RESEARCH METHODOLOGY

(03 Credits - 3 hours/week)

Course Objectives:

By the end of this course, students should be able to:

CO1	Understand the meaning of research
CO2	Apply the knowledge of research tools to conduct research projects
CO3	Evaluate a research paper to determine research gap, authenticity and research posers.
CO4	Analyse a problem and develop a research model
CO5	Remember the various indexing factors associate with research and authorship.

Unit I: Fundamentals of Research

What is research? Introduction to scientific methods, classification of research methods, research philosophy and approach. Objectives of research: theoretical models. Importance of methodology in scientific research: philosophy, concept, aim, purpose and scope of research. Review of literature: importance of literature review in defining a problem, literature sources-primary and secondary, reviews, monographs, patents, research databases, web as a source, searching the web, identifying gap areas from literature and research database, development of working hypothesis. Writing a literature review report. (08 hours)

Self-study: Types of research: descriptive vs analytical, pure vs applied, conceptual vs empirical, qualitative vs quantitative, scientific vs technical, diagnostic, evaluation, action and experimental research. (02 hours)

Unit II: Planning of Research

The planning process, selection and identification of a problem for research, formulation of the selected problems, hypothesis formation, measurement, research design/plan. Statement of research problem, meaning; importance; sources; evaluating a research problem, objectives, design and execution of experiments, collection and interpretation of experimental data, arriving at conclusions. Experimental research and design: approximation of data, simulation and modelling. Good laboratory practices and safety measures. Sampling: types of sampling, questionnaire and observational methods of data collection. Reporting the results of research – style and format – title, abstract and the text, references, tables, figures, elucidations, quotations and footnote. Case studies. (09 hours)

Unit III: Tools and Techniques in Research

Use of search engines for literature review and gap identification: google scholar, scopus, science direct, scifinder, internet archive, arxiv, web of science, research rabbit, pubmed, ResearchGate and Shodhganga. Application of common software in Physics. AI tools in

physics: tools for automating tasks, providing authentic data. Streamlining the research process: Mendeley, Zotero, and Cite-maker. Use of Mendeley/ Zotero in a report writing.
(09 Hours)

Unit IV: Scientific Communication

Introduction to writing reports, thesis, review, research paper and monographs. Steps to write a research paper: title, abstract and keywords, introduction, materials and methods, results and discussion, conclusion, references, conflict of interest, acknowledgment. Relevance and quality of tables, figures, schemes and graphs, appendices, supplementary information and cover letters. Use of LaTeX. General communication in magazines, newspapers, blogs for science outreach and public engagement. Seminar/conference/webinar presentation: oral and poster. Research proposals: writing and submission. (07 Hours)

Self-study: Writing articles, a research proposal to industrial and academic funding agencies, and preparing a poster. (02 hours)

Unit V: Research Publication and Ethics

Types of journals and publications- domain-based, university, private, individual, regional, society/association, open access journals, article processing charges. Peer Review process. Journal indexing: Scopus, Web of Science, Google Scholar. Research Identity: Vidhwan, ORCID and indexing parameters. Scientometrics: impact-factor, SNIP, SJR, IPP, Citescore, research interest score, h-index, d-index, calculation of h-index, i10-index, Altmetrics. Research Data-availability, storage, open access and statements. Publication ethics - introduction and importance, best practices/standards setting initiatives and guidelines. Conflict of interest, Credit Author Statement (CAS). Retraction: publication misconduct, violation of publication ethics. Plagiarism and similarity: Turnitin Pro with AI and other open-source tools. Predatory Journals. (06 Hours)

Self-study: Brief introduction to IPR: patent, copyright and trademark. (02 hours)

Reference Material

1. Research methodology – methods and techniques; c. R. Kothari; and g. Gaurav; new age international publishers, 2019.
2. Research methodology: methods & techniques; s. K. Gupta; and r. Praneet; kalyani publishers, 2017.
3. Research methodology – A step-by-step guide for beginners; R. Kumar; 2nd Edition, Pearson Education, 2016.
4. Research methods for science; M. P. Marder; Cambridge University Press, 2011.
5. Research methodology – Methods and techniques; C. R. Kothari; Wiley Eastern Limited, 2004.
6. How do I write a scientific article? A personal perspective; G. Lippi; Annals of Translational Medicine, 5(20), 416, 2017.

7. Writing scientific research articles: Strategy and steps; M. Cargill; and P. O'Connor; 2nd Edition, John Wiley and Sons, 2013.
8. Ethics in research; I. Gregory; Viva Books Pvt. Ltd., 2005.
9. Case study research methods; B. Gillham; Viva Books Pvt. Ltd., 2005.
10. Predatory Journals: What the Researchers and Authors Should Know; A. Chandra; and S. Dasgupta; The American Journal of Medicine, 6(137), 2024.
11. Predatory journals and their effects on scientific research community; F. Habibzadeh; and A. M. Simundic; Biochemia Medica, 27(2), 270, 2017.
12. Origin 9.1 User Guide – OriginLab (https://www.originlab.com/doc/User-Guide).

RESEARCH PROPOSAL LAB

(04 credits – 02 labs/week (03 hour each lab))

Guidelines:

- Students must perform a research project on a topic selected by them and the respective guides.
- Students may choose one of the department faculties as their project guides.
- Alternatively, students may find research guides outside the University, with one department faculty as a co-guide, post approval by the Department.
- The students need to perform the tasks according to the following timeline:

Sl. No.	Week	Task
1	1	Identification and Interaction with Supervisor
2	2	Identifying the research area, Problem definition and research objectives
3	3	Literature Review
4	4	Project Timeline planning
5	5-9	Progress presentation, with weekly update to guide & lab in-charge.
6	10-13	Progress presentation and final submission

- Students need to submit **weekly** reports to the project guide and lab in-charge, which will be included in internal evaluation.
- **Monthly** progress presentations should be delivered by the students to the respective guide and lab in-charge, and a corresponding report should be submitted.
- Students may prepare a Gantt chart based on the above table and include the same in their presentation, showing the progress of each week.

Marking Scheme and Question Paper Pattern

(for all theory papers except Research Methodology)

1. The B.Sc. VII Semester program will be assessed based on the following pattern:

- 10% evaluation marks based on Continuous Internal Assessment (CIA I)
- 10% evaluation marks based on Continuous Internal Assessment (CIA II)
- 20% evaluation marks based on Mid Semester Examination
- 60% marks based on End Semester Examination

2. The question paper for the mid-semester exam will be set as follows:

Question Paper Part	Total Number of Questions	Marks of Each Question	No. of Questions to be attempted	Maximum Marks
Part A	06	05	04	20
Part B	03	05	02	10
Total				**30**

3. The question paper for the end-semester exam will be set as follows:

Question Paper Part	Total Number of Questions	Marks of Each Question	No. of Questions to be attempted	Maximum Marks
Part A	06	10	04	40
Part B	06	05	04	20
Total				**60**

4. Questions should be mapped according to Bloom's Taxonomy.

(for Physics Lab I & II)

Evaluation	Marks	Assessment Basis
Internal	20 marks	Internal assessment of each practical class
End-semester	25 marks	End-Sem practical examination
	05 marks	Viva-Voce during End-Sem practical examination
	Total = 50 marks.	

Marking Scheme and Question Paper Pattern

(for Research Methodology paper)

1. The B.Sc. VII Semester program will be assessed based on the following pattern:

- 10% evaluation marks based on CIA I
- 10% evaluation marks based on CIA II
- 20% evaluation marks based on Mid Semester Examination
- 60% marks based on End Semester Examination

2. The question paper for the mid-semester exam will be set as follows:

Question Paper Part	Total Number of Questions	Marks of Each Question	No. of Questions to be attempted	Maximum Marks
Part A	06	05	04	20
Part B	03	05	02	10
Total				**30**

3. The question paper for the end-semester exam will be set as follows:

Question Paper Part	Total Number of Questions	Marks of Each Question	No. of Questions to be attempted	Maximum Marks
Part A	07	03	05	15
Part B	03	15	02	30
Part C	15 (MCQ)	1	15	15
Total				**60**

Mode of Evaluation

(for research proposal lab)

- The B.Sc. VII Semester program will be assessed based on the following pattern:
    - 40 evaluation marks based on Continuous evaluation and project report
        - 20 marks based on continuous weekly & monthly assessment during the lab
        - 15 marks based on the project report
        - 05 marks based on the attendance (01/05 for minimum 75% attendance)
    - 30 evaluation marks based on the End semester Viva-Voce examination
        - 15 marks awarded by the external examiner
        - 15 marks awarded by the internal examiners
    - 30 marks awarded by the project guide(s)

<table>
<tr><th colspan="6">Total Marks: 100</th></tr>
<tr><th colspan="3">60 marks</th><th colspan="3">40 marks</th></tr>
<tr><td>15 marks by Internal examiners</td><td>15 marks by External Examiner</td><td>30 marks by The respective project guide(s)</td><td>20 marks Continuous Weekly and Monthly progress assessment</td><td>15 marks Project report</td><td>05 marks Attendance</td></tr>
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