B.Sc. (Hons.) in Physics

under the Framework of Honours School System
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Physics and their applications. The syllabus will provide comprehensive knowledge, and improve theoretical and practical skills of Physics subject and other Science subjects opted by the student. The syllabus contents are in accordance with UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. (Hons.) in Physics.

Semester I

CORE COURSE (PHYSICS)

Theory Papers:
Core Course-1 (C1): Mathematical Physics – I 100 Marks (4 credits)
Core Course-2 (C2): Mechanics 100 Marks (4 credits)

Practicals:
Core Course-1 Practical (C1 Lab): Mathematical Physics – I 50 Marks (2 credits)
Core Course-2 Practical (C2 Lab): Mechanics 50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSORY COURSE

Ability Enhancement Compulsory Course-I (AECC1) 50 Marks (2 credits)
English/Environmental Science 50 Marks (2 credits)

GENERIC ELECTIVE

Each student may opt for any two of the generic electives offered by the other Departments of Panjab University out of following:
(i) Mathematics
(ii) Chemistry/Biochemistry/Biophysics
B.Sc. (Hons.) in Physics under the Framework of Honours School System

(iii) Economics
(iv) Computer Science
(v) Statistics
(vi) Geology

Generic Elective -1 (GE1) 150 Marks (6 credits)
Generic Elective -2 (GE-2) 150 Marks (6 credits)

Semester II

CORE COURSE (PHYSICS)

Theory Papers:
Core Course-3 (C3): Electricity and Magnetism 100 Marks (4 credits)
Core Course-4 (C4): Waves and Optics 100 Marks (4 credits)

Practicals:
Core Course-3 Practical (C3 Lab): Electricity and Magnetism 50 Marks (2 credits)
Core Course-4 Practical (C4 Lab): Waves and Optics 50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSORY COURSE

Ability Enhancement Compulsory Course-II (AECC2) 50 Marks (2 credits)
English/Environmental Science

GENERIC ELECTIVE

Each student may opt for any two of the generic electives offered by the other Departments of Panjab University out of following:
(i) Mathematics
(ii) Chemistry/Biochemistry/Biophysics
(iii) Economics
(iv) Computer Science
(v) Statistics
(vi) Geology

Generic Elective -3 (GE3) 150 Marks (6 credits)
Generic Elective -4 (GE4) 150 Marks (6 credits)
# Semester III

## CORE COURSE (PHYSICS)

<table>
<thead>
<tr>
<th>Theory Papers:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Course-5 (C5):</td>
<td>Mathematical Physics - II 100 Marks (4 credits)</td>
</tr>
<tr>
<td>Core Course-6 (C6):</td>
<td>Thermal Physics 100 Marks (4 credits)</td>
</tr>
<tr>
<td>Core Course-7 (C7):</td>
<td>Digital Systems and Applications 100 Marks (4 credits)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practicals:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Course-5 (C5):</td>
<td>Mathematical Physics - II 50 Marks (2 credits)</td>
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<tr>
<td>Core Course-6 (C6):</td>
<td>Thermal Physics 50 Marks (2 credits)</td>
</tr>
<tr>
<td>Core Course-7 (C7):</td>
<td>Digital Systems and Applications 50 Marks (2 credits)</td>
</tr>
</tbody>
</table>

## SKILL ENHANCEMENT COMPULSORY COURSE

Each student shall opt for any one of the skill enhancement courses offered out of following:

1. PHY-SEC1: Physics Enhancement Skills 50 Marks (2 credits)
2. PHY-SEC2: Computational Physics Skills 50 Marks (2 credits)
3. PHY-SEC3: Electrical Circuits and Network Skills 50 Marks (2 credits)
4. PHY-SEC4: Basic Instrumentation Skills 50 Marks (2 credits)
5. PHY-SEC5: Renewable energy and energy harvesting 50 Marks (2 credits)

## GENERIC ELECTIVE

Each student may opt for any one of the generic electives studied in semesters I and II offered by the other Departments of Panjab University out of following:

(i) Mathematics  
(ii) Chemistry/BioChemistry/Biophysics  
(iii) Economics  
(iv) Computer Science  
(v) Statistics  
(vi) Geology

Generic Elective -3 (GE5) 150 Marks (6 credits)
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Semester IV

CORE COURSE (PHYSICS)

Theory Papers:
Core Course-5 (C8): Mathematical Physics - III 100 Marks (4 credits)
Core Course-6 (C9): Elements of Modern Physics 100 Marks (4 credits)
Core Course-7 (C10): Analog Systems and Applications 100 Marks (4 credits)

Practicals:
Core Course-8 (C8): Mathematical Physics - III 50 Marks (2 credits)
Core Course-9 (C9): Elements of Modern Physics 50 Marks (2 credits)
Core Course-10 (C10): Analog Systems and Applications 50 Marks (2 credits)

SKILL ENHANCEMENT COMPULSORY COURSE

Each student shall opt for any one of the skill enhancement courses (other than that taken during Semester III) offered out of following:

1. PHY-SEC1: Physics Enhancement Skills 50 Marks (2 credits)
2. PHY-SEC2: Computational Physics Skills 50 Marks (2 credits)
3. PHY-SEC3: Electrical Circuits and Network Skills 50 Marks (2 credits)
4. PHY-SEC4: Basic Instrumentation Skills 50 Marks (2 credits)
5. PHY-SEC5: Renewable Energy and Energy Harvesting 50 Marks (2 credits)

GENERIC ELECTIVE

Each student may opt for any one of the generic electives studied in semesters I and II offered by the other Departments of Panjab University out of following:

(i) Mathematics
(ii) Chemistry/BioChemistry/Biophysics
(iii) Economics
(iv) Computer Science
(v) Statistics
(vi) Geology

Generic Elective -3 (GE5) 150 Marks (6 credits)
EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 marks) for theory papers in each semester. End-semester examination will be of 80% of total marks (80 marks).

2. Evaluation of Practicals for Core Subjects Subjects - There shall be internal assessment for practicals having weightage of 20% of the total marks. It will be based on performance of the students in the laboratory, viva voice of each experiment, regularity (attendance) in the class and number of experiments performed. The final end-semester examination will be of 80% of the total marks and 3 hours duration. The evaluation will be based on the following components:
   (i) 15% of total marks for the Project report evaluation, (ii) There will be written comprehensive test of 60 minutes duration containing short answer questions and consisting of two sections – first section containing questions of general type related to experimental skills and second section with 50% choice containing questions based on all the experiments in the course. The test will have a weightage of 20% of the total marks and will be jointly set by the teachers involved in the examination, (iii) 25% of total marks are allocated to performance in the allotted Experiment in the end-semester examination and (iv) 20% of total marks are allocated to evaluation by the External examiner.

3. Evaluation of Practicals for Generic Elective Subjects - There shall be internal assessment for practicals having weightage of 20% marks of the total marks. It will be based on performance of the students in the laboratory, viva voice of each experiment, regularity (attendance) in the class and number of experiments performed. The final end-semester examination will be of 80% marks and 3 hours duration. The evaluation will be based on the following components with equal weightage:
   (i) performance in the allotted Experiment and (ii) evaluation by the External examiner in the end-semester examination

4. Evaluation in Skill Development Courses : Projects/Jobs will be allocated to the students and will be evaluated by a Committee during (i) the midterm interaction with weightage 30%, (ii) end-semester evaluation based on the presentation and project report, and innovation will be given extra credits.

5. To qualify a Course consisting of Theory and Practical parts, the student has to obtain minimum of 40% marks in each of the examinations held for the Theory and Practical parts. Failing in one component (Theory/Practical), the candidate has to reappear in that component only.

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage. It will include one Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

(ii) The remaining eight questions will be placed in Four Units comprising two questions each, uniformly covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. The candidate will be asked to attempt five questions.
PREAMBLE

Physics is the science that involves the study of matter and its motion through space and time, along with related concepts. One of the most fundamental scientific disciplines, the main goal of physics is to understand how the universe evolved and behaves. New ideas in physics often explain the fundamental mechanisms of other sciences and the boundaries of physics are not rigidly defined. Physics also makes significant contributions through advances in new technologies that arise from theoretical breakthroughs.

After partition of India, the Department of Physics was re-established in 1947, in Govt. College, Hoshiarpur (Punjab) and later, shifted to the present campus in August 1958. With the modest beginning of research in high-energy particle physics (nuclear emulsion) and optical UV spectroscopy, the research activities got a major filip with installation of cyclotron accelerator in late sixties. The department strengthened its research activities through UGC Special Assistance Programme (SAP) from 1980 to 1988 and College Science Improvement Programme from 1984 to 1991. In 1988, the department was accorded the status of Center of Advanced Study (CAS) by UGC with three major thrust areas, Particle physics, Nuclear physics and Solid-state physics, which is a unique feature in itself. The department is now in CAS fifth phase. The department participates in various national and international research initiatives in Accelerator-based research in High Energy Physics, Nuclear Physics and Solid-State Physics. The department houses Cyclotron lab, EDXRF lab., Detector development lab., Experimental Solid-state Physics laboratories, Molecular Physics lab. and Advanced computation facilities for analyses of data from High Energy Physics, and Nuclear Spectroscopy and Reaction experiments. High Performance Computation facility is available for Condensed matter Physics and Nuclear Physics simulation calculations.

The Physics department is running undergraduate and postgraduate courses in Physics, and Physics (Specialization in Electronics) under the Honours School System. At present the department has strength of about 30 faculty members and Post-doctoral fellows, 50 non-teaching/administrative staff, 120 research students and 400 graduate and undergraduate students. The department has well equipped Practical and computing laboratories, Workshops and Library. The department has an 11-inch telescope to encourage/inculcate the scientific temper among public and with particular emphasis on college and school students. The department houses Indian Association of Physics Teachers (IAPT) office and actively leads in IAPT and Indian Physics Association (IPA) activities.
# COURSE STRUCTURE

<table>
<thead>
<tr>
<th>SEMESTER I (Credits = 26, Marks = 650)</th>
<th>SEMESTER II (Credits = 26, Marks = 650)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1    PHY-C1: Mathematical Physics – I</td>
<td>C3    PHY-C3: Electricity and Magnetism</td>
</tr>
<tr>
<td>C2    PHY-C2: Mechanics</td>
<td>C4    PHY-C4: Waves and Optics</td>
</tr>
<tr>
<td>AECC1 PHY-AECC1: English/Environmental Science</td>
<td>AECC2 PHY-AECC2: English/Environmental Science</td>
</tr>
<tr>
<td>GE1*</td>
<td>GE3*</td>
</tr>
<tr>
<td>GE2*</td>
<td>GE4*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMESTER III (Credits = 26, Marks = 650)</th>
<th>SEMESTER IV (Credits = 26, Marks = 650)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5    PHY-C5: Mathematical Physics - II</td>
<td>C8    PHY-C8: Mathematical Physics - III</td>
</tr>
<tr>
<td>C6    PHY-C6: Thermal Physics</td>
<td>C9    PHY-C9: Elements of Modern Physics</td>
</tr>
<tr>
<td>C7    PHY-C7: Digital Systems and Applications</td>
<td>C10   PHY-C10: Analog systems and Applications</td>
</tr>
<tr>
<td>SEC1**</td>
<td>SEC2**</td>
</tr>
<tr>
<td>GE5*</td>
<td>GE6*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMESTER V (Credits = 24, Marks = 600)</th>
<th>SEMESTER VI (Credits = 24, Marks = 600)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12   PHY-C12: Solid State Physics</td>
<td>C14   PHY-C14: Statistical Mechanics</td>
</tr>
<tr>
<td>DSE1#</td>
<td>DSE3#</td>
</tr>
<tr>
<td>DSE2#</td>
<td>DSE4#</td>
</tr>
</tbody>
</table>

C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective
B.Sc. (Hons.) in Physics under the Framework of Honours School System

*GE - General Elective courses are to be selected by the student from the pool of GE subjects - Mathematics, Chemistry/Biochemistry/Biophysics, Geology, Statistics, Economics and Computer Science offered by other Departments of the University.

**SEC - SKILL Enhancement Courses are to be selected by the student from the courses offered by the Physics Department in semesters III and IV.

# DSE - DISCIPLINE SPECIFIC ELECTIVE COURSES are to be selected by the student from the courses offered by the Physics Department in semesters V and VI.

*SKILL ENHANCEMENT COURSES (any one per semester in semesters III and IV)

1. PHY-SEC1: Physics Enhancement Skills
2. PHY-SEC2: Computational Physics Skills
3. PHY-SEC3: Electrical Circuits and Network Skills
4. PHY-SEC4: Basic Instrumentation Skills
5. PHY-SEC5: Renewable Energy and Energy Harvesting

#DISCIPLINE SPECIFIC ELECTIVE COURSES
(Any two per semester in semesters V and VI. Course under these will be offered only if a minimum of 10 students opt for the same.)

PHY-DSE1: Experimental Techniques in Physics

1. PHY-DSE2: Physics of Resonance Techniques
2. PHY-DSE3: Classical Dynamics
3. PHY-DSE4: Medical Physics
4. PHY-DSE5: Nuclear and Particle Physics
5. PHY-DSE6: Science of Materials and Nano Systems
6. PHY-DSE7: Astronomy and Astrophysics
7. PHY-DSE8: Dissertation
B.Sc. (Hons.) in Physics under the Framework of Honours School System

GENERIC ELECTIVE SUBJECTS (Offered by the Physics Department) for the students of Bio-Medical Sciences (BMS) and Physical Sciences (PHS):

<table>
<thead>
<tr>
<th>Semesters I</th>
<th>PHY-GE1 Electricity and Magnetism  OR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PHY-GE2 Mathematical Physics I</td>
</tr>
<tr>
<td>Semesters II</td>
<td>PHY-GE3 Elements of Modern Physics</td>
</tr>
<tr>
<td></td>
<td>OR</td>
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<tr>
<td></td>
<td>PHY-GE4 Mechanics</td>
</tr>
<tr>
<td>Semesters III</td>
<td>PHY-GE5 Waves and Optics    OR</td>
</tr>
<tr>
<td></td>
<td>PHY-GE6 Mathematical Physics II</td>
</tr>
<tr>
<td>Semesters IV</td>
<td>PHY-GE7 Digital, Analog Circuits and Instrumentation  OR</td>
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<tr>
<td></td>
<td>PHY-GE8 Thermal Physics and Statistical Mechanics</td>
</tr>
</tbody>
</table>

Credits and Maximum Marks:

1. Core Courses (C1-C14)
   Credits = 06 (04 Theory + 02 Practicals) each
   Total marks 150 each

2. Discipline Specific Elective (DSE1-DSE4)
   Credits = 06 each
   Total marks = 150 each

3. Skill Enhancement Courses (SEC1-SEC2)
   Credits = 02 each
   Total marks = 50 each

4. Ability Enhancement (AECC1-AECC2)
   Credits = 02 each
   Total marks = 50 each

5. Generic Elective (GE1-GE6)
   Credits = 06 each
   Total marks = 150 each.
Objective: The emphasis of course is on applications in solving problems of interest to physicists. The objective of the course is to equip the student with the mathematical techniques that are required for understanding theoretical treatment in different Physics subjects being taught.

Calculus:
Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).


Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.


**Vector Integration:** Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).  

(14 Lectures)

**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. 

(6 Lectures)

**Introduction to probability:**

Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance.  
Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.  

(4 Lectures)

**Dirac Delta function and its properties:**


(2 Lectures)

**Suggested Reading**

Objective: The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use any one operating system Linux or Microsoft Windows

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C1P: Mathematical Physics–I, PHY-C2P: Mechanics, PHY-C3P: Electricity and Magnetism and PHY-C4P: Waves and Optics, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 15 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Description with Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction and Overview</td>
<td>Computer architecture and organization, memory and Input/output devices</td>
</tr>
<tr>
<td>Basics of scientific computing</td>
<td>Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &amp; overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods</td>
</tr>
<tr>
<td>Errors and error Analysis</td>
<td>Truncation and round off errors, Absolute and relative errors, Floating point computations.</td>
</tr>
<tr>
<td>Review of C &amp; C++ Programming fundamentals</td>
<td>Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out,</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programs:</th>
<th>Sum &amp; average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random number generation</td>
<td>Area of circle, area of square, volume of sphere, value of pi ((\pi))</td>
</tr>
<tr>
<td>Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods</td>
<td>Solution of linear and quadratic equation, solving (\alpha=\tan\alpha); (I=I_o\left[\frac{\sin\alpha}{\alpha}\right]^2) in optics</td>
</tr>
<tr>
<td>Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation</td>
<td>Evaluation of trigonometric functions e.g. (\sin\theta), (\cos\theta), (\tan\theta) etc.</td>
</tr>
<tr>
<td>Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method</td>
<td>Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop</td>
</tr>
</tbody>
</table>
| Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, | First order differential equation  
• Radioactive decay  
• Current in RC, LC circuits with DC source |
modified Euler and Runge-Kutta (RK) second and fourth order methods

• Newton’s law of cooling
• Classical equations of motion

Attempt following problems using RK 4 order method:

Solve the coupled differential equations
\[
\frac{dx}{dt} = y + x - \frac{x^3}{3}; \quad \frac{dy}{dt} = -x
\]
for four initial conditions
\(x(0) = 0, y(0) = -1, -2, -3, -4.\)
Plot \(x\) vs \(y\) for each of the four initial conditions on the same screen for \(0 \leq t \leq 15\)

The differential equation describing the motion of a pendulum is \(\frac{d^2 \theta}{dt^2} = -\sin \theta\). The pendulum is released from rest at an angular displacement \(\alpha\) and \(\theta'(0) = 0\). Solve the equation for \(\alpha = 0.1, 0.5\) and \(1.0\) and plot \(\theta\) as a function of time in the range \(0 \leq t \leq 8\pi\). Also plot the analytic solution valid for small \(\theta\) \((\sin \theta = \theta)\)

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**Suggested Reading**

7. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006, Cambridge Univ. Press
PHY-C2: MECHANICS
PHY-C2 (T): MECHANICS
THEORY

Total Lectures: 60                                        Credits: 4
Max. Marks: 100

Objective: The purpose of the course is to train the students in the Newtonian Mechanics and Special Theory of Relativity formalisms to an extent that they can use these in the modern branches of Physics.


(6 Lectures)


(4 Lectures)

Elastic and Inelastic Scattering: Types of scattering and conservation laws, Laboratory and centre of mass systems, collision of particles which stick together, General elastic collision of particles of different mass, Cross-section of elastic scattering, Rutherford scattering.

(3 Lectures)


(12 Lectures)

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

(3 Lectures)
**Fluid Motion:** Kinematics of Moving Fluids: Poiseuille’s Equation for Flow of a Liquid through a Capillary Tube. (2 Lectures)


**Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. (5 Lectures)


Suggested Reading


Additional Suggested Reading


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PHY-C2 (P): MECHANICS

PRACTICALS

Total Lectures: 60 Credits: 2
Max. Marks: 50

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C1P: Mathematical Physics–I, PHY-C2P: Mechanics, PHY-C3P: Electricity and Magnetism and PHY-C4P: Waves and Optics, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 15 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
1. Use of Vernier callipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometers, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level.

2. To study the random error in observations.

3. Determination of height (of inaccessible structure) using sextant.

4. To study the Motion of Spring and calculate (a) Spring constant, (b) \( g \) and (c) Modulus of rigidity.

5. To determine the Moment of Inertia of a Flywheel.

6. To determine \( g \) and velocity for a freely falling body using Digital Timing Technique.

7. To determine the value of \( g \) using Kater’s Pendulum.

8. To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of \( g \) in the laboratory.


11. To determine the Young's Modulus of a Wire by Optical Lever Method.

12. To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar.


14. To determine the elastic Constants of a wire by Searle’s method.

15. To study one dimensional collision using two hanging spheres of different materials.

**Suggested Reading**

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House


3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal


Objective: The student is exposed to Electrostatics and Magnetostatics including Boundary value problems, Maxwell equations and their applications and analysis of Alternating current circuits.

Electric Charges and Fields: Conservation and quantization of charge, Coulomb’s Law, Energy of a system of charges. Electric field lines, Electric flux, Gauss’ Law with applications to charge distributions with spherical, cylindrical and planar symmetry. (6 Lectures)

Conservative nature of Electrostatic Field. Electrostatic Potential. Potential as line integral of field, potential difference, Gradient of a scalar function, Derivation of the field from the potential, potential of a charge distribution, Uniformly charged disc. Force on a surface charge, energy associated with an electric field, Gauss’s theorem and differential form of Gauss’s law, Laplacian and Laplace’s equation, Poisson’s equation. Force and Torque on a dipole. (6 Lectures)

Dielectric Properties of Matter: Dielectrics, Moments of a charge distribution, Potential and field of a dipole, Atomic and molecular dipoles, Induced dipole moments, Permanent dipole moments, electric field caused by polarized matter, field of a polarized sphere, dielectric sphere in a uniform field, Gauss’s law in a dielectric medium, Electrical susceptibility and atomic polarizability, Energy changes in polarization, Polarization in changing fields. Displacement vector $\mathbf{D}$. Relations between $\mathbf{E}$, $\mathbf{P}$ and $\mathbf{D}$. (8 Lectures)

The Fields of Moving Charges: Magnetic forces, Measurement of a charge in motion, invariance of charge, Electric field measured in different frames of reference, Field of a point charge moving with constant velocity, Field of a charge that starts or stops, Force on a moving charge, Interaction between a moving charge and other moving charges. (4 Lectures)


Magnetic Properties of Matter: Response of various substances to magnetic field, Force on a dipole in an external field, Electric currents in Atoms, Electron spin and Magnetic moment, types of magnetic materials, Magnetization vector ($\mathbf{M}$). Magnetic Intensity ($\mathbf{H}$). Magnetic Susceptibility and permeability. Relation between $\mathbf{B}$, $\mathbf{H}$, $\mathbf{M}$. Ferromagnetism. B-H curve and hysteresis. (4 Lectures)


**Suggested Reading**

1. Electricity and Magnetism (Berkley, Phys. Course 2), Edward M. Purcell, 1986 McGraw-Hill Education
**PHY-C3 (P): ELECTRICITY AND MAGNETISM (PRACTICALS)**

**Total Lectures : 60**

**Credits: 2**

**Max. Marks : 50**

**Objective:** The aim of this course is to build an understanding about various components of an electrical circuit and to develop skill to measure the related physical quantities.

**Note:** The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C1P: Mathematical Physics–I, PHY-C2P: Mechanics, PHY-C3P: Electricity and Magnetism and PHY-C4P: Waves and Optics, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 15 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster’s Bridge.
4. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
5. To determine the value of an air capacitance by de-Sauty Method and to find permittivity of air. Also to determine the dielectric constant of a liquid.
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
8. To determine self inductance of a coil by Anderson’s bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
11. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
12. Determine a high resistance by leakage method using Ballistic Galvanometer.
13. To determine self-inductance of a coil by Rayleigh’s method.
14. To determine the mutual inductance of two coils by Absolute method.
16. To study the magnetic field produced by a current carrying solenoid using a pick-up coil/Hall sensor and to find the value of permeability of air.
17. To determine the frequency of A.C. mains using sonometer.
18. To determine the resistance of an electrolyte for A.C current and study its concentration dependence. Also to study temperature dependence.
19. Study of temperature dependence resistivity of Cu conductor, Manganin/constantin alloy and semiconductor (FET channel).
20. To measure thermo e.m.f. of a thermocouple as a function of temperature and find inversion temperature.
21. To study C.R.O. as display and measuring device by recording sines and square waves, output from a rectifier, verification (qualitative) of law of electromagnetic induction and frequency of A.C. mains.
22. To plot the Lissajous figures and determine the phase angle by C.R.O.
23. To study B-H curves for different ferromagnetic materials using C.R.O.
24. Determination of low inductance by Maxwell-Wein bridge.
25. Study of R.C. circuit with a low frequency a.c. source.
26. Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.

**Suggested Reading**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
Objective: The course covers Harmonic oscillations and coupled oscillations, wave motion in damped, driven media. It also covers the Interference, diffraction and polarisation of light and their applications with emphasis on Holography.

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. (4 Lectures)

Coupled oscillations: Stiffness coupled oscillations, normal coordinates and modes of vibrations. Normal frequencies, Forced vibrations and resonance of coupled oscillators, masses on string-coupled oscillators. (3 Lectures)


Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. longitudinal waves on a rod, Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton’s Formula for Velocity of Sound. Laplace’s Correction. Reflection and transmission of transverse waves on a string at the discontinuity. Impedance matching, eigen frequencies and eigen functions for stationary waves on a string. (6 Lectures)


(7 Lectures)


(3 Lectures)


(9 Lectures)

**Interferometer:** Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

(4 Lectures)

**Diffraction:** Kirchhoff’s Integral Theorem, Fresnel-Kirchhoff’s Integral formula. (Qualitative discussion only)

(2 Lectures)


(8 Lectures)

**Fresnel Diffraction:** Fresnel’s Assumptions. Fresnel’s Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel’s Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

(7 Lectures)


(3 Lectures)

**Suggested Reading**


**PHY-C4 (P) : WAVES AND OPTICS**

**PRACTICALS**

Total Lectures : 60                                                                                       Credits: 2

Max. Marks : 100

**Objective:** The course covers experiments related to damped, driven and forced oscillations, wave motion in media. Properties and Characteristics of light through experiments related to interference and diffraction phenomenon are highlighted.

**Note:** The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C1P: Mathematical Physics–I, PHY-C2P: Mechanics, PHY-C3P: Electricity and Magnetism and PHY-C4P: Waves and Optics, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. **15** experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. To determine the frequency of an electric tuning fork by Melde’s experiment and verify $\lambda^2 – T$ law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material/liquid of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson’s interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.
13. To study Malus’s law of polarization.
14. To find the resolving power and magnification of a telescope.
15. To find the resolving power and magnification of a diffraction grating.
16. To study hydrogen/Neon gas discharge tube spectrum using diffraction grating.
17. To study temperature dependence of refractive index of organic liquid using Abbe’s refractometer.
18. To study the variation of specific rotation of sugar solution with concentration.
19. To measure power distribution and divergence parameters of He-Ne and Semiconductor lasers.
20. To study Moire’s fringe patterns and applications to measure small distance and angle.

**Suggested Reading**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
Generic Elective Papers (GE) (Minor-Physics) for Physical Sciences and Bio-Medical Sciences Departments/Disciplines

PHY-GE1 ELECTRICITY AND MAGNETISM

PHY-GE1 (T) : ELECTRICITY AND MAGNETISM THEORY

Total Lectures : 60

Credits: 4

Max. Marks : 100

Objective: This course focuses on essentials of electrostatics and magnetostatics along with Maxwell’s mathematical formulation of electric and magnetic fields.

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Magnetism:

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector
potential. Ampere's circuital law.


(10 Lectures)


(6 Lectures)

**Maxwell’s equations and Electromagnetic wave propagation:** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

(10 Lectures)

**Suggested Reading**

1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education

**PHY-GE1(P) : ELECTRICITY AND MAGNETISM**

**PRACTICAL**

Total Lectures: 60

Credits: 2

Max. Marks : 50

**Objective:** This course aims to impart practical knowledge to students related to electricity and magnetism.

**Note:** The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE1(P): Electricity and Magnetism, PHY-GE2(P): Mathematical Physics–I, PHY-GE3(P): Elements of Modern Physics, PHY-GE4(P): Mechanics are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (b) DC Current, and (d) checking electrical fuses.


3. To compare capacitances using De’Sauty’s bridge.

4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)

5. To study the Characteristics of a Series RC Circuit.

6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor

7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q

8. To calibrate the wire of Carey Foster bridge and hence determine Low Resistance of two turns of a tangent galvanometer.

9. To verify the Thevenin and Norton theorems

10. To verify the Superposition, and Maximum Power Transfer Theorems

11. Self-inductance by Anderson’s bridge.

12. Verification of laws of electromagnetic induction.

13. Verification of maximum power theorem.

14. To study the concentration dependence of the resistance electrolyte

15. To study dependence of magnetic field in a solenoid on various parameters and hence to evaluate \( \mu_0 \).

16. To study the variation of the resistance of filament of bulb with its temperature.

17. Study of B-H curves of various materials using C.R.O, and determination of various parameters.

**Suggested reading**


3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

B.Sc. (Hons.) in Physics under the Framework of Honours School System

PHY-GE2 MATHEMATICAL PHYSICS-I

PHY-GE2 (T) : MATHEMATICAL PHYSICS

THEORY

Total Lectures : 60
Credits: 4
Max. Marks : 100

Objective: The emphasis of the course is on applications in handling problems of physics. Students to be examined on the basis of problems, seen and unseen.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. (6 Lectures)


Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). (4 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. (10 Lectures)

Suggested Reading
4. An Introduction to Ordinary Differential Equations, E.A Coddington, 1961, PHI Learning
7. Publications.
PHY-GE2 (P) : MATHEMATICAL PHYSICS  
PRACHTICAL

Total Lectures: 60  
Credits: 2  
Max. Marks : 50

Objective : The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE1(P): Electricity and Magnetism, PHY-GE2(P): Mathematical Physics–I, PHY-GE3(P): Elements of Modern Physics, PHY-GE4(P): Mechanics are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Description with Applications</th>
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<tbody>
<tr>
<td>Introduction to Numerical computation software Scilab</td>
<td>Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational &amp; logical operators, the while loop, for loop, details of loop operations, break &amp; continue statements, nested loops, logical arrays</td>
</tr>
</tbody>
</table>
and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/O functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).

| Curve fitting, Least square fit, Goodness of fit, standard deviation | Ohms law to calculate R, Hooke’s law to calculate spring constant |
| Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems | Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses) |
| Generation of Special functions using User defined functions in Scilab | Generating and plotting Legendre Polynomials Generating and plotting Bessel function |
| Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method | First order differential equation  
• Radioactive decay  
• Current in RC, LC circuits with DC source  
• Newton’s law of cooling  
• Classical equations of motion  
• Second order Differential Equation |
- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and
- Steady state solution
- Apply above to LCR circuits also

Solve
\[ x^2 \frac{d^2 y}{dx^2} - 4x(1 + x) \frac{dy}{dx} + 2(1 + x)y = x^3 \]

with the boundary conditions at
\[ x = 1, \ y = \frac{1}{2} \varepsilon^2, \ \frac{dy}{dx} = \varepsilon^2 - 0.5, \]

In the range \(1 \leq x \leq 3\). Plot \( y \) and \( \frac{dy}{dx} \) against \( x \) in the given range on the same graph.

<table>
<thead>
<tr>
<th>Partial differential equations</th>
<th>Partial Differential Equation:</th>
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<tbody>
<tr>
<td></td>
<td>• Wave equation</td>
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<td>• Heat equation</td>
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<td></td>
<td>• Poisson equation</td>
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<td>• Laplace equation</td>
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</tbody>
</table>

Using Scicos / xcos

- Generating square wave, sine wave, saw tooth wave
- Solution to harmonic oscillator
- Study of beat phenomenon
- Phase space plots
Suggested Reading

3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
B.Sc. (Hons.) in Physics under the Framework of Honours School System

**PHY-GE3 ELEMENTS OF MODERN PHYSICS**

**PHY-GE3 (T) : ELEMENTS OF MODERN PHYSICS**

**THEORY**

*Total Lectures: 60*  
*Credits: 4*  
*Max. Marks: 100*

**Objective:** The aim of the course is to provide students with insight of the exciting results and reasoning of the physical phenomena on the basis of modern physics.

Planck’s quantum, Planck’s constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment.  
(8 Lectures)

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.  
(4 Lectures)

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.  
(4 Lectures)

Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.  
(11 Lectures)

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.  
(12 Lectures)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.  
(6 Lectures)
Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; $\alpha$ decay; $\beta$ decay - energy released, spectrum and Pauli's prediction of neutrino; $\gamma$-ray emission. \hspace{1cm} (11 Lectures)

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. \hspace{1cm} (4 Lectures)

Suggested Reading


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PHY-GE3 (P) : ELEMENTS OF MODERN PHYSICS

PRACTICAL

Total Lectures : 60 \hspace{1cm} Credits: 2

Max. Marks : 50

Objective : This course is established for practical understanding of the results obtained from modern physics.

Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE1(P): Electricity and Magnetism, PHY-GE2(P): Mathematical Physics–I, PHY-GE3(P): Elements of Modern Physics, PHY-GE4(P): Mechanics are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of Planck’s constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure its intensity variation using Photosensor & compare with incoherent source – Na.
8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
9. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.
11. Determination of Eg in Si and Ge.
12. Determination of Planck's constant using photocell.
13. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue).
14. Verification of Rutherford- Soddy nuclear decay formula - mechanical analogue.
15. To find half-life period of a given radio-active substance using GM counter/ Charterctisits of GM Counter

**Suggested Reading**

Objective: The objective of the course is to train the students in the Newtonian Mechanics and Special Theory of Relativity formalisms to an extent that they can use these in the modern branches of Physics.

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. (4 Lectures)

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. (6 Lectures)


Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. (5 Lectures)


Elasticity: Hooke’s law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson’s Ratio-Expression for Poisson’s ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searles method. (8 Lectures)


Note: Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.

Suggested Reading

PHY-GE4 (P) : MECHANICS

PRACTICAL

Total Lectures : 60

Credits: 2

Max. Marks : 50

Objective: The course is related to measurements and experiments on basic mechanics.

Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE1(P): Electricity and Magnetism, PHY-GE2(P): Mathematical Physics–I, PHY-GE3(P): Elements of Modern Physics, PHY-GE4(P): Mechanics are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
B.Sc. (Hons.) in Physics under the Framework of Honours School System

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. (i) Analysis of experimental data by Fitting of given data to a straight line. (ii) Calculation of probable error.
2. To determine the Height of a (of inaccessible structure) using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
6. To determine the Elastic Constants of a Wire by Searle’s method.
7. To determine $g$ by Bar Pendulum.
8. To determine $g$ by Kater’s Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) $g$.
10. Determination of modulus of rigidity by torsional pendulum.
11. Determination of coefficient of viscosity of a given liquid by Stoke's method.
12. Study of one dimensional collision.

Suggested Reading


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Objective: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.


(10 Lectures)


(24 Lectures)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).


(6 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of

Reference Books:

PHY-C5 (P): MATHEMATICAL PHYSICS-II
PRACTICALS

Total Lectures : 30 Credits: 2
Max. Marks : 50

Objective: The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY- C7 (P): Digital Systems and Applications, PHY- C8 (P): Mathematical Physics - III, PHY- C9 (P): Elements of Modern Physics, PHY- C10 (P): Analog Systems and Applications, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
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<td>Solution of mesh equations of electric circuits (3 meshes); Solution of coupled spring mass systems (3 masses)</td>
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<td>Solution of ODE</td>
<td>First order differential equation</td>
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<tr>
<td>First order Differential equation Euler, modified Euler and Runge-Kutta second order methods</td>
<td>• Current in RC, LC circuits with DC source</td>
</tr>
<tr>
<td>Second order differential equation</td>
<td>• Newton’s law of cooling</td>
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<tr>
<td>Fixed difference method</td>
<td>• Classical equations of motion</td>
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<tr>
<td>• Second order Differential Equation</td>
<td>• Harmonic oscillator (no friction)</td>
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<td>• Over damped</td>
<td>• Damped Harmonic oscillator</td>
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<td>• Oscillatory</td>
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<tr>
<td>• Steady state solution</td>
<td>• Apply above to LCR circuits also</td>
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<tr>
<td>• Solve</td>
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<tr>
<td>[ x^2 \frac{d^2 y}{dx^2} - 4x(1 + x) \frac{dy}{dx} + 2(1 + x)y = x^3 ]</td>
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<tr>
<td>with the boundary conditions at</td>
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<td>( x = 1, y = \frac{1}{2} ), ( \frac{dy}{dx} = \frac{1}{2} )</td>
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<td>In the range ( 1 \leq x \leq 3 ). Plot ( y ) and ( \frac{dy}{dx} ) against ( x ) in the given range on the same graph.</td>
<td>In the range ( 1 \leq x \leq 3 ). Plot ( y ) and ( \frac{dy}{dx} ) against ( x ) in the given range on the same graph.</td>
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<td>Partial differential equations</td>
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<td>• Wave equation</td>
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<td>• Heat equation</td>
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</table>
### B.Sc. (Hons.) in Physics under the Framework of Honours School System

| Using Scicos / xcos | • Poisson equation  
|                     | • Laplace equation  
|                     | • Generating square wave, sine wave, saw tooth wave  
|                     | • Solution to harmonic oscillator  
|                     | • Study of beat phenomenon  
|                     | • Phase space plots  

**Reference Books:**

3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett  

Introduction to Thermodynamics


Equation and Ehrenfest equations. \hfill (7 Lectures)

Maxwell’s Thermodynamic Relations: Derivations and applications of Maxwell’s Relations.
Maxwell’s Relations: (1) Clausius Clapeyron equation, (2) Values of $C_p - C_v$, (3) TdS Equations,
(4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. \hfill (7 Lectures)

Kinetic Theory of Gases
Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas
and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern’s Experiment.
Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. \hfill (7 Lectures)

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. \hfill (4 Lectures)


Reference Books:
B.Sc. (Hons.) in Physics under the Framework of Honours School System

PHY-C6 (P) : THERMAL PHYSICS

PRACTICALS

Total Lectures : 60                                                                                      Credits: 2

Max. Marks : 50

Objective: The laboratory exercises have been so designed on measurements of thermal conductivity, Temperature Coefficient of Resistance, and use of various temperature transducers.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY-C7 (P): Digital Systems and Applications, PHY-C8 (P): Mathematical Physics - III, PHY-C9 (P): Elements of Modern Physics, PHY-C10 (P): Analog Systems and Applications, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
2. To measure the coefficient of linear expansion for different metals and alloys.
3. To determine the value of Stefan’s Constant of radiation.
4. To determine the Coefficient of Thermal Conductivity of Cu by Searle’s Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom’s Method.
6. To measure the thermal conductivity and thermal diffusivity of a conductor.
7. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton’s disc method.
8. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
9. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions. To calibrate a thermocouple to measure temperature in a specified Range using (i) Null Method, (ii) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
10. To determine thermal conductivity of a bad conductor disc using Advance kit involving constant current source for heating and thermocouples for temperature measurements.
Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

PHY-C7: DIGITAL SYSTEMS AND APPLICATIONS

PHY-C7 (T): DIGITAL SYSTEMS AND APPLICATIONS

THEORY

Total Lectures : 60                                                                                      Credits: 4

Objective: The course covers CRO, basics of integrated circuit technology, binary arithmetic, Logic gates, sequential and combinational circuits, Timers and counters, Microprocessor basics, Computer organization.


Integrated Circuits (Qualitative treatment only): Active & Passive components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs. (3 Lectures)


Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.


Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). (2 Lectures)

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous (4 Lectures)


Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions. (4 Lectures)

Reference Books:
Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory course of digital electronics. It covers practical training on basic Logic gates, flip-flops, sequential and combinational circuits, Timers and counters, Assembly language programming of 8085 Microprocessor.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY- C7 (P): Digital Systems and Applications, PHY- C8 (P): Mathematical Physics - III, PHY- C9 (P): Elements of Modern Physics, PHY- C10 (P): Analog Systems and Applications, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
   a) Addition and subtraction of numbers using direct addressing mode
b) Addition and subtraction of numbers using indirect addressing mode

c) Multiplication by repeated addition.

d) Division by repeated subtraction.

e) Handling of 16-bit Numbers.

f) Use of CALL and RETURN Instruction.

g) Block data handling.

h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:


Semester IV

PHY-C8: MATHEMATICAL PHYSICS-III

PHY-C8 (T): MATHEMATICAL PHYSICS-III
(THEORY)

Total Lectures : 60

Credits: 4

Max. Marks : 100

Objective: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.


Integrals Transforms:

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and
Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2\textsuperscript{nd} order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1\textsuperscript{st} order. Solution of heat flow along infinite bar using Laplace transform. (15 Lectures)

Reference Books:
3. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8\textsuperscript{th} Ed., 2011, Cambridge Univ. Press
6. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

PHY-C8 (P): MATHEMATICAL PHYSICS-III (PRACTICALS)

Total Lectures : 60 Credits: 2 Max. Marks : 50

Objective: The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY- C7 (P): Digital Systems and Applications, PHY- C8 (P): Mathematical Physics - III, PHY- C9 (P): Elements of Modern Physics, PHY- C10 (P): Analog Systems and Applications, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
**Scilab/C++ based simulations experiments based on Mathematical Physics problems like**

1. Solve differential equations:
   - \( \frac{dy}{dx} = e^{-x} \) with \( y = 0 \) for \( x = 0 \)
   - \( \frac{dy}{dx} + e^{-x} y = x^2 \)
   - \( \frac{d^2y}{dt^2} + 2 \frac{dy}{dt} = -y \)
   - \( \frac{d^2y}{dt^2} + e^{-t} \frac{dy}{dt} = -y \)

2. Dirac Delta Function: Evaluate \( \frac{1}{\sqrt{2\pi \sigma}} \int e^{-\frac{(x-3)^2}{2\sigma^2}} (x + 3) \, dx \) for \( \sigma = 1, 0.1, 0.01 \) and show it tends to 5.

3. Fourier Series:
   - Program to sum \( \sum_{n=-\infty}^{\infty} (\theta - \mu)^n \)

   Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:
   - \( \int_{-1}^{+1} P_n(\mu) P_m(\mu) \, d\mu = \delta_{nm} \)

   Plot \( P_n(x), j_\nu(x) \).

   Show recursion relations.

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error.
   - Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. \( \sin \theta \), Given Bessel’s function at \( N \) points find its value at an intermediate point.
   - Complex analysis: Integrate \( 1/(x^2+2) \) numerically and check with computer integration.

8. Compute the \( n^{th} \) roots of unity for \( n = 2, 3, \) and 4.

9. Find the two square roots of \( -5+12j \).

10. Integral transform: FFT of

11. Solve Kirchoff’s Current law for any node of an arbitrary circuit using Laplace’s
transform.


Reference Books:

- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

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PHY-C9: ELEMENTS OF MODERN PHYSICS

PHY-C9 (T): ELEMENTS OF MODERN PHYSICS

THEORY

Total Lectures : 60

Credits: 4

Max. Marks : 100

Objective: The course content covers foundations of modern physics, experiments forming basis of quantum mechanics, Schrodinger equation and applications, uncertainty principle, nature of nuclear force, nuclear models, fission and fusion, nuclear reactors, stellar energy Spontaneous and Stimulated emissions and Lasers.

Gravitational Red-shift of photons.  

(14 Lectures)

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.  

(5 Lectures)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.  

(10 Lectures)

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.  

(10 Lectures)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.  

(6 Lectures)

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli’s prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.  

(8 Lectures)

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).  

(3 Lectures)

Reference Books:
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

Additional Books for Reference

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**PHY-C9 (P): ELEMENTS OF MODERN PHYSICS**

**PRACTICALS**

Total Lectures : 60

Credits: 2

Max. Marks : 50

Objective: The laboratory experiments forming basis of quantum mechanics photoelectric effect – photoelectric effect, ionization potential, measurement of absorption and emission spectra, diffraction, diffraction of light, change on electron, and tunneling effect.

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY- C7 (P): Digital Systems and Applications, PHY- C8 (P): Mathematical Physics - III, PHY- C9 (P): Elements of Modern Physics, PHY- C10 (P): Analog Systems and Applications, are to be clubbed
together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. Measurement of Planck’s constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck’s constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine (i) wavelength and (ii) angular spread of He-Ne laser using plane diffraction grating
12. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue).
13. Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.
14. To determine energy band gap of a given semiconductor.

Reference Books
1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

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PHY-C10: ANALOG SYSTEMS AND APPLICATIONS

PHY-C10 (T): ANALOG SYSTEMS AND APPLICATIONS

THEORY

Total Lectures : 60                                                                                     Credits: 4

Max. Marks : 100

Objective: The course content covers basic network theorems for circuit analysis, semiconductor physics and devices, diodes and applications, bipolar junction transistors, amplifiers, feedback concepts, Operation amplifiers and applications.


Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. (6 Lectures)

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains $\alpha$ and $\beta$. Relations between $\alpha$ and $\beta$. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. (6 Lectures)

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. (4 Lectures)

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. (4 Lectures)


Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. (4 Lectures)


Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) (3 Lectures)

Reference Books:
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

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Objective: The laboratory exercises have been so designed that the students learn to study characteristics of various diodes, solar cells, and BJT and their biasing aspects, amplifiers, oscillators, ADC and DAC and OPAMP based application circuits

Note: The experiments listed in the Practical Part of the Core Papers, i.e., PHY-C5 (P): Mathematical Physics - II, PHY-C6 (P): Thermal Physics, PHY- C7 (P): Digital Systems and Applications, PHY- C8 (P): Mathematical Physics - III, PHY- C9 (P): Elements of Modern Physics, PHY- C10 (P): Analog Systems and Applications, are to be clubbed together and will be performed by the students during the Semesters I and II. Basic experiments of these core papers will be covered in Semester I and the rest will be done in Semester II. 20 experiments are to be performed in each Semester without any repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. To study I-V characteristics of different diodes - Ge, Si, LED and Zener. Use constant current source for Zener.
2. To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters. Use of Zener diode and IC regulators.
3. To study common emitter characteristics of a given transistor and to determine various parameters.
4. Study of I-V & power curves of solar cells, and find maximum power point & efficiency.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a Wien bridge oscillator for given frequency using an op-amp.
8. To design a phase shift oscillator of given specifications using BJT.
9. To study the Colpitt’s oscillator.
10. To design a digital to analog converter (DAC) of given specifications.
11. To study the analog to digital convertor (ADC) IC.
12. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
13. To design inverting amplifier using Op-amp (741,351) and study its frequency response.
14. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
15. To study the zero-crossing detector and comparator
16. To add two dc voltages using Op-amp in inverting and non-inverting mode
17. To design a precision Differential amplifier of given I/O specification using Op-amp.
18. To investigate the use of an op-amp as an Integrator.
19. To investigate the use of an op-amp as a Differentiator.
20. To design a circuit to simulate the solution of a 1st/2nd order differential equation.
21. To draw the characteristics of a given triode and to determine the tube parameters.
22. Calibration of a Si diode, a thermistor and thermocouple for temperature measurements.
23. To measure low resistance by Kelvin’s double bridge/ Carey Foster’s bridge.

**Reference Books:**

Skill Enhancement Course (any four) (Credit: 02 each)

PHY-SEC1 to PHY-SEC4

PHY-SEC1: PHYSICS ENHANCEMENT SKILLS

Total Lectures : 30

Credits: 2

Max. Marks : 50

Objective: The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode, and to improve the abilities of the students to frame and tackle problems in Physics.

Note: The students in the class will be divided in to groups. There will be regular teaching of the theoretical aspects (8 hours) along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospectus) by the end-semester. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

Introduction: Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

(4 Lectures)


(10 Lectures)

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having
discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.

**(10 Lectures)**

**Introduction to prime movers:** Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. **(6 Lectures)**

Reference Books:


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**PHY-SEC2: COMPUTATIONAL PHYSICS**

Total Lectures : 30

Credits: 2

Max. Marks : 50

**Objective:** The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- Use of computer language as a tool in solving physics problems (applications)
- Course will consist of hands on training on the Problem solving on Computers.

**Note:** The students in the class will be divided in to groups. There will be regular teaching of the theoretical aspects (8 hours) along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospectus) by the end-semester. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of Linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

(4 Lectures)


(5 Lectures)

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:
1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write source codes in FORTRAN.
3. To print out all natural even/odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.

5. Calculating Euler number using exp(x) series evaluated at x=1 \( (6 \text{ Lectures}) \)

**Scientific word processing: Introduction to LaTeX:** TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

**Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

**Visualization:** Introduction to graphical analysis and its limitations. Introduction to GnuPlot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

**Hands on exercises:**
1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

\( (9 \text{ Lectures}) \)
Reference Books:

2. Computer Programming in Fortran 77”. V. Rajaraman (Publisher: PHI).

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PHY-SEC3: ELECTRICAL CIRCUITS AND NETWORK SKILLS

Total Lectures : 30                                                                                           Credits: 2

Max. Marks : 50

Objective: The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Note: The students in the class will be divided in to groups. There will be regular teaching of the theoretical aspects (8 hours) along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospectus) by the end-semester. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.


(3 Lectures)


Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. (3 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. (4 Lectures)

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. (3 Lectures)


Reference Books:
2. A text book of Electrical Technology - A K Theraja

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B.Sc. (Hons.) in Physics under the Framework of Honours School System

**PHY-SEC4: BASIC INSTRUMENTATION SKILLS**

Total Lectures : 30  
Credits: 2  
Max. Marks : 50

**Objective:** This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

**Note:** The students in the class will be divided into groups. There will be regular teaching of the theoretical aspects (8 hours) along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospects) by the end-semester. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.  
(4 Lectures)

**Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier-rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.  
(4 Lectures)

**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.  
(6 Lectures)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.  
(3 Lectures)

**Signal Generators and Analysis Instruments:** Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. Brief idea for
testing, specifications. Distortion factor meter, wave analysis. (4 Lectures)

**Impedance Bridges & Q-Meters:** Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. (3 Lectures)


**Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. (3 Lectures)

**The test of lab skills will be of the following test items:**
1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

**Laboratory Exercises:**
1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.

Open Ended Experiments:
1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:
2. Performance and design of AC machines - M G Say ELBS Edn.
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

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PHY-SEC5 RENEWABLE ENERGY AND ENERGY HARVESTING
Total Lectures : 30  
Credits: 2  
Max. Marks : 50

Objective: The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Note: The students in the class will be divided in to groups. There will be regular teaching of the theoretical aspects (8 hours) along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospectus) by the end-semester. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of

(3 Lectures)

**Solar energy**: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

(6 Lectures)

**Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

(3 Lectures)


(2 Lectures)


(2 Lectures)

**Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

(2 Lectures)

**Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

(4 Lectures)

**Electromagnetic Energy Harvesting**: Linear generators, physics mathematical models, recent applications.

(2 Lectures)

Carbon captured technologies, cell, batteries, power consumption

(2 Lectures)

Environmental issues and Renewable sources of energy, sustainability.

(1 Lecture)

**Demonstrations and Experiments**

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.
Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.

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Generic Elective Papers (GE) (Minor-Physics) 
for Physical Sciences & Bio Medical Sciences 
Departments/Disciplines 

PHY-GE5 : WAVES AND OPTICS 
PHY-GE5 (T) : WAVES AND OPTICS 

THEORY 

Total Lectures : 60                                                                   Credits: 4 
Max. Marks : 100 

Objective : The course covers Harmonic oscillations and coupled oscillations, wave motion in damped, driven media. It also covers the Interference, diffraction and polarisation of light and their applications. 

Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). (4 Lectures) 

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. (2 Lectures) 


Sound: Simple harmonic motion - forced vibrations and resonance - Fourier’s Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine’s formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. (6 Lectures) 


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Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton’s Rings: measurement of wavelength and refractive index. **(10 Lectures)**

**Michelson’s Interferometer:** Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes. **(3 Lectures)**

**Diffraction:** Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(14 Lectures)**

**Polarization:** Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

**Reference Books:**

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**PHY-GE5 (P) : WAVES AND OPTICS**

**PRACTICAL**

**Total Lectures : 60**

**Credits: 2**

**Max. Marks : 50**

**Objective:** The aim of the laboratory exercises is to train the students in handling the equipments, verifying some laws they study in theory and making them confident to perform precise measurements.

**Note:** The experiments listed in the Practical Part of the Generic Elective Papers, i.e., **PHY-GE5P (B) : Waves and Optics, PHY-GE6P (B): Mathematical Physics II, PHY-GE7P (B): Digital, Analog Circuits and Instrumentation, PHY-GE8P (B): Thermal Physics and Statistical Mechanics,** are to be clubbed together and will be performed by the students during the Semesters III and IV. Basic experiments of these Generic Elective papers will be covered in Semester III and the rest will be done in Semester IV. **8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.**

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde’s Experiment and to verify \( \lambda^2 - T \) Law.
3. To study Lissajous Figures
4. Familiarization with Schuster’s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. Determination of refractive index of prism for different wave-lengths using Spectrometer and determine the value of Cauchy Constants.
10. To determine wavelength of sodium light using Fresnel Bprism.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.
16. Determination of focal length of convex mirror by beam compass method.
17. Determination of magnifying power of a telescope by slit method.
18. Determination of resolving power of a telescope.
19. To determine the wave-length of laser light using a plane diffraction grating.
22. Determination of frequency of A.C. mains by using electrical vibrator.
23. Determination of velocity of ultrasonic waves in a given liquid

**Reference Books:**

PHY-GE6 : MATHEMATICAL PHYSICS-II

PHY-GE6 (T) : MATHEMATICAL PHYSICS-II

THEORY

Total Lectures : 60

Credits: 4

Max. Marks : 100

Objective: The emphasis of the course is on applications in handling problems of physics. Students to be examined on the basis of problems, seen and unseen.


Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).


Suggested Reading

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PHY-GE6 (P): MATHEMATICAL PHYSICS-II

PRACTICAL

Total Lectures: 60                      Credits: 2
Max. Marks: 50

Objective : The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem

Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE5P (B) : Waves and Optics, PHY-GE6P (B):Mathematical Physics II, PHY-GE7P (B): Digital, Analog Circuits and Instrumentation, PHY-GE8P (B): Thermal Physics and Statistical Mechanics, are to be clubbed together and will be performed by the students during the Semesters III and IV. Basic experiments of these Generic Elective papers will be covered in Semester III and the rest will be done in Semester IV. 8 experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.
<table>
<thead>
<tr>
<th>Topics</th>
<th>Description with Applications</th>
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<tbody>
<tr>
<td>Introduction to Numerical computation software Scilab</td>
<td>Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational &amp; logical operators, the while loop, for loop, details of loop operations, break &amp; continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/O functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).</td>
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<tr>
<td>Curve fitting, Least square fit, Goodness of fit, standard deviation</td>
<td>Ohms law to calculate R, Hooke’s law to calculate spring constant</td>
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<tr>
<td>Solution of Linear system of equations</td>
<td>Solution of mesh equations of electric</td>
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by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems

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<th>circuits (3 meshes)</th>
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<tr>
<td>Solution of coupled spring mass systems (3 masses)</td>
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<tr>
<th>Generation of Special functions using User defined functions in Scilab</th>
<th>Generating and plotting Legendre Polynomials</th>
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<td>Generating and plotting Bessel function</td>
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<tr>
<th>Solution of ODE</th>
<th>First order differential equation</th>
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<tr>
<td>• Radioactive decay</td>
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<td>• Current in RC, LC circuits with DC source</td>
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<td>• Newton’s law of cooling</td>
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<td>• Classical equations of motion</td>
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<td>• Second order Differential Equation</td>
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<td>• Harmonic oscillator (no friction)</td>
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<td>• Damped Harmonic oscillator</td>
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<td>• Over damped</td>
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<td>• Oscillatory</td>
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<td>• Forced Harmonic oscillator</td>
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<td>• Transient and</td>
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<td>• Steady state solution</td>
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<td>• Apply above to LCR circuits also</td>
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<tr>
<td>• Solve $x^2 \frac{d^2 y}{dx^2} - 4x(1 + x) \frac{dy}{dx} + 2(1 + x)y = x^3$ with the boundary conditions at $x = 1, y = \frac{1}{2}e^2, \frac{dy}{dx} = e^2 - 0.5,$</td>
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<tr>
<td>In the range $1 \leq x \leq 3$. Plot $y$ and $\frac{dy}{dx}$</td>
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against x in the given range on the same graph.

<table>
<thead>
<tr>
<th>Partial differential equations</th>
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<td>• Wave equation</td>
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<td>• Heat equation</td>
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<td>• Poisson equation</td>
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<td>• Laplace equation</td>
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</table>

| Using Scicos / xcos                                   | • Generating square wave, sine wave, saw tooth wave                  |
|                                                      | • Solution to harmonic oscillator                                   |
|                                                      | • Study of beat phenomenon                                          |
|                                                      | • Phase space plots                                                  |

**Suggested Reading**

3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
PHY-GE7 : DIGITAL, ANALOG CIRCUITS AND INSTRUMENTATION

PHY-GE7 (T) : DIGITAL, ANALOG CIRCUITS AND INSTRUMENTATION

THEORY

Total Lectures : 60                                                                   Credits: 4
Max. Marks : 100

Objective : The course covers binary arithmetic, Logic gates, sequential and combinational circuits, semiconductor physics and devices, diodes and applications, bipolar junction transistors, amplifiers, Operation amplifiers and applications, CRO and Power supply.

Digital Circuits

(4 Lectures)


(5 Lectures)


(4 Lectures)

Semiconductor Devices and Amplifiers:

(5 Lectures)


(12 Lectures)

Operational Amplifiers (Black Box approach):

(13 Lectures)
Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator (5 Lectures)

Instrumentations: Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. (3 Lectures)

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation. (6 Lectures)

Timer IC: IC 555 Pin diagram and its application as Astable and Monostable Multivibrator. (3 Lectures)

Reference Books:
4. Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
PHYSICS  (P) : DIGITAL, ANALOG CIRCUITS AND INSTRUMENTATION

PRACTICAL

Total Lectures : 60                                                                   Credits: 2
Max. Marks : 50

Objective : The experiments included in this laboratory course are aimed at training the students
            to the digital and analogue electronics and develop confidence to use later the sophisticated
            instruments in their respective fields.

Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-
       GE5P (B): Waves and Optics, PHY-GE6P (B): Mathematical Physics II, PHY-GE7P (B):
       Digital, Analog Circuits and Instrumentation, PHY-GE8P (B): Thermal Physics and
       Statistical Mechanics, are to be clubbed together and will be performed by the students
during the Semesters III and IV. Basic experiments of these Generic Elective papers will be
covered in Semester III and the rest will be done in Semester IV. 8 experiments are to be
performed in each Semester without repetition. General evaluation procedure has been
defined under the heading “Evaluation” in the beginning of the syllabus.

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency
    response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its
    Frequency Response.
14. To investigate a differentiator made using op-amp.
15. To design a Wien Bridge Oscillator using an op-amp.
16. Study of Solar-Cell characteristics
17. Study of C.R.O. as display and measuring device, Study of Sine-wave, square wave signals (half wave and full wave rectification)
19. Study of vacuum triode characteristics.

Reference Books:

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PHY-GE8 : THERMAL PHYSICS AND STATISTICAL MECHANICS

PHY-GE8 (T) : THERMAL PHYSICS AND STATISTICAL MECHANICS

THEORY

Total Lectures : 60
Credits: 4
Max. Marks : 100

Objective: The course covers laws of thermodynamics and applications, Thermodynamic Potentials, Maxwell’s Thermodynamic Relations, Kinetic theory of gases, theory of radiation. It also covers basics of Statistical mechanics


Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell’s relations and applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for \( (C_p - C_v) \), \( C_v/C_p \), TdS equations. (10 Lectures)

Kinetic Theory of Gases: Derivation of Maxwell’s law of distribution of velocities and its
experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. **(10 Lectures)**

**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien’s distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien’s displacement law from Planck’s law. **(6 Lectures)**


**Reference Books:**

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**PHY-GE8 (P) : THERMAL PHYSICS AND STATISTICAL MECHANICS**

**PRACTICAL**

**Total Lectures : 60**

**Credits: 2**

**Max. Marks : 50**

**Objective :** The aim of the laboratory exercises is to train the students in handling the equipments, verifying some laws they study in theory and making them confident to perform precise measurements.

**Note: The experiments listed in the Practical Part of the Generic Elective Papers, i.e., PHY-GE5P (P) : Thermal Physics and Statistical Mechanics, PHY-GE6P (P): Waves and Optics, PHY-GE7P (P): Elements of Modern Physics, PHY-GE8P (P): Digital, Analog Circuits and Instrumentation, are to be clubbed together and will be performed by the students during the Semesters III and IV. Basic experiments of these Generic Elective papers will be covered in Semester III and the rest will be done in Semester IV. 10-12**
experiments are to be performed in each Semester without repetition. General evaluation procedure has been defined under the heading “Evaluation” in the beginning of the syllabus.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
3. Determination of coefficient of linear expansion
4. To determine Stefan’s Constant.
5. To determine the coefficient of thermal conductivity of Cu by Searle’s Apparatus.
6. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom’s Method.
7. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton’s disc method.
8. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
9. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
10. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
11. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Reference Books:


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