

# SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]



## DEPARTMENT OF PHYSICS SCHOOL OF BASIC & APPLIED SCIENCES SHRI GURU RAM RAI UNIVERSITY

Bachelor of Science/  
Bachelor of Science (Hons.) in Physics/  
Bachelor of Science (Hons. with Research) in Physics

**Based on NEP 2020**

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

**Effective from Academic Session 2023- 2024**

**(Revised on 30<sup>th</sup> July 2024 & 12 August 2025)**

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Patel Nagar, Dehradun, Uttarakhand

**Basic Structure of UG Multidisciplinary Programme (with Three Core disciplines)****B.Sc. with Physics, Mathematics, and Chemistry/Geology/Defense & Strategic Studies/Statistics as core disciplines****Type of Course**

Discipline Specific Core (DSC)

Discipline Specific Elective (DSE)

General Elective (GE)

Ability Enhancement Courses (AEC)

Skill Enhancement Course (SEC)

Internship/Apprenticeship / Project/ Community Outreach (IAPC)

Value Addition course (VAC)

## UG Multidisciplinary Courses of Study Bachelor of Science (Honours/Honours with Research)

Sem	Core - Discipline Specific Core (DSC)	Elective- Discipline Specific Elective (DSE)	Elective- Generic Elective (GE)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	(Internship /Apprenticeship / Project/ Community Outreach) (IAPC)	Value Addition Course (VAC)	Total credits
	Course/credit distribution (Credits 4) Theory or Theory + Practicum (3T+1L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (Credits 4T or 3T+1L or 2T+2L)	Course/ credit distribution (Credits 2)	Course/credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	22
I	DSC A(Physics) 1- (4) DSC B (Mathematics) 1- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 1- (4) (3T+1L)		Choose one from a pool of courses GE – 1 (4)	AEC – 1 (2)	Choose one from a pool of courses SEC – 1 (2)		Choose one from a pool of courses VAC – 1 (2)	22
II	DSC A(Physics) 2- (4) DSC B (Mathematics) 2- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 2- (4)(3T+1L)		Choose one from a pool of courses GE – 2 (4)	AEC – 2 (2)	Choose one from a pool of courses SEC – 2 (2)		Choose one from a pool of courses VAC – 2 (2)	22
<b>Students on exit shall be awarded Undergraduate Certificate (in the field of</b>								<b>Total =</b>
<b>Multidisciplinary study) after securing requisite 44 credits in semester I &amp; I</b>								<b>44</b>

III	DSC A(Physics) 3- (4) DSC B (Mathematics) 3- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 3- (4) (3T+1L)	Choose one from a pool of courses, DSE A/B/C (4) OR GE - 3 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC – 3 (2)	Choose one from SEC 3 – (2)  OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)	Choose one from a pool of courses VAC – 3 (2)	22
IV	DSC A(Physics) 4- (4) DSC B (Mathematics) 4- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 4- (4) (3T+1L)	Choose one from a pool of courses, DSE A/B/C (4) credits) OR GE - 4 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC – 4 (2)	Choose one from SEC 4 – (2)  OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)	Choose one from a pool of courses VAC – 4 (2)	22
<b>Students on exit shall be awarded Undergraduate Diploma (in the field of Multidisciplinary study/Discipline) after securing requisite 88 credits in semester III &amp; IV</b>						<b>Total = 88</b>
V	DSC A(Physics) 5- (4) DSC B (Mathematics) 5- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 5- (4) (3T+1L)	Choose one from a pool of courses, DSE A/B/C (4) credits) ( 3T+1L/or 2T+2L) OR MOOC	Choose one from a pool of courses GE – 5 (4) OR MOOC		Choose one from SEC 5 – (2)  OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)	22
VI	DSC A(Physics) 6- (4) DSC B (Mathematics) 6- (4) DSC C (Chemistry/Geology/Defense and Strategic Studies/Statistics) 6- (4) (3T+1L)	Choose one from a pool of courses, DSE A/B/C (4) credits) ( 3T+1L/or 2T+2L) OR MOOC	Choose one from a pool of courses GE – 6 (4) OR MOOC		Choose one from SEC 6 – (2)  OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)	22
<b>Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) after securing requisite 132 credits on completion of semester VI</b>						<b>Total= 132</b>
VII	DSC A/B/C 7 - (4) (3T+1L)	Choose 3 DSE (3x4) courses OR Choose 2 DSE – (2x4) and one GE (4) course OR Choose 1 DSE (4) and 2 GE (2x4) courses (Total= 12)			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2) [B.Sc. Honours with Research] DSE 4 Seminar 2 [B.Sc. Honours (H)]	22

VIII	<b>DSC A/B/C 8 - (4)</b>  (3T+1L)	<b>Choose 3 DSE (3x4) courses</b> OR <b>Choose 2 DSE – (2x4) and one GE (4) course</b> OR <b>Choose 1 DSE (4) and 2 GE (2x4) courses</b> (Total= 12)		Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2) <b>B.Sc. Honours with Research]</b> <b>DSE 4</b> <b>Seminar 2 [B.Sc. Honours (H)]</b>	22
<b><i>Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) (Honours with Research or Honours with Academic project/Entrepreneurship) after securing requisite 176 credits on completion of semester VIII</i></b>					<b>Total = 176</b>

### Course Introduction:

The new curriculum of B.Sc. with Physics, Chemistry and Mathematics as core disciplines offers one-year Undergraduate certificate, two-year Undergraduate diploma, three-year Undergraduate degree and four-year Undergraduate degree (Hons. with Research) after securing required credits as per the Curriculum and credit framework for Undergraduate programme guidelines by UGC.

B.Sc. (Discipline specific core A – Physics) offers combination of courses that include DSC (discipline specific core course), DSE (discipline specific elective courses), GE (generic elective courses), SECs, AECs and VACs. The teaching–learning process is student-centric and it involves both theory and practical elements. It offers flexibility in Programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge. As a result, the multidisciplinary approach and commitment to creative approaches within the curriculum framework are highlighted. Additionally, it gives a student the greatest amount of freedom in designing their undergraduate degree with a variety of exit options based on their needs and aspirations in terms of their life goals, all the while maintaining the quality of teaching and learning in both qualitative and quantitative terms. This will meet the needs of students today by safeguarding their pathways to further education or employment.

### Eligibility for admission:

Any candidate who has passed the Plus Two of the Higher Secondary Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in Science with not less than 45% marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per university rules.

**Program Objectives:**

1	To emphasize on the important branch of Science and Mathematics for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
2	To develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Fields
3	To highlights the importance of Science and Mathematics in supporting existing industries and fostering new enterprises, thereby creating job opportunities across all levels of employment.
4	To develop broad and balanced knowledge and understanding of physical concepts, principles and theories of science and mathematics.
5	To learn, design, and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.

**Programme outcome (POs)**

<b>PO 1</b>	Bachelor of Science offers theoretical as well as practical knowledge about different subject areas.
<b>PO2</b>	Graduates will develop scientific temperament to solve scientific problems in emerging areas of science at National and International level.
<b>PO3</b>	Graduates will acquire coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future.
<b>PO4</b>	Graduate will have clarity of thought and expression. Qualities like logical thinking and decision making will be enhanced
<b>PO5</b>	Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
<b>PO6</b>	Graduates will be able to compete in various national and international competitive examinations.
<b>PO7</b>	Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological context with a systematic approach towards sustainable development.
<b>PO8</b>	Graduates will have critical thinking, follow innovations and developments in Science and technology
<b>PO9</b>	Graduates will acquire effective communication skills
<b>PO10</b>	Graduates will understand ethical principles and responsibilities for effective citizenship.
<b>PO11</b>	Graduates will develop new and enhancing conversational skills that lead to not only to good communication but also to the excellent drafting abilities linked with technical reports and presentations.
<b>PO12</b>	Graduates will competent enough for doing jobs in Govt. and private sectors of academia, research and industry.

**Program Specific Outcome (PSOs):**

<b>PSO 1</b>	Acquire a strong foundation in core areas of Physics and apply these concepts to understand and explain real-world phenomena.
<b>PSO2</b>	Design and analyze experiments using electrical circuits, optical instruments, lab equipment, and computational tools, ensuring accuracy, reproducibility, and safety.
<b>PSO3</b>	Apply theoretical and experimental knowledge to solve practical problems in science, technology, and industry, contributing to societal needs.
<b>PSO4</b>	Demonstrate skills in independent research, literature review, data analysis, and scientific communication, preparing for careers in academia, industry, research institutions, and government organizations such as BARC, DRDO, ISRO, IISc, and IITs.

**Examination Scheme:**

<b>Components</b>	<b>I<sup>st</sup> internal</b>	<b>II<sup>nd</sup> Internal</b>	<b>External (ESE)</b>
<b>Weightage (%)</b>	<b>15</b>	<b>15</b>	<b>70</b>

**PHYSICS UG COURSE STRUCTURE****Semester Wise Discipline Specific Core**

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-A (Physics)	PHYDC101	Mechanics	3	0	0	3
		PHYDL102	Mechanics Lab.	0	0	2	1
II		PHYDC201	Electricity and Magnetism	3	0	0	3
		PHYDL202	Electricity and Magnetism Lab.	0	0	2	1
III		PHYDC301	Thermodynamics	3	0	0	3
		PHYDL302	Thermodynamics Lab.	0	0	2	1
IV		PHYDC401	Waves and Optics	3	0	0	3
		PHYDL402	Waves and Optics Lab.	0	0	2	1
V		PHYDC501	Elements of Modern Physics	3	0	0	3
		PHYDL502	Elements of Modern Physics Lab.	0	0	2	1
VI		PHYDC601	Solid State Physics	3	0	0	3
		PHYDL602	Solid State Physics Lab.	0	0	2	1
VII		PHYDC701	Classical Mechanics	3	1	0	4
		PHYDC801	Quantum Mechanics and Applications	3	1	0	4
VIII							

**Semester Wise Discipline-Specific Elective**

Semester	Course Type	Course Code	Course Title	L	T	P	C
III	DSE-A (Physics)	PHYDE306	Biophysics	3	1	0	4
IV		PHYDE406	Astrophysics	3	1	0	4
V		PHYDE506	Advanced Mathematical Physics	3	1	0	4
VI		PHYDE606	Optoelectronics	3	1	0	4
VII		PHYDE702	Nanomaterials and application	3	0	0	3
		PHYDL703	Nanomaterials Lab.	0	0	2	1
		PHYDE704	Atomic and Molecular Physics	3	1	0	4
		PHYDE705	Research Methodology	3	1	0	4
		PHYDE706	Nuclear Physics	3	1	0	4
		PHYDE707	Advanced Quantum Mechanics	3	1	0	4
		PHYDE708	Basic Electronics	3	0	0	3
		PHYDE709	Basic Electronics Lab	0	0	2	1
VIII		PHYDE802	Research-IPR	3	1	0	4
		PHYDE803	Laser Physics	3	1	0	4
		PHYDE804	Statistical Mechanics	3	1	0	4
		PHYDE805	Physics of Semiconductor Devices	3	0	0	3
	PHYDL806	Physics of Semiconductor Devices Lab.	0	0	2	1	
	PHYDE807	Material Characterization Techniques	3	1	0	4	
	PHYDE808	Physical Optics	3	0	0	3	
	PHYDL809	Physical Optics Lab.	0	0	2	1	

**Semester Wise Generic Elective**

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE-A (Physics)	PHYGE103	Mechanics I	4	0	0	4
II		PHYGE203	Introduction to Electromagnetic Theory	4	0	0	4
III		PHYGE303	Digital and Analog Systems	4	0	0	4
IV		PHYGE403	Modern Physics	4	0	0	4
V		PHYGE503	Radiation Physics	4	0	0	4
VI		PHYGE603	Computational Physics	4	0	0	4

**Semester Wise Ability Enhancement Course**

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	AEC	AEC-104	Environment Science-I	2	0	0	2
II		AEC-204	Environment Science-II	2	0	0	2
III		AEC-304	English Communication-I	2	0	0	2
IV		AEC-404	English Communication-II	2	0	0	2

**Semester Wise Skill Enhancement Course/IAPC**

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	SEC-A/IAPC (Physics)	PHYSC105	Basic Instrumentation Skills	2	0	0	2
II		PHYSC205	Electronics Instrumentation skills	2	0	0	2
III		PHYSC305 OR PHYSC306	Number System and Boolean Algebra OR Disaster Management OR Internship/Apprenticeship / Project/ Community Outreach/ /MOOC	2	0	0	2
IV		PHYSC405	Digital Electronics OR Internship/Apprenticeship / Project/ Community Outreach/ /MOOC	2	0	0	2
V		PHYSC505	Energy Storage Devices OR Internship/Apprenticeship / Project/ Community Outreach/ /MOOC	2	0	0	2
VI		PHYSC605	Weather Forecasting OR Internship/Apprenticeship / Project/ Community Outreach/ /MOOC	2	0	0	2
Any Other as per the interest of students				2	0	0	2

**Seminar/Dissertation\***

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	PHYDS710	Seminar/ Academic Project/ Entrepreneurship (For Hons. Only)	0	0	0	2
		PHYDT711	Dissertation (Discipline-Specific) (Mandatory for Hons. with research)	0	0	12	6
VIII	IAPC	PHYDS810	Seminar/Academic Project/ Entrepreneurship (For Hons. Only)	0	0	0	2
		PHYDT811	Dissertation (Discipline-Specific) (Mandatory for Hons. with research)	0	0	12	6

**Value Addition Course (VAC):**

S. No	Value Addition Course (VAC) (2 Credits each)			Name of The Course	Contact Hours			credit
	Year	Semester	Course Code		L	T	P	
1	I	I		choose from the pool of courses offered by the University				2
2	I	II		choose from the pool of courses offered by the University				2
3	II	III		choose from the pool of courses offered by the University				2
4	II	IV		choose from the pool of courses offered by the University				2

## Discipline Specific Core Courses

<b>Course code</b> : PHYDC101				
<b>Course Name</b> : Mechanics				
<b>Semester /Year</b> : I				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the Vectors, Coordinate system and Newton’s Law of Motion and acquire basic knowledge and understanding of dynamics of rigid body and moment of inertia

### Course Contents

#### Unit 1

##### Vectors Algebra

Vector algebra. Scalar and vector products, scalar and vector triple products, Derivative of a vector with respect to a parameter, Del operator, gradient, divergence and curl, Gauss divergence theorem, Stokes curl theorem and Green's theorem, Line, surface and volume integral of a vector function.

#### Unit 2

##### Gravitation field and potential

Gravitational field and potential, Gravitational potential energy, Gravitational field Intensity and potential due to a ring, a spherical shell, solid sphere and circular disc, gravitational self-energy, Inverse square law of forces, Kepler’s laws of planetary motion.

#### Unit 3

##### Conservation Laws

Frames of reference, Concept of inertial and non-inertial frames of references, Work energy theorem, Conservative and non-Conservative forces, Linear restoring force, Gradient of potential, Conservation of energy for the particle; Energy function, Concept of Centre of mass, Angular momentum and torque, Laws of conservation of total energy, total linear momentum and total angular momentum along with their examples.

#### Unit 4

##### Dynamics of rigid body and Moment of Inertia

Translatory and Rotatory motion, Equation of motion for Rotating rigid body, angular momentum vector and moment of inertia, Theorem of parallel and perpendicular axes, Moment of inertia of a cylinder, rod, lamina, ring, disc, spherical shell, solid sphere, kinetic energy of rotation, rolling along a slope, Application to compound pendulum.

#### Unit 5

##### Properties of Matter

Basic concept, Elastic constants and their Interrelations, torsion of cylinder, bending of beam, bending moment, Cantilever, shape of Girders/ rail tracks. Viscosity, Stokes’s law, Posieuille’s formula, Equation of continuity, Bernoulli’s theorem, Surface tension and its molecular interpretation.

**Text Books:**

- TB1.** Integrated Mechanics, J.P. Agarwal, Pragati Publication  
**TB2.** Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.

**Reference Books:**

- RB1.** University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison- Wesley  
**RB2.** Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley  
**RB3.** University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	<b>Define</b> vector algebra and describe Gravitation field and potential, Conservation Laws, Dynamics of rigid body and Moment of Inertia and Properties of Matter.
<b>CO2</b>	<b>Describe</b> Posieuille’s formula, Bernoulli’s theorem, Elastic constants, Gauss divergence theorem, Stokes curl theorem and Green's theorem, Conservations laws, moment of inertia, Stoke’s law and Surface tension.
<b>CO3</b>	Apply moment of inertia to various bodies, Gravitational field Intensity and potential to various systems, and application of vector algebra and surface tension.
<b>CO4</b>	Analyze work-energy theorem, Kepler’s law of planetary motion, frame of reference, vector calculus, dynamics of rigid body and properties of matter, Conservative and non-Conservative forces.
<b>CO5</b>	Evaluate properties of matter, Gravitational field and potential, theorem of parallel and perpendicular axes
<b>CO6</b>	<b>Formulate</b> scalar and vector products, Line, surface and volume integral of a vector function, moment of inertia and viscosity, surface tension.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	0	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	0	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	0	3	2	2	2	0	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b>	: PHYDL102			
<b>Course Name</b>	: Mechanics Lab.			
<b>Semester /Year</b>	: I			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to teach the students about coefficient of viscosity, Young's modulus, elastic constants and pendulums characteristics by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents**

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine g and velocity for a freely falling body using Digital Timing Technique
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.
12. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope

**Text Books:**

**TB1.** Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia.

**TB2.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.

**Reference Books:**

**RB1.** Indu Prakash: Practical Physics

**RB2.** S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyze the readings and interpret the data.
<b>CO5</b>	Find errors and interpret the data
<b>CO6</b>	Formulate the results of various experiments like, coefficient of viscosity, elastic constants, acceleration due to gravity etc.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	0	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	0	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	0	3	2	2	2	0	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b>	<b>: PHYDC201</b>			
<b>Course Name</b>	<b>: Electricity and Magnetism</b>			
<b>Semester /Year</b>	<b>: II</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the basic concepts of electricity, magnetism and their application. This course will help in understanding electromagnetic induction, alternating current and magnetostatics.

### Course Contents

#### Unit 1

##### Electric field and potential

Coulomb law, Gauss' theory, its integral and differential forms, line integral of Electric field, Electric field and potential due to an arbitrary charge distribution. Electrostatic energy, energy stored in an Electric field. Electric field and potential due to long charged wire, Spherical shell, sphere, disc, dipole.

#### Unit 2

##### Electric and Magnetic fields in Matter

Moments of charge distributions, Polar and non-polar molecule, polarization vector, electric displacement vector, three electric vectors, dielectric susceptibility and permittivity, polarizability, Clausius-Mossotti relation Magnetization, magnetic susceptibility, diamagnetic, paramagnetic and ferromagnetic substances, Hysteresis and B-H curve, Langevin's theories of Diamagnetism and paramagnetism, Weiss theory of ferromagnetism.

#### Unit 3

##### Electric Currents (Steady and Varying)

Current density, Equation of Continuity, Ohm's law and electrical conductivity, Lorentz Drude theory, Wiedmann-Frenz law, Kirchhoff's laws, and their applications, Transient current, Growth and decay of D. C. in L - Rand L - C circuits, charging and discharging of a capacitor through a resistance.

#### Unit4

##### Magnetostatics

Lorentz force, Bio-Savart's law, Ampere's law, Application of Biot-Savert law, magnetic field due steady current in a long straight wire, Interaction between two wires, field due a Helmholtz coil, solenoid and current loop, magnetic vector potential, permeability, Energy stored in Magnetic field.

**Unit 5****Electromagnetic Induction and Alternating Current**

Faraday's laws of induction, Lenz's law, Electromotive force, Measurement of magnetic field, Eddy current, Mutual inductance, Self-inductance. Impedance, admittance and reactance, R-C, R-L and L-C circuits with alternating e.m.f. source, series and parallel L-C-R circuits, resonance and sharpness, Quality factor, Power in A. C. circuits, Choke coil.

**Text Books:**

- TB1.** Integrated Electricity and Magnetism, J.P. Agarwal, Pragati Publication.  
**TB2.** Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House

**Reference Books:**

- RB1.** D.J. Griffiths, Introduction to Electrodynamics, 3<sup>rd</sup> Edn, 1998, Benjamin Cumming  
**RB2.** Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.  
**RB3.** University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define vector analysis, electrostatics, magnetism, electromagnetic induction, Maxwell's equations and Electromagnetic wave propagation
<b>CO2</b>	Describe Gauss's divergence theorem, Stoke's theorem, Gauss theorem and its applications, Maxwell's equation, equation of continuity, Polarisation.
<b>CO3</b>	Explain and distinguish between dia-, para-, and ferromagnetic material. Apply Biot-Savart's law, Ampere's circuital law in various systems
<b>CO4</b>	Analyse Electromagnetic Induction and Alternating Current poynting vector, displacement current,
<b>CO5</b>	Evaluate and assess Faraday's laws of electromagnetic induction, Gauss's theorem in dielectrics
<b>CO6</b>	Solve the problems based on electric field, electric potential, magnetism, dielectrics and electromagnetic wave propagation.

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL202</b>			
<b>Course Name</b>	<b>: Electricity and Magnetism Lab.</b>			
<b>Semester /Year</b>	<b>: II</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to teach the students resistance, voltage, current, galvanometer, capacitance, various circuits and ballistic galvanometer having the students perform hands on experiments supervised by a specialized instructor.

### Course Contents

1. Frequency of A.C. Mains.
2. Calibration of Voltmeter by potentiometer.
3. Calibration of ammeter by potentiometer.
4. Specific resistance determination.
5. Conversion of a Galvanometer into a Voltmeter.
6. Conversion of a Galvanometer into Ammeter.
7. Variation of magnetic field along the axis of a current carrying circular coil.
8. Comparison of capacities by Ballistic Galvanometer.
9. Determination of Ballistic Constant.
10. Electrochemical equivalent.
11. De Sauty's bridge- C1/ C2
12. R1/R2 by potentiometer.
13. Study of R-C, L-C-R circuits.
14. Determination of self inductance, mutual inductance.
15. Magnetic field determination by search coil and ballistic galvanometer.

### Text Books:

- TB1.** Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia.  
**TB2.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.

### Reference Books:

- RB1.** A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11<sup>th</sup> Edition, 2011, Kitab Mahal, New Delhi.

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyze the readings and interpret the data.
<b>CO5</b>	Find errors and interpret the data
<b>CO6</b>	Formulate the results of various experiments like, calibration of voltmeter, ammeter and conversion experiments etc.

Cours e	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC301</b>			
<b>Course Name</b>	<b>: Thermodynamics</b>			
<b>Semester /Year</b>	<b>: III</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the laws of thermodynamics, Entropy, the thermodynamic potentials and their physical significance. To provide knowledge and understanding of kinetic theory of gases and transport of heat.

## Course Contents

### Unit 1

#### Basic concepts and First law of thermodynamics

Thermodynamic Systems, Thermal equilibrium and Zeroth law of thermodynamics, Equation of state and First law of thermodynamics, Discussion of Heat and Work, Quasi-static Work; Reversible and Irreversible; Path Dependence; Heat Capacities Adiabatic Processes, Vander Wall equation, Distinction between Joule, Joule-Thompson and Adiabatic expansion of a gas.

### Unit 2

#### Second law of Thermodynamics and Entropy

Insufficiency of first law of thermodynamics, Condition of Reversibility, Carnot's Engine and Carnot's Cycle, Second law of thermodynamics, Carnot's Theorem, Thermodynamic scale of temperature and its identity to perfect gas, scale of temperature. Entropy, Mathematical formulation of Second law of thermodynamics, Entropy of an ideal gas, T-S diagram and its applications, Evaluation of Entropy changes in simple cases, Third law of thermodynamics.

### Unit 3

#### Thermodynamic Relations

Thermodynamic potentials, Maxwell's equation from thermodynamic potentials, The Clausius–Clapeyron's equations, Triple point, Applications of Maxwell's thermo dynamical relations.

### Unit 4

#### Transport of Heat

Modes of heat transfer via Conduction, Convection and Radiation, Fourier's law, One dimensional steady state conduction, Heat conduction through plane. Black body radiation, Kirchhoff's Laws, Derivation of Stefan Boltzmann Law, Wein's displacement law, Black body spectrum formula early attempts, Raleigh Jeans Law, Quantum theory of Radiation, Planck's formula for black body spectrum, Wien's law.

### Unit 5

#### Kinetic Theory of Gases

Kinetic theory of gases, Microscopic description of an Ideal gas, Degrees of freedom, Law of Equipartition of Energy, Distribution law of velocities, Most probable speed, Average speed and

root mean square velocity of molecules, Pressure exerted by a perfect gas.

### Text Books:

**TB1.** Integrated Thermal Physics And Statistical Mechanics, J.P. Agarwal, Pragati Publication.

**TB2.** A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.

### Reference Books:

**RB1.** Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.

**RB2.** Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G. L. Salinger. 1988, Narosa.

### Course outcomes (COs):

Upon successful completion of the course a student will be able to

<b>CO1</b>	Define Basic concepts and First law of thermodynamics, Second law of Thermodynamics and Entropy, Thermodynamic Relations, Transport of Heat, Kinetic Theory of Gases
<b>CO2</b>	Describe Carnot's Engine, Entropy, Maxwell's thermodynamic relations, laws of thermodynamics, and its applications, Black body radiation
<b>CO3</b>	Apply laws of thermodynamics, Equation of state and First law of thermodynamics, Thermodynamic potentials, Maxwell's equation from thermodynamic potentials, Stefan Boltzmann Law, Wein's displacement law.
<b>CO4</b>	Analyze Kinetic theory of gases, laws of thermodynamics and its applications
<b>CO5</b>	Evaluate Kirchhoff's Laws, Derivation of Stefan Boltzmann Law, Wein's displacement law, Black body spectrum formula early attempts, Raleigh Jeans Law, Quantum theory of Radiation, Planck's formula for black body spectrum, Wien's law, Radiation as a photon gas.
<b>CO6</b>	Solve problems on Distribution law of velocities, Stefan Boltzmann Law, Wein's displacement law, Degrees of freedom, Law of Equipartition of Energy.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL302</b>			
<b>Course Name</b>	<b>: Thermodynamics Lab.</b>			
<b>Semester /Year</b>	<b>: III</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to teach the students heat flow, black body radiation, thermal conductivity, thermo couple and null method by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents**

1. Thermal conductivity of a bad conductor by Lee's method.
2. Mechanical equivalent of heat by Searle's method.
3. Stefan's law
4. Platinum resistance thermometer.
5. Thermal conductivity of a good conductor by Searle's method.
6. Determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. Random throw- statistical method.
7. Newton's law of cooling, sp. heat of Kerosene oil.
8. Constant volume thermometer.
9. Variation of thermo-emf across two junctions of a thermocouple with Temperature

**Text Books:**

**TB1.** Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.

**TB2.** A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

**Reference Books:RB1.** A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication

**RB2.** Practical Physics, Gupta Kumar, Pragati Publication.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyze the readings and interpret the data.
<b>CO5</b>	Find errors and interpret the data
<b>CO6</b>	Formulate the results of various experiments like, thermal conductivity, stefan's law etc.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC401</b>			
<b>Course Name</b>	<b>: Waves and Optics</b>			
<b>Semester /Year</b>	<b>: I</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about oscillations, principle of superposition, sound and lens system. Acquire knowledge and understanding of wave motion and geometrical optics

### Course Contents

#### Unit 1

**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages, damped oscillations, forced vibrations and resonance.

#### Unit 2

**Superposition Principle and Sound:** Oscillations having equal frequencies and Oscillations having different frequencies (Beats). Lissajous Figures (1:1 and 1:2) and their uses. Fourier's Theorem-Application to saw tooth wave and square wave – Intensity and loudness of sound – Decibels – Intensity levels – musical notes – musical scale.

#### Unit 3

**Waves motion and Optics:** Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

#### Unit 4

Image Theory for Lens Systems Gauss's general theory of image formation, Coaxial symmetrical system, Cardinal points of an optical system, General relationships, Thick and Thin lens, lens combinations, Newton's formula Coaxial lens system, Lagrange's equation of magnification, Refraction through a thick lens.

#### Unit 5

Associated Optical Instruments Nodal Slide, Eyepiece, Ramsden's, Huygen's, and Gaussian eyepieces, their comparison. Types of telescopes, Astronomical Reflecting and refracting telescope, Microscopes: principle and types, Spectrometer and its uses, Oil immersion objectives meniscus lens.

### Text Books:

**TB1.** Integrated Wave and Optics, J.P. Agarwal, Pragati Publication.

**TB2.** Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill

### Reference Books:

**RB1.** Principles of Optics, B.K. Mathur, 1995, Gopal Printing

**RB2.** Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication

**RB3.** University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison.

**Course outcomes (Cos):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Oscillations, Superposition Principle and Sound, optics, Image Theory for Lens Systems Gauss's general theory of image formation, Associated Optical Instruments Nodal Slide, Eyepiece.
<b>CO2</b>	Describe the concept of SHM, Optical Instruments, Electromagnetic theory, lens system.
<b>CO3</b>	Illustrate with examples standing waves, Lissajous figures, telescope, and microscopes.
<b>CO4</b>	Analyse about Huygen's, and Gaussian eyepieces,, Fourier's Theorem, Huygen's principle , types of oscillations, lens system. Lissajous figures.
<b>CO5</b>	Describe the Newton's formula Coaxial lens system, Lagrange's equation of magnification , Group velocity, Phase velocity , Group velocity, Phase velocity, principle of superposition of waves
<b>CO6</b>	Formulate the principle of SHM, lens system , Microscopes: principle and types, Spectrometer and its uses, Oil immersion objectives meniscus lens.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL402</b>			
<b>Course Name</b>	<b>: Waves and Optics Lab.</b>			
<b>Semester /Year</b>	<b>: IV</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objectives:** The objectives of this course is to teach the students coupled oscillators, Tuning Fork, Schuster’s focusing, refractive index of the material, resolving power of a prism, Newton’s Rings, Fresnel Biprism, single-slit, and plane diffraction grating by having the students perform hands on experiments supervised by a specialized instructor.

### Course Contents

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 focusing; determination of angle of prism.
5. To determine the Height of a Building using a Sextant.
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light.
8. To determine the value of Cauchy Constants of a material of a prism.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton’s Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of Mercury light using plane diffraction Grating.
14. To measure the intensity using photo sensor and laser in diffraction patterns of single and double slits.

### Text Books:

**TB1.** Practical Physics, Gupta Kumar, Pragati Publication.

**TB2.** Advanced Practical Physics for students, B. L. Flint & H. T. Worsnop, 1971, Asia Publishing House.

### Reference Books:

**RB1.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.

**RB2.** A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11<sup>th</sup> Edition, 2011, Kitab Mahal, New Delhi.

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyze the readings and interpret the data.
<b>CO5</b>	Find errors and interpret the data
<b>CO6</b>	Formulate the results of various experiments like, Melde's Experiment etc.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC501</b>			
<b>Course Name</b>	<b>: Elements of Modern Physics</b>			
<b>Semester /Year</b>	<b>V</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about Photoelectric effect, de Broglie hypothesis and various atomic models. Acquire knowledge and understanding of Schrodinger equation, nuclear properties, radioactive decay and processes.

### Course Contents

#### Unit 1

**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.

#### Unit 2

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.

#### Unit 3

**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. Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability current densities in one dimension.

#### Unit 4

**One dimensional infinitely rigid box**- energy eigen values and eigen functions, normalization; Quantum mechanical scattering and tunnelling in one dimension- across a step potential and across a rectangular potential barrier.

#### Unit 5

**Size and structure of atomic nucleus** and its relation with atomic weight; Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy. Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life;  $\alpha$  decay;  $\beta$  decay. 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

**Text Books:**

**TB1.** Integrated Elements of Modern Physics, J.P. Agarwal, Pragati Publication.

**TB2.** Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill

**Reference Books:**

**RB1.** Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A. Dubson, 2009, PHI Learning

**RB2.** Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill

**RB3.** Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.

**RB4.** Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define quantum Mechanics and Bohr Atom Model, and Heisenberg Uncertainty Principle, Matter Waves, Radioactivity, Fission and fusion.
<b>CO2</b>	Describe Radioactivity: stability of nucleus; Law of radioactive decay, De Broglie wavelength and matter waves; Davisson-Germer experiment, Bohr's model, nuclear forces, liquid drop model
<b>CO3</b>	Apply Compton scattering, semi-empirical mass formula and binding energy, packing fraction, expectation value, Mean life & half-life; One dimensional infinitely rigid box-energy eigenvalues and eigen functions.
<b>CO4</b>	Analyze $\alpha$ decay; $\beta$ decay, $\gamma$ decay, Fission and fusion, Nuclear reactor, Planck's constant, Photoelectric effect, binding energy, packing fraction, expectation value, wave function
<b>CO5</b>	Evaluate Schrodinger equation, Heisenberg uncertainty principle, laws of photoelectric emission, Rutherford model, Bohr's model, quantization rule and atomic stability.
<b>CO6</b>	Solve Probability and probability current densities in one-dimension, binding energy, Mean life & half-life; Fission, fusion

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL502</b>			
<b>Course Name</b>	<b>:Elements of Modern Physics Lab.</b>			
<b>Semester /Year</b>	<b>V</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to teach the students Boltzmann constant, work function of material, Planck’s constant using LEDs, diffraction patterns of single and double slits, Photo-electric effect, and Millikan oil drop apparatus by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents:**

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 value of Planck’s constant using LEDs of at least 4 different colours.
4. To determine the ionization potential of mercury.
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 source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light.
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 magnetic focusing.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.

**Text Books:**

- TB1.** Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- TB2.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

**Reference Books:**

- RB1.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.
- RB2.** A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Outline the characteristics of PN Junction diode, vacuum Diode, diffraction patterns, LEDs
<b>CO2</b>	Explain work function of material of filament of directly heated vacuum Diode, value of Boltzmann constant using V-I characteristic of PN diode, absorption lines in the rotational spectrum of Iodine vapour
<b>CO3</b>	Apply the Photo-electric effect and calculate photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
<b>CO4</b>	Analyse Millikan oil drop apparatus and determine the charge of an electron, the absorption lines in the rotational spectrum of Iodine vapour
<b>CO5</b>	Evaluate the value of $e/m$ by magnetic focusing, the wavelength of H- alpha emission line of Hydrogen atom, value of Planck's constant using LEDs of at least 4 different colours
<b>CO6</b>	Design the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC601</b>			
<b>Course Name</b>	<b>: Solid State Physics</b>			
<b>Semester /Year</b>	<b>: VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objectives:** The objectives of this course is to provide an understanding about the Crystal structure, Magnetic and Dielectric properties of materials and acquire basic knowledge and understanding of superconductors.

## Course Contents

### Unit 1

**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

### Unit 2

**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.  $T^3$  law

### Unit 3

**Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

### Unit 4

**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mossotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Langevin-Debye equation. Complex Dielectric Constant.

### Unit 5

**Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect.

**Text Books:**

- TB1.** Introduction to Solid State Physics, Charles Kittel, 8<sup>th</sup> Ed., 2004, Wiley India Pvt. Ltd.  
**TB2.** Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India

**Reference Books:**

- RB1.** Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill  
**RB2.** Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning  
**RB3.** Solid-state Physics, H.Ibach and H Luth, 2009, Springer  
**RB4.** Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter, Dielectric Properties of Materials, Elementary band theory, superconductivity
<b>CO2</b>	Describe Type I and type II Superconductors, London's Equation, Langevin-Debye equation, Brillouin Zones, Langevin Theory of dia – and Paramagnetic Domains, Discussion of B-H Curve. Hysteresis and Energy Loss.
<b>CO3</b>	Illustrate Unit Cell. Miller Indices. Reciprocal Lattice, Dia-, Para-, Ferri- and Ferromagnetic Materials, Einstein and Debye theories of specific heat of solids. $T^3$ law,
<b>CO4</b>	Analyze Types of Lattices, Acoustical and Optical Phonons, P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient, Normal and Anomalous Dispersion, Diffraction of X-rays by Crystals. Bragg's Law.
<b>CO5</b>	Evaluate Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. B-H Curve. Hysteresis and Energy Loss, Isotope effect, Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors.
<b>CO6</b>	Solve Unit Cell. Miller Indices. Reciprocal Lattice, Atomic and Geometrical Factor, Susceptibility. Polarizability. Clausius Mossotti Equation, Langevin-Debye equation, Complex Dielectric Constant.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL602</b>			
<b>Course Name</b>	<b>: Solid State Physics Lab.</b>			
<b>Semester /Year</b>	<b>: VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objectives:** The objectives of this course is to teach the students magnetic susceptibility, dielectric constant, refractive index and hall coefficient by having the students perform hands on experiments supervised by a specialized instructor.

### Course Contents

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe method (from room temperature to 150 °C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

### Text Books:

- TB1.** Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia  
**TB2.** Publishing House.  
**TB3.** Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition,  
reprinted 1985, Heinemann Educational Publisher

### Reference Books:

- RB1.** A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11<sup>th</sup> Ed.,  
2011, Kitab Mahal, New Delhi  
**RB2.** Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Outline the characteristics of Magnetic susceptibility, Ferroelectric Crystals, Dielectric Constant, semiconductors, magnetic materials
<b>CO2</b>	Describe the concept and measure the Magnetic susceptibility of Solids, the resistivity of a semiconductor (Ge) crystal with temperature by four probe method
<b>CO3</b>	Apply the principle and calculate the Coupling Coefficient of a Piezoelectric crystal, the Hall coefficient of a semiconductor sample
<b>CO4</b>	Analyze and measure the Dielectric Constant of a dielectric Materials with frequency, the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance
<b>CO5</b>	Evaluate the refractive index of a dielectric layer using SPR, susceptibility of paramagnetic solution, Hysteresis loop of a Ferroelectric Crystal
<b>CO6</b>	Formulate and draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC701</b>			
<b>Course Name</b>	<b>: Classical Mechanics</b>			
<b>Semester /Year</b>	<b>: VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to apply the Newtonian laws using various mathematical formulations to describe the motions of macroscopic objects using generalized coordinates, momentum, forces and energy. The classical mechanics would be helpful in understanding of advanced branches of modern physics.

**Unit I**

**Lagrangian formulation and Variational Principle:** Mechanics of particles and system of particles, conservation law, constraints, degree of freedom, generalized coordinates, D'Alembert's principle,

**Unit II**

**Lagrange's equations** of motion from D'Alembert's principle, application of Lagrange's equation of motion to a particle and system of particles, conservation theorem, Hamilton's variational principle, Euler- Lagrange's differential equation.

**Unit III**

**Hamilton's formalism:** Need of Hamilton's procedure, Legendre's transformation and Hamilton's equation of motion, physical significance of H, cyclic coordinates, Hamilton's equation in cylindrical and spherical coordinates and applications, applications of Hamilton's equation of motion to a particle and system of particles

**Unit IV**

**Principle of least action:** Canonical or contrast transformation, their advantages and examples, condition for a transformation to be canonical, infinitesimal contact transformation (ICT) Poisson brackets: Definition and properties, Invariance with respect to Canonical transformation, equation of motion in Poisson's Bracket form, Jacobian's form.

**Unit V**

**Mechanics of Rigid Bodies and Theory of Small Oscillations:** Coordinates of rigid body motion, Euler's angle, and angular momentum of a rigid body moments and products of inertia, principle axis transformation, Euler's equation of motion of a rigid body, stable and unstable equilibriums.

**Text book [TB]:**

TB1. Gupta K.C., "Classical Mechanics of particles and Rigid Bodies", Wiley Eastern (2001).

TB2. Goldstein H., Classical Mechanics, Pearson Education Asia Pte Ltd. House (2002).

**Reference books [RB]:**

RB1. Rana N. C and Joag P S, Classical Mechanics, Tata McGraw-Hill (1991)

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define and describe Lagrangian formulation, Variational Principle, Hamilton's formalism, principle of least action and mechanics of Rigid bodies and theory of small Oscillation.
<b>CO2</b>	Discuss Lagrange's Equations, Hamilton's Variational Principle, Canonical Transformation, Hamilton's Formulation, principle of least action and mechanics of Rigid bodies, Conservation theorems.
<b>CO3</b>	Apply Lagrange's Equations, Hamilton's Formulation, Canonical transformation, Poisson brackets to various systems
<b>CO4</b>	Analyze constraints, degree of freedom, generalized coordinates, D'Alembert's principle, conservation theorems, Poisson brackets, mechanics of rigid bodies, theory of small Oscillation
<b>CO5</b>	Evaluate angular momentum, energy, moment of inertia, theorems on rigid body and applications of Lagrangian, Hamiltonian, canonical and Poissons bracket formulation
<b>CO6</b>	Solve Problems on Lagrangian, Hamilton's formulation, Canonical transformation, Poissons bracket, mechanics of Rigid bodies and theory of Oscillation.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
CO5	2	1	1	2	1	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDC801</b>			
<b>Course Name</b>	<b>: Quantum Mechanics</b>			
<b>Semester /Year</b>	<b>: VIII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the Time dependent and independent Schrodinger equation, Larmor's theorem, Zeeman effect and acquire basic knowledge of Spin orbit coupling and Vector model.

## Course Contents

### Unit 1

**Time dependent Schrodinger equation:** Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Eigen values and Eigen functions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum.

### Unit 2

**Time independent Schrodinger equation-Hamiltonian,** stationary states and energy Eigen values; Eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle

### Unit 3

**General discussion of bound states in an arbitrary potential-** continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method.

### Unit 4

**Atoms in Electric and Magnetic Fields:** Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

### Unit 5

**Atoms in External Magnetic Fields:** Normal and Anomalous Zeeman Effect. Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings.

**Text Books:**

- TB1.** A Text book of Quantum Mechanics, P.M.Mathews & K.Venkatesan, 2<sup>nd</sup>Ed., 2010, McGraw Hill  
**TB2.** Quantum Mechanics, Robert Eisberg and Robert Resnick, 2<sup>nd</sup> Edn., 2002, Wiley.  
**TB3.** Quantum Mechanics, Leonard I. Schiff, 3<sup>rd</sup>Edn. 2010, Tata McGraw Hill.

**Reference Books:**

- RB1.** Quantum Mechanics, G. Aruldhas, 2<sup>nd</sup>Edn. 2002, PHI Learning of India.  
**RB2.** Quantum mechanics, SatyaPrakash, Swati Saluja, KedarNath, Ram Nath&Co.  
**RB3.** Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.  
**RB4.** Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define time dependent and independent Schrodinger equation, bound states in an arbitrary potential, Atoms in Electric and Magnetic Fields, Many electron atoms.
<b>CO2</b>	Explain Spin-orbit coupling in atoms-L-S and J-J couplings , Time dependent Schrodinger equation and independent equation, Time independent Schrodinger equation in spherical polar coordinates, Stern-Gerlach Experiment.
<b>CO3</b>	Apply Normal and Anomalous Zeeman Effect, Pauli's Exclusion Principle, application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions.
<b>CO4</b>	Analyze Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions, Spectral Notations for Atomic States. Total Angular Momentum. Vector Model, Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem.
<b>CO5</b>	Evaluate uncertainty principle, Properties of Wave Function. Interpretation of Wave Function, Probability and probability current densities in three dimensions
<b>CO6</b>	Solve commutation relation, angular momentum operator and quantum numbers; Radial wave functions, Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

**Discipline Specific Elective Courses (DSEC)**

<b>Course code</b>	<b>: PHYDE306</b>			
<b>Course Name</b>	<b>: Biophysics</b>			
<b>Semester /Year</b>	<b>: III</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objectives:** The objectives of this course is to deal with principles of physics and related sciences to understand the various phenomena of living cells and organisms.

**Course Content****Unit I**

**Molecules of life:** Metabolites, proteins, and nucleic acids. Their sizes, types, and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling.

**Unit II**

**Atoms, ions and molecules:** Atoms and ions, molecules essential for life, Quantum numbers, stable and unstable atoms, Aufbau rule, hund's rule

**Unit III**

**Living state interactions:** Molecular interactions: Hydrogen Bonds, Vander Waal' s interaction. Forces and molecular bonds, electric & thermal interactions, electric dipoles, domains of physics in biology.

**Unit IV**

**Living State Thermodynamics:** Thermodynamic equilibrium, the first law of thermodynamics, and conservation of energy. Entropy and the second law of thermodynamics, Physics of many-particle systems, Two-state systems, continuous energy distribution

**Unit V**

**Open systems and chemical thermodynamics:** Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, ensemble.

**Textbook [TB]:**

**TB1.** Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartlett Publishers

**Reference Books:**

**RB1.** Aspects of Biophysics, Hugh S W, John Willy and Sons.

**RB2.** Essentials of Biophysics by P Narayanan, New Age International.

**Course outcomes (COs):**

**Upon successful completion of the course, a student will be able to**

<b>CO1</b>	Define molecules of life and the Structure of Living State, Living State Thermodynamics and Open systems, and chemical thermodynamics
<b>CO2</b>	Describe the molecules of life and the Structure of the Living State, Living State Thermodynamics, open systems, and chemical thermodynamics
<b>CO3</b>	Explain the important role of heat transfer, thermodynamics, statistical mechanics, and diffusion in the biological domain and the molecules of life
<b>CO4</b>	Analyzing the molecules of life and the Structure of Living State, Heat Transfer in biomaterials, Living State Thermodynamics, open systems, and chemical thermodynamics
<b>CO5</b>	Describe the Physics of many-particle systems, and Living State Thermodynamics, molecules of life.
<b>CO6</b>	Formulating the principle of living state and thermodynamics, molecules of life

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	0	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	0	1	2	0	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE406</b>			
<b>Course Name</b>	<b>: Astrophysics</b>			
<b>Semester /Year</b>	<b>: IV</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** This course gives an overview on astronomical phenomenon, from the daily and yearly motion of stars and planets in the night sky. To develop observation skills of students to explain astronomical features and stellar system.

## Course Content

### Unit I

**The Solar System:** Study of Planets: Classification of the Planets, Properties of Planets, Orbits, Laws of planetary motion,

### Unit II

**Asteroids, Meteors and Meteorites:** Discovery of minor planets (Asteroids). Meteors and Meteorites. Meteorites, their types and composition. Meteorite craters. Nature of dust particles and origin of comets.

### Unit III

**Sun As a Star:** History of Sun, Sun's interior, the photosphere, the solar atmosphere, Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Absolute magnitudes and distance modulus.

### Unit IV

**Physics of Galaxies:** Basic structure and properties of different types of Galaxies, Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way, Rotation Curve of the Galaxy and the Dark Matter

### UNIT V

**Astronomy in India:** Astronomy in ancient, medieval, and early telescopic era of India, current Indian observatories, Indian astronomy missions

### Text Books:

**TB1.** Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

**TB2.** Baidyanath Basu, An introduction to Astrophysics, Prentice Hall of India Private Limited.

**TB3.** The Physical Universe: An Introduction to Astronomy, F H Shu, University Science Books

### Reference Books:

**RB1.** Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer

**RB2.** Fundamental of Astronomy, H. Karttunen et al, Springer

**RB3.** Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley Publishing Co.

**RB4.** Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College

Publishing.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Describe sun and solar system, physics of galaxies, astronomy of India, and basic parameters of stars.
CO2	Discuss about the sun and solar system, types of galaxies, astronomy of India, and basic parameters of stars.
CO3	Explain the concept of modern astrophysical observations, the photosphere, the solar atmosphere, Salient features of sunspot
CO4	Analyse the contribution of Indian to astronomy, both in ancient times and in modern era. Classify the concept of modern astrophysical observations, the photosphere, the solar atmosphere, Salient features of sunspot
CO5	Evaluate the understanding of our present picture of stellar system, Meteors and Meteorites, Brightness scale for stars, types of stars, galaxies and its types, and, Components of solar system and its evolution.
CO6	Express the features of planets, stars, sun and types of galaxies.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	1	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE506</b>			
<b>Course Name</b>	<b>: Advanced Mathematical Physics</b>			
<b>Semester /Year</b>	<b>: V</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objective of this course is to introduce students to the method of Mathematical Physics. To understand linear algebra and various properties of vector spaces, matrices and their properties.

## Course Content

### Unit I

**Differential Equations:** Special equations of Mathematical Physics, Series Solution, Bessel functions of first and second kind, generating function, Integral representation and recurrence relations for Bessel's functions of first kind, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality; Legendre polynomials: recurrence relations, Parity and orthogonality.

### Unit II

**Complex Variable:** Introduction, Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula, Taylor and Laurent's expressions, residues at various poles, theorem of residues, Contour integration.

### Unit III

**Matrix and Tensors:** Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values- Eigen vectors and Diagonalization of matrices, Coordinate transformation, Covariant and contravariant Tensors, addition, multiplication and contraction of tensors, Associated tensors.

### Unit IV

#### Fourier series and Fourier transform

Fourier series: definition and expansion of periodic functions. Dirichlet's conditions, Complex representation of Fourier series, problems related to periodic functions, Fourier integrals, convergence of FS, solving simple partial differential equations using Fourier series-

### Unit V

**Fourier transforms:** sine, cosine & complex transforms- solving simple partial differential equations using the Fourier transform. Fourier transforms of standard functions, Solution of PDE using the Fourier transform—Dirac delta function,

### Textbook [TB]:

TB1. Harper C. Analytical Mathematics in Physics, Prentice Hall (1999).

**Patel Nagar, Dehradun, Uttarakhand.**  
TB2. Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, New York (1983).

**Reference books [RB]:**

RB1. Arfken G. and Weber H.J., Mathematical Methods for Physicists, Academic Press (2005).

RB2. Dass, H.K., Mathematical Physics, S. Chand (2018).

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe differential equations, Fourier series, and the Fourier transform, partial differential equations, matrix and tensors and complex variable
<b>CO2</b>	Discuss Special functions (Bessel's, Legendre), recurrence relations, Parity and orthogonality, Cauchy's integral theorem, eigenvalues-eigenvectors, for solving definite integrals, Laplace equation.
<b>CO3</b>	Illustrate Taylor and Laurent's expressions, residues at various poles, the theorem of residues, Contour integration, partial differential equations using boundary value problems, wave and heat equations.
<b>CO4</b>	Explain the Fourier series and Fourier transform, Dirichlet's conditions, Complex representation of the Fourier series, Complex Variable, Matrix and Tensors, Special function
<b>CO5</b>	Estimate Fourier transforms of standard functions, Solution of PDE using the Fourier transform. Dirac delta function
<b>CO6</b>	Solve the matrix and tensor problems related to periodic functions, Fourier integrals, convergence of FS, and the two-dimensional heat equation

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	1	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code : PHYDE606</b>				
<b>Course Name : Optoelectronic devices</b>				
<b>Semester /Year : VI</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** Teach fundamentals of light interaction with Semiconductor materials and vice-versa and to be able to understand how some of the optoelectronic devices like, LED, Laser Diode, Photodiodes and Photo-voltaic cells work.

### Course Contents

#### UNIT 1

Semiconductor Science (review): Semiconductors and Energy Bands, Band gap Diagrams, pn junctions; Science and engineering of light emitting diodes.

#### UNIT 2

Stimulated Emission Devices: Laser Diodes, Fabry-Perot and distributed-feedback lasers; vertical-cavity surface-emitting lasers..

#### UNIT 3

Photodetectors: pn junction, photodiode science and operation, avalanche and heterojunction photodiodes, phototransistors. Photovoltaic Devices: Solar energy spectrum, device principles, I- V characteristics, equivalent circuit, temperature effects, materials, devices, and efficiencies.

#### UNIT 4

Polarization and Modulation of light: Polarization, propagation in anisotropic media, birefringent devices, optical activity,

#### UNIT 5

Electro-optic effects, integrated optical modulators, acousto-optic modulators, magneto-optic modulators.

#### **Text book [TB]:**

**TB1.** Optoelectronics sensors and instrumentation, M.K Ghosh , 2014

**TB2.** Introduction to optical and optoelectronics properties of nanostructure, Vladimir V. Mitin,viacheslav A. Kochelap, Mitra Dutta, Michael A. Stroschio ,2019

#### **Reference books [RB]:**

**RB1-** S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, 1st ed., Pearson Education,2001. 2.

**RB2-** S. L. Chuang, Physics of Photonic Devices, 2nd ed., New York: Wiley, 2009.

**RB3-** Saleh and Teich, Fundamentals of Photonics, 2nd ed. Wiley Interscience 2007

**P a t e l N a g a r , D e h r a d u n , U t t a r a k h a n d**

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Semiconductor Science, stimulated emission devices Photodetectors, Phototransistors and polarization and modulation of light.
<b>CO2</b>	Describe Semiconductors, photodiode, photovoltaic devices, phototransistor, polarization and modulation.
<b>CO3</b>	Illustrate pn junction, Stimulated Emission Devices: Laser Diodes, Fabry-Perot and distributed-feedback lasers; vertical-cavity surface-emitting lasers.
<b>CO4</b>	Analyze Photovoltaic Devices: Solar energy spectrum, device principles, I-V characteristics, equivalent circuit, temperature effects, materials, devices, and efficiencies
<b>CO5</b>	Assess Semiconductors and Energy Bands, Band gap Diagrams, Polarization and Modulation of light: Polarization, propagation in anisotropic media, birefringent devices, optical activity.
<b>CO6</b>	Familiarize and formulate electro-optic effects, integrated optical modulators, acousto-optic modulators, magneto-optic modulators.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	1	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE702</b>			
<b>Course Name</b>	<b>: Nanomaterials and Applications</b>			
<b>Semester /Year</b>	<b>: VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objective:** The main objective of the course on Physics of Nano Materials is to impart knowledge about the physics in quantum well, quantum wire and quantum dot and to aware the students about size, shape-controlled synthesis of nanomaterials and their future applications in industry.

**Course contents:**

**Unit I**

**Nanoparticles: Synthesis and Properties:** R F Plasma Chemical Methods, Thermolysis, Pulsed laser Methods, Biological Methods, Synthesis using micro-organisms, Synthesis using Plant extract, Metal Nanoclusters, Magic Numbers, modeling of Nano Particles, Bulk of Nano Transitions.

**Unit II**

**Carbon Nano Structures:** Nature of Carbon Clusters, Discovery of C60, Structure of C60 and its crystal, Superconductivity in C60, Carbon Nano Tubes: Synthesis, structure, Electrical and Mechanical Properties.

**Unit III**

**Carbon 2D Nano Structures:** Graphene: Discovery, Synthesis and Structural Characterization through TEM, Elementary concept of its applications

**Unit IV**

**Quantum Wells, Wires and Dots:** Preparation of Quantum Nano Structures, Size Effects, Conduction Electrons and Dimensionality, Properties Dependent on Density of States. Analysis Techniques for Nano Structures/Particles: Scanning Probe Microscopes (SPM), Diffraction Techniques, Spectroscopic Techniques, Magnetic Measurements.

**Unit V**

**Bulk Nano Structure Materials:** Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers, Metal Nano Cluster, Composite Glasses, Porous Silicon.

**Text book [TB]:**

TB1. Edward L. Wolf: Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd ed., Wiley-VCH (2015)

TB 2. Handbook of Nano Structured Materials and Nano Technology: Nalva

**Reference books [RB]:**

RB1. Introduction to Nano Technology: Poole and Owners

RB2. Quantum Dots: Jacak, Hawrylak and Wojs

**P a t e l N a g a r , D e h r a d u n , U t t a r a k h a n d**

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe the nanoparticles: Synthesis and Properties, carbon nano structures, carbon nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
<b>CO2</b>	Explain the synthesis and properties of nanomaterials, Carbon Nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
<b>CO3</b>	Apply Nanoscience and Nanotechnology in modern device applications and in various fields
<b>CO4</b>	Analysis of various properties of nanomaterial by using different techniques
<b>CO5</b>	Evaluate the Different properties of nanomaterial for various fields.
<b>CO6</b>	Develop nanomaterials for various field applications, Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	1	2	1	1	1	0	1	2	1	1	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL703</b>			
<b>Course Name</b>	<b>: Nanomaterials Lab.</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to teach the students about Practical aspects of nanomaterials and their applications in real life.

**Course Contents**

**Total hours: 30**

List of Experiments:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

**Text book [TB]:**

TB1. Edward L. Wolf: Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd ed., Wiley-VCH (2015)

TB 2. Handbook of Nano Structured Materials and Nano Technology: Nalva

**Reference books [RB]:**

RB1. Introduction to Nano Technology: Poole and Owners

RB2. Quantum Dots: Jacak, Hawrylak and Wojs

**Course outcomes (Cos):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyse the readings and interpret the data.
<b>CO5</b>	Find errors in interpret the data
<b>CO6</b>	Examine the fabrication of various nano materials

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	0	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE704</b>			
<b>Course Name</b>	<b>: Atomic and Molecular Physics</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:**

The main objective of the course on atomic and molecular physics is to impart knowledge about various atomic spectroscopy. Using these tools student would understand and handle various spectroscopic concepts to study physics problems if he/she chooses to pursue research in physics as a career.

**Course Contents**

**UNIT 1**

**Atomic Spectroscopy:** Hydrogen, Helium and Alkali spectra, Vector atom model of Hydrogen atom, Relativistic correction, Spin-orbit coupling, Hydrogen fine structure, Spectroscopic terms, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling, Hyperfine structure.

**UNIT 2**

**Atom in Magnetic Field:** Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field, Stark effect, First order Stark effect in hydrogen

**UNIT 3**

**Atom in Electric Field:** Interaction of atoms in electric field, Stark effect, First order Stark effect in hydrogen

**UNIT 4**

**Molecular Spectroscopy:** Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Condon parabola. Rotational fine structure of electronic-vibration transitions, Electronic spectra.

**UNIT 5**

**Spin Resonance Spectroscopy:** Electron spin resonance and nuclear magnetic resonance spectroscopy

**Text book [TB]:**

TB 1. C.N. Banwell, E.M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).

TB 2. R. Kumar, Atomic and Molecular Physics, Campus Books International (2013).

**Patel Nagar, Dehradun, Uttarakhand**

**Reference books [RB]:**

RB 1. B.H. Bransden & C. J. Joachin Physics of Atoms and Molecules.2nd Edition Prentice Hall (2003)

RB 2. H.E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe the atomic spectra, atoms in electric and magnetic field, molecular spectroscopy and spin resonance.
<b>CO2</b>	Explain hydrogen spectra, rotational and vibrational spectra. Rotational and vibrational spectra of diatomic molecule
<b>CO3</b>	Apply coupling jj and L-S, rigid rotator, Zeeman effect, ESR and NMR. Franck-Condon principle, Condon parabola. Rotational fine structure of electronic-vibration transitions.
<b>CO4</b>	Analyse spectroscopic term, hyperfine structure and Raman spectroscopy. Spin-orbit coupling
<b>CO5</b>	Evaluate Born opp. Approximation, Pauli's exclusion principle, Stark effect, First order Stark effect in hydrogen, Parity,
<b>CO6</b>	Formulate Lande interval rule, electronic spectra. Hydrogen, Helium and Alkali spectra

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE705</b>			
<b>Course Name</b>	<b>: Research Methodology</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives: The objectives of this course are**

1. To introduce with meaning, functions of research and research process.
2. To highlights the various postulates of research problems, research Design, interpretation and report writing.
3. To expose the student to concepts of measure of central tendency and variation and their application to analyze the statistical data.
4. To acquire the knowledge of correlation, regression, data analysis and hypothesis testing using suitable test of statistical significance.

**UNIT-I: Meaning & Functions of Research**

Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.

**UNIT –II: Research Problem and Research Design**

Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.

**UNIT- III: Interpretation and Report Writing**

Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report

**UNIT-IV: Statistical Techniques and Tools -I**

Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution

**UNIT-V: Statistical Techniques and Tools –II**

Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

**Text Books:**

TB1. Ganesan R, Research Methodology for Engineers, MJP Publishers, Chennai. 2011

**Patel Nagar, Dehradun, Uttarakhand**

TB2. C.R.Kothari, “Research Methodology”, 5<sup>th</sup> edition, New Age Publication,  
 TB3. Cooper, “Business Research Methods”, 9<sup>th</sup> edition, Tata McGraw hills publication

### Reference Books:

RB1. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.  
 RB2. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.  
 RB3. Morris R Cohen: An Introduction to logic and Scientific Method (Allied Publishers) – P 197-222; 391–403

### Course outcomes (COs):

Upon successful completion of the course a student will be able to

<b>CO1</b>	Define various kind of research, objectives of doing research, research process and research design.
<b>CO2</b>	Discuss the ability to choose methods appropriate to research aims and objectives.
<b>CO3</b>	Analyze data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
<b>CO4</b>	Explain Statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
<b>CO5</b>	Summarize the properties of mechanism of research methodology
<b>CO6</b>	Create and Formulate a research methodology

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	2	2	1	2	1	1	1	2	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	2	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE706</b>			
<b>Course Name</b>	<b>: Nuclear Physics</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

### **Course Objective:**

The objective of the course is to provide an understanding about the general nuclear properties and knowledge of nuclear models: liquid drop model, shell model and collective model. To provide knowledge and understanding of scattering process and decay phenomenon.

### **Course Contents**

#### **Unit I**

**General Properties of Nucleus -:** Nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistics, Binding energy, Semi-empirical mass formula.

#### **Unit II**

**Nuclear Models:** Liquid drop model, Shell model, Collective model.

#### **Unit III**

**Nuclear Forces and Detector** – Ground state of deuteron, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces, G.M. Counter, Electron & Proton Synchrotron.

#### **Unit IV**

**Radioactive decay:** Radioactive decay equation equilibrium units, Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay.

#### **Unit V**

**Nuclear Reactions-** Q-value of nuclear reaction, Bohr's Theory of compound nucleus, scattering cross section of nuclear reaction

### **Text book [TB]:**

TB1. B.R. Martin : Nuclear & Particle Physics

TB2. Tayal, D.C. , Nuclear Physics, Himalaya Publishing House, Mumbai

TB3. Nuclear & Particle Physics-B.R. Martin & G. Shaw

### **Reference books [RB]:**

RB1. S.B. Patel : Nuclear Physics

RB2. M.K. Pal : Theory of Nuclear Structure

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe the general properties & models, nuclear forces and detector, radioactive decay, nuclear reactions
<b>CO2</b>	Explain the binding energy, Liquid drop model, Shell model magic number and spin parity related to shell model, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces
<b>CO3</b>	Illustrate the Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, radioactive decay, various decay phenomena and their process
<b>CO4</b>	Analyze the nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistic, the principle and application of G.M counter and synchrotron.
<b>CO5</b>	Evaluate the Q-value of nuclear reaction, parity violation in beta decay, electromagnetic decays. Ground state of deuteron
<b>CO6</b>	Express the stimulation Electron & Proton Synchrotron, Nuclear magnetic moments, Binding energy

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE707</b>			
<b>Course Name</b>	<b>: Advanced Quantum Mechanics</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

### **L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:** The main objective of the course on Advanced Quantum mechanics is to impart knowledge about various approximation methods in physics and to give them ideas about laboratory and center of mass frame and study the scattering phenomena in both these frames.

### **Course Contents**

#### **Unit I**

**Scattering Theory:** General considerations: kinematics, wave mechanical picture, scattering amplitude, differential and total cross section. Green's function for scattering. Partial wave analysis: asymptotic behavior of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation. Born approximation; its validity.

#### **Unit II**

**Applications of Scattering theory:** Application to low energy scattering; resonant scattering, Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Applications of Born approximation

#### **Unit III**

**Identical Particles:** The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and Para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

#### **Unit IV**

**Relativistic Wave Equations:** Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, Extension of Klein-Gordon equation Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

#### **Unit V**

**Quantization of wave fields:** The quantization of wave fields, Classical and quantum field equations, quantization of non-relativistic Schrodinger equation, second quantization, N-representation, creation and annihilation operators.

#### **Text book [TB]:**

**Patel Nagar, Dehradun, Uttarakhand**

TB 1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH) TB 2. R.P Feynman and A.R.Hibbs; Quantum Mechanics and Path Integrals.  
TB 3. L. I. Schiff, Quantum Mechanics (McGraw Hill).

**Reference books [RB]:**

- RB 1. Thankappan, V.K., Quantum Mechanics, New Age International (2004).  
RB 2. Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).  
RB 3. S. Davydov, Quantum Mechanics (Pergamon).

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define scattering theory, identical particles, Relativistic Wave Equations, Quantization of wave fields
<b>CO2</b>	Explain various scattering techniques for low and high energy particles, Klein-Gordon equation, Dirac equation formulation, theory of identical particles, Quantization of wave fields
<b>CO3</b>	Apply partial wave and Born approximation techniques to various systems, K-G and Dirac equation, Pauli's exclusion principle to different systems.
<b>CO4</b>	Analyse theory of identical particles, Pauli's exclusion principle, second quantization, Covariance of Dirac equation, scattering amplitude, differential and total cross section and Green's function for scattering.
<b>CO5</b>	Evaluate the problems based on partial wave and Born approximation. Distinguish between Lab. Frame and center of mass frame
<b>CO6</b>	Formulate and develop understanding on theory of identical particles, N-representation, creation and annihilation operators, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron,

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b> : PHYDE708				
<b>Course Name</b> : Basic Electronics				
<b>Semester /Year</b> : V				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding of different Network Theorems for simplifying complicated electronics circuits, Regulated Power Supply, different types of Rectifiers, Filters, different types of special diodes and their applications, Transistors and their applications in different types of Amplifiers.

### Unit 1

#### Network Theorems

Superposition Theorems, Constant voltage source and constant current source, Conversion of voltage source into current source, Thevenin's Theorem and procedure for finding the Thevenin equivalent circuit, Norton's Theorem and procedure for finding Norton equivalent circuit, Applications of Network Theorems.

### Unit 2

#### Power Supplies

Semiconductor diode: P-N Junction diode, Diode as a rectifier: Half and Full wave rectifiers, Bridge rectifiers, Peak inverse voltage, Efficiency, Ripple factor, Filters: Low pass and High pass filters, Band pass and Band stop filters, L and  $\pi$  – filters (Series inductor, Shunt capacitor, LC, CLC filters), Zener diode, its characteristics, Voltage regulation.

### Unit 3

#### Special Diodes

Special Diodes Tunneling effect Tunnel diode, Varactor diode, Point contact diode, V-I characteristic of these diodes, Optoelectronic devices: Light emitting diode, Photodiode.

### Unit 4

#### Transistors

Bipolar junction transistor, Transistor operation and its Biasing rule, Transistor currents, Transistor circuit configuration, Transistor characteristics in different configurations, cut-off and saturation points, Active region.

### Unit 5

**Transistor Amplifiers**

Single-stage transistor amplifiers, Common base (CB), Common emitter (CE), and Common collector (CC) amplifier, Comparison of an amplifier configuration. Power amplifiers (Class A, Push-Pull amplifier, Class B and Class C), Noise and Distortion in amplifiers, RC-coupled two-stage amplifier and its frequency response, Advantage of RC coupling.

**Text Books:**

**TB1.** M.K. Baagde, S.P. Singh and Kamal Singh: Elements of Electronics

**TB2.** B.L. Theraja : Basic Electronics

**Reference Books:**

**RB1.** V.K. Mehta : Elements of Electronics

**RB2.** J.D. Ryder : Networks, Lines and Fields

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recall Network Theorems, Power supplies, special diodes, Transistors, Transistors Amplifiers
<b>CO2</b>	Summarize Common base (CB), Common emitter (CE) and, Common collector (CC) amplifier, Network Theorems, Power supplies, special diodes
<b>CO3</b>	Apply Special Diodes, Network Theorems, Half and Full wave rectifiers, Low pass and High pass filters, P-N Junction diode
<b>CO4</b>	Analyze General idea of FETs, Power amplifiers, special diodes, Transistors, Transistors Amplifiers
<b>CO5</b>	Evaluate Zener diode, its characteristics, Light emitting diode, Photodiode, Advantage of RC coupling., Semiconductor diode: P-N Junction diode,
<b>CO6</b>	Generalize Problems on network theorem, diodes and their types and transistor amplifiers.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2	2	3	1	2	3	2	3	2	3	2
CO2	2	2	1	3	2	2	2	3	3	2	2	2	3	2	2	1
CO3	3	3	3	2	2	3	0	3	2	1	1	2	3	2	2	2
CO4	2	2	1	1	2	0	1	0	1	1	2	1	1	2	2	1
CO5	2	2	1	1	1	1	1	1	1	3	1	2	1	2	1	2
CO6	2	2	2	1	2	2	2	2	1	2	2	2	2	2	2	1

<b>Course code</b>	<b>: PHYDL708</b>			
<b>Course Name</b>	<b>: Basic Electronics Lab.</b>			
<b>Semester /Year</b>	<b>: V</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objectives:** The objectives of this course is to teach the students that Experimental physics has the most striking impact on the industry wherever the instruments are used to study the Electronics and its application in industry and research. Measurement precision and perfection is achieved through Lab Experiments.

### Course Contents

**Total hours: 60**

1. To study characteristics of R-C coupled Amplifier with and without feedback.
2. To study the characteristics of integrating and differentiating circuit.
3. To draw the characteristics of P-N junction diode.
4. To draw the characteristics of PNP and NPN junction transistor.
5. Measurements of h-parameters of a transistor.
6. Study of different types of Rectifiers and Filters.
7. Verification of Network theorems.
8. Child Langmuir law.
9. Triode/ Tetrode/ Pentode characteristics and constants.
10. Study of power supply (Ripple factor).
11. Study of Zener diode and regulation (taking different source voltage and loads).
12. Phase measurement using a C.R.O.
13. Study characteristics of T.C. Amplifier and B.W.
14. To study the Characteristics of a Photo-diode.
15. Inverse square law using Photo-Voltaic Cell

### Text Books:

**TB1.** B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for students”, Methuen & Co., Ltd., London, 1962.

**TB2.** S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage learning India Pvt. Ltd., 2015.

### Reference Books:

**RB1.** Indu Prakash : Practical Physics

**RB2.** S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of various electronics instruments.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYD802</b>			
<b>Course Name</b>	<b>: Research and Publication Ethics</b>			
<b>Semester /Year</b>	<b>VII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

### **L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to convey the principles of ethical research. Students will gain the knowledge of hands-on experience to identify research misconduct and predatory publications.

### **Course Contents**

#### **Unit 1 - Philosophy and Ethics**

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions.

**Unit 2 - Scientific Conduct:** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, and Plagiarism (FFP). Redundant publication: duplicate and overlapping publication, salami slicing. Selective reporting and misrepresentation of data

**Unit 3 - Publication Ethics :** Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributorship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals Practice

**Unit 4- Open Access Publishing:** Open access publications and initiatives. SHERPA / ROMEO online resource to check publisher copyright and self-archiving policies. Software tools to identify predatory publications developed by SPPU. Journal finder / journal suggestion tools viz. JANE, Elsevier journal Finder, Springer, Journal Suggester, etc.

**Unit 5- Publication Misconduct:** A. Group Discussion: Subject specific ethical issues, FFP, authorship. Conflicts of interest Complaints and appeals: examples and fraud from India and abroad. B. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools. **Databases and Research Metrics:** A. Databases : Indexing databases. Citation databases: Web of Science, Scopus, etc. B. Research Metrics : Impact factor of journal as per journal Citation report, SNP, SJR, IPP, Cite score. Metrics: h-index, g index, i10 index, altmetrics

#### **Text Books:**

TB1. Todorovich M, Kurtz P, The Ethics of Teaching and Scientific Research, Sidney Hook.  
TB2. Michael P Marder (2004) Research Methods for Science. Oxford Press TB3. Murthy S N, Bhojanna U (2008) Business Research Methods Excel Books

#### **Reference Books:**

RB1. Kambadur M K, Ghosh A, Singhvi A K, (2019) ETHICS in, Science Education, Research and Governance, Indian National Science Academy New Delhi, India

**P a t e l N a g a r , D e h r a d u n , U t t a r a k h a n d**

RB2. Erlbaum J L L, (2003) Ethics and Values in Industrial-Organizational Psychology. RB3. Barbara H. S., Joan E. Sieber; Gary B. Melton Research Ethics: A Psychological Approach By

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1.</b>	Define research ethics, publications misconduct and plagiarism.
<b>CO2.</b>	Describe Philosophy and Ethics, Scientific Conduct Intellectual honesty and research integrity.
<b>CO3.</b>	Apply Publication Ethics, Scientific Conduct, Databases and Research Metrics in Research Publication field.
<b>CO4.</b>	Analyze open access publication and initiatives, Publication Ethics, Scientific Conduct, Databases and Research Metrics
<b>CO5.</b>	Assess the principles of open access publication and initiatives, Publication Ethics, Scientific Conduct, Databases and Research Metrics
<b>CO6.</b>	To create the research matrices based on cite score.

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>PHYDE803</b>			
<b>Course Name</b>	<b>: Laser Physics</b>			
<b>Semester /Year</b>	<b>VIII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**Course Objective:** The main objective of the course on Laser physics is to aware students about the laser and its types and phenomena of laser spectroscopy, optical fibers.

**Course contents:**

**Unit I**

**Basic principles and modulators:** Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion, spatial and temporal coherence, Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acoustic optic effect, acoustic optic modulators, magneto-optic effect, optical directional couplers and optical switches, phase modulators.

**Unit II**

**Types of lasers, Optical sources:** Gas lasers, He-Ne, argon ion, N<sub>2</sub>, CO<sub>2</sub> lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers, spin flip lasers, laser spikes, mode locking Q-switching, Laser devices, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light,

**Unit III**

**Detectors**

photo detector, noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD. PIN photodiodes, avalanche photodiodes, micro channel plates. photodiodes: structure, materials and working,

**Unit IV**

**Non- linear optics and Fiber optics:** Theory of non-linear phenomenon, second and third harmonic generation, phase matching, parametric generation, self-focusing, Basic characteristics of optical fibers, structure and fundamentals of waveguides, step and graded index fibers, signal degradation in optical fibers, absorption scattering, radiation and core cladding losses, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers.

**Unit V**

**Laser spectroscopy:** Laser fluorescence spectroscopy using CW and pulsed lasers, Single photon counting. Laser Raman spectroscopy, multiphoton processes, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy.

**Text book [TB]:**

**Patel Nagar, Dehradun, Uttarakhand**

TB1. K.R. Nambiar: Lasers: Principles, types and Applications

**Reference books [RB]:**

RB1. Lasers: Ghatak and Thyagrajan

RB2. O. Svelto: Principles of Lasers

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define the Basic principles and modulators, Types of lasers, Optical sources and detectors, Non- linear optics and Fiber optics, and Laser spectroscopy Holography
<b>CO2</b>	Describe the Gas lasers, He-Ne, argon ion, N2, CO2 lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers
<b>CO3</b>	Illustrate Laser interferometry, PIN photodiodes and modulator, Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion
<b>CO4</b>	Analyse the photo detector, LED etc. for practical purposes, optical fiber, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light
<b>CO5</b>	Evaluate Distinguish laser interferometry, PIN photodiodes, Electro optic effect, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy
<b>CO6</b>	Express various applications of laser in research field, Einstein's coefficients, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE804</b>			
<b>Course Name</b>	<b>: Statistical Mechanics</b>			
<b>Semester /Year</b>	<b>:VIII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:**

The main objective of the course on statistical physics is to impart knowledge about macroscopic and mesoscopic systems employed to study physics problems.

**Course Contents**

**Unit I**

**Basic Postulates-** Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boltzmann's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

**Unit II**

**Application of classical distribution to the ideal gases:** Degrees of freedom, translational motion, Helmholtz free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.

**Unit III**

**Imperfect gases:** Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases, general properties of liquids, Fermi theory, liquid Helium, phase rule.

**Unit IV**

**Quantum Statistics:** Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non-degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

**Unit V**

**Black Body Radiation:** Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law.

**Text book [TB]:**

- TB 1. Reif F., Fundamentals of Statistical and Thermal Physics, McGraw Hill (1985).
- TB 2. . Landau and Lifshitz: Statistical Physics

**Reference books [RB]:**

RB 1. Pathria R.K., Statistical Mechanics, Butterworth-Heinemann (1996).

RB 2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Basic Postulates, Application of classical distribution to the ideal gases, Imperfect gases, Quantum Statistics, Black Body Radiation
<b>CO2</b>	Describe statistics, phase space, ensembles, fermi theory, liquid helium phase rule, absorption and emission of radiation, Einstein and Debye's theory of specific heat of solids.
<b>CO3</b>	Examine partition function, Sackur tetrode equation, B.E condensation principle, Wein's displacement formula, Gibb's paradox, Liouville's theorem
<b>CO4</b>	Deduce Stefan's law, ensembles, pressure energy relationship, Rayleigh Jean's formula, general properties of liquids, Statistical equilibrium
<b>CO5</b>	Evaluate partition functions, virial coefficients, Planck's distribution, pressure and energy relationship of photons, Phase space
<b>CO6</b>	Formulate Gibb's paradox, degenerate cases, specific heat of solids, Vander Waal constant and Virial coefficient

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	1	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0=1	1	1	1	1	1	1	1	1	1	1

<b>Course code : PHYDE805</b>				
<b>Course Name : Physics of Semiconductor Devices</b>				
<b>Semester /Year : VIII</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** Teach fundamentals of unit cells, defects and imperfections in crystal structures and to be able to understand how semiconductors , p-n junction , MOSFET, JFET and LED works.

### Course Contents

#### UNIT 1

**Introduction:** Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects. Electrical conductivity:

#### UNIT 2

**Electrical conductivity:** Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration

#### UNIT 3

**Band theory of solids:** origin of energy bands, effective mass, distinction between metals, insulators and semiconductors. Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors.

#### UNIT 4

**Fermi level in intrinsic and extrinsic semiconductors:** Carrier generation – recombination, mobility, drift-diffusion current. Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.

#### UNIT 5

**Bipolar junction transistor:** p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Semiconducting devices: Optical devices: optical absorption in a semiconductor, e- -hole generation. Solar cells – p-n junction, conversion efficiency. Light emitting diode (LED) – generation of light, internal and external quantum efficiency.

**Text book [TB]:**

**TB1.** C Kittel, “Introduction to Solid State Physics”, Wiley, 7<sup>th</sup> Edn., 1995.

**TB2.** D A Neamen, “Semiconductor Physics and Devices”, TMH, 3<sup>rd</sup> Edn., 2007.

**Reference books [RB]:**

**RB1.** S M Sze, “Physics of Semiconductor Devices”, Wiley, 1996.

**RB2.** P Bhattacharya, “Semiconductor Opto- Electronic Devices”, Prentice Hall, 1996.

**RB3.** M K Achuthan & K N Bhat, “Fundamentals of Semiconductor Devices”, TMH, 2007.

**RB4.** J Allison, “Electronic Engineering Materials and Devices”, TMH, 1990.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define unit cells, Band theory of solids, Theory of semiconductors, Bipolar junction transistor, p-n-p and n-p-n transistors.
<b>CO2</b>	Describe cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections, diode and transistor
<b>CO3</b>	Explain forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.
<b>CO4</b>	Analyze Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation – recombination, mobility, drift-diffusion current.
<b>CO5</b>	Evaluate Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET.
<b>CO6</b>	Familiarize and formulate Optical devices: optical absorption in a semiconductor, e- -hole generation. Solar cells – p-n junction, conversion efficiency, light emitting diode.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code : PHYDL 806</b>				
<b>Course Name : Physics of Semiconductor Devices</b>				
<b>Semester /Year VIII</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:**

To teach the student's properties of various semiconductor and transistor characteristics by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents:**

1. Study of UJT
2. Study of MOSFET
3. Study of JFET
4. Study of NPN and PNP transistor characteristics
5. Study of Four Probe method
6. To determine value of Planck's constant using LEDs of at least 4 different colours.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Recognize the set up and calibrate the experimental setup.
<b>CO2</b>	Describe the basic principles of experiments.
<b>CO3</b>	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
<b>CO4</b>	Analyse the readings and interpret the data.
<b>CO5</b>	Find errors in interpret the data.
<b>CO6</b>	Examine the verification of in the study of UJT, FET, NPN & PNP Transistor etc. to calculate several physical parameter.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	0	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE807</b>			
<b>Course Name</b>	<b>: Materials Characterization Techniques</b>			
<b>Semester /Year</b>	<b>: VIII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

L - Lecture T – Tutorial P – Practical C – Credit

**Course Objective:** The objectives of this course is to gain knowledge in understanding various techniques and tools for studying the substructure and atomic structure of materials. The course broadly covers various characterization techniques including optical microscopy, X-ray diffraction, scanning electron microscope, transmission electron microscope, atomic force microscopy, UV-Vis spectroscopy, thermogravimetric analysis.

### Course Contents

#### Unit 1

**Optical microscope:** Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Specimen preparation).

#### Unit 2

**Fundamentals of crystallography:** an atom, unit cell, a cubic system (SC, BCC, FCC & Diamond cubic), structure factor, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction, Neutron diffraction.

#### Unit 3

**Interaction of electrons with solids:** scanning electron microscopy, Transmission electron microscopy, Energy dispersive spectroscopy. Atomic force microscopy.

#### Unit 4

**X-ray photoelectron spectroscopy:** Atomic absorption spectroscopies, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy.

#### Unit 5

**Photoluminescence spectroscopy:** Thermal Analysis: Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis.

#### Text Books:

TB1. ASM Handbook: Volume 10: Materials Characterization; Crankovic; ASM International; (1986)

TB2. Sibilina J.P., A Guide to Materials Characterization and Chemical Analysis, VCH (1997)

TB3. Smallman, R.E., and Bishop, R.J., Metals and Materials – Science, Processes,

**Patel Nagar, Dehradun, Uttarakhand**

Applications, Butterworth-Heinemann (2013).

**Reference Books:**

RB1. Cullity, B.D. Elements of X-Ray Diffraction, Addison Wesley (1967)

RB2. Microstructural Characterization of Materials; Brandon & Kaplan; Wiley; 2008

**Course outcomes (Cos):**

Upon successful completion of the course a student will be able to

<b>CO1</b>	Define various materials characterization techniques.
<b>CO2</b>	Describe appropriate selection of characterization techniques for macro-microstructure examination.
<b>CO3</b>	Determine the crystal structure and phase analysis of the materials.
<b>CO4</b>	Examine the optical, electronic and thermal behavior of the materials.
<b>CO5</b>	Explain calorimetric behavior of the materials using thermal techniques
<b>CO6</b>	Write the principle, construction and working of various characterization techniques.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	1	1	1	1	1	2	3	2	1	1
CO2	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1
CO5	2	1	1	2	1	1	1	1	1	1	1	2	1	2	2	1
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDE808</b>			
<b>Course Name</b>	<b>: Physical Optics</b>			
<b>Semester /Year</b>	<b>: VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding of Interference and Diffraction. Acquire knowledge and understanding of polarization and Optical Instruments.

#### **Unit 1**

Interference The principle of superposition, Two slit interference, coherence, Division of wave front and amplitude, Optical path retardations lateral shift of fringes, Fresnel biprism, Interference with multiple reflection, Thin films, Haidinger fringes, Fringes of equal thickness and equal inclination.

#### **Unit 2**

Diffraction Fresnel's Class: Fresnel half period zones, Zone plate, intensity distribution Diffraction at a straight edge.

#### **Unit 3**

Diffraction Fraunhofer Class: Diffraction at single slit, Diffraction at double slit Resolution of image, Rayleigh criterion, Resolving power of telescopes and microscopes, Diffraction grating, Resolving power of grating and comparison with resolving powers of prisms.

#### **Unit 4**

Polarization Plane polarized, Circular polarized and elliptically polarized light, Malus law, Brewster's law, Double reflection and uniaxial crystals, Optical rotation, Rotation of plane of polarization.

#### **Unit 5**

Associated Optical Instruments Michelson interferometer and its application for precise measurement of wavelength, Wavelength difference and width of spectral lines, Twyman-Green interferometer .

#### **Text Books:**

**TB1.** A.K. Ghatak : Physical Optics

**TB2.** Brijlal and Subrahmanyam : Optics

#### **Reference Books:**

**RB1.** Principles of Optics, B.K. Mathur, 1995, Gopal Printing

**RB2.** Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication

**RB3.** University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison.

#### **Course outcomes (COs):**

**Patel Nagar, Dehradun, Uttarakhand**

**Upon successful completion of the course a student will be able to**

<b>C01</b>	Define interference, diffraction, polarization, and optical instruments.
<b>C02</b>	Describe Interference, Diffraction, polarization and optical instruments.
<b>C03</b>	Apply Diffraction: Fresnel's and Fraunhofer diffraction, interference, optical instruments, and Polarization in various phenomena.
<b>C04</b>	Explain the principle of interference, diffraction, polarization, and optical instruments.
<b>C05</b>	Assess the working principle of Interference, Diffraction, polarization and optical instruments.
<b>C06</b>	Solve Problems on Interference, Diffraction, polarization and optical instruments.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	1
CO2	2	2	1	0	2	1	2	1	1	1	0	1	2	1	1	1
CO3	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	1
CO6	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDL809</b>			
<b>Course Name</b>	<b>: Physical Optics Lab.</b>			
<b>Semester /Year</b>	<b>: VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

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**Course Objectives:** The objectives of this course is to teach the students that Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties. Measurement precision and perfection is achieved through Lab Experiments.

### Course Contents

1. Biprism- determination of  $\lambda$ .
2. Newton's ring experiment- Determination of  $\lambda$ .
3. Determination of  $\lambda$  by a transmission grating.
4. Zone-plate experiment study of different orders.
5. Malus Law
6. Spectrometer: Refractive index of the material of a prism using sodium light
7. Spectrometer: Dispersive power of the material of a prism using mercury light
8. Polarimeter: Specific rotation of sugar solution.

### Text Books:

**TB1.** B.L. Worsnop, H.T. Flint, "Advanced Practical Physics students", Methuen & Co., Ltd., London, 1962.

**TB2.** S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage learning India Pvt. Ltd., 2015.

### Reference Books:

**RB1.** Indu Prakash : Practical Physics

**RB2.** S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

### Course outcomes (COs):

**Upon successful completion of the course a student will be able to**

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of various optical instruments.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	1
CO2	2	2	1	0	2	1	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	1
CO6	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1

### Skill Enhancement Courses (SEC)

<b>Course code</b> : PHYVC105				
<b>Course Name</b> : Basic Instrumentation Skills				
<b>Semester /Year</b> : I				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the basic concepts of measurement, multimeter, and comparing analog and digital instruments.

#### Course Contents

##### Unit 1

##### Basics of Measurement

Instruments accuracy, precision, sensitivity, resolution, range, least count of different instruments etc. Errors in measurements and loading effects.

##### Unit 2

##### Galvanometer, Voltmeter and Ammeter

Principle of Galvanometer, Voltmeter and Ammeter, Conversion of galvanometer into voltmeter and ammeter.

##### Unit 3

##### Multimeter

Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity.

##### Unit 4

##### 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.

##### Unit 5

##### Digital Instruments:

Comparison of analog and digital instruments. Characteristics of a digital meter. Working principle of digital voltmeter.

**Patel Nagar, Dehradun, Uttarakhand**

**Text Books:**

**TB1.** B L Theraja : A text book in Electrical Technology

**TB2.** M G Say : Performance and design of AC machines

**Reference Books:**

**RB1.** Venugopal : Digital Circuits and Systems

**RB2.** P. Vingron, Shimon : Logic Circuit Design

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define basics of measurement, multimeter, digital multimeter and digital instruments.
<b>CO2</b>	Describe Principle of Galvanometer, Voltmeter and Ammeter, Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance, Conversion of galvanometer into voltmeter and ammeter.
<b>CO3</b>	Apply concepts to calculate time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution, Errors in measurements and loading effects and least count of different instruments etc.
<b>CO4</b>	Analyze errors in measurements and loading effects, Working principle of digital voltmeter, Comparison of analog and digital instruments.
<b>CO5</b>	Evaluate advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity, Comparison of analog and digital instruments.
<b>CO6</b>	Design circuits for the calculation of characteristics of a digital meter, time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	1
CO2	2	2	1	0	2	1	2	1	0	1	0	1	2	1	0	1
CO3	2	1	1	2	0	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	0	2	1	1	2	0	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	1
CO6	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYSC205</b>			
<b>Course Name</b>	<b>: Electronics Instrumentation skills</b>			
<b>Semester /Year</b>	<b>: II</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about the basics of CRO, voltmeter and their application. This course will help in understanding of signal and pulse generator and impedance bridges.

### Course Contents

#### Unit 1

##### Electronic Voltmeter

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 milli -voltmeter, specifications and their significance.

#### Unit 2

##### 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.

#### Unit 3

##### Applications of CRO

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.

#### Unit 4

##### Signal and pulse Generators

Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

#### Unit 5

##### Impedance Bridges

Block diagram of bridge. Working principles of basic (balancing) RLC bridge. Specifications of RLC bridge. Block diagram and working principle as of a Q- meter. Digital LCR bridges.

**Text Books:****TB1.** B L Theraja : Basic Electronics**TB2.** M G Say : Performance and design of AC machines**Reference Books:****RB1.** Venugopal : Digital Circuits and Systems**RB2.** P. Vingron, Shimon : Logic Circuit Design**RB3.** Subrata Ghoshal : Digital Electronics**RB4.** S. Salivahanan & N. S.Kumar : Electronic Devices and Circuits**RB5.** V. K. Mehta: Basic Electronics**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe Electronic Voltmeter, Cathode Ray Oscilloscope, Signal and pulse Generators and Impedance Bridges
<b>CO2</b>	Explain working principle as of a Q- meter,CRO, CRT, Electron gun, electrostatic focusing and acceleration
<b>CO3</b>	Discuss ac milli -voltmeter, specifications and their significance, Principles of voltage, measurement, Amplifier- rectifier, Digital storage Oscilloscope, Brief idea for testing, specifications
<b>CO4</b>	Analyze Distortion factor meter, wave analysis, Use of CRO for the measurement of voltage. Special features of dual trace, introduction to digitaloscilloscope, probes
<b>CO5</b>	Assess the working of Voltmeter, Multimeter, CRO, Special features of dual trace, digitaloscilloscope, probes, and Amplifier- rectifier, and their significance.
<b>CO6</b>	Design and formulate low frequency signal generator and pulse generator. Brief idea for testing, specifications, Distortion factor meter, wave analysis, AC millivoltmeter and its types

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	0	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	0	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	0	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b>	<b>: PHYSC305</b>			
<b>Course Name</b>	<b>: Number System and Boolean Algebra</b>			
<b>Semester /Year</b>	<b>: III</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about number system. To provide knowledge and understanding of Boolean algebra.

### Course Contents

#### Unit 1

**Number systems:** Decimal number system, Binary number system, Octal number system and Hexadecimal number systems.

#### Unit 2

Operations on number system : Binary addition, Binary subtraction. Complement of a number (1's complement and 2's complement), Binary division, Representation of a Binary number as electrical signals.

#### Unit 3

**Conversions:** Binary to decimal conversion, Decimal to Binary conversion, Conversion of Binary to octal and octal to binary, Advantages of octal number system, Hexadecimal number system, Binary to hexadecimal and vice-versa (Inter- conversion), BCD, GREY, EXCESS-3 codes

#### Unit 4

**Boolean algebra:** Features of Boolean algebra, Laws of Boolean algebra, Equivalent switching circuit, Demorgan's theorems and Duals.

#### Unit 5

**Logic Gates:** principle and working of AND, OR, NOT, NAND, NOR, X-OR and X-NOR gates, and its applications

#### Text Books:

**TB1.** Basic Electronics, B.L. Theraja, S. Chand Publication.

**TB2.** Principles of Electronics, V.K. Mehta, Rohit Mehta, S. Chand Publication.

**TB3.** Handbook of Electronics, Gupta Kumar, Pragati Publication.

#### Reference Books:

**Patel Nagar, Dehradun, Uttarakhand**

**RB1.** Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.

**RB2.** Electronic Devices and Circuits, S. Salivahanan & N. S.Kumar, 3<sup>rd</sup>Ed.,2012, Tata McGraw Hill.

**RB3.** Digital Principles and Applications, A.P. Malvino , D.P. Leach & Saha,7<sup>th</sup> Ed., Tata McGraw Hill

**RB4.** Fundamentals of Digital Circuits , A. Anand kumar, 2<sup>nd</sup> Edition,2009, PHI Learning Pvt. Ltd.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe the number system and its inter conversions and boolean algebra.
<b>CO2</b>	Discuss various number systems, Binary addition, Binary subtraction.
<b>CO3</b>	Apply, Binary, Decimal, Hexadecimal and Octal number systems and interconversions, boolean algebra in various problems.
<b>CO4</b>	Analyze logic gate and Boolean algebra, and number system and its inter conversions
<b>CO5</b>	Estimate the results of analysis of Boolean algebra, and number system and its inter conversions.
<b>CO6</b>	Solve problems on Binary, Decimal, Hexadecimal and Octal number systems and interconversions and Boolean algebra.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b>	<b>: PHYSC306</b>			
<b>Course Name</b>	<b>: Disaster Management</b>			
<b>Semester /Year</b>	<b>: III</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about number system. To provide knowledge and understanding of Boolean algebra.

## Course Contents

### Unit 1

#### Introduction to Disaster Management

Basics of hazards, disasters, vulnerability, risk, and capacity; types of disasters; disaster management cycle; global frameworks like the Sendai Framework.

### Unit 2

#### Natural Disasters

Earthquakes, cyclones, floods, droughts, landslides, avalanches, volcanic eruptions – causes, impacts, preparedness, and key case studies.

### Unit 3

#### Man-Made Disasters

Industrial accidents, chemical and nuclear hazards, fires, epidemics, transportation accidents; real-world examples and preventive measures.

### Unit 4

#### Preparedness and Mitigation

Risk assessment, early warning systems, community-based disaster management, structural/non-structural measures, role of agencies and NGOs.

### Unit 5

#### Response and Recovery

Search, rescue, relief, rehabilitation, psychological support, disaster laws and policies, and use of GIS, remote sensing, and drones. Text Books:

**TB1.** Asthana , N.C. and Asthana P. (2014). Disaster Management. Pointer Publishers

**TB2.** mith, Keith (2013). Environmental Hazards: Assessing risk and reducing disasters.

**TB3.** Singh, J. (2007). Disaster Management: Future Challenges and Opportunities. IK International Pvt. Ltd, New Delhi

## Reference Books:

**RB1.** Modh, S. (2010). Managing Natural Disaster: Hydrological, Marine and Geological Disasters. Macmillan, Delhi

**RB2.** Sinha, A. (2001). Disaster Management: Lessons drawn and Strategies for Future. New Patel Nagar, Dehradun, Uttarakhand

United Press, New Delhi

**RB3.** Digital Principles and Applications, A.P. Malvino , D.P. Leach & Saha, 7<sup>th</sup> Ed., Tata McGraw Hill

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define basics of Disaster Management, Natural Disasters, Man-Made Disasters, Preparedness and Mitigation, Response and Recovery
<b>CO2</b>	Describe Natural Disasters, Man-Made Disasters, Preparedness and Mitigation, Response and Recovery
<b>CO3</b>	Illustrate the basics of Disaster Management, Natural Disasters, Man-Made Disasters, Preparedness and Mitigation, Response and Recovery
<b>CO4</b>	Analyze basics of Disaster Management, Natural Disasters, Man-Made Disasters, Preparedness and Mitigation, Response and Recovery
<b>CO5</b>	Evaluate the results of analysis of Boolean algebra, and number system and its inter conversions.
<b>CO6</b>	Formulate the principles of Disaster Management, Natural Disasters, Man-Made Disasters, Preparedness and Mitigation, Response and Recovery

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2



<b>Course code</b>	<b>: PHYSC405</b>			
<b>Course Name</b>	<b>: Digital Electronics</b>			
<b>Semester /Year</b>	<b>: IV</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding logic gates.To provide knowledge and understanding of logic families and flip flops.

### Course Contents

#### Unit 1

**Basic Gates:** Positive and Negative logic, Two input OR gate, Diode OR gate and transistor OR gate, Three input OR gate and its truth table, Exclusive OR gates, The AND gate, Diode AND gate and transistor AND gate, The NOT gate

#### Unit 2

Universal Gates: The NOR gate, The NAND gate, NAND and NOR as universal gates, The XNOR gate.

#### Unit 3

**Logic Families:** Saturated and Non- saturated Logic circuits, Characteristics of Logic Families, RTL Circuits, DTL Circuits, TTL Circuits.

#### Unit 4

**Flip Flop:** RS Latch, D-type flip flop and T-type Flip Flop . JKFlip Flop and Master Slave Flip Flop.

#### Unit 5

**Registers:** Registers and its types, shift register and its types, applications and uses, Adders and subtractors, Half Adders, Full adders.

### Text Books:

**TB1.** Basic Electronics, B.L. Theraja, S. Chand Publication.

**TB2.** Principles of Electronics, V.K. Mehta, Rohit Mehta, S. Chand Publication.

**TB3.** Handbook of Electronics, Gupta Kumar, Pragati Publication.

**Reference Books:**

**RB1.** Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.

**RB2.** Electronic Devices and Circuits, S. Salivahanan & N. S.Kumar, 3<sup>rd</sup>Ed.,2012, Tata McGraw Hill.

**RB3.** Digital Principles and Applications, A.P. Malvino , D.P. Leach & Saha,7<sup>th</sup> Ed., Tata McGraw Hill

**RB4.** Fundamentals of Digital Circuits , A. Anand kumar, 2<sup>nd</sup> Edition,2009, PHI Learning Pvt. Ltd.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe Positive and Negative logic gates, Bubbled gates, Logic Families, Flip Flops, registers
<b>CO2</b>	Discuss Positive and Negative logic gates, Bubbled gates, Logic Families, various Flip Flops, registers
<b>CO3</b>	Illustrate Positive and Negative logic gates, Bubbled gates, Logic Families, Flip Flops in various areas
<b>CO4</b>	Determine the results of Positive and Negative logic gates, Bubbled gates, Logic Families, various Flip Flops, registers in various areas
<b>CO5</b>	Estimate the results of Positive and Negative logic gates, Bubbled gates, Logic Families, various Flip Flops, registers in various areas
<b>CO6</b>	Solve problems on Positive and Negative logic gates, Bubbled gates, Logic Families, registers, various Flip Flops

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	0	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	0	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b> : <b>PHYSC505</b>				
<b>Course Name</b> : <b>Energy Storage Devices</b>				
<b>Semester /Year:</b> <b>V</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** To equip learners with a deep understanding of electrochemical principles governing battery and supercapacitor systems, from materials design to performance optimization.

### Course Contents

#### Unit I

**Fundamentals of Electrochemistry:** Electrochemical cell type: Galvanic and electrolytic cells: thermodynamics and kinetics, Charge transfer processes and mass transport, Nernst equation, electrode potentials, and reaction mechanisms.

#### **Unit -II**

**Supercapacitor Principal and Application:** Supercapacitor, Types and Classification, electrochemical double-layer capacitors (EDLCs), pseudo capacitors, hybrid systems, Charge storage mechanisms: surface adsorption vs. redox activity, Emerging applications

#### **Unit -III**

**Batteries: Principal and Application:** Primary and secondary: Basic concept, Battery design, General Characteristics, Applications, Types, and Characteristics Comparison of the Performance Characteristics of Battery Systems, Advanced Batteries for Electric Vehicles, and Emerging Applications.

#### **Unit IV**

**Comparative Integration and Sustainability:** Comparative analysis of batteries and supercapacitors, Sustainability strategies: recycling, second-life applications, and waste-derived materials, Industrial prototyping and real-world deployment.

**Unit V**

**Innovation Frontiers and MSME-Scale Impact:** Emerging trends: Advanced materials, and MSME-scale innovations, Translational research: bridging lab-scale breakthroughs to commercial viability, Policy, funding, and global collaboration opportunities.

**Textbooks [TB]**

**TB1:** *Electrochemical Power Sources – V.S. Bagotsky*

**TB2:** *Modern Electrochemistry I & II – Bockris & Reddy*

**Reference Books [RB]**

**RB1:** *Electrochemical Supercapacitors – B.E. Conway*

**RB2:** *Lithium-ion Batteries: Science and Technologies – Yoshio et al.*

**RB3:** *Nanostructured Materials for Electrochemical Energy Storage – Springer Series*

**Course Outcomes (COs)**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Explain the basic principles of electrochemistry, including cell types, thermodynamics, and kinetics
<b>CO2</b>	Analyze mass transport, Nernst equation applications, and electrode potential behavior in electrochemical systems
<b>CO3</b>	Classify and describe different types of supercapacitors and their charge storage mechanisms
<b>CO4</b>	Compare and evaluate battery technologies, focusing on design, characteristics, and emerging applications
<b>CO5</b>	Assess the techno-economic feasibility and circular economy alignment of electrochemical energy storage technologies.
<b>CO6</b>	Propose innovative energy storage solutions using advanced materials and MSME-scale strategies, considering policy and global collaboration.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	2	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b>	<b>: PHYSC605</b>			
<b>Course Name</b>	<b>: Weather Forecasting</b>			
<b>Semester /Year</b>	<b>: VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objective of the course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

### Course Contents

#### Unit I

**Introduction to atmosphere:** Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

#### Unit II

**Measuring the weather:** Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

#### Unit III

**Weather systems:** Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

#### Unit IV

**Climate and Climate Change:** Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate

#### Unit V

**Basics of weather forecasting:** Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

#### Text book [TB]:

**TB1.**Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books

**TB2.**The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.

#### Reference books [RB]:

**Patel Nagar, Dehradun, Uttarakhand**

**TB1.** Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.

**RB2.** Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.

**RB3.** Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.

**RB4.** Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe about atmosphere, weather system, climate change and forecasting system.
<b>CO2</b>	Explain Wind; forces acting to produce wind; wind speed direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.
<b>CO3</b>	Illustrate Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps
<b>CO4</b>	Explain atmosphere: physical structure and composition; compositional layering of the atmosphere; cyclones and anticyclones
<b>CO5</b>	Assess Weather systems, Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate
<b>CO6</b>	Familiarize and formulate the various application of weather system, forecasting system.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

**Generic Elective (GE) Courses:**

<b>Course code</b>	<b>: PHYGE103</b>			
<b>Course Name</b>	<b>: Mechanics – I</b>			
<b>Semester /Year</b>	<b>: I</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course involves basic concepts and fundamental principles, and which therefore have wide applicability.

**Course Contents****UNIT 1**

**Scalars and vectors:** Scalars, vectors, plane polar coordinates, vectors in a plane, scalars, and pseudo-scalars, kinematics in a plane, vectors in a 3-dimensional space, the finite rotation formula

**UNIT 2**

**Ordinary Differential Equations:** 1<sup>st</sup> order homogeneous differential equations. 2<sup>nd</sup> order homogeneous differential equations with constant coefficients.

**UNIT 3**

**Physical Laws:** The nature of physical laws, Fundamental constants, dimensional analysis, the fundamental forces of nature. Conservation laws and Newton's equations, conservation of angular momentum, two-body scattering, two body collision kinematic, conservative forces-the concept of a potential,

**UNIT 4**

**Simple harmonic motion:** simple harmonic motion, equation. examples and applications of simple harmonic motion,

**UNIT 5**

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

**Text Books:**

**TB1.** Integrated Mechanics, J.P. Agarwal, Pragati Publication

**TB2.** Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.

**Patel Nagar, Dehradun, Uttarakhand**

**Reference Books:**

**RB1.** University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison-Wesley

**RB2.** Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley

**RB3.** University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define vector calculus, Ordinary Differential Equations, Superposition of Two Collinear Harmonic oscillations.
<b>CO2</b>	Describe about gravity, angular momentum, Moment of Inertia and elastic property, laws of motion.
<b>CO3</b>	Explain conservation laws of energy and linear and angular momentum and apply them to solve problems.
<b>CO4</b>	Classify and differentiate Forces, frame of reference and types of oscillations.
<b>CO5</b>	Evaluate fundamentals of harmonic oscillator model, including damped and forced oscillators and grasp the significance of terms like quality factor and damping coefficient.
<b>CO6</b>	Solve the problems of vectors and differential equation.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code</b> : PHYGE203				
<b>Course Name</b> : Introduction to Electromagnetic theory				
<b>Semester /Year</b> : II				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to introduce the basic mathematical concepts related to electromagnetic vector fields and impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.

### Course Contents

#### UNIT 1

##### **Electric Field, Electric Potential and Electric Potential Energy**

Scalar and vector product, gradient divergence, Coulomb's law Divergence of electric field Gauss' law Curl of electric field Stokes' theorem Electrostatic potential. Laplace's equation for electrostatic potential Laplace's equation in other fields Uniqueness of solution of Laplace's equation Poisson equation and uniqueness of its solution Method of images for planar surfaces Work and energy in electrostatics.

#### UNIT 2

##### **Dielectric Properties of Matter:**

Conductors and capacitors Reciprocity theorem Polarization and bound charges Linear dielectrics Electric displacement Fields in dielectrics.

#### UNIT 3

##### **Magnetic Field:**

Magnetic field due to a magnet Magnetic field due to a steady current Divergence and curl of magnetic field Ampere's law. The vector potential Magnetization and bound currents. Magnetic fields in matter.

#### UNIT 4

##### **Electromagnetic Induction and Electromagnetic waves:**

Maxwell's equations Work done by electromagnetic field Poynting's theorem Momentum in electromagnetic field Angular momentum in electromagnetic field Electromagnetic waves: the wave equation.

#### UNIT 5

**Wave equation** Plane electromagnetic waves Energy carried by electromagnetic waves Pressure due to electromagnetic waves Refection and transmission of electromagnetic waves Reflection and transmission of electromagnetic waves

**Text book [TB]:**

**TB 1.** Modern Electrodynamics by A. Zangwill, Cambridge, 2013.

**TB 2.** Introduction to Electrodynamics by D. Griffiths

**Reference books [RB]:**

**RB 1.** P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)

**RB 2.** J.B. Marion: Classical Electromagnetic Radiation

**RB 3.** Landau and Lifshitz: The Classical theory of Fields (Pergman Press)

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Electric Field, Electric Potential and Electric Potential Energy, Dielectric Properties of Matter, Electromagnetic Induction and Electromagnetic waves.
<b>CO2</b>	Describe Electromagnetic Induction and Electromagnetic waves, Dielectric Properties of Matter, Magnetic Field.
<b>CO3</b>	Apply Electromagnetic Induction and Electromagnetic waves, Dielectric Properties of Matter, Magnetic Field in various fields
<b>CO4</b>	Explain with derivation Electric Field, Electric Potential and Electric Potential Energy, Dielectric Properties of Matter, Electromagnetic Induction and Electromagnetic waves
<b>CO5</b>	Estimate various problems related to Electric Field, Electric Potential and Electric Potential Energy, Dielectric Properties of Matter, Electromagnetic Induction and Electromagnetic waves.
<b>CO6</b>	Solve the problems on Electric Field, Electric Potential and Electric Potential Energy, Dielectric Properties of Matter

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code : PHYGE303</b>				
<b>Course Name : Digital And Analog Systems</b>				
<b>Semester /Year : III</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to introduce the basic mathematical concepts related to electromagnetic vector fields and impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.

### Course Contents

#### UNIT 1

##### Digital Circuits

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Min terms and Max terms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

#### UNIT 2

##### Semiconductor Devices

Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell

#### UNIT 3

**Amplifiers:** . 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 & Q-point. Active, Cutoff & Saturation regions. Voltage Divider Bias Circuit for CE Amplifier. Analysis of single-stage CE amplifier using hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

#### UNIT 4

##### Operational Amplifiers:

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed- loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator

#### UNIT 5

**Sinusoidal Oscillators:** Barkhausen's Criterion for self-sustained oscillations. Determination of frequency RC oscillator.

**Patel Nagar, Dehradun, Uttarakhand**

**Text book [TB]:****TB1.** Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-GrawHill.**TB2.** Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill**Reference books [RB]:****RB1** Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7<sup>th</sup> Ed.,2011, Tata McGrawHill**RB2.** Fundamentals of Digital Circuits, A. Anand Kumar, 2<sup>nd</sup> Edition, 2009, PHILearning Pvt. Ltd.**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Digital circuits, oscillators, semiconductor devices, amplifiers.
<b>CO2</b>	Describe oscillators, semiconductor devices, amplifiers, digital circuits
<b>CO3</b>	Illustrate with examples oscillators, semiconductor devices, amplifiers, and digital circuits in various areas
<b>CO4</b>	Analyze the working of oscillators, semiconductor devices, amplifiers, digital circuits
<b>CO5</b>	Compare various semiconductor devices, digital circuits, amplifiers and oscillators.
<b>CO6</b>	Formulate and design various digital and analog circuits.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	2	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	1	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code : PHYGE403</b>				
<b>Course Name : Modern Physics</b>				
<b>Semester /Year : IV</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objectives of this course is to provide an understanding about Photoelectric effect, de Broglie hypothesis. Acquire knowledge and understanding of Schrodinger equation, nuclear properties, radioactive decay and processes.

### Course Contents

#### UNIT 1

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.

#### UNIT 2

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Energy-time uncertainty principle. 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.

#### UNIT 3

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, Quantum mechanical scattering and tunneling in one dimension - across a step potential and across a rectangular potential barrier. 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, semi- empirical mass formula and binding energy.

#### UNIT 4

**Radioactivity:** stability of nucleus; Law of radioactive decay; Meanlife and half-life; $\alpha$ decay;  $\beta$ decay - energy released, spectrum and Pauli's prediction of neutrino;  $\gamma$ -ray emission.

#### UNIT 5

**Fission and Fusion:** 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 thermo nuclear reactions.

**Text Books:**

**TB1.** Integrated Elements of Modern Physics, J.P. Agarwal, Pragati Publication.

**TB2.** Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill

**Reference Books:**

**RB1.** Modern Physics, John R.Taylor, Chris D.Zafiratos, Michael A.Dubson,2009, PHI

**RB2.** Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define Bohr Atom Model, Quantum Systems and Heisenberg Uncertainty Principle, Matter Waves and Schrödinger Equation, Motion in a Potential Well, Radioactivity, Fission and fusion.
<b>CO2</b>	Describe Radioactivity: Law of radioactive decay, De Broglie wavelength and matter waves; Davisson-Germer experiment, Bohr's model, nuclear forces,
<b>CO3</b>	Explain semi-empirical mass formula and binding energy, packing fraction, expectation value, Mean life & half-life; Potential problems.
<b>CO4</b>	Analyze $\alpha$ decay; $\beta$ decay, $\gamma$ decay, Fission and fusion , Nuclear reactor, Planck's constant, Photoelectric effect, binding energy, packing fraction, expectation value, wave function
<b>CO5</b>	Evaluate Schrodinger equation, Heisenberg uncertainty principle, laws of photoelectric emission, Rutherford model, Bohr's model, quantization rule and atomic stability.
<b>CO6</b>	Solve Probability and probability current densities in one dimension, binding energy, problems on radioactivity

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	1	1	2	1	2	3	3	1	2	2	2	2
CO2	3	3	2	3	2	1	1	2	2	3	3	1	2	2	2	3
CO3	3	2	2	1	3	1	2	1	3	3	3	2	3	2	2	1
CO4	3	3	2	2	1	1	2	1	2	3	3	1	2	2	2	1
CO5	3	3	1	3	2	2	2	1	2	2	2	3	3	2	2	1
CO6	3	3	2	2	2	1	2	1	2	3	2	2	2	1	2	2

<b>Course code : PHYGE503</b>				
<b>Course Name : Radiation Physics</b>				
<b>Semester /Year : V</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objectives:** The objective of the Radiation Physics course is to provide a comprehensive understanding of the origin, nature, and interaction of ionizing radiation with matter. It aims to equip students with knowledge of radiation detection, measurement, dosimetry, and safety for applications in medical, industrial, and research fields.

### Course Contents

#### UNIT 1

**Fundamentals of Radiation:** Classification of radiation: electromagnetic (X-rays, gamma-rays) and particle (alpha, beta, neutron), Atomic and nuclear structure,

#### UNIT 2

**Radioactivity:** Natural radioactivity, laws of radioactive decay, Rutherford and soddy equation, Radioactive decay types:  $\alpha$ ,  $\beta$ ,  $\gamma$ ; half-life

#### UNIT 3

**Radiation–Matter Interactions:** Photon interactions: photoelectric effect, Compton scattering, pair production; attenuation Charged particle interactions: Classical theory of inelastic collisions with atomic electrons, Cerenkov radiation, Bragg curve, specific ionization, Bethe Bloch formula for collision, stopping power and radiation stopping power, Neutron interactions: Elastic and inelastic scattering coefficients and cross sections

#### UNIT 4

**Radiation Detection:** Principles of radiation detectors: gas-filled detectors (ionization chambers, proportional counters, GM tubes), cyclotrons, scintillators, semiconductor detectors.

#### UNIT 5

**Applications and Measures:** Radiation protection basics: units, shielding, ALARA. Applications: medical imaging, radiotherapy, industrial radiography, nuclear dating, tracer techniques, neutron activation analysis

**Text Books:**

**TB1.** G.F.Knoll, Radiation detection and measurements

**TB2.** Edward L. Alphen, “Radiation Biophysics” Academic Press, Second Edition.

**TB3.** The Physical Universe: An Introduction to Astronomy, F H Shu, University Science Books

**Reference Books:**

**RB1.** W.E. Burcham & M. Jobs – Nuclear and Particle Physics – Longman (1995)

**RB2.** A LANGE medical book “Basic Radiology” 2nd Edition, The McGrawHill 2011

**RB3.** G.F.Knoll : “Nuclear Radiation Detectors” (Willy international, New york)

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Define Fundamentals of Radiation, Radiation–Matter Interactions, Radiation Detection, Applications and Measures of radiation.
CO2	Discuss Fundamentals of Radiation, Interaction of Radiation with matter Radiation Detection, Applications and Measures of radiation.
CO3	Apply Fundamentals of Radiation, Interaction of Radiation with matter Radiation Detection in various real life problems.
CO4	Explain Fundamentals of Radiation, Interaction of Radiation with matter Radiation Detection, Applications and Measures of radiation.
CO5	Assess Fundamentals of Radiation, Interaction of Radiation with matter Radiation Detection, Applications and Measures of radiation.
CO6	Formulate the principles of radiation interaction, measures in radiation detection.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYGE603</b>			
<b>Course Name</b>	<b>: Computational Physics</b>			
<b>Semester /Year</b>	<b>VI</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:** The main objective of the course on computational physics is to impart knowledge about how to solve physics problems through different numerical techniques and use computer programming for the analysis of data.

**Course contents:**

### Unit I

**Roots of equation:** Regular Falsi method, Newton Raphson method, bisection method, interpolation, Runge-Kutta Method.

### Unit II

**Matrices:** Eigenvalues and eigenvectors of matrices, Solution of Linear Algebraic Equations: Gauss elimination, Gauss-Seidel method, Matrix inversion

### Unit III

Basic statistical analysis: mean, median, mode, standard deviation, Binomial distribution

### Unit IV

**Numerical Integration Methods:** Integration by trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule

### Unit V

**Introduction to MATLAB:** MATLAB interface and workspace, Basic commands and operations, Variables and data types, Scripts and functions

### Text book [TB]:

- TB1. MK Jain, S.R.K. Iyengar, RK Jain: Numerical Methods
- TB2. MATLAB: A Practical Introduction to Programming and Problem Solving – Stormy Attaway
- TB3. **Computational Physics** – R. H. Landau, M. J. Páez, and C. C. Bordeianu

### Reference books [RB]:

- RB1. Numerical Methods in Engineering and Science – B.S. Grewal
- RB2. An Introduction to Computational Physics – Tao Pang

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe, interpolation, Roots of equation, numerical integration, matrix inversion, MATLAB, statistical methods
<b>CO2</b>	Discuss Solution of Linear Algebraic Equations, MATLAB, numerical integration, interpolation, statistical methods
<b>CO3</b>	Compute Roots of equation, Solution of Linear Algebraic Equations, MATLAB, numerical integration, interpolation, statistical methods
<b>CO4</b>	Calculate Eigenvalues and eigenvectors of matrices, Solution of Linear Algebraic Equations, numerical integration, matrix inversion, MATLAB, statistical methods
<b>CO5</b>	Evaluate Roots of equation, Solution of Linear Algebraic Equations, MATLAB, numerical integration, interpolation, statistical methods
<b>CO6</b>	Solve Problems on Eigenvalues and eigenvectors of matrices, Solution of Linear Algebraic Equations, numerical integration, matrix inversion, MATLAB, statistical methods

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

## Seminar/Dissertation

<b>Course code</b> : PHYDS710				
<b>Course Name</b> : Seminar				
<b>Semester /Year</b> : VII				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>

**Course Objective:** The main objective of this course to analyze, construct and evaluate scientific information and research topics. Students will make a quality scientific presentation and speak in front of a scientific audience.

### Course Contents

Presentation topic must be related to the student's current research and innovation, nanoscience and technology, any material characterization and analytical techniques, and current thesis or project.

### Text book [TB]:

1. R. Williams, Non-Designer's Presentation Book, The: Principles for effective presentation design
2. N. Duarte, Slide: ology: The Art and Science of Creating Great Presentations

### Reference books [RB]:

1. G. Reynolds, Presentation Zen: Simple Ideas on Presentation Design and Delivery

### **Course outcomes (COs):**

**Upon successful completion of the course a student will be able to:**

CO1	Memorize scientific information.
CO2	Express quality scientific presentation.
CO3	Explain, Present, and apply scientific information.
CO4	Classify and analyze scientific work for presentation.
CO5	Evaluate scientific information and then analyse it.
CO6	Develop scientific understanding towards research oriented topics

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	2	1	2	2	1	2	1	1	2	2	1	2	2	1	1

<b>Course code</b> : PHYDT711				
<b>Course Name</b> : Dissertation				
<b>Semester /Year</b> : VII				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>12</b>	<b>6</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:** The main objective of the course is to carry out extensive research. Student will able to identify gap, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research.

**Course contents:**

This course will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Observe practical experience of the research process.
<b>CO2</b>	Describe the principles of research.
<b>CO3</b>	Explain the principles of research design to solve the problems in the field of research.
<b>CO4</b>	Analyse various research solutions.
<b>CO5</b>	Evaluate links between theory and methods within their field of study
<b>CO6</b>	Create various research solution.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

<b>Course code</b>	<b>: PHYDS810</b>			
<b>Course Name</b>	<b>: Seminar</b>			
<b>Semester /Year</b>	<b>: VIII</b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>

**Course Objective:** The main objective of this course to analyze, construct and evaluate scientific information and research topics. Students will make a quality scientific presentation and speak in front of a scientific audience.

**Course Contents**

Presentation topic must be related to the student's current research and innovation, nanoscience and technology, any material characterization and analytical techniques, and current thesis or project.

**Text book [TB]:**

1. R. Williams, Non-Designer's Presentation Book, The: Principles for effective presentation design
2. N. Duarte, Slide: ology: The Art and Science of Creating Great Presentations

**Reference books [RB]:**

1. G. Reynolds, Presentation Zen: Simple Ideas on Presentation Design and Delivery

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Memorize scientific information.
CO2	Express quality scientific presentation.
CO3	Explain, Present, and apply scientific information.
CO4	Classify and analyze scientific work for presentation.
CO5	Evaluate scientific information and then analyse it.
CO6	Develop scientific understanding towards research oriented topics

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	2	1	2	2	1	2	1	1	2	2	1	2	2	1	1

<b>Course code : PHYDT808</b>				
<b>Course Name : Dissertation</b>				
<b>Semester /Year : VIII</b>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>12</b>	<b>6</b>

**L - Lecture T – Tutorial P – Practical C – Credit**

**Course Objective:** The main objective of the course is to carry out extensive research. Student will able to identify gap, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research.

**Course contents:**

This course will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Observe practical experience of the research process.
<b>CO2</b>	Describe the principles of research.
<b>CO3</b>	Explain the principles of research design to solve the problems in the field of research.
<b>CO4</b>	Analyse various research solutions.
<b>CO5</b>	Evaluate links between theory and methods within their field of study
<b>CO6</b>	Create various research solution.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	1	1	1	2	2	3	1	1	2	2	2
CO2	2	2	1	1	2	1	2	1	1	1	1	1	2	1	1	1
CO3	2	1	1	2	2	1	1	2	1	1	1	1	2	1	1	2
CO4	2	2	1	2	1	1	2	1	1	1	1	1	2	1	2	1
CO5	1	2	1	2	1	1	1	2	1	1	1	1	1	1	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1