BACHELOR OF SCIENCE (HONOURS) IN PHYSICS

DEPARTMENT OF PHYSICS

Amaravati 522240, Andhra Pradesh

INDIA

CURRICULUM AND SYLLABI

(For students to be admitted from the academic year 2020)

Objectives:

1. To help the students to acquire a comprehensive knowledge and sound understanding of the fundamentals of Physics.

2. To develop practical, analytical, and mathematical skills of Physics.

3. To prepare students to acquire a range of general skills, to solve problems, to evaluate information, to use computers productively, to communicate with society effectively and learn independently.

4. To enable them to acquire a job efficiently in diverse fields such as Science and Engineering, Education, Banking, Public Services, Business etc.

Eligibility:

The candidates seeking admission to the B.Sc. Degree with Honours (Research) program shall be required to have passed (10+2) (Higher Secondary) examination or any other equivalent examination of any authority, recognized by this University, with Physics, Chemistry and Mathematics.

Program duration: 3+1 Years (6+2 Semesters)

PROGRAM outcomes:

The curriculum and syllabus for the Bachelor of Science degree Physics with Honours (Research) conform to outcome-based teaching-learning process. In general, FOURTEEN STUDENT OUTCOMES (a-n) have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. Further, each course in the program spells out clear instructional objectives which are mapped on to the student outcomes.

On successful completion of this program, students will have the ability to

a) Apply knowledge of basic science, mathematics and computing appropriate to the discipline

b) Acquire knowledge and understanding of fundamental concepts, principles and theories related to the identified subject areas.

c) Acquire advanced knowledge in some areas of interest in physics and is familiar with contemporary research within various fields of physics.

d) Develop skills of critical thinking, hypothesis building, and to apply the scientific method to physics concepts, theoretical models and laboratory experiments.

e) Develop problem-solving skill to, independently and creatively, identify and formulate problems and to plan and, use theoretical and/or experimental methods, carry out advanced tasks within specified time limits.

f) Develop the skill to combine and use knowledge from several disciplines to enter/propose novel ideas that require an analytic and innovative approach, and disseminate subject matter and results to both specialists and a broader audience.

g) Use computers effectively to solve problems through numerical methods and simulations and to analyze the data through available software.

h) Handle standard and advanced laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

i) Develop skills to interpret and explain the limits of accuracy of experimental data in terms of significance and underlying theory.

j) Collaborate and to lead collaborative work to accomplish a common goal.

k) Understands the role of physics in the society and have the background to consider ethical, legal and security issues and responsibilities.

l) Demonstrate written and oral communication skills for the dissemination of scientific results in a report, article, or oral presentation formats.

m) Develop an adequate background for pursuing pedagogic education and international perspective on her/his discipline, and a commitment to life-long learning and professional development.

n) Assist in the creation of an effective project plan.

SRM UNIVERSITY – AP, ANDHRA PRADESH

CURRICULUM FRAMEWORK

PROGRAM:

BACHELOR OF PHYSICS WITH HONOURS + One Year Optional (Research)

REGULATION YEAR: 2020

CURRICULUM

SEMESTER - I

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
FC	FC-1	Foundation course 1	3	1	0	4	4
FC	FC-2	Foundation course 2	3	1	0	4	4
FC	FC-3	Foundation course 3	3	1	0	4	4
C	PHY103	Mathematical Physics	3	1	0	4	4
C	PHY 104	Mechanics	3	0	0	3	3
C	PHY 104L	Laboratory: Mechanics	0	0	4	4	2
E	SOFT SKILLS	Soft Skills					
		TOTAL	**15**	**4**	**4**	**26**	**21**

SEMESTER – II

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
FC	FC-4	Foundation course 4	3	1	0	4	4
FC	FC-5	Foundation course 5	3	1	0	4	4
C	PHY 111	Classical and Modern Physics	3	0	0	3	3
C	PHY 111L	Laboratory: Classical and Modern Physics	0	0	4	4	2
C	PHY 112	Heat & Thermodynamics	3	0	0	3	3
C	PHY 112L	Laboratory: Heat & Thermodynamics	0	0	4	4	2
C	PHY 114	Electrostatics and Electric Current	3	0	0	3	3
C	PHY 114L	Laboratory: Electrostatics and Electric Current	0	0	4	4	2
		TOTAL	**15**	**2**	**12**	**29**	**23**

SEMESTER - III

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
FC	FC-6	Foundation course 6	3	1	0	4	4
C	PHY 201	Wave and Oscillations	3	0	0	3	3
C	PHY 201L	Laboratory: Wave and Oscillations	0	0	4	4	2
C	PHY 202	Introduction to Optics	3	0	0	3	3
C	PHY 202L	Laboratory: Introduction to Optics	0	0	4	4	2
C	PHY 203	Quantum Mechanics	3	1	0	4	4
A	Mathematics 1	Mathematics 1	3	1	0	4	4
A	Chemistry 1 / Computer 1/SLABS Course	Chemistry 1 / Computer 1/SLABS Course	4	0	0	4	4
		TOTAL	**20**	**2**	**4**	**26**	**26**

SEMESTER – IV

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
C	PHY 211	Analog and Digital Electronics	3	0	0	3	3
C	PHY 211L	Laboratory: Analog and Digital Electronics	0	0	4	4	2
C	PHY 212	Electrodynamics	3	0	0	3	3
C	PHY 212L	Laboratory: Electrodynamics	0	0	4	4	2
C	PHY 213	Free space and Optical fibre communication	3	1	0	4	4
A	Mathematics 2	Mathematics 2	3	1	0	4	4
A	Chemistry 2 / Computer 2/SLABS Course	Chemistry 2 / Computer 2/SLABS Course	4	0	0	4	4
DE		Department Elective I	4	0	0	4	4
		TOTAL	**20**	**2**	**8**	**30**	**26**

SEMESTER – V

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
C	PHY 301R	Project - 1	0	0	4	4	2
C	PHY 302	Atomic and Molecular Physics	3	0	0	3	3
C	PHY 302L	Laboratory: Atomic-Molecular Physics	0	0	4	4	2
C	PHY 303	Solid state Physics	3	0	0	3	3
C	PHY 303L	Laboratory: Solid State Physics	0	0	4	4	2
C	PHY 304	Non Linear Optics	3	0	0	3	3
C	PHY 305L	Laboratory: Introduction to Lab View	0	0	4	4	2
OE		Open Elective – I	4	0	0	4	4
		TOTAL	**13**	**0**	**20**	**33**	**21**

SEMESTER – VI

Course Category	Course Code	Course Name	L	T	P	L+T+P	C
C	PHY 311R	Project - 2	0	0	10	10	5
C	PHY 312	Statistical Physics	3	1	0	4	4
C	PHY 313	Nuclear and Particle Physics	3	0	0	3	3
C	PHY XXXL	Laboratory: Introduction to Impedance spectroscopy and ZView	0	0	4	4	2
C	PHY314	Department Seminar/Industry-Academic Visit	0	0	0	0	2
DE		Department Elective - II	3	1	0	4	4
OE		Open Elective - II	3	1	0	4	4
		TOTAL	**12**	**3**	**14**	**29**	**24**

Optional One Year

SEMESTER - VII							
Course Category	**Course Code**	**Course Name**	**L**	**T**	**P**	**L+T+P**	**C**
C	PHY 401R	Research Degree Project - 1	0	0	24	24	12
RE		Research Elective-1	3	1	0	4	4
RE		Research Elective-2	3	1	0	4	4
RE		Research Elective-3	3	1	0	4	4
		TOTAL	**9**	**3**	**24**	**36**	**24**

SEMESTER – VIII							
Course Category	**Course Code**	**Course Name**	**L**	**T**	**P**	**L+T+P**	**C**
C	PHY 411R	Research Degree Project - 2	0	0	24	24	12
RE		Research Elective-4	3	1	0	4	4
		TOTAL	**3**	**1**	**24**	**28**	**16**

Total Program Credits Requirement:

21 + 23 + 26 + 26 + 21 + 24 +24+16= 181

List of Foundation Courses

Foundation course 1 (FC1)	**Communicative English**
Foundation course 2 (FC2)	**Environmental Science**
Foundation course 3 (FC3)	**Psychology for everyday living**
Foundation course 4 (FC4)	**TO BE ANNOUNCED**
Foundation course 5 (FC5)	**TO BE ANNOUNCED**
Foundation course 6 (FC6)	**TO BE ANNOUNCED**

List of Allied Subjects (Semester III and Semester IV)

Semester III	
Mathematics 1/	**TO BE ANNOUNCED**
Chemistry 1 /	**TO BE ANNOUNCED**
Computer 1	**TO BE ANNOUNCED**
Semester IV	
Mathematics 2/	**TO BE ANNOUNCED**
Chemistry 2 /	**TO BE ANNOUNCED**
Computer 2	**TO BE ANNOUNCED**

List of Compulsory Elective subjects

Soft Skills (NO Credit requirements)	**TO BE ANNOUNCED**
Departmental Elective (DE)	**TO BE ANNOUNCED**
Open Elective (OE)/Course on Computer Concepts (CCC)	**TO BE ANNOUNCED**
Research Elective (RE)	**TO BE ANNOUNCED**

SRM UNIVERSITY – AP, ANDHRA PRADESH

CURRICULUM FRAMEWORK

PROGRAM:

BACHELOR OF PHYSICS (HONOURS) WITH ONE Year Optional Research

REGULATION YEAR: 2020

SYLLABUS

SEMESTER –I

FOUNDATION COURSE 1 (FC 1)

FOUNDATION COURSE 2 (FC 2)

FOUNDATION COURSE 3 (FC 3)

SOFT SKILL

PHY 103	**MATHEMATICAL PHYSICS**		**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	CORE	MATHEMATICAL PHYSICS				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce the students to the fundamental mathematical requirements for the subsequent courses in the curriculum.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, students will be able to								
1.	Use tools of vector calculus and complex variables to physical systems							
2.	To solve problems involving partial differentiation of multivariable functions							
3.	Solve first and second-order linear differential equations for various physical systems using Power series, Laplace, Fourier transforms and other methods							
4.	To familiarize with the concept of linear vector spaces and their relations with matrix algebra							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - Vector Algebra and Vector Analysis	**12**			

1.	Introduction to scalars, vectors, Dot product and cross product of vectors	1	C		1,2
2.	Scalar triple product and its geometrical interpretation, Vector triple product and its proof	1	C		1,2
3.	Differentiation of vectors with respect to scalar, scalar and vector fields, Vector differential operator	1	C		1,2
4.	Tutorial-I	1	I		1,2
5.	Gradient of a scalar field and its physical significance	1	C-D		1,2
6.	Divergence of a scalar field and its physical significance	1	C-D		1,2
7.	Curl of a vector field and its physical significance	1	C-D		1,2
8.	Tutorial-II	1	I		1,2
9.	Vector integrals: line, surface and volume integral with their examples	1	C		1,2
10.	Gauss-Divergence theorem	1	D-I		1,2
11.	Stoke's theorem, Vector identities	1	D-I		1,2
12.	Tutorial-III	1	I		
	UNIT II – Complex Numbers	**12**			
13.	Introduction to complex numbers	1	C		1,2
14.	Algebra of complex numbers	1	C		1,2
15.	Argand diagram	1	C		1,2
16.	Tutorial-I	1	I		1,2
17.	De-Moivre's Theorem	1	C		1,2
18.	Trigonometric, hyperbolic and exponential functions	1	C-D		1,2
19.	Powers, roots and log of complex numbers	1	C-D		1,2
20.	Tutorial-II	1	I		1,2
21.	Applications of complex numbers: Classical mechanics, LCR circuits	1	D-I		1,2
22.	Determine velocity and acceleration in a curved motion	1	D-I		1,2
23.	Worked examples – determine velocity and acceleration in curved motion	1	D-I		1,2
24.	Tutorial-III	1	I		1,2
	UNIT III – Partial Differentiation	**12**			
25.	Definition of partial differentiation, Successive differentiation	1	C		1,2
26.	Total differentiation, exact differential	1	C		1,2

27.	exact differential, Chain rule	1	C		1,2
28.	Tutorial-I	1	I		1,2
29.	Application - Change of variables from Cartesian to Polar coordinates	1	D-I		1,2
30.	Application - Change of variables from Cartesian to cylindrical coordinates	1	D-I		1,2
31.	Application - Change of variables from Cartesian to spherical coordinates	1	D-I		1,2
32.	Tutorial-II	1	I		1,2
33.	Implicit and explicit functions	1	C		1,2
34.	Conditions for maxima and minima	1	C		1,2
35.	Worked examples for maxima and minima of two-variable functions	1	C,D		1,2
36.	Tutorial-III	1	I		1,2
	UNIT IV - Differential Equations	**12**			
37.	Ordinary differential equations (ODEs) and partial differential equations (PDEs)	1	C		1,2
38.	Series solution of ODEs	1	C		1,2
39.	Special functions- Legendre and Bessel functions	1	C		1,2
40.	Tutorial-I	1	I		1,2
41.	Introduction to Laplace transformation	1	C		1,2
42.	Solutions for ODEs using Laplace transformation	1	C-D		1,2
43.	Introduction to Fourier analysis	1	C		1,2
44.	Tutorial-II	1	I		1,2
45.	Solving PDEs using Fourier transformations	1	D		1,2
46.	Application of Differential equations in Physics – Radioactivity, conductivity and diffusivity	1	D-I		1,2
47.	Fourier equation for the propagation of heat, Steady-state solution for rectilinear, radial and the cylindrical flow of heat	1	D		1,2
48.	Tutorial-III	1	I		1,2
	UNIT V - Matrix Algebra	**12**			
49.	Linear equations and matrix formalism	1	C		1,2
50.	Inverse of a square matrix	1	C		1,2

51.	Eigenvalues and eigenvectors of matrices	1	C		1,2
52.	Tutorial-I	1	I		1,2
53.	orthogonal sets of eigenvectors	1	C		1,2
54.	orthogonal transformations	1	C-D		1,2
55.	Hermitian and unitary matrices	1	C-D		1,2
56.	Tutorial-II	1	I		1,2
57.	diagonalization of matrices	1	D		1,2
58.	Linear vector spaces, the dual space and the scalar product	1	C-D		1,2
59.	linear operators, Hermitian operators	1	C-D		1,2
60.	Tutorial-III	1	I		1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Erwin Kreyszig 10th Edition (2011) – Advanced Engineering Mathematics, Wiley Publishers (International Student Version)
2	Essential Mathematical Methods for the Physical Sciences, K. F Riley, M. P Hobson, 1stEdition, 2011, Cambridge University Press
3	Mathematical Methods In The Physical Sciences, Mary L. Boas, 3 Edition, 2006, Wiley Publication

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 104	MECHANICS			L	T	P	C
				3	0	0	3
Co-requisite:	PHY 104						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category		CORE	MECHANICS				
Course designed by	Department of Physics						

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce the students to the fundamental principles of classical Newtonian dynamics of a system of particles (discrete or continuous) and their general collective behaviours (e.g. surface tension, viscosity).							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, students will be able to								
1.	Address classical mechanical problems of particles and rigid bodies following Newtonian mechanics							
2.	To solve problems related to classical conservation principles.							
3.	To understand rigid body motions and their conservation principles							
4.	To familiarize with general characterization properties of systems (e.g. surface tension, viscosity).							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - Newton's Laws of Motion (Review)	**9**			
1.	Distance, Displacement, Time, Average Velocity, Instantaneous Velocity	1	C		1,2
2.	Average and Instantaneous Acceleration, Motion under Constant Acceleration	1	C		1,2
3.	Velocity and Position from acceleration, velocity and acceleration from Position vectors	1	C		1,2
4.	Motion under non-constant Acceleration; model rocket and related example	1	C		1,2
5.	Contact Forces, Static friction	1	C		1,2
6.	Kinetic friction	1	C		1,2
7.	Worked examples of static and kinetic frictions	1	C-D		1,2
8.	Free body force diagrams and Newton's law	1	C-D		1,2

9.	Solution of dynamics with free body diagrams and Newton's law	1	C-D		1,2
	UNIT II – Kinematics	**9**			
10.	Motion of particles in two dimensions	1	C-D		1,2
11.	Motion of particles in three dimensions	1	D		1,2
12.	Tensions and springs, pushing, pulling and tension	1	D		1,2
13.	Solving pulley systems	1	D		1,2
14.	Impulse, conservation of linear momentum	1	C		1,2
15.	Conservation of kinetic and potential energy	1	C		1,2
16.	Uniform circular motion, angular velocity and acceleration	1	C		1,2
17.	Period and Frequency, Newton's Second law and circular motion	1	C		1,2
18.	worked examples – bending of roads, roller coaster motion	1	C		1,2
	UNIT III – Work Energy and Collision	**9**			
19.	Kinetic Energy and Work in 1D, Work by a Constant Force	1	C		1,2
20.	Work by a Non- Constant Force	1	C		1,2
21.	Conservative and Non-conservative Forces, Path Independence - Gravity	1	C		1,2
22.	Path Dependence – Friction, Potential energy	1	C		1,2
23.	Principle of energy conservation and worked examples	1	C		1,2
24.	Work-Kinetic Energy Theorem in 2D	1	C		1,2
25.	Work-Kinetic Energy Theorem: worked examples	1	C		1,2
26.	Elastic and inelastic collisions: Conservation of momentum and energy	1	C		1,2
27.	Collision in 1D and in 2D and worked examples	1	C		1,2
	UNIT IV - Rigid Body Motion	**9**			
28.	Motion of a system of particles, Centre of mass motion, work example – simple collision, projectile fragments	1	C		1,2
29.	Center of mass of system of particles and continuous objects	1	C		1,2
30.	System of particles and rigid bodies	1	C		1,2

31.	Motion of a rigid body, rotation about an axis, moment of inertia	1	C		1,2
32.	Theorem of parallel and perpendicular axes	1	C		1,2
33.	Calculation of moment of inertia for simple cases (rod, disk, sphere etc.),	1	C		1,2
34.	Compound pendulum	1	C		1,2
35.	Angular momentum and torque of system of particles	1	C		1,2
36.	Conservation of angular momentum and conservation of energy in rigid body rotational motion	1	C		1,2
	UNIT V - General Properties of Matter	**9**			
37.	Elastic, inelastic and plastic bodies. Stress-strain curve	1	C		1,2
38.	Hooke's law, elastic modulus: Young's modulus, Shear modulus and bulk modulus	1	C		1,2
39.	Torsion of a cylinder – torsional pendulum	1	C		1,2
40.	Bending moment of a Cantilever, Beam supported at both ends	1	C-D		1,2
41.	Shape of liquid drop, Excess pressure over a curved liquid surface, Capillarity	1	C-D		1,2
42.	Surface tension - Molecular forces, surface tension and surface energy	1	C-D		1,2
43.	Viscosity of liquids - Streamline and turbulent motion; Reynold's number, Poiseuille's equation	1	C-D		1,2
44.	Stoke's law and worked examples	1	C-D		1,2
45.	Equation of continuity; Euler's equation for liquid flow; Bernoulli's theorem	1	C-D		1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Physics for Scientist and Engineers with Modern Physics, 9rd Edition (2013) – Raymond A. Serway, Clement J Moses and Curt A Moyer (Publisher: Thomson Learning (Asia Region) Singapore)
2	Concepts of Modern Physics (2017)- Arthur Besier, Shobhit Mahajan, S. Rai Choudhury (Tata McGraw Hill)
3	Introduction to classical mechanics, with Problems and Solutions, David Morin, South Asia Edition, 2020, Cambridge University Press

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
					End semester examination Weightage :	**50%**

PHY 104L	**LABORATORY: MECHANICS**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	PHY 104				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category		CORE	LABORATORY: MECHANICS		
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how basic principles of classical mechanics are manifested in real-world environment through properly designed experiments.						
LEARNING OBJECTIVES		**STUDENT OUTCOMES**					
At the end of the course, student will be able to							
1.	Correlate classical mechanics theories with real life examples						
2.	Analyze experimental data and calculate experimental error						
3.	Handle basic instruments involving linear and rotational motion and simple and compound oscillation						
4.	Be able to experimentally calculate important and advanced classical mechanics concepts like Young's modulus, rigidity modulus, moment of inertia etc. of a given material						

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	a Graphs plotting using a graph paper. Computation methods of data analysis with MS-Excel b. Experimental data collection and error analysis	4	I,O		1,2
2.	a) Vernier calliper b) Determination of length, width and thickness of a metal rod and sheets	4	I,O		1,2

	c) Screw Gauge d) Determination of radius of a given metal wire				
3.	a) Measure the time period for a given simple pendulum with various lengths b) Measure the time period for a given compound pendulum with various lengths c) Determine the radius of gyration of a given pendulum d) Compare the value of gravitational acceleration obtained from Simple and compound pendulum	4	I,O		1,2
4.	Verification of Hooke's Law and determine spring constant of a spring.	4	I,O		1,2
5.	To determine the Young's modulus of a steel bar by deflection method	4	I,O		1,2
6.	To determine the rigidity modulus of a given wire by torsional pendulum	4	I,O		1,2
7.	Measurement of surface tension of different liquids	4	I,O		1,2
8.	To measure the viscosity of a sample liquid based on Stokes' Law	4	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**36**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	K.G. Mazumdar and B. Ghosh, "*Advanced Practical Physics*" Sreedhar Publishers, Revised edition Jan 2004
2	R.K. Shukla and Anchal Srivastava, "*Practical Physics*" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3	Hugh D.Young, Roger A. Freedman and Lewis Ford "*University Physics with Modern Physics*" (12th Edition, 2015) –(Publisher – Pearson Education)

Course nature			**Practical**		
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

SEMESTER –II

FOUNDATION COURSE 4 (FC 4)

FOUNDATION COURSE 5 (FC 5)

<table>
<tr><td rowspan="2">PHY 111</td><td rowspan="2" colspan="3">CLASSICAL AND MODERN PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Co-requisite:</td><td colspan="7">PHY 111L</td></tr>
<tr><td>Prerequisite:</td><td colspan="7">PHY 103, PHY 104</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="7">NIL</td></tr>
<tr><td>Course Category</td><td></td><td>CORE</td><td colspan="5">CLASSICAL AND MODERN PHYSICS</td></tr>
<tr><td>Course designed by</td><td colspan="7">Department of Physics</td></tr>
</table>

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

<table>
<tr><td>PURPOSE</td><td colspan="8">The purpose of this course is to introduce the students to advanced methods of classical mechanics (Lagrangian and Hamiltonian) and relativistic mechanics</td></tr>
<tr><td colspan="2">LEARNING OBJECTIVES</td><td colspan="7">STUDENT OUTCOMES</td></tr>
<tr><td colspan="2">At the end of the course, student will be able to</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.</td><td>Use tools of classical mechanics tools (Lagrangian and Hamiltonian formalism)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td>Solve problems of rigid body dynamics</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td>Understand the concepts space-time</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td>To solve problems on relativistic motions</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - Mechanics of system of particles in different coordinate systems	**9**			
1.	Coordinate systems: Cartesian and Polar	1	C		1,2
2.	Cylindrical and Spherical co-ordinate systems	1	C		1,2
3.	Inertial and Non-inertial frames of references	1	C-D		1,2
4.	Galilean invariance	1	C-D		1,2
5.	Worked examples on Galilean invariance	1	C-D		1,2
6.	Rotating co-ordinate system	1	C-D		1,2
7.	Coriolis's force	1	D		1,2
8.	Effect of Coriolis's force on cyclone formation, river flow	1	D		1,2
9.	flight of missiles and freely falling body on Earth's surface	1	D		1,2
	UNIT II – Central force and Introduction to Langrangian and Hamiltonian	**9**			
10.	Newton's Law of Gravitation	1	C		1,2
11.	Central force, motion under central force	1	C		1,2
12.	Conservation of angular momentum	1	D		1,2
13.	Kepler's law of motion	1	D		1,2
14.	Deduction of Kepler's laws of planetary motion, orbits of artificial satellite	1	D		1,2
15.	Types of constraints, degrees of freedom, Generalized co-ordinates	1	C-D		1,2
16.	Lagrangian of a system, Lagrange's equation	1	C		1,2
17.	Hamiltonian of a system, Hamiltonian's equations	1	C-D		1,2
18.	Worked examples: Simple harmonic motion, at wood machine	1	C-D		1,2
	UNIT III – Wave Properties and Dual Nature	**9**			
19.	Electromagnetic Waves	1	C		1,2
20.	X-Rays, X-Rays Diffraction	1	C		1,2
21.	Photoelectric effect	1	C		1,2
22.	Blackbody Radiation	1	C-D		1,2
23.	Planck's Radiation Law	1	C-D		1,2
24.	Physical Significance of Planck's constant	1	D		1,2
25.	Quantum Double Slit Experiment	1	C		1,2
26.	Davisson and Germer experiment	1	C		1,2
27.	De-Broglie Hypothesis: wave particle duality	1	D-I		1,2
	UNIT IV - Atomic Structure	**9**			

28.	Rutherford experiment, Geiger–Marsden experiments	1	C-D		1,2
29.	The Nuclear atom: An atom is largely empty space	1	C-D		1,2
30.	Electron Orbits: The planetary model of the atom and why it fails	1	C-D		1,2
31.	Atomic Spectra: Each element has a characteristic line spectrum	1	C-D		1,2
32.	The Bohr Atom	1	C-D		1,2
33.	Energy levels and spectra	1	C-D		1,2
34.	Success and need in the revision of Bohr Atomic Model	1	C-D		1,2
35.	Sommerfeld Atomic model	1	I		1,2
36.	Sommerfeld Atomic model: Application	1	I		1,2
	UNIT V - The Special Theory of Relativity	**9**			
37.	Concept of space, time, and mass (absolute and invariant nature according to Newtonian Mechanics)	1	C		1,2
38.	Frames of reference, Newtonian relativity	1	C		1,2
39.	Galilean transformation and its inverse	1	C		1,2
40.	Ether hypothesis, Michelson-Morley Experiment, and outcome	1	C		1,2
41.	Lorentz transformation and inverse Lorentz transformation	1	C		1,2
42.	Length Contraction and Time dilation, muon decay	1	C-D		1,2
43.	Relativity of simultaneity, twin paradox.	1	C		1,2
44.	Barn and ladder paradox, space-time plot	1	C-D		1,2
45.	Relativistic momentum, mass and energy ($E = mc^2$) relation, Compton scattering	1	C-D		1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Introduction to Classical Mechanics, R. G. Takawale, P. S. Puranik, Reprint edition, 1978, Tata McGraw Hill publishing Company Ltd
2	Classical Mechanics, N. C. Rana, P. S. Joag, Reprint Edition, 1991 Tata Mc Graw Hill Publishing company Ltd.
3	Classical Mechanics, Herbert Goldstein, Reprint Edison, 1998, Narosa Publishing House

Course nature	**Theory**
Assessment Method (Weightage 100%)	

In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 111L	LABORATORY: CLASSICAL AND MODERN PHYSICS	L	T	P	C
		0	0	4	2
Co-requisite:	PHY 111				
Prerequisite:	PHY 104L				
Data Book / Codes/Standards	NIL				
Course Category	CORE	CLASSICAL MECHANICS			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how advanced principles of classical mechanics are manifested in real world environment through properly designed experiments.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Correlate classical mechanics theories with real life examples							
2.	Do Numerical simulation using C/Python program							
3.	Handle advanced instruments involving primarily damped and coupled oscillation							
4.	Be able to experimentally calculate important and advanced classical mechanics concepts like Young's modulus, rigidity modulus, moment of inertia etc. of a given material							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Using classical energy conservation law, determine the moment of inertia of a flywheel	4	I,O		1,2
2.	To record the Franck-Hertz characteristic curve for neon emission	4	I,O		1,2
3.	a) To determine the wavelengths of Balmer series in the visible region from Ar-atomic emission b) To determine the Rydberg constant	4	I,O		1,2
4.	To determine Planck's Constant by Cs Photocell	4	I,O		1,2
5.	Determine charge of an electron using Millikan's Oil Drop method	4	I,O		1,2
6.	Plotting linear graph using python				

7.	To develop numerical formalism for flight of missiles and freely falling body on Earth's surface on C/python platform	4	I,O		1,2
8.	To develop numerical formalism for motion of charge particles in electric and magnetic fields	4	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**32**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	K.G. Mazumdar and B. Ghosh, "*Advanced Practical Physics*" Sreedhar Publishers, Revised edition Jan 2004
2	R.K. Shukla and Anchal Srivastava, "*Practical Physics*" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3	Hugh D.Young, Roger A. Freedman and Lewis Ford "*University Physics with Modern Physics*" (12th Edition, 2015) –(Publisher – Pearson Education)

Course nature				**Practical**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

PHY 112	**HEAT AND THERMODYNAMICS**

Course Code	PHY 112	**Course Category**	Core Course	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	NIL	**Co-Requisite Course(s)**	PHY112L	**Progressive Course(s)**	PHY			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the concept of ideal gas equation and the kinetic theory of gases.

Objective 2: Analyse the basic concepts behind the various laws of thermodynamics.

Objective 3: Discuss the various thermodynamic relations.

Objective 4: Understand the concept of thermoelectricity.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Knowledge on Maxwells Velocity distribution law and kinetic energy of particles per degree of freedom	1	70%	65%
Outcome 2	Gain expertise in basic of Thermodynamics such as State and Path functions, Process, Path and Reversible process	2	70%	65%
Outcome 3	Solve the problem first law of thermodynamics and second law of thermodynamics. Knowledge of Entropy and Engine and Refrigerator working principles.	3	70%	65%
Outcome 4	Knowledge of Thermodynamics and can design basic thermoelectric devices	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				2			2	3	1	2
Outcome 2	3	3	3	3	2				2			2	3	2	2
Outcome 3	3	3	3	3	3				2			3	3	2	2
Outcome 4	3	3	3	3	3				3			2	3	2	2
Course Average	**3**	**3**	**3**	**3**	**3**				**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	**Unit Name**	**Required Contact Hours**	**CLOs Addressed**	**References**
Unit 1	**Kinetic Theory of Gases**	**9**		
	Ideal Gas, Ideal Gas Equation	1	1	1, 2
	Assumptions of Kinetic Theory of gases, Pressure of an ideal gas (no derivation)	1	1	1, 2
	Kinetic interpretation of Temperature, Ideal Gas equation	1	1	1, 2

	Degree of freedom, Law of equipartition of energy and its applications for specific heats of gases	1	1	1, 2
	Maxwell distribution of gas molecules speed (derivation)	1	1	1, 2
	Experimental verification of Maxwell's Law of speed distribution	1	1	1, 2
	Most probable speed, average and root mean square (r.m.s.) speed, Mean free path	1	1	1, 2
	Real gases, Andrew's experiment,	1	1	1, 2
	Vander Waal's equation of ideal gases, interpretation of a and b parameters	1	1	1, 2
Unit 2	**Basic Concepts of Thermodynamics**	**9**		
	Thermodynamic state of a system, Thermal Equilibrium	1	1, 2	1, 2
	Zeroth law of Thermodynamics	1	1, 2	1, 2
	Internal Energy of System-Concept of heat and temperature	1	2	1, 2
	Equation of State: The Ideal Gas Equation, Indicator Diagram	1	1	1, 2
	First law of Thermodynamics	1	2	1, 2
	Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric	1	1, 2	1, 2
	Adiabatic relations of system for perfect gas	1	2	1, 2
	Work done during Isothermal and Adiabatic changes	1	1, 2	1, 2
	Reversible and Irreversible processes in thermodynamics	1	1	1, 2
Unit 3	**Second Law of Thermodynamics: Entropy**	**9**		
	Conversion of Heat into Work and its converse	1	3	1, 2
	Carnot's Cycle and Carnot's Heat Engine and its efficiency	1	3	1, 2
	Second law of Thermodynamics: Statements, Carnot Theorem	1	3	1, 2
	Entropy, Principle of Increase in Entropy	1	3	1, 2
	Generalised form of the First and Second laws	1	3	1, 2
	Entropy changes for an Ideal Gas	1	3	1, 2
	Entropy changes for van der Waals' gas	1	3	1, 2
	Otto cycle, Diesel cycle and its comparison, efficiencies	1	3	1, 2
	The Carnot Refrigerator, Air conditioning: principle and its applications	1	3	1, 2
Unit 4	**Thermodynamic relations and Equation of state**	**9**		
	Maxwell's thermodynamics relations	1	4	2,3
	How to remember the maxwell's relations	1	4	2,3
	Significance of Maxwell's relations	1	4	2,3
	Thermodynamics relations with heat capacities	1	4	2,3
	Three TdS equations	1	4	2,3
	Helmholtz Free energy	1	4	2,3
	Gibbs Free energy	1	4	2,3
	Enthalpy	1	4	2,3
	Clausius-Clapeyron's equations	1	4	2,3
Unit 5	**Thermoelectric effect**	**9**		
	Seebeck effect	1	4	2,3
	Peltier effect	1	4	2,3
	Thomson effect	1	4	2,3
	Full thermoelectric equations	1	4	2,3
	Thomson relations	1	4	2,3

	Thermoelectric generators	1	4	2,3
	Applications of Thermoelectric generators and its applications	1	4	2,3
	Thermocouples, Temperature measurement	1	4	2,3
	Thermoelectric materials	1	4	2,3

Recommended Resources

1. Thermal Physics (Heat & Thermodynamics), A.B. Gupta, H.P. Roy, (Revised Edison 2010) Books and Allied (P) Ltd, Calcutta.
2. Heat and Thermodynamics, Mark. W. Zemansky, Richard H. Dittman, Seventh Edition, (2015) McGraw-Hill International Editions.
3. University Physics with Modern Physics with Mastering Physics, (12th Edition, 2015) – Hugh D.Young, Roger A. Freedman and Lewis Ford (Publisher – Pearson Education)

Other Resources

1. Heat and Thermodynamics, Brijlal, N. Subrahmanyam, S. Chand & Company Ltd, New Delhi

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		60%		35%		70%		30%	
	Understand										
Level 2	Apply	60%		40%		65%		30%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Course Designers

a. Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP
b. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras
c. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad

PHY 112L	LABORATORY: HEAT AND THERMODYNAMICS

Course Code	PHY 112L	**Course Category**	Core Course	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	PHY 104L	**Co-Requisite Course(s)**	PHY112	**Progressive Course(s)**	-			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Determine important thermodynamic properties like thermal conductivity, coefficient of thermal expansion, specific heat capacity of a given unknown solid.

Objective 2: Determine boiling point of an unknown liquid (using platinum resistance thermometer).

Objective 3: Fabricate a Thermocouple circuit and utilize it to measure Thermo-EMF of a thermocouple and temperature of an unknown thermo-couple.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop expertise in measurement of specific heat and thermal conductivity	1	70%	65%
Outcome 2	Gain expertise on the measurement of Joule's constant and can corelate the expansion of metal with temperature	2	70%	65%
Outcome 3	Can explain and use the platinum resistant for measurement of temperature	3	70%	65%
Outcome 4	Expertise on the working principle of thermocouple and can design of thermoelectric devices	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)

	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	3				2			2	3	2	2
Outcome 2	3	3	2	3	3				2			2	3	3	2
Outcome 3	3	3	3	3	3				2			3	3	2	2
Outcome 4	3	3	2	3	3				3			2	3	2	2
Course Average	**3**	**3**	**2**	**3**	**3**				**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Serial No.	Unit Name	Required Contact Hours	CLOs Addressed	References
1	To study the thermal conductivity of a given material in a constant temperature gradient	4	1	1,2
2	Determine the specific heat capacity of given metal and insulating materials by heat exchange method	6	1	1,2
3	Measurement of Joule's constant (J) by electrical method	4	2	1,2
4	To find coefficient of thermal expansion of copper, aluminium and brass using their pipes	6	2	1,2
5	Determination of the boiling point of a liquid by platinum resistance thermometer	4	2	1,2
6	a) Development of Thermocouple circuit using commercially available thermocouple b) To study the variation of Thermo-EMF of a thermocouple with Difference of temperature of its two junctions	6	3	1,2
7	Determination of the unknown temperature by thermocouple	6	3	1,2
	Total contact hours (Experiments +Demo + Extra class)	36 Hours		

Recommended Resources

1. K.G. Mazumdar and B. Ghosh, "Advanced Practical Physics" Sreedhar Publishers, Revised edition Jan 2004
2. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

Other Resources

1. Hugh D.Young, Roger A. Freedman and Lewis Ford "University Physics with Modern Physics" (12th Edition, 2015) –(Publisher – Pearson Education)

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Experiments (20%)		Record/ Observation Note (10%)		Viva Voce + Model examination (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember				40%		30%		
	Understand								
Level 2	Apply		40%		60%		30%		50%
	Analyse								
Level 3	Evaluate		60%				40%		50%
	Create								
Total		100%		100%		100%		110%	

Course Designers

a. *Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP*
b. *Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras*
c. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

PHY 114	ELECTROSTATICS AND ELECTRIC CURRENT

Course Code	PHY 114	Course Category	Core Course	L-T-P-C	3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)	PHY 114P	Progressive Course(s)				
Course Offering Department	Physics	Professional / Licensing Standards						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the behavior of electric charges and their interactions with magnetism.

Objective 2: To understand the interaction of electric and magnetic fields in materials.

Objective 3: To learn AC circuit elements and their behavior.

Objective 4: To learn the applications of AC circuits in different systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Knowledge on electric charges and their forces of interactions.	1	70%	65%
Outcome 2	Electric field and potentials in different discrete and continuous charge systems.	2	70%	65%
Outcome 3	Solve the problem on interaction of Electric and Magnetic field in matter, polarizations, magnetic induction.	3	70%	65%
Outcome 4	Knowledge of AC circuits and its applications.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				3			2	3	1	2
Outcome 2	3	3	3	3	2				2			3	3	2	2
Outcome 3	3	3	3	3	2				3			3	3	2	2
Outcome 4	3	3	3	3	3				3			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**2**				**3**			**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	**Unit Name**	**Required Contact Hours**	**CLOs Addressed**	**References**
Unit 1	**Electrostatics**	**9**		
	Vector calculus & co-ordinate systems	1	1	1, 2, 3
	Line, surface, and volume integral.	1	1	1, 2, 3
	Coulomb's law & Electrostatic Force	1	1	1, 2, 3
	Superposition principle	1	1	1, 2, 3
	Electric field due to point charge & group of charges	1	1	1, 2, 3
	Electric field due to continuous charge distribution	1	1	1, 2, 3
	Concept of electric flux – introduction to Gauss Law	1	1	1, 2, 3
	Electrostatic potential – inter-relation with ES field	1	1	1, 2, 3
	Electro-static energy of the system of point charges and charge distribution – worked examples	1	1	1, 2, 3
Unit 2	**Application of Gauss Law and Boundary Value**	**9**		1, 2, 3

	Problems			
	ES field due infinite wire and infinite sheet of charge	1	1, 2	1, 2, 3
	ES field due to conducting and insulating sphere	1	1, 2	1, 2, 3
	ES field due to conducting and insulating cylinder	1	1, 2	1, 2, 3
	Worked examples of boundary value problems	1	1, 2	1, 2, 3
	Problems with azimuthal symmetry	1	1, 2	1, 2, 3
	Problems with circular symmetry	1	1, 2	1, 2, 3
	Problems with spherical symmetry	1	1, 2	1, 2, 3
	Conducting sphere in a uniform field	1	1, 2	1, 2, 3
	Review of boundary value problems	1	1, 2	1, 2, 3
Unit 3	**Electric dipole, dipole moment and quadrupoles**	**9**		1, 2, 3
	Electric potential due to dipole	1	3	1, 2, 3
	Electric field intensity due to dipole	1	3	1, 2, 3
	Torque on electric dipole in external electric field	1	3	1, 2, 3
	Effect of external electric field on non-polar molecules	1	3	1, 2, 3
	induced dipole moment – Image charge formation	1	3	1, 2, 3
	Dipole-dipole interaction in a plane, out of plane and positioned at certain angle	1	3	1, 2, 3
	Dipoles in Uniform and non-uniform electric field	1	3	1, 2, 3
	Potential near an Arbitrary Charge Distribution	1	3	1, 2, 3
	Quadrupole Moment, Two Simple Quadrupoles, Qualitative discussion on Octuplet Moment	1	3	1, 2, 3
Unit 4	**Dielectric materials**	**9**		1, 2, 3
	Polar and non-polar molecules	1	3	1, 2, 3
	Atomic polarizability and related problems	1	3	1, 2, 3
	Electric polarization of dielectric material	1	3	1, 2, 3
	Electric polarization vector, Strength of dielectric material and Dielectric breakdown	1	3	1, 2, 3
	Electric displacement and Gauss law in dielectric, Relation between three electric vectors (E, D and P)	1	3	1, 2, 3
	Plane Parallel Capacitor, Capacitor filled with dielectric	1	3	1, 2, 3
	Coaxial Cylindrical Capacitor, Concentric Spherical Capacitor	1	3	1, 2, 3
	Capacitors in Parallel, Capacitors in Series	1	3	1, 2, 3
	Charging and discharging of Capacitor using High Resistance.	1	3	1, 2, 3
Unit 5	**Alternative current and transient circuit**	**9**		1, 2, 3
	Revisiting Resistors: Series and Parallel resistance. Color code of resistors. Kirchhoff’s Law’s.	1	4	1, 2, 3
	Introduction to inductors: self and mutual inductance.	1	4	1, 2, 3
	Transient current in DC Circuits: LR, LC, LCR circuits.	1	4	1, 2, 3
	Alternating currents: basic ideas of generation, mean and RMS values	1	4	1, 2, 3
	Behaviour of resistor (R), capacitor (C) and inductor (L) in AC circuits: Introduction of Phasor Diagram	1	4	1, 2, 3
	Current and Voltage in LR & CR circuits in AC using phasor diagram: Impedance triangle.	1	4	1, 2, 3
	LCR circuit, series and parallel resonance, bandwidth,	1	4	1, 2, 3

	and Q-value.			
	Losses in A. C. circuits: the skin effect & eddy current. Delta & Star Network of Impedance.	1	4	1, 2, 3
	Working of a Transistor: Step-up and Step-down transformer. Properties of ideal transformer. Impedance matching of a transformer.	1	4	1, 2, 3

Recommended Resources

1. Introduction to Electrodynamics, David J. Griffiths, 4/e Edition, 2015, Pearson Publication
2. Electricity and Magnetism (In Si Units): Berkeley Physics Course - Vol.2 Edward Purcell 2017, McGraw Hill Education
3. Classical Electrodynamics, John David Jackson, 3 Edition 2007, Wiley

Other Resources

1. Classical Electrodynamics, Walter Griener, (2006), SPRINGER (SIE)

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		40%		70%		30%	
Level 2	Apply Analyse	60%		40%		60%		30%		70%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Course Designers

a. *Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP*
b. *Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras*
c. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

PHY 114L	LABORATORY: ELECTROSTATICS AND ELECTRIC CURRENT

Course Code	PHY 114L	Course Category	Core Course	L-T-P-C	0	0	2	1
Pre-Requisite Course(s)		Co-Requisite Course(s)	PHY114	Progressive Course(s)	-			
Course Offering Department	Physics	Professional / Licensing Standards						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Determine important electric and magnetic properties like dielectric constant, capacitance, resistance, inductance in different systems.

Objective 2: Learn to connect AC and DC circuits for real life applications.

Objective 3: Fabricate a LCR circuit and utilize it to make the step up/ step down transformers.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Correlate electricity & magnetism theories with real life examples	1	70%	65%
Outcome 2	Study and calculate electrical parameters of capacitor, inductor, resistor and other components	2	70%	65%
Outcome 3	Design, fabricate and study series and parallel circuits involving capacitor, inductor and resistor.	3	70%	65%
Outcome 4	Study and Design different types of step up/ step down transformers	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	3				2			2	3	2	2
Outcome 2	3	3	2	3	3				2			2	3	3	2

Outcome 3	3	3	3	3	3				2			3	3	2	2
Outcome 4	3	3	2	3	3				3			2	3	2	2
Course Average	**3**	**3**	**2**	**3**	**3**				**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Serial No.	Unit Name	Required Contact Hours	CLOs Addressed	References
1	a) To use a multimeter for measuring Resistances, A/C and DC Voltages, AC and DC Currents, Capacitances, and Frequencies b) Determine electrical parameters of commercially available electronic components	4	1, 2	1,2
2	To determine the capacitance of a parallel plate capacitor by the measurement of charge. To measure the capacitance as a function of area and distance between the plates.	4	1, 2	1, 2
3	To determine the dielectric constant of different dielectric materials	4	1, 2	1, 2
4	To determine the value of High Resistance by Leakage Method	4	1, 2	1, 2
5	To study the response curve of a Series LCR circuit and determine its (a) Resonant Frequency, (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width	4	2, 3	1, 2
6	To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality Factor Q	4	3	1, 2
7	To find the mutual inductance of two coils	4	3	1, 2
8	To study the working of step-down/step-up transformer	4	3, 4	1, 2
	Total contact hours (Experiments +Demo + Extra class)	32 Hours		

Recommended Resources

3. K.G. Mazumdar and B. Ghosh, "Advanced Practical Physics" Sreedhar Publishers, Revised edition Jan 2004
4. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

Other Resources

2. Hugh D.Young, Roger A. Freedman and Lewis Ford "University Physics with Modern Physics" (12th Edition, 2015) –(Publisher – Pearson Education)

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Experiments (20%)		Record/ Observation Note (10%)		Viva Voce + Model examination (20%)			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember				40%		30%		
	Understand								
Level 2	Apply		40%		60%		30%		50%
	Analyse								
Level 3	Evaluate		60%				40%		50%
	Create								
Total		**100%**		**100%**		**100%**		**100%**	

Course Designers

d. *Dr. Siddhartha Ghosh, Asst. Prof. Dept. of Physics. SRM University - AP*
e. *Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP*
f. *Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras*
g. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

SEMESTER-III

FOUNDATION COURSE 6 (FC 6)

PHY 201	WAVES AND OSCILLATIONS		L	T	P	C
			3	0	0	3
Co-requisite:	PHY 201L					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	CORE	WAVES and OSCILLATIONS				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to understand the physics behind various phenomena associated with oscillations, waves and optical instruments.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, students will be able to								
1.	Address different types of oscillations and its various applications							
2.	Understand transverse and longitudinal waves and their propagation							
3.	Learn Doppler'e effect and its applications							
4.	Gain the basic principles of several optical instruments							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit -1: Undamped and Damped Oscillations	**9**			
1.	Different types of equilibria (stable, unstable, neutral equilibrium, Saddle points)	1	C		1-7
2.	Definition of linear and angular S.H.M	1	C		1-7
3.	Differential equation of S.H.M. and its solution (exponential form)	1	C		1-7
4.	Composition of two perpendicular linear S.H.Ms. for frequencies 1:1 and 1:2 (analytical method)	1	C		1-7
5.	Lissajous's figures and its uses	1	D,I		1-7
6.	Lissajous's figures and its Applications (mechanical, electrical and optical)	1	D,I		1-7

7.	Differential equation of damped harmonic oscillator and its solution, discussion of different cases	1	C,D		1-7
8.	Logarithmic decrement, Energy equation of damped oscillations	1	C,D		1-7
9.	Power dissipation, Quality factor	1	C,D		1-7
	Unit – II: Forced Oscillations	**9**			
10.	Forced oscillation with one degree of freedom	1	C		1-7
11.	Differential equation of forced oscillation and its solution (transient and steady state)	1	C,D		1-7
12.	Amplitude of forced oscillation	1	C		1-7
13.	Resonance and its examples: mechanical (Barton's pendulum)	1	C,I		1-7
14.	Resonance and its examples: optical (sodium vapor lamp), electrical (LCR Circuit) (description only)	1	C,I		1-7
15.	Velocity and Amplitude resonance, Sharpness of resonance	1	C		1-7
16.	Energy of forced oscillations, Power dissipation	1	C		1-7
17.	Quality factor and Bandwidth	1	C		1-7
18.	Equation of coupled oscillations, electrically coupled oscillations	1	C,D		1-7
	UNIT III - Wave Motion	**9**			
19.	Differential equations of wave motion in continuous media	1	C		1-7
20.	Group and Phase velocity of a Wave Packet	1	C		1-7
21.	Self-Phase Modulation	1	C		1-7
22.	Equations for longitudinal waves and one dimension solution	1	C		1-7
23.	Wave propagation in solid, liquid, gases	1	C		1-7
24.	Equation for transverse waves and its solution (one dimension only)	1	C		1-7
25.	Transverse Vibrations of a Stretched String	1	C		1-7
26.	Energy density and intensity of a wave	1	C		1-7
27.	Discussion of seismic waves	1	C,D		1-7
	UNIT IV: Sound and Doppler Effect	**9**			
28.	Definition of sound intensity, loudness, pitch, quality and timber	1	C		1-7
29.	Interference of sound waves, beats, combination tones	1	C,D		1-7
30.	Application of Fourier's series to the vibration of strings-struck and plucked strings, Energy of a vibration string	1	C,I		1-7
31.	Acoustic intensity level measurement, Acoustic pressure and it's measurement- The Helmholtz	1	C,I		1-7

	resonator; The Kundt's tube				
32.	Sabine's formula (without derivation), Stroboscope	1	C,D		1-7
33.	Waves generated by high-speed projectiles, Shock waves	1	C,D		1-7
34.	Explanation of Doppler Effect in sound, Expression for apparent frequency in different cases	1	C,D		1-7
35.	Doppler Effect in light, symmetric nature of Doppler Effect in light	1	C,D		1-7
36.	Applications: Red shift, Violet shift, Radar, Speed trap, Width of a spectral line	1	I,O		1-7
	UNIT V: Superposition of Waves	**9**			
37.	Huygens' theory of wave motion	1	C,D		1-7
38.	Application of Huygens' Principle to Study Refraction and Reflection	1	C,D		1-7
39.	Stationary Waves on a String Whose Ends are Fixed, Nodes and Anti-nodes	1	C,D		1-7
40.	Superposition of Two Sinusoidal Waves: Stationary Light Waves: Ives' and Wiener's Experiments	1	C,D		1-7
41.	The Graphical Method for Studying Superposition of Sinusoidal Waves	1	C,D		1-7
42.	The Complex Representation of superposition of waves	1	C,D		1-7
43.	Interference pattern produced on the surface of Water	1	C,D		1-7
44.	Temporal and Spatial coherence in wave preparation	1	D,I		1-7
45.	Superposition of Light waves: Interference by Division of wave front	1	D,I		1-7
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Advanced Acoustics D. P. Roy Chowdhury, Reprint Edition, 2015, Chayan Publisher
2	Vibrations and Waves, Anthony Philip French, reprint Edition, 1971, Nelson
3	Introduction to Geometrical and Physical Optics, B. K. Mathur, 7 Edition, 1967, Gopal Printing
4	Fundamentals of Optics, Francis Jenkins, Harvey White, 4 edition, 2017 McGraw Hill Education
5	Waves Oscillations and Acoustics, Kakani S.L., 2 Edison, 2020, CBS Publishers & Distributors
6	Textbook of sound A. B. Wood, 2 Edison, 1941, London, G. Bell and sons, ltd.

7	A Textbook on Light, K G Mazumdar and B Ghosh, 3rd revised Edition, 2010, Sreedhar Publication, India

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
					End semester examination Weightage	**50%**

PHY 201L	**LABORATORY: WAVES AND OSCILLATIONS**		**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Co-requisite:	PHY 201					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category		CORE	LABORATORY: WAVE AND OSCILLATIONS			
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how principles of waves & oscillations are manifested in real-world environment through properly designed experiments.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand crucial concepts of waves & oscillations like damped oscillation, forced oscillations and resonance through numerical method with C/Python							
2.	Handle and utilize acoustic instruments							
3.	Experimental realization of damped, forced and coupled oscillations and resonance behavior							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	To investigate the damping effect of an oscillating spring in high viscosity liquid like oil or glycerin.	4	I,O		1,2

2.	To develop numerical formalism to investigate resonance in forced oscillations	4	I,O		1,2
3.	a. To determine the coupling factors for a coupling lengths, the angular frequencies or "in-phase" and "in opposite phase" and the beat mode. b. To determine the linear relation between the square of the coupling lengths, beat mode, and the square of the frequency for "in-opposite phase" vibration.	4	I,O		1,2
4.	To develop numerical formalism to investigate stationary waves of a both end fixed string.	4	I,O		1,2
5.	To verify the relationship among wave velocity, wavelength, and frequency of a transverse wave using standing waves on a string	4	I,O		1,2
6.	To determine polar response characteristics of microphone by measuring open circuit voltage generated at varying orientations	4	I,O		1,2
7.	Frequency response of loudspeaker: determine frequency response by measuring sound pressure level (SPL) for a true characteristic	4	I,O		1,2
8.	Interference of sound using PC speakers: studying the interference pattern; comparing experimental observations with theoretical calculations leading to verification of the superposition principle	4	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**32**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	K.G. Mazumdar and B. Ghosh, "*Advanced Practical Physics*" Sreedhar Publishers, Revised edition Jan 2004
2	R.K. Shukla and Anchal Srivastava, "*Practical Physics*" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3	Hugh D.Young, Roger A. Freedman and Lewis Ford "*University Physics with Modern Physics*" (12th Edition, 2015) –(Publisher – Pearson Education)

Course nature			**Practical**		
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
End semester examination Weightage :					**50%**

PHY 202	INTRODUCTION TO OPTICS	L	T	P	C
		3	0	0	3

Co-requisite:	PHY 202L	
Prerequisite:	PHY 114	
Data Book / Codes/Standards	NIL	
Course Category	CORE	INTRODUCTION TO OPTICS
Course designed by	Department of Physics	

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how different principles of optics and light are manifested in real-world environment through properly designed experiments.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Account for fundamental quantities for optics.							
2.	Identify, illustrate and explain physical concepts in optics.							
3.	Describe and discuss technical applications of simple optical instruments.							
4.	Solve problems using suitable models, assumptions and approximations as well as be able to assess the results.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: Physical optics	**9**			
1.	The propagation of light and Rayleigh scattering	1	C,D		1-4
2.	Laws of reflection and refraction	1	C,D		1-4
3.	Fermat's principle	1	C,D		1-4
4.	The electromagnetic approach of light propagation	1	C,D		1-4
5.	The Fresnel equations	1	C,D		1-4
6.	Total internal reflection and evanescent waves	1	C,D		1-4
7.	Optical properties of metals, Interaction of light and matter	1	C,D		1-4
8.	Stokes treatment of reflection and refraction	1	C,I		1-4
9.	Photons and the laws of reflection and refraction	1	C,I		1-4
	UNIT II: Geometrical optics	**9**			

10.	Prisms: dispersion and reflection properties	1	C,D		1-4
11.	Planar and aspherical mirrors	1	C,D		1-4
12.	Thick lenses and lens systems, Newton formula, lateral magnification	1	C,D		1-4
13.	Analytical ray tracing and development of Matrix methods	1	C,D		1-4
14.	Matrix analysis of system of two thin lenses, Unit and Nodal planes	1	C,D		1-4
15.	Matrix analysis of mirror systems	1	C,D		1-4
16.	Monochromatic aberrations – Spherical aberration, Coma, Astigmatism, Field curvature, Distortion	1	C,D		1-4
17.	Chromatic aberrations, Thin achromatic doublets	1	C,I		1-4
18.	GRIN Systems and optical glasses	1	D,I		1-4
	UNIT III: Interference of light	**9**			
19.	Coherence and Interference of Light Waves by Division of Wave Front	1	C,D		1-4
20.	Interference pattern and intensity distribution	1	C,D		1-4
21.	Fresnel Biprism and Interference with white light, Displacement of fringes	1	C,D		1-4
22.	Interference by a plane parallel film illuminated by a plane wave and Cosine law	1	C,D		1-4
23.	High reflectivity from deposited thin film and reflection by a periodic structure	1	C,D		1-4
24.	Interference by a plane parallel film when illuminated by a point source	1	C,D		1-4
25.	Interference by a film with two nonparallel reflecting surfaces Color of Thin Films and Newton's Rings	1	C,I		1-4
26.	The Michelson Interferometer	1	D,I		1-4
27.	Multiple reflections from a plane parallel film, Fabry–Perot etalon and resolving power of Fabry–Perot interferometer	1	C,D		1-4
	UNIT IV: Diffraction of Light	**9**			
28.	Fraunhofer diffraction - single-slit diffraction pattern	1	C,D		1-4
29.	Two-slit Fraunhofer diffraction pattern	1	C,D		1-4
30.	N-slit Fraunhofer diffraction pattern	1	C,D		1-4
31.	The Diffraction Grating and its resolution	1	C,D		1-4
32.	The Fresnel diffraction integral, and Fraunhofer approximation	1	C,D		1-4
33.	Fraunhofer Diffraction by a Long Narrow Slit, Rectangular Aperture and Circular Aperture, Array	1	C,D		1-4

	of Identical Apertures and Spatial Frequency Filtering				
34.	The free propagation of a spherical wave - Fresnel diffraction, half-period zones	1	C,D		1-4
35.	Diffraction at circular apertures, the Zone plate	1	D,I		1-4
36.	Diffraction of a plane wave by a long narrow slit and transition to the Fraunhofer region	1	C,I		1-4
	UNIT V: Polarization of light	**9**			
37.	The Nature of Polarized Light, Types of polarization - plane, circular Elliptical Polarization	1	C,D		1-4
38.	Polarizers, Malus's Law of Polarization	1	C,D		1-4
39.	Dichroism, Dichroic Crystals and Polaroid	1	C,D		1-4
40.	Birefringence, Ordinary and extraordinary light,	1	C,D		1-4
41.	Birefringent Crystals and Birefringent Polarizers	1	C,D		1-4
42.	Polarization by Reflection, The Fresnel Equations and Brewster's Law of Polarization	1	C,D		1-4
43.	Circular Polarizers, Half and full wave plates	1	C,D		1-4
44.	Theory of Optical Activity and Polarimetry	1	C,I		1-4
45.	Induced Optical Effects—Optical Modulators, The Faraday Effect, The Kerr and Pockels Effects	1	C,I		1-4
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Introduction to Geometrical and Physical Optics, B. K. Mathur, 7 Edition, 1967, Gopal Printing
2	Fundamentals of Optics, Francis Jenkins, Harvey White, 4 edition, 2017 McGraw Hill Education
3	A Textbook on Light, K G Mazumdar and B Ghosh, 3rd revised Edition, 2010, Sreedhar Publication, India
4	Optics, Eugene Hecht, 5th Global Edition, 2017, Pearson Education Limited

Course nature			**Theory**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
					End semester examination Weightage	**50%**

PHY 202L	**LABORATORY: INTRODUCTION TO OPTICS**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	PHY 202				
Prerequisite:	PHY 114L				
Data Book / Codes/Standards	NIL				
Course Category	CORE	LABORATORY: INTRODUCTION TO OPTICS			
Course designed by	Department of Physics				
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date			

PURPOSE	The purpose of this course is to introduce students about how different principles of optics and light are manifested in real-world environment through properly designed experiments.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand crucial concepts of Optics like interference, diffractions and polarization through experimental methods							
2.	Handle and utilize a prism and find its various optical properties like angle of deviation (i) – deviation (D), Refractive Index, dispersion power etc.							
3.	Handle and utilize a modern light sources like lasers							
4.	Plan and conduct simple experiments and give an oral and a written presentation of the results.							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	a) Determine angle of deviation (i) – deviation (D) of a given prism. b) To determine the Refractive Index of the Material of a given Prism using Sodium Light.	4	I,O		1,2
2.	a) To determine the dispersion power of a prism material using Mercury light b) To Determine Cauchy's A and B constant with μ $vs. 1/\lambda^2$ graph.	4	I,O		1,2
3.	a) Determination of phase difference and wavelength using Michelson's interferometer b) Determination of Refractive index of glass plate using Michelson's interferometer	4	I,O		1,2
4.	a) To observe the diffraction patterns by holes/single slit double slit with He-Ne laser source	4	I,O		1,2

	b) To observe the diffraction patterns by grating and obtain resolving power of the grating				
5.	To measure the light intensity of plane polarized light as a function of the analyzer position and verify Malus law (inverse square law)	6	I,O		1,2
6.	To determine the specific rotation of cane sugar solution using Polarimeter	6	I,O		1,2
7.	a) Experimental verification of Fresnel's equations for reflection of electromagnetic waves b) Experimental verification of Brewster's Law	6	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**34**			

PHY 203	**QUANTUM MECHANICS**

Course Code	PHY 203	**Course Category**	Core Course	**L-T-P-C**	3	1	0	4
Pre-Requisite Course(s)	PHY 111	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	PHY xxx			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand about the concept of "quantum mechanics" and difference from classical mechanics.

Objective 2: To understand the wave – particle duality, photon theory and matter wave.

Objective 3: To implement the concept and form a wave equation known as Schrodinger equation.

Objective 4: Application of Schrodinger equation to find the properties of microscopic particles.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Knowledge on Radiation Laws, Quantum uncertainty and origin of quantum mechanics	1	70%	65%
Outcome 2	Wave particle duality and superposition knowledge will help to learn the course Quantum Computation	2	70%	65%
Outcome 3	Solve the problem in particle in 3D box and for other potential, and will know why increase of band gap of materials happen in nanodimension	3	70%	65%

Outcome 4	Knowledge in Quantum Tunnelling angular momentum and Commutation relation	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				3			2	3	1	2
Outcome 2	3	3	3	3	2				2			3	3	2	2
Outcome 3	3	3	3	3	2				3			3	3	2	2
Outcome 4	3	3	3	3	3				3			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**2**				**3**			**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Radiation**	**12**		
	Detection of thermal radiation	1	1	1, 2
	Prevost's theory	1	1	1, 2
	Emissive power of different bodies	1	1	1, 2
	Absorptive power of different bodies	1	1	1, 2
	Black body radiation	1	1	1, 2
	Kirchhoff's law	1	1	1, 2
	Pressure of radiation	1	1	1, 2
	Stefan-Boltzmann law and its experimental verification	1	1	1, 2
	Nernst heat theorem	1	1	1, 2
	Tutorial class (Black Body Radiation)	1	1	1, 2
	Tutorial class (Stefan-Boltzmann law)	1	1	1, 2
	Problem-practice class (Stefan-Boltzmann law)	1	1	1, 2
Unit 2	**Origin of Quantum Mechanics**	**12**		
	Planck's Radiation Law	1	1, 2	1, 2
	Photoelectric Effect	1	1, 2	1, 2
	Numerical of Photoelectric effect	1	2	1, 2
	Compton Effect	1	1	1, 2
	Wave particle duality	1	2	1, 2
	Matter waves, De Broglie hypothesis	1	1, 2	1, 2

	Concept of wave packet, The principle of Superposition	1	2	1, 2
	Davisson and Germer experiment	1	1, 2	1, 2
	Phase velocity, group velocity and relation between them	1	1	1, 2
	Tutorial class (Photoelectric Effects)	1	2	1, 2
	Tutorial class (Compton Effect)	1	1, 2	1, 2
	Problem-practice class (De Broglie hypothesis)	1	1	1, 2
Unit 3	**Heisenberg Uncertainty Principle & Basic of Schrodinger equation I**	12		
	Heisenberg's uncertainty principle with thought experiment	1	3	1, 2
	Different forms of uncertainty, Electron diffraction experiment	1	3	1, 2
	Wave function and its physical interpretation, Boundary Condition of Wavefunction	1	3	1, 2
	Definition of an operator in Quantum mechanics	1	3	1, 2
	Linear vector space & Hilbert Space	1	3	1, 2
	Hermitian Operator, Linear Operator	1	3	1, 2
	Position, Momentum and Total energy operator	1	3	1, 2
	Commutator brackets- Simultaneous Eigen functions	1	3	1, 2
	Commutator algebra, Commutation of position and momentum	1	3	1, 2
	Tutorial class (Heisenberg's uncertainty principle)	1	3	1, 2
	Tutorial class (Operator and Wavefunction)	1	3	1, 2
	Problem-practice class (Operator, Commutator bracket)	1	3	1, 2
Unit 4	**Basic of Schrodinger equation II**	12		
	Probability Amplitude, Probability Density, Probability	1	3,4	2,3
	Stationary States	1	3,4	2,3
	Expectation value	1	3,4	2,3
	Eigen function and Eigen values	1	3,4	2,3
	Ehrenfest's theorem	1	3,4	2,3
	Schrodinger time dependent	1	3	2,3
	Schrodinger time independent equation	1	3	2,3
	Probability Current Density	1	3	2,3
	Stationary States and Bound States	1	3	2,3
	Tutorial class (Eigen function and Eigen values)	1	3	2,3
	Tutorial class (Schrodinger time independent equation)	1	3	2,3
	Problem-practice class (Expectation Value)	1	3	2,3
Unit 5	**Schrodinger time independent equation**	12		
	Free particle, Particle in infinitely deep potential well (one – dimensional)	1	4	2,3
	Particle in a three dimensional rigid box	1	4	2,3

	Step potential, potential barrier (Qualitative discussion)	1	4	2,3
	Barrier penetration and tunneling effect	1	4	2,3
	Harmonic oscillator (one-dimension)	1	4	2,3
	Schrodinger equation in spherical polar coordinate	1	4	2,3
	Hydrogen atom: Qualitative discussion on the radial and angular parts of the bound state energy	1	4	2,3
	Quantum numbers $\boldsymbol{n}$, $\boldsymbol{l}$, $\boldsymbol{m}_l$, $\boldsymbol{m}_s$ – Degeneracy	1	4	2,3
	Angular Momentum	1	4	2,3
	Tutorial class (Potential Barrier)	1	4	2,3
	Tutorial class (Angular Momentum)	1	4	2,3
	Problem-practice class (Particle in a three dimensional rigid box)	1	4	2,3

Recommended Resources

5. Introduction to Quantum Mechanics, D. Griffiths 2 edition, 2004, Pearson
6. Quantum Mechanics, G. Aruldhas, 2^{nd} Edition, 2013, PHI
7. Quantum Mechanics: Theory and Applications, Ajoy Ghatak, S. Lokanathan, 1st Edition, 2004, Mc. Millan.

Other Resources

3. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. Eisberg and R. Resnik 2ed Edison, 2006, Wiley

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		40%		70%		30%	
Level 2	Apply Analyse	60%		40%		60%		30%		70%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Course Designers

h. Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP

i. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras

j. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad

ALLIED COURSE

MATHEMATICS

MAT 154	Differential Equations			L 3	T 1	P 0	C 4
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	Core	Differential equations				
Course designed by	DEPARTMENT OF MATHEMATICS						

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	This introductory course on ordinary differential equations (**ODEs**) covers the theory, solution techniques, and applications surrounding linear and non-linear first and second-order differential equations, including systems of equations.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Model some elementary physical situations by writing an appropriate differential equation.							
2	Student will be able to solve first order simple, linear, and separable equations							
3	Solve higher order differential equations using characteristic roots, undetermined coefficients, and the Laplace transform.							
4	Understand the qualitative nature of the solution to the linear and non-linear systems of equations.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I First Order Differential Equations	**8**			
1.	Geometric meaning of $y' = f(x,y)$, Direction Fields	1	C		1
2.	Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable	1	C		1

3.	Integrating Factor, Bernoulli Equations	2	C		1
4.	Initial Value Problem	1	C		1
5.	Modelling (Free falling object, Radioactivity, RL-circuit).	2	C		1
6.	Tutorila-1	1	C, I		1,2
	UNIT-II Second and Higher Order Linear ODEs	**9**			1,2
7.	Homogeneous Linear ODEs	1	C		1
8.	Modelling of Free Oscillations of a Mass-Spring System	2	C		1
9.	Euler-Cauchy Equations	1	C		1
10.	Non-homogeneous ODEs	2	C		1
11.	Variation of Parameters, Modelling (Forced Oscillations, Electric Circuits)	2	C		1
12.	Tutorial-2	1	C, I		1
	UNIT-III System of ODEs	**13**			
13.	Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as systems of ODEs	3	C		1
14.	Wronskian, Phase-Plane Method	2	C		1
15.	Tutorial-3	1	C,I		1
16.	Critical Points & Stability, Qualitative Methods for Nonlinear Systems	3	C		1
17.	Nonhomogeneous Linear Systems of ODEs.	3	C		1
18.	Tutorial-4	1	C,I		1
	UNIT -IV Series Solutions of ODEs	**15**			
19.	Introduction to power series method	1	C		1
20.	Legendre’s equation & polynomials	3	C		1
21.	Properties of Legendre’s polynomial and generating function	3	C		1, 3
22.	Tutorial-5	1	C, I		1
23.	Frobenius Method	2	C		1
24.	Bessel’s Equations & Functions	2	C		1

25.	Properties of Bessel's functions	2	C		1, 3
26.	Tutorial-6	1	C, I		1
	UNIT-V Laplace Transforms	**15**			
27.	Laplace transforms of standard functions	1	C		1,3
28.	Shifting Theorems, Transforms of derivatives and integrals	2	C		1
29.	Unit step function, Dirac's delta function	3	C		1
30.	Tutorial-7	1	C,I		1,2
31.	Inverse Laplace transforms, Convolution theorem (without proof).	3	C		1
32.	Application: Solutions of ordinary differential equations using Laplace transforms	3	C		1,2
33.	Final Reciation and Tutorial-7	2	C, I		1,2
	TOTAL HOURS	60			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley-India.
2	Mary L. Boas, *Mathematical Methods in Physical Sciences*, 3rd Edition, Wiley-India.
3	G. F. Simmons, *Differential Equation with Applications and Historical Notes*, TATA McGraw Hill
4	S. Vaidyanathan, *Advanced Applicable Engineering Mathematics*, CBS Publishers

Course nature			**Theory**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	15%	15%	10%	10%	**50%**
End semester examination Weightage:					**50%**	

ALLIED COURSE

CHEMISTRY

CHE111	Principles of Chemistry-1A	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	DC	ALLIED SUBJECT	GENERAL CHEMISTRY		
Course designed by	Department of Chemistry				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course provides an over view of general concept of chemical bonding and will discuss coordination bonding in chemistry with practical application. In addition, the course will provide basic introduction of fundamental physical chemistry such as thermodynamics, phase rule, chemical kinetics. Finally, the properties of crystalline materials will be covered. In short, throughout this course, the fundamental concepts will be illustrated by the recent examples along with the contemporary knowledge

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Address the different properties of chemical bonding	a						
2.	Know which are the coordination compounds	a						
3.	Develop a deep knowledge about thermodynamics, phase rule, chemical kinetics and crystalline materials.	a		c				
4.	Learners should be able to provide physical explanation in key concepts of bonding and basic physical chemistry.	a						

Sec.	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - CHEMICAL BONDING	**12**			
1	Ionic, covalent, and metallic bonds. Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond.	2	C		1
2	Non-covalent interactions: Van der Waals interactions, dipole-dipole interactions, and hydrogen bonding. Hybridization: Types of hybridization, sp, sp2, sp3, sp3d, d2sp3.	2	C		1
3	Shapes of molecules (VSEPR Theory): $BeCl_2$, CO_2, BF_3, H_2O,	2	D, I		1,3
4	Shapes of molecules (VSEPR Theory): NH_3, CH_4, PCl_5, XeF_2, SF_6, XeF_4.	2	D, I		1,3
5	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method), bond order,	2	C, D		1,3
6	homo- (H_2, O_2, N_2) and heteronuclear diatomic Molecules (NO, CO).	2	D, I		1,3
	UNIT-II: COORDINATION CHEMISTRY	**12**			
7	Werner's theory, valence bond theory (inner and outer orbital complexes), EAN rule,	2	C		2,4
8	Crystal field theory, measurement of 10 Dq (Δo)	2	C		2,4
9	CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt).	2	C		2,4
10	Octahedral vs. tetrahedral coordination, Qualitative aspect of Ligand field and MO Theory.	2	C		2,4
11	IUPAC nomenclature of coordination compounds, isomerism in coordination compounds.	2	C		2,4
12	Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes.	2	C		2,4
	UNIT-III: INTRODUCTION TO THERMODYNAMICS	**12**			
13	Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.	2	C		1,3

14	*First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities,	2	C, I		1,3
15	Calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.	2	C, I		1,3
16	*Second Law:* Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics;	2	C, I		1,3
17	Molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.	2	C		1,3
18	*Third Law:* Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.	2	C, I		1,3
	UNIT IV – PHASE RULE AND KINETICS	**12**			
19	Phase rule: Introduction. Definition of the terms used in phase rule with examples.	3	C		2,4
20	Application of phase rule to water system, sulphur system and lead-silver system.	3	C, I		2,4
21	Kinetics: Order and molecularity of reactions, zero order	3	C		2,4
22	First order and second order reactions.	3	C		2,4
	UNIT V. CRYSTALLINE MATERIALS	**12**			
23	Crystal structure: crystal systems, Bravais lattices,	3	C		1,3,4
24	Miller indices.	1	C		1,3,4
25	Properties of cubic crystals.	3	C		1,3,4
26	X-ray diffraction.	2	C,D,I		1,3,4
27	Defects: point, line, surface and bulk.	3	C		1,3,4
	Total contact hours	60			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Peter, A. & Paula, J. de. *Physical Chemistry* 10th Ed., Oxford University Press (2014).
2	Inorganic Chemistry: Mark Weller, Tina Overton, Jonathan Rourke, and Fraser Armstrong, 6th edition, Oxford University Press, 2014.
3	Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
4	Inorganic Chemistry: J.E. Huheey, E.A. Keiter and R.L. Keiter (2007) 4th edition, Pearson Education.

Course nature		**Theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :		50%				**50%**

ALLIED COURSE

COMPUTER SCIENCE

CSC 202	Introduction to Computer Science and Programming	L	T	P	C
		3	0	2	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Core Course	Engineering Science			
Course designed by	Department of CSE				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course aims to provide ability to design algorithmic solutions to problems and convert algorithms to Python programs. Design modular programs using functions and develop recursive solutions. Provide ability to design programs with interactive input and output, utilizing arithmetic expression repetitions, decision making and design object-oriented solutions. To analyze the computational complexity of the programs.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**							
At the end of the course, student will be able to									
1.	To learn basics of programming knowledge in Python								
2.	The course is designed to get the knowledge of developing problem solving skills using Python								
3.	Decision making and functions in python.								
4.	To introduce basic concepts of object-oriented design technique								
5.	To introduce the concept of computational complexity								

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: Introduction to Python	**9**			
1.	Knowledge, Machines, Languages.	1			1
2	Types, Variables Operators and Branching.	1			
3.	**Core elements of programs**: Bindings, Strings, Input/Output, IDEs.	1			1

4.	Input/Output, IDEs.	1			
5.	Control Flow, Iteration, Guess and Check.	1			1
6.	**Simple Programs**: Approximate Solutions.	1			1
7.	Bisection Search.	1			1
8.	Floats and Fractions.	1			1
9.	Newton-Raphson.	1			1
	Unit II	**9**			
10.	**Functions**: Decomposition and Abstraction.	1			1
11.	Functions and Scope.	1			1,2
12.	Keyword Arguments, Specifications.	1			1,2
13.	Iteration vs Recursion.	1			1,2
14.	Inductive Reasoning.	1			1
15.	Towers of Hanoi.	1			1,2
16.	Fibonacci.	1			
17.	Recursion on non-numerics.	1			
18.	Files.	1			
	UNIT III –	**9**			
19.	**Tuples and Lists**: Tuples, Lists, List Operations.	1			1
20.	Mutation, Aliasing, Cloning.	1			1
21.	**Dictionaries**: Functions as Objects, Dictionaries.	1			1
22.	Example with a Dictionary, Fibonacci and Dictionaries.	1			1
23.	Global Variables.	1			1
24.	**Debugging**: Programming Challenges.	1			
25.	Classes of Tests, Bugs, Debugging, Debugging Examples.	1			1
26.	**Assertions and Exceptions,** Assertions, Exceptions.	1			

27.	Exception Examples.	1			
	UNIT IV:	9			
28.	**Classes and Inheritance**	1			4
29.	Object Oriented Programming.	1			4
30.	Basic Concept of Object.	1			4
31.	Class, Inheritance, Polymorphism.	1			4
32.	Class Instances, methods Classes Examples.	1			4
33.	Why OOP, Hierarchies, Your Own Types – **An Extended Example**: Building a Class.	1			
34.	Visualizing the Hierarchy.	1			
35.	Adding another Class, Using Inherited Methods.	1			
36.	Gradebook Example, Generators.	1			
	UNIT V:	**9**			
37.	**Computational Complexity**:	1			2
38.	Program Efficiency, Big Oh Notation.	1			2,4
39.	Complexity Classes Analysing 10Complexity.	1			2
40.	**Searching and Sorting Algorithms**:	1			2,4
41.	Introduction on search and sorting.	1			
42.	Linear Search.	1			
43.	Bisection Search.	1			
44.	Bogo and Bubble Sort.	1			
45.	Selection Sort, Merge Sort	1			
	Total contact hours	45			

LEARNING RESOURCES	
	TEXTBOOKS/REFERENCE BOOKS/OTHER READING MATERIAL

1.	Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher, Revised and Expanded version (Referred by MIT)
2.	Python Programming using problem solving Approach by ReemaThareja, Oxford University, Higher EducationOxford University Press; First edition (10 June 2017), ISBN-10: 0199480173
3.	Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016)
4.	Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February 2009)

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	A company decided to give bonus of 5% to employee if his/her year of service is more than 5 years. Ask user for their salary and year of service and print the net bonus amount.	1	I,O		1,2,3,4
2.	Write a program that computes the real roots of a quadratic function. Your program should begin by prompting the user for the values of a, b and c. Then it should display a message indicating the nature of real roots, along with the values of the real roots (if any).	2	I,O		1,2,3,4
3.	Write a Python program to find the factorial of the given number (Example: 5!= 5*4*3*2*1 =120).	1	I,O		1,2,3,4
4.	Write a Python program to read the numbers from the keyboard using a loop, perform the sum and average of all the input numbers until "-10" is encountered.	2	I,O		1,2,3,4
5.	Write a Python program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings.	1	I,O		1,2,3,4
6.	Write a python program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm? Explain with an example, where the list of elements is not sorted then what would be the output after each iteration/pass.	2	I,O		1,2,3,4
7.	Write a python program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?	1	I,O		1,2,3,4
8.	Write a Program in python using object-oriented concept to make calculator which has the following operations: Addition, Subtraction, Multiplications, Divisions, Exponentials, Modulus.	2	I,O		1,2,3,4
9.	Define is inheritance? Explain with suitable example: Single level inheritance, Multiple Inheritance, Multi-level Inheritance.	1	I,O		1,2,3,4
10.	Write a Program in python using object-oriented concept to create a base class called **Polygon** and there are three	2	I,O		1,2,3,4

	derived classes named **as triangle, rectangle** and **square**. The base class consists of the **input function** for accepting sides length and the derived classes must have **output function** for displaying area of triangle, rectangle and square.				
	Total Hours	15			

Course nature				**Theory and Lab**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Mid Term I	Mid Term II	Assignments	Lab Performance	Quiz	**Total**
	Weightage Theory	**15%**	**15%**	**5%**	**10%**	**5%**	**50%**
End semester examination Weightage:						**50%**	

SEMESTER – IV

PHY 211	ANALOG AND DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3
Co-requisite:	PHY 211L				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	CORE	Electronics			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about the basic electronics and electronic devices.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the concept of band gap in semiconductors.							
2.	Design op-amps, adders and oscillators for a variety of applications							
3.	Understand rectifiers, filters							
4.	Design different circuits using logic gates							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - Semiconductor Fundamentals	**9**			
1.	Types of solids	1	C		1-4
2.	Semiconducting materials: Introduction	1	C		1-4
3.	Semiconducting materials: Types	1	C		1-4
4.	Conduction energy band valance energy band	1	C		1-4
5.	Origin of band gap	1	C		1-4
6.	Doping of semiconductor	1	C		1-4
7.	p type semiconductor	1	C		1-4
8.	n type semiconductor	1	C		1-4

9.	Energy levels of doped semiconductors	1	C		1-4
	UNIT II – Analog electronics	**9**			
10.	P-n junction diodes and equivalent circuit	1	C		1-4
11.	Zener diodes and its applications	1	C		1-4
12.	Clipping and clamping application	1	I		1-4
13.	Bipolar junction transistor, types	1	C-D		1-4
14.	Symbols and basic configurations (Common Base, Common Emitter & Common Collector)	1	C		1-4
15.	Definition of alpha, beta and their relations	1	C		1-4
16.	Input, output and transfer characteristics of CE and CB configurations	1	C-D		1-4
17.	AC and DC load lines	1	C		1-4
18.	operating point (Q point)	1	C		1-4
	UNIT III - Operational Amplifiers and Oscillators	**9**			
19.	Positive and negative feedback, four types of negative feedback	1	C-D		1-4
20.	Operational amplifier: IC 741- Block diagram, Characteristics: ideal and practical	1	C-D		1-4
21.	Concept of virtual ground	1	C		1-4
22.	Inverting and non-inverting operational amplifiers with concept of gain	1	C-D		1-4
23.	Operational amplifier as an adder, subtracted and other examples	1	C-D		1-4
24.	Oscillators: concept of positive and negative feedback	1	C-D		1-4
25.	Barkhausein criteria**,** Phase shift oscillator and Wien bridge oscillator (Derivation for frequency and feedback factor for both oscillators)	1	C-D		1-4
26.	Power amplifiers	1	C-D		1-4
27.	Class A / B / C and operators	1	C		1-4
	UNIT IV: Power Supplies	**9**			
28.	Half wave, Full wave rectifier	1	C-D		1-4
29.	Ripple factor	1	D		1-4

30.	Bridge rectifier	1	D		1-4
31.	Capacitor filter	1	D		1-4
32.	Difference between regulated and unregulated power supply	1	D-I		1-4
33.	Definition of Line and Load regulation	1	D		1-4
34.	Series and Shunt regulators- Block diagram and circuit of regulated power supply using discrete components	1	D-I		1-4
35.	Simple current limiting circuit	1	D-I		1-4
36.	Design of a regulated DC power supply	1	D-I		1-4
	UNIT V: Digital Electronics	**9**			
37.	Number systems: Binary, Binary coded decimal (BCD), Octal, Hexadecimal	1	C-D		1-4
38.	Addition and subtraction of binary numbers and binary fractions	1	C-D		1-4
39.	Basic logic gates: OR, AND, NOT	1	C-D		1-4
40.	Derived gates: NOR, NAND, EXOR, EXNOR with symbols and truth tables	1	C-D		1-4
41.	Boolean algebra	1	C-D		1-4
42.	Boolean Equations	1	C-D		1-4
43.	De Morgan's theorems and its verification	1	D		1-4
44.	Introduction to ROM, RAM, and PROM	1	C		1-4
45.	Introduction to EPROM, and EEPROM	1	C		1-4
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Electronic Devices and Circuit Theory: Robert L. Boylestad and Louis Nashelsky (2015) 11th Edition, Pearson
2	Digital Principles and Applications, D. Leach, A. Malvino and G Saha (2010) 7th Edition Tata Mc-Graw Hills Pub
3	Electronic Principles: A. Malvino and D. Bates (2006) 7th edition, Mc- Graw-Hill
4	The Art of Electronics: P. Horwitz and W. Hill (1989) 2nd edition, Cambridge University Press

Course nature					**Theory**	
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 211L	**Laboratory: Analog and Digital Electronics**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	PHY 211				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	CORE	Basic Electronics			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to train students about design and utilization as well as understanding of several basic and advanced electronics devices using both analogue and digital electronics circuit elements.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Use various electronic circuit elements and electronics 'bread board' to construct various electronics devices.							
2.	Design and use and understand circuit characteristics of various analogue electronics devices like diodes, transistor, rectifier, CE & Operational amplifier.							
3.	Design and verify various digital electronics logic gates (i.e. AND, NOT, OR, NOR etc.).							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	To determine the forward and reverse characteristics of p-n junction. To determine the Load line of junction diode	2	I,O		1,2
2.	To study the characteristics of a Zener Diode and to study its use as a Voltage Regulator	2	I,O		1,2

3.	To understand the theory of operation of the clipping and clamping diode circuits. To design wave shapes that meet different circuit's needs	2	I,O		1,2
4.	To study Half-wave Rectifier and investigate the effect of C, L and π filters To study Full-wave Bridge Rectifier and investigate the effect of C, L and π filters	4	I,O		1,2,3
5.	a) To study the various Transistor Biasing configurations a) To study the CE Characteristics of a Transistor and finding load line and Q-factor	4	I,O		1,2,3
6.	To study the working of op- amp as adder, sub tractor and comparator, To investigate the use of an op-amp as an Integrator and Differentiator. Design an analog circuit to simulate the solution of a first/second order differential equation.	4	I,O		1,2,3
7.	To design an Inverting and Non-Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.	2	I,O		1,2,3
8.	To design and study a precision Differential Amplifier of given I/O specification using Op-amp 741.	2	I,O		1,2,3
9.	To design a DC power supply with a given voltage and current output characteristic and define its load line	4	I,O		1,2,3
10.	Verify and design AND, OR, NOT and XOR gates truth tables with diode and Transistors.	2	I,O		1,2,3
11.	To verify and design AND, OR, NOT and XOR gates using NAND gate ICs	2	I,O		1,2,3
12.	To design a combinational logic system for a specified Truth Table	2	I,O		1,2,3
13.	To design a stable multi-vibrator of given specifications using IC-555 Timer	2	I,O		1,2,3
	Total contact hours (Experiments +Demo + Extra class)	**34**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Robert L. Boylestad and Louis Nashelsky "*Electronic Devices and Circuit Theory*" (2015) 11th Edition, Pearson
2	D. Leach, A. Malvino and G Saha "*Digital Principles and Applications*", (2010) 7th Edition Tata Mc-Graw Hills Pub
3	P. Horwitz and W. Hill "*The Art of Electronics*" (1989) 2nd edition, Cambridge University Press

Course nature			**Practical**		
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

PHY 212	**ELECTRODYNAMICS**		**L**	**T**	**P**	**C**
			3	**0**	0	**3**
Co-requisite:	PHY 212L					
Prerequisite:	PHY 114					
Data Book / Codes/Standards	NIL					
Course Category	CORE	ELECTRODYNAMICS				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about the electromagnetic wave, magnetic properties and electrodynamics.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To understand the general concepts in Magnetostatics							
2.	To learn the fundamentals of electromagnetic wave theory							
3.	To develop problem solving skills in Electromagnetism							
4.	To explore the field of electricity and magnetism							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - Magnetostatics	**9**			

1.	Concept of magnetic field intensity (B) and flux, Definition and properties of magnetic field	1	C		1,2
2.	Definition of B and H, Calculation of divergence and curl of B with boundary conditions	1	C		1,2
3.	Lorentz Force law, motion of charged particles in electric and magnetic field, Cyclotron frequency	1	C		1,2
4.	Biot – Savart's law, Illustration with long straight conductor, current carrying circular loop on the axis	1	C-D		1,2
5.	Calculation of field on the Axis and in plane of a circular current-carrying Coil, Helmholtz Coils	1	C-D		1,2
6.	Magnetic moment of a current carrying loop	1	D		1,2
7.	The Permeability of Free Space, Ampère's Law – worked examples	1	D-I		1,2
8.	Force Between Two Current-carrying Wires	1	C		1,2
9.	Problems based on magnetic field and Magnetostatics	1	I		1,2
	UNIT II – Magnetism and Magnetic properties	**9**			
10.	Magnetic Materials - An Overview	1	C		1,2
11.	Magnetic moment, Bohr magneton	1	C		1,2
12.	Magnetisation (M), Magnetic Intensity (H) and magnetic induction (B) – their mathematical relations	1	C		1,2
13.	Magnetisation and Susceptibility and magnetic permeability of magnetic materials	1	C		1,2
14.	Magnetic field of magnetized objects and bound currents	1	C		1,2
15.	Magnetic field due to a uniformly magnetized sphere	1	C		1,2
16.	Diamagnetic, paramagnetic and ferromagnetic	1	C		1,2
17.	Explanation of Diamagnetic, paramagnetic and ferromagnetic with the help of susceptibility and permeability Hysteresis and B-H Loops	1	C		1,2
18.	Problems on magnetism and its properties	1	I		1,2
	UNIT III - Electromagnetic Induction	**9**			
19.	Time varying fields: Faradays law of induction, worked examples	1	C-I		1,2
20.	Mutual inductance, coupled circuits and coefficient of coupling	1	C-D		1,2
21.	Leakage inductance, impedance matching	1	C-D		1,2

22.	Transformer circuit	1	C		1,2
23.	Reflected impedance transformation, equivalent circuit of a transformer	1	C		1,2
24.	Lenz's Law, Worked examples	1	C-D		1,2
25.	Ballistic Galvanometer and the Measurement of Magnetic Field	1	C		1,2
26.	AC Generator, AC Power,0 Linear Motors Generators, Rotary Motors	1	C-D		1,2
27.	Generators, Rotary Motors	1	C		1,2
	UNIT IV: Electrodynamics	**9**			
28.	Generalization of Amperes' law	1	C		3,4,5
29.	Problems on Amperes' law – worked examples	1	I		3,4,5
30.	Maxwell's equation	1	C		3,4,5
31.	Maxwell's equation - Differential form	1	C		3,4,5
32.	Maxwell's equation -Integral form	1	C		3,4,5
33.	Problems on Maxwell's equation	1	I		3,4,5
34.	Magnetic Vector potentials	1	C		3,4,5
35.	Retarded potential	1	C		3,4,5
36.	Problems on Magnetic potentials	1	I		3,4,5
	UNIT V: Electromagnetic waves	**9**			
37.	Wave equation and plane waves in free space	1	C		3,4,5
38.	Poynting theorem	1	C		3,4,5
39.	Polarizations of plane wave	1	C		3,4,5
40.	Plane monochromatic waves in conducting media	1	C-I		3,4,5
41.	Reflection from a conducting plane	1	C-I		3,4,5
42.	Skin effect ,Absorption and scattering	1	C-I		3,4,5
43.	Absorption and scattering of electromagnetic waves	1	C		3,4,5

44.	Anomalous dispersion	1	C-I		3,4,5
45.	Problems on electromagnetic waves – worked examples	1	C-I		3,4,5
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS
1	University Physics with Modern Physics, Hugh D. Young, Roger A. Freedman, A Lewis Ford, 13 Edition, 2013, Pearson India
2	Electricity and Magnetism (In Si Units): Berkeley Physics Course - Vol.2 Edward Purcell 2017, McGraw Hill Education
3	Introduction to Electrodynamics, David J. Griffiths, 4/e Edition, 2015, Pearson Publication
	REFERENCE BOOKS/OTHER READING MATERIAL
4	Classical Electrodynamics, John David Jackson, 3 Edition 2007, Wiley
5	Physics, Volume 2 David Halliday, Robert Resnick, Kenneth S. Krane, 5 Edition, 2001, John Wiley & Sons

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 212L	LABORATORY: ELECTRODYNAMICS	L	T	P	C
		0	0	4	2

Co-requisite:	PHY 212	
Prerequisite:	PHY114L	
Data Book / Codes/Standards	NIL	
Course Category	CORE	LABORATORY: ELECTRODYNAMICS
Course designed by	Department of Physics	

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how the fundamental properties of magnetic materials and its importance in the everyday life technological applications. Correlate the impact of fundamental electromagnetic principles to the advanced technology.

	LEARNING OBJECTIVES	**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Realize the importance of fundamental Maxwell electromagnetic equations and be able to develop numerous applications using electronic and magnetic properties of matter.							
2.	Realize the necessity of time varying electric, magnetic fields in energy and power sectors.							
3.	Handle high current and voltage power supplies.							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	To study the magnetic field along the axis of a current carrying circular loop and study the dependency of magnetic field on the diameter of coil	6	I,O		1,2
2.	To calculate the magnetic flux induced by the falling magnet as a function of the velocity of the magnet and measure induced voltage impulse as a function of the velocity of the magnet	6	I,O		1,2
3.	To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field	6	I,O		1,2
4.	To demonstrate Dia-Para-Ferro magnetism in a given material using an inhomogeneous magnetic field	2	I,O		1,2
5.	To study permeability curve of a given material.	6	I,O		1,2

6.	To determine susceptibility of paramagnetic sample by using Quinck's tube method.	6	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**32**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	K.G. Mazumdar and B. Ghosh, "*Advanced Practical Physics*" Sreedhar Publishers, Revised edition Jan 2004
2	R.K. Shukla and Anchal Srivastava, "*Practical Physics*" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3	Michael Coey, "Magnetism and Magnetic Materials" Cambridge University Press, 2010 [ISBN: 9780511845000]

Course nature				**Laboratory**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/Observation note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

PHY 213	**FREE SPACE AND FIBER OPTICAL COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**
Co-requisite:	NIL				
Prerequisite:	PHY 104, PHY 104L, PHY 203				
Data Book / Codes/Standards	NIL				
Course Category	CORE				
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course aims to cover the basics of optical communication through free space as well

	fibers. This course mainly concentrate on the propagation of light through required medium and study their communication ability.

LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	This introductory course on Optical Communication is proposed to give the basic idea about optical communication and its necessity to the present era.							
2.	This course mainly discusses about the free space and fiber optical communication protocols along with the description of fibers.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – Free space optical channel models	**12**			
1.	Overview	1	C		1,2
2.	Free space optical communication	1	C		1,2
3.	Atmospheric channel – losses	1	C		1,2
4.	TUTORIAL - I	1	D-I		1,2
5.	Atmospheric channel – Turbulence	1	C		1,2
6.	Turbulence mitigation	1	C-D		1,2
7.	Optical transmitter – design	1	C-D		1,2
8.	TUTORIAL - II	1	D-I		1,2
9.	Optical receiver	1	C-D		1,2
10.	Post and pre-amplifiers	1	C-D		1,2
11.	channel link design	1	C-D		1,2
12.	TUTORIAL - III	1	D-I		1,2
	UNIT II – Tracking and pointing	**12**			
13.	acquisition link configuration	1	C-D		1,2
14.	Scanning technique	1	C-D		1,2
15.	Tracking and pointing – Necessity	1	C-D		1,2
16.	TUTORIAL - I	1	D-I		1,2
17.	Integration of ATP system	1	C-D		1,2
18.	ATP link budget	1	C-D		1,2
19.	BER performance I	1	C-D		1,2
20.	TUTORIAL - II	1	D-I		1,2
21.	BER performance II	1	C-D		1,2
22.	Different models for BER performance	1	C-D		1,2
23.	Experimental implementation	1	C-D		1,2
24.	TUTORIAL - III	1	D-I		1,2
	UNIT III – Optical Fibres	**12**			

25.	Introduction and Historical development	1	C		1,2
26.	Description of Fibres	1	C		1,2
27.	Classification of Fibres	1	C-D		1,2
28.	TUTORIAL - I	1	D-I		1,2
29.	Fibre fabrication and characteristics	1	C-D		1,2
30.	Fibre Materials	1	C-D		1,2
31.	Optical fibre cables	1	C-D		1,2
32.	TUTORIAL - II	1	D-I		1,2
33.	Transmission Characteristics	1	C-D		1,2
34.	Dispersion of light	1	C		1,2
35.	loss of light in Fibres	1	C		1,2
36.	TUTORIAL - III	1	D-I		1,2
	UNIT IV: Source and Detection systems	**12**			
37.	Development of lasers	1	C		1,2
38.	Lasers for fibre optical communication	1	C		1,2
39.	Materials for optical sources	1	C		1,2
40.	TUTORIAL - I	1	D-I		1,2
41.	Development of low loss Fibres	1	C-D-I		1,2
42.	Coupling of light to Fibres	1	D-I		1,2
43.	Fibre splices	1	D-I		1,2
44.	TUTORIAL - II	1	D-I		1,2
45.	Fibre connectors	1	C		1,2
46.	Photo Detectors	1	D		1,2
47.	Noise Analysis	1	C		1,2
48.	TUTORIAL - III	1	D-I		1,2
	UNIT V: Fibre Communication	**12**			
49.	Optical Transmitters	1	C		1,2
50.	Multi-Channel transmitter	1	C		1,2
51.	Optical Amplifiers	1	C-D		1,2
52.	TUTORIAL - I	1	D-I		1,2
53.	Fibre Amplifiers	1	D		1,2
54.	Photonic Integrated Circuits	1	C		1,2
55.	Other optical devices	1	C		1,2

56.	TUTORIAL - II	1	D-I		1,2
57.	Multiplexers and De-Multiplexers	1	C-D		1,2
58.	Wavelength Division multiplexing	1	C-D		1,2
59.	Other communication protocols	1	C-D		1,2
60.	TUTORIAL - III	1	D-I		1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
	TEXTBOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Free space optical communication, (2009) – H. Kaushal, V. K. Jain, S. Kar (Publisher – Springer)
2	Optical Fiber Communication, (2015) – P Chakrabarti, McGraw Hill Publications

Course nature						**Theory**
Assessment Method – Theory Component (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY XXX	**DEPARTMENT ELECTIVE - I**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category					
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

Course Name	Code	L	T	P	C
ELECTRONIC MATERIALS & DEVICE PHYSICS	PHY 306E	4	0	0	4
SPECIAL THEORY OF RELATIVITY	PHY 307E	3	1	0	4
INTRODUCTION TO ASTROPHYSICS	PHY 308E	3	1	0	4
INTRODUCTION TO PHOTONICS	PHY 702E	3	0	2	4
INTRODUCTION TO QUANTUM COMPUTATION	PHY 709E	3	1	0	4
INTRODUCTION TO SOFT MATTER PHYSICS	PHY 711E	3	1	0	4
QUANTUM OPTICS	PHY 712E	3	1	0	4

*PHY 306E, PHY 307E, PHY 308E courses are offered depending on the students strength.

***There are specific *Prerequisite Courses for PHY 702E, PHY 709E, PHY 711E, PHY 712E* Courses. Undergraduate students are requested to consult with respective faculty members or Head of the Department, Physics for registering these elective courses.

ALLIED COURSE

MATHEMATICS

MAT 251	COMPLEX ANALYSIS		L	T	P	C
			4	0	0	4
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	CORE	COMPLEX ANALYSIS				
Course designed by	DEPARTMENT OF MATHEMATICS					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	This course is aimed to introduce the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced. The notion of the Riemann sheet is presented to help student visualize multi-valued complex functions. Complex integration and complex power series are presented. We then discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. Students will be equipped with the understanding of the fundamental concepts of complex variable theory. In particular, students will acquire the skill of contour integration to evaluate complicated real integrals via residue calculus.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Determine whether a given function is differentiable, and if so find its derivative. Use power series and line integrals to construct differentiable functions. Construct branches of inverse functions.							
2	Find parametrizations of curves, and compute line integrals directly. Use antiderivatives or Cauchy's integral theorem or formula to compute line integrals. Determine whether given functions have antiderivatives, logarithms, and nth roots. Find Laurent series about isolated singularities, and determine residues. Use the residue theorem to compute several kinds of real integrals							
3	Construct conformal mappings between many kinds of domain. Use conformal mapping to solve the Dirichlet problem in a region							
4	Determine whether a sequence of analytic functions converges uniformly on compact sets. Express some functions as infinite series or products.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I - The Algebra Geometry and Topology of the Complex Plane	**12**			
1.	Complex numbers, conjugation, modulus, argument and inequalities. Powers and roots of complex numbers,	2	C		1

2.	geometry in the complex plane, the extended complex plane	2	C		1
3.	Topology of the complex plane, open sets	2	C		1
4.	closed sets, limit points, isolated points	2	C		1
5.	interior points, boundary points, exterior points, compact sets	2	C		1
6.	connected sets, sequences and series of complex numbers and convergence	2	C		1
	Unit II- Complex Functions: Limits, Continuity and Differentiation	**12**			
7.	Limits and continuity	3	C		1
8.	Differentiation and the Cauchy-Riemann equations	3	C		1
9.	Analytic functions,	3	C		1
10.	Harmonic functions	3	C		1
	Unit III – Complex Integration Theory	**12**			
11.	Introducing curves, paths and contours, contour integrals and their properties,	1	C		1
12.	Fundamental theorem of calculus	2	C		1
13.	Cauchy's theorem as a version of Green's theorem	2	C		1
14.	Cauchy-Goursat theorem for a rectangle	2	C		1
15.	The antiderivative theorem	1	C		1
16.	Cauchy-Goursat theorem for a disc	2	C		1
17.	The deformation theorem	2	C		1
	Unit IV – Further Properties of Analytic Functions	**12**			
18.	Power series, their analyticity,	2	C		1
19.	Taylor's theorem	2	C		1
20.	Zeroes of analytic functions	2	C		1
21.	Rouche's theorem	2	C		1
22.	Open mapping theorem	2	C		1
23.	Maximum modulus theorem	2	C		1

	Unit V – Isolated Singularities and Residue Theorem	**12**			
24.	Isolated singularities,	2	C		1
25.	removable singularities, Poles	2	C		1
26.	Classification of isolated singularities	2	C		1
27.	Casoratti-Weierstrass theorem, Laurent's theorem	2	C		1
28.	Residue theorem	2	C		1
29.	The argument principle	2	C		1
Total contact hours		60			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Saff Edward B., Snider Arthur David. Fundamentals of complex analysis: engineering, sci and mathematics. Harlow, England
2	H.A. Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006
3	L.V. Ahlfors, Complex Analysis, 3rd edition, McGraw Hill, 2000
4	J.E. Marsden and M. J. Hoffman, Basic Complex Analysis, 3rd edition, W.H. Freeman, 1999

Course nature			**Theory**			
	Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Cycle test I	Cycle test II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

ALLIED COURSE

CHEMISTRY

CHE112	PRINCIPLES OF CHEMISTRY-IB			L	T	P	C
				3	0	2	4
Co-requisite:	CHE 113 L						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	DA	PROFESSIONAL CORE	GENERAL CHEMISTRY				
Course designed by	Department of Chemistry						

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course provides an over view of general organic chemistry and will discuss the proprieties varies organic molecules carbohydrates, amino acids, peptides and proteins. The course will give detailed accounts of different kinds of spectroscopy techniques for analysis of organic molecules. Electronic spectra and Electroanalytical methods will be covered briefly. The fundamental concepts could be illustrated by the recent examples along with the contemporary knowledge

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Address the different properties of organic molecules	a	b					
2.	Know which are the carbohydrates, amino acids, peptides and proteins.	a	b					
3.	Develop a deep knowledge about the different kind spectroscopy techniques involved in the organic molecules characterization.		b				f	
4.	Learners should be able to provide physical explanation in key concepts of Electronic spectra and electroanalytical techniques.	a	b					

Session	Description of Topic	Contact	C-D-	IOs	Reference

		hours	I-O		
	UNIT-I: INTRODUCTION TO ORGANIC CHEMISTRY	**12**			
1.	Electronic structure and bonding	1	C		1,2
2.	Physical Effects: Boiling points, van der Waals forces, Dipole-Dipole Interactions	1	C		1,2
3.	Electronic Displacements: Inductive Effect, Electromeric Effect	2	C		1,2
4.	Cleavage of Bonds: Homolysis and Heterolysis	1	C,D		1,2
5.	Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.	2	C		1,2
6.	Reactive Intermediates: Carbocations, Carbanions	1	C		1,2
7.	Free radicals and carbenes	1	C		1,2
8.	Strength of organic acids and bases: Definition of pKa, HSAB principle	2	C		1,2
9.	Aromaticity: Benzenoids and Hückel's rule	1	C		1,2
	UNIT-II: CARBOHYDRATES, AMINO ACIDS, PEPTIDES AND PROTEINS	**9**			
10.	Classification of carbohydrates, reducing and non-reducing sugars.	1	C		1,2
11.	General Properties of Glucose and Fructose, their open chain structure	1	C		1,2
12.	Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides	1	C		1,2
13.	Classification of Amino Acids, Strecker synthesis using Gabriel's phthalimide synthesis.	1	C		1,2
14.	Zwitterion structure and Isoelectric point.	1	C		1,2
15.	Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins	1	C		1,2
16.	Determination of primary structure of peptides	1	C		1,2
17.	Determination of N-terminal amino acid (by DNFB and Edman method)	1	C		1,2

18.	C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).	1	C		1,2
	UNIT-III: INFRARED AND VIBRATIONAL SPECTROSCOPIES	**9**			
19.	Vibrational spectra, selection rules	1	C		1,2
20.	vibrational spectra of polyatomic molecules	1	C		1,2
21.	Normal modes and anharmonicity	1	C		1,2
22.	Interpretation of hydroxyl, carbonyl functional group	2	C		1,2
23.	Amino, and aromatic functional group	1	C		1,2
24.	Qualitative prediction of IR spectra	1	C		1,2
25.	Introduction to Raman spectroscopy	1	C		1,2
26.	Interpretation of infrared spectra of some organic and inorganic compounds.	1	C		1,2
	UNIT-IV: ELECTRONIC SPECTROSCOPY	**9**			3,4
27.	Transition moments, assignment of electronic transitions in organic molecular systems	1	C		3,4
28.	Fluorescence and phosphorescence	1	C		3,4
29.	Interpretation of absorption and emission spectra of small organic molecules and inorganic complexes.	2	C		3,4
30.	X-ray photoelectron spectroscopy	1	C		3,4
31.	Photoelectron spectroscopy	1	C		3,4
32.	Usefulness XPES and PES spectra	1	C		3,4

33.	Interpretation of spectra using organic and inorganic compounds	2	C		3,4
	UNIT-V: ELECTROANALYTICAL METHODS	**6**			3,4
34.	Classification of electroanalytical methods	1	C		3,4
35.	Basic principle of pH metric	1	C		3,4
36.	Potentiometric and conductometric titrations	2			3,4
37.	Techniques used for the determination of equivalence points	1	C		3,4
38.	Techniques used for the determination of pKa values.	1	C		3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
2	Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3	William Kemp, Organic Spectroscopy, MacMillon.
4	Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4 th Ed. Tata McGraw-Hill: New Delhi (2006).

Course nature	**Theory**					
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Midterm I	Midterm II	CLA1	CLA2	**Total**
	Weightage	**15**	**15**	**10**	**10**	**50%**
End semester examination Weightage :	**50**					**50%**

CHE 113 L	Physical Chemistry – I: Laboratory			L	T	P	C
				0	0	3	2
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	DCP	DEPARTMENT CORE LABORATORY	PHYSICAL CHEMISTRY				
Course designed by	DEPARTMENT OF CHEMISTRY						

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

LIST OF EXPERIMENTS

Conductometry

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:

i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Mixture of strong acid and weak acid vs. strong base
iv. Strong acid vs. weak base

Potentiometry

I. Perform the following potentiometric titrations:

- Strong acid vs. strong base
- Weak acid vs. strong base
- Dibasic acid vs. strong base
- Potassium dichromate vs. Mohr's salt

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Course nature				**Laboratory**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Lab Performance	Model Exam	Observation Notes	**Total**

	Weightage	20%	20%	10%	50%
End semester examination Weightage :				50%	50%

ALLIED COURSE

COMPUTER SCIENCE

CSC212	**Web Technology**		**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Co-requisite:	NIL					
Prerequisite:	Knowledge in any programming language					
Data Book / Codes/Standards	NIL					
Course Category	√	Core Course	Engineering Science			
Course designed by	Department of CSE					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course focus on learning the basics of world wide web and developing interactive web-based applications. The development of web-based applications requires knowledge about the underlying technology and the knowledge in the programming languages for web development.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
	Learn the basics of internet and communication models	a						
	Learn the basics of client side programming techniques	a	b	c				
	Understand the basics of document object models	a	b	c				
	Understand the ways to store and transport data	a	b	c				
	Learn about various web services and how it’s useful in web development	a	b	c				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**

	UNIT I: Web Essentials	**6**			
1.	Introduction to World Wide Web (WWW)	1	C	1	1
	Introduction to Communication Models.	1	C	1	1
	Web site design principles, planning the site and navigation.	1	C, D	1	1
	Introduction to Hypertext Markup Language (HTML)		C, D, I	1	1
	Form design using HTML.	1	C,D,I	1	1
	Basics of Extensible Hypertext Markup Language (XHTML)	1	C, D, I	1	1
	Basics of W3C Markup Validation Service.	1	C, D	1	1
	UNIT II: Client Side Scripting	**7**			
	Introduction to Cascading Style Sheets (CSS).	1	C	2	1
	Style sheets in HTML.	1	C,D	2	1
	Introduction to Java scripts.	1	C	2	1
	Syntax variables and data types in Java scripts.	1	C, D	2	1
	Operators in Java scripts.	1	C, D, I	2	1
	Arrays and user defined functions in Java script.	1	C, D, I	2	1,2
	Java script objects.	1	C, D, I	2	1,2
	UNIT III: Host Objects: Browsers and the DOM	**10**			
	Introduction to Document Object Model (DOM)	1	C	3	1,2
	Event objects and Event listeners.	1	C, D	3	1,2
	Mouse events and Window events.	1	C, D	3	1,2
	Event propagation and dropdown menus, Event cancelling and Form validation.	1	C, D	3	1
	Accommodating Noncompliant Browsers.	1	C, D, I	3	1
	Introduction to Server-Side Programming	1	C, D, I	3	1
	Architecture of Java servlets.	1	C,D	3	1
	Introduction to servlets.	1	C, D	3	1

	Parameter Data, Sessions, Cookies.	1	C, D, I	3	1
	URL Rewriting and Servlet concurrency.	1	C, D, I	3	1
	UNIT IV: Representing Web Data	**8**			
	XML-Documents and Vocabularies.	1	C	4	1, 2, 3
	XML Namespaces.	1	C	4	1, 2, 3
	Ajax in web development.	1	C	4	1,2,3
	Event based parsing in XML.	1	C	4	1, 2, 3
	XPath and XSLT.	1	C, D	4	1, 2, 3
	Introduction to JSP.	1	C, D	4	1, 2, 3
	JSP and Servlets.	1	C,D,I	4	1, 2, 3
	Standard Tag Library in JSP.	1	C,D,I	4	1, 2, 3
	UINT V: Web Services	**10**			
	Web Servers (IIS, PWS and Apache).	1	C	5	1, 2, 3
	HTTP Request Types.	1	C, D	5	1, 2, 3
	Accessing Web Servers.	1	C	5	1, 2, 3
	Database connectivity.	1	C	5	1, 2, 3
	Applets and Servlets.	1	C	5	1, 2, 3
	JDBC connectivity.	1	C	5	1, 2, 3
	JSP and Web development Frameworks.	1	C	5	1, 2, 3
	Web development Frameworks	1	C, D, I	5	1, 2, 3
	Application programming interface (API) for Remote Procedure Calls (RPC).	1	C	5	1, 2, 3
	Simple Object Access Protocol (SOAP) and Representational State Transfer (REST) APIs	1	C	5	1, 2, 3
Total contact hours		**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Deitel, Deitel and Nieto, Internet and Worldwide Web - How to Program, 5th Edition,

	PHI,2011
2.	Jeffrey C.Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education
3.	Marty Hall and Larry Brown,"Core Web Programming" Second Edition, Volume I and II, Pearson Education, 2001
4.	Kalin, Martin. Java Web Services: Up and Running: A Quick, Practical, and Thorough Introduction. " O'Reilly Media, Inc.", 2013.

Course nature						**Theory and Lab**	
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Assignments	Lab Performance	Quiz	**Total**
	Weightage Theory	**15%**	**15%**	**5%**	**10%**	**5%**	**50%**
End semester examination Weightage :							**50%**

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Familiarize all the basic HTML tags.	1	I,O		1,2,3,4
	Implement a static HTML personal webpage by using all the possible basic tags. [Each student can develop his own bio-data page]	2	I,O		1,2,3,4
	To create an html file to link to different html page which contains images, tables, and also link within a page use Frames, Forms, etc. also.	1	I,O		1,2,3,4
	Create an HTML file by applying the different styles using inline, external and internal style sheets.	2	I,O		1,2,3,4
	a. Create an html page to change the background color for every click of a button using Java script. b. Write a Java script program to define a user defined function for sorting the values in an array. Create an html page with 2 combo box populated with month & year, to display the calendar for the selected month & year from combo box using java script.	1	I,O		1,2,3,4
	Develop a webpage with HTML and Java Script to read name and marks of five subjects obtained for that particular student using forms. Further, it should compute the Grade and display it as a message box.	2	I,O		1,2,3,4
	Create a form to collects the name, email, user id, password and confirms password from the user. All the inputs are mandatory and email address should be entered in standard format. Also, the values entered in the password and confirm password textboxes should be the	1	I,O		1,2,3,4

	same. For the security reasons make sure that the password entered by the contains both small letters and capital letters, digits, special symbols also. If the given password does not contain all these give an error message to the user. After validating all the details using JavaScript display a message like "You have successfully entered all the details".				
	Design an XML document to store information about the student of SRM University AP. The information must include Roll No, Name, Branch, Year of Joining, and email id. Make up sample data for 3 students. Create a CSS style sheet and use it to display the document.	2	I,O		1,2,3,4
	Develop a registration form with various graphical user component interfaces like Text boxes (Roll No), Text boxes (Name) option buttons (gender), Qualification (Check boxes), State (Combo), etc. and store the information given by the user into a MySql database using JSP.	1	I,O		1,2,3,4
	Develop a webpage to display the details of a student. For this the user will enter Roll Number in the text box given and the details of that particular student should be retrieved from the database and display it on the same webpage. Use JSP to solve this problem.	2	I,O		1,2,3,4
Total Hours		**15**			

SRM UNIVERSITY AP
Andhra Pradesh

SEMESTER – V

PHY 301R	**Project 1**	**L**	**T**	**P**	**C**
		0	**0**	**8**	**4**
Co-requisite:	NIL				
Prerequisite:	ALL PHYSICS CORE COURSES				
Data Book / Codes/Standards	NIL				
Course Category	CORE	**Dissertation**			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The project provides students with the opportunity to explore a particular problem of interest and address it through focused study and applied research under the direction of a faculty member. The Dissertation demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real problems. This Dissertation affirms students' ability to think critically and creatively, to solve practical problems, to make ethical and wise decisions, and to communicate effectively

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.							
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.							
3.	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.							
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	The project is a major component of our Physics curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during				

	the last three years				
2.	Each student must register to the Dissertation course				
3.	Dissertation course consists of one semester and allow to be registered only during the final year of study.				
4.	Students enrolled in Dissertation course are grouped with a maximum of 3 students in one group.				
5.	Each Dissertation topic is assigned a faculty, who will act as the supervisor.				
6.	Each group must document and implement a management structure.				
7.	Each group is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session.				
8.	Salient points discussed at meetings with the supervisor (i.e.,suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.				
9.	The contribution of each individual student in a group will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.				
10.	A project report is to be submitted on the topic which will be evaluated during the final review.				
11.	Assessment components will be as spelt out in the regulations.				
12.	The Dissertation report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level,				

PHY 302	ATOMIC AND MOLECULAR PHYSICS	L	T	P	C
		3	0	0	3

Course Code	PHY 302	**Course Category**	Core Course	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	PHY 213	**Co-Requisite Course(s)**	PHY 303 PHY 302L	**Progressive Course(s)**	-			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the quantum mechanical phenomena at the atomic and molecular level.

Objective 2: To understand periodic table & origin of Atomic and Molecular Spectra.

Objective 3: To understand multi-electron atoms, LS & jj coupling in multi-electron atoms.

Objective 4: To learn spin orbit interactions and Zeeman effect.

Objective 5: To gain an insight of Electromagnetic wave, Photo-electric effect & X-ray emission.

Objective 6: To understand the lasing action in lasers.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the atomic structure.	2	70%	65%
Outcome 2	Understanding periodic table & origin of Atomic and Molecular Spectra.	2	70%	65%
Outcome 3	Understanding atomic structure of multi-electron atoms, LS & jj coupling	3	70%	65%
Outcome 4	Explain the spin orbit coupling and Zeeman effect	3	70%	65%
Outcome 5	Gain an insight of Electromagnetic wave, Photo-electric effect & X-ray emission	3	70%	65%
Outcome 6	Implement the concept of atomic emission in Lasers	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				2			2	3	1	2
Outcome 2	3	3	3	2	3				2			3	3	2	1
Outcome 3	3	3	3	3	3				2			2	3	2	2
Outcome 4	3	3	3	3	3				2			2	3	2	2
Outcome 5	3	3	3	3	3				2			2	3	2	2
Outcome 6	3	3	3	3	3				2			2	3	2	2
Course Average	**3**	**3**	**3**	**3**	**3**				**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Atomic structure**	**9**	**1**	
	Thomson Model & Rutherford Scattering Exp	1	1	1, 2
	Rutherford Model: Stability of Atomic Model	1	1	1, 2
	Numerical problems on Rutherford scattering	1	1	1, 2
	Bohr Postulate & Bohr Atom	1	1	1, 2
	Energy levels and spectra	1	1	1, 2
	Numerical on energy level and spectra	1	1	1, 2
	Sommerfeld’s Corrections: Elliptic Orbital	1	1	1, 2
	Relativistic correction of Sommerfeld’s theory	1	1	1, 2
	Corresponding Principle and related problems	1	1	1, 2
Unit 2	**Vector atom model**	**9**	**1,2**	
	Vector atom model – Failure of BSW Model	1	1	1, 2
	Three dimension – three Q. Numbers	1	1	1, 2
	Concept of space quantization	1	1	1, 2
	Stern-Gerlach Experiment	1	1,2	1, 2
	Introduction of electron spin – failure of classical model. Rotational velocity of electronic surface.	1	1,2	1, 2
	Introduction of Spin Q. number	1	1,2	1, 2
	Numerical Problems on Four Quantum Numbers	1	2	1, 2

	Transition Rates and Selection Rules	1	2	1, 2
	Atomic Spectra (Qualitative)	1	2	1, 2
Unit 3	**One and two valence electron systems**	**9**	**2,3,4**	
	Pauli Exclusion Principle	1	2	2, 3
	Electronic Configuration	1	2	2, 3
	Periodic Tables	1	2	2, 3
	Spin-orbit coupling	1	4	2, 3
	Multi-electron Atom	1	3	2, 3
	L-S COUPLING – worked out examples	1	3	2, 3
	j-j COUPLING – worked out examples	1	3	2, 3
	Term Symbol in atomic physics	1	3	2, 3
	Normal and Anomalous Zeeman Effect	1	4	2, 3
Unit 4	**Atomic and Molecular spectroscopy**	**9**	**2,5**	
	Electromagnetic Wave: Property and Propagation	1	5	2, 3
	EM Wave Spectra and Microwave	1	5	2, 3
	Photo-electric effect: concept of work-function	1	5	2, 3
	X-ray emission spectra: Inverse of PE Effect	1	5	2, 3
	Bremsstrahlung effect & Origin of Sharp peaks: Duane and Hunt’s Rule	1	5	2, 3
	Mosley’s law and Quantization of Atomic Spectra	1	5	2, 3
	Augur Effect and X-ray Diffraction	1	5	2, 3
	Molecular Bond and Molecular Orbital Pairing	1	2	2, 3
	Molecular Spectroscopy: Rotational and Vibrational Spectra	1	2	2, 3
Unit 5	**Lasers**	**9**	**6**	
	Basics and Development of LASER	1	6	2, 3
	Characteristics of LASER	1	6	2, 3
	How to make a LASER: Transition between two states	1	6	2, 3
	Einstein coefficient & thermal equilibrium	1	6	2, 3
	Optical Gain Medium & Population Inversion in Two State system	1	6	2, 3
	Three state energy system and Lasing mechanism	1	6	2, 3
	Types of LASERS: Continuous and Pulsed Laser. Gas Laser, SSL, FEL etc.	1	6	2, 3
	Classification of LASER and Safety of LASER Use	1	6	2, 3
	Application of LASER in Industry and Research: Brief discussion of Pulsed Laser Deposition process	1	6	2, 3

Recommended Resources

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. Eisberg and R. Resnik 2nd Edison, 2006, Wiley
2. Concepts of Modern physics, Arthur Besier, S. Rai Choudhury, Shobhit Mahajan, 7th Edition, 2015, Mcgraw Higher Ed

3. Atomic Physics, J. M. Rajam, Revised Edition, 2010, S Chand Publication
Other Resources 4. The Fundamentals of Atomic and Molecular Physics, Brooks, Robert L. 1 Edition, 2013, Springer-Verlag New York 5. Physics of Atoms and Molecules, B. H. Bransden, C. J. Joachain, 2 Edition, Pearson Education India

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		40%		60%		30%	
Level 2	Apply Analyse	60%		40%		60%		40%		70%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Course Designers

k. *Dr. Sabyasachi Mukhopadhyay. Asst. Professor. Dept. Of Physics. SRM University - AP*
l. *Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras*
m. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

PHY 302L	**LABORATORY: ATOMIC AND MOLECULAR PHYSICS**		**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Co-requisite:	PHY 302					
Prerequisite:	PHY 201L, PHY 202L, PHY 212L					
Data Book / Codes/Standards	NIL					
Course Category	CORE	Atomic and Molecular Physics				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how the fundamental atomic, molecular physics and basic Laser characteristics aid in the advanced

	technology through properly designed experiments.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Correlate Atomic and Molecular physics theories with real life examples							
2.	Realize the profound importance of atomic and molecular spectroscopy in the basic and inter disciplinary science.							
3.	Handle up to class 3 Lasers and realize the importance of safety, scientific and industrial applications of various Lasers.							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	a) To demonstrate the Kerr effect in nitrobenzene solution by observing brightness on detector depending on voltage applied. b) To determine half wave voltage and Kerr constant for blue light.	6	I,O		1,2
2.	Measuring the speed of sound, by measuring the Bragg angle using an acousto-optics modulator and laser diffraction.	6	I,O		1,2
3.	To determine beam divergence and M-parameter of a He-Ne laser beam.	4	I,O		1,2
4.	To determine beam divergence and M-parameter of a commercial laser pointer beam	4	I,O		1,2
5.	To determine particle size of a given powders using wave optics method	4	I,O		1,2
6.	Examination of molecular absorption signatures for different organic molecules	6			
7.	Examination of electron-light interaction following plasmonic absorption of gold nanoparticles	6			
	Total contact hours (Experiments +Demo + Extra class)	**36**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	K.G. Mazumdar and B. Ghosh, "*Advanced Practical Physics*" Sreedhar Publishers, Revised edition Jan 2004
2	R.K. Shukla and Anchal Srivastava, "*Practical Physics*" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3	http://www.atomic.physics.lu.se/education/mandatory-courses/fystc11-atomic-and-molecular-physics-for-science-faculty/laboratory-exercises/

Course nature					Practical
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/Observation note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

PHY 303	**SOLID STATE PHYSICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Code	PHY 303	**Course Category**	Core Course	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	PHY 213	**Co-Requisite Course(s)**	PHY 301, PHY 302	**Progressive Course(s)**	PHY 302			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the basic knowledge on crystal structures and crystal systems.
Objective 2: To acquire the knowledge on the classification solids into conductors, semiconductors and insulators.
Objective 3: To acquire knowledge on lattice vibrations, thermal properties and electric conductivity of solids.
Objective 4: To comprehend the concepts of dielectric and magnetic properties of solids.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Learn the crystallography.	1	70%	65%
Outcome 2	Understand the importance of phonons on thermal properties of matter.	2	70%	65%
Outcome 3	Understand the electrons transport, thermal transport.	3	70%	65%
Outcome 4	Understand the evolution of electronic band gaps in solid.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				3			2	3	2	2
Outcome 2	3	3	3	3	2				2			3	3	3	3
Outcome 3	3	3	3	3	2				3			3	3	3	2
Outcome 4	3	3	3	3	3				3			3	3	3	3
Course Average	**3**	**3**	**3**	**3**	**2**				**3**			**3**	**3**	**3**	**3**

Course Unitization Plan

Session	Description of Topic	Required Contact hours	CLOs Addressed	References
	UNIT I - Crystallography	**9**		
1.	Crystalline and amorphous solids, Lattice, Basis, Translational vectors, Primitive unit cell.	1	1	1,2
2.	Symmetry operations, Different types of lattices-2D and 3D (Bravais lattices)	1	1	1,2
3.	SC, BCC and FCC structures, Packing fraction	1	1	1,2
4.	Miller indices, Inter-planer distances	1	1	1,2
5.	Crystal structures- NaCl, diamond, CsCl, ZnS	1	1	1,2
6.	Concept of reciprocal lattice and its properties with proof.	1	1	1,2
7.	Ionic, covalent, molecular and metallic binding in crystalline solids Cohesive energies of ionic crystals	1	1	1,2
8.	Bragg’s law	1	1,2	1,2

9.	Debye Scherrer method	1	1,2	1,2
	UNIT II – Lattice Vibrations and specific heat of solids	**9**		
10.	Specific heats of solids	1	1	1,2
11.	Classical theory of Specific heat, Dulong-Petit Law	1	1	1,2
12.	Breakdown of classical theory, Einstein theory of specific heat	1	1,2	1,2
13.	Debye theory of specific heat, T^3 law	1	1,2	1,2
14.	Lattice vibrations. Concept of phonons.	1	1,2	1,2
15.	One dimensional monoatomic lattice	1	1	1,2
16.	Phase velocity and group velocity	1	1,2	1,2
17.	Phonon vibration of diatomic linear lattice	1	1,2	1,2
18.	Qualitative description of the phonon spectrum in solids. Acoustical and optical phonons	1	1,2	1,2
	UNIT III - Free electron theory of metals	**9**		
19.	Classical theory of free electrons, Drude-Lorentz theory	1	1	1,2,3
20.	Temperature dependent electrical resistivity of metals	1	1,2	1,2,3
21.	Thermal conductivity of metals,	1	1,2	1,2,3
22.	Wiedemann-Frank's law, Failure of classical theory	1	1	1,2,3
23.	Free electron gas in one dimension	1	1,2	1,2,3
24.	Fermi-Dirac distribution function	1	1,2	1,2,3
25.	Free-electron theory of metals	1	1	1,2,3
26.	Heat capacity of the electron gas	1	1	1,2,3

27.	Thermionic emission	1	1	1,2,3
	UNIT IV: Band theory of solids, Semiconductors	**9**		
28.	Failure of Free electron theory of metals	1	1,2	1,2,3
29.	Nearly free electron model, Bloch theorem	1	1	1,2,3
30.	Kronig Penny model	1	1	1,2,3
31.	Brillouin zones, Concept of effective mass	1	1,2	1,2,3
32.	Distinction between metal, semiconductor and insulator	1	1,2	1,2,3
33.	Band theory of solids	1	2	1,2,3
34.	Temperature dependent resistivity of metals, semiconductors and insulators	1	1,2	1,2,3
35.	Intrinsic and extrinsic semiconductors P-type and N-type semiconductors	1	1,2	1,2,3
36.	Hall effect in semiconductors	1	1	1,2,3
	UNIT V: Dielectric and Magnetic properties of materials	**9**		
37.	Polarization	1	1	1,2,3
38.	Local electric field at an atom	1	1,2	1,2,3
39.	Depolarization field, Dielectric susceptibility and polarizability, Dielectric constant	1	1,2	1,2,3
40.	Clausius-Mosotti equation	1	1	1,2,3
41.	Diamagnetic, paramagnetic, Ferromagnetic and ferrimagnetic materials	1	1,2	1,2,3
42.	Classical Langevin’s theory of diamagnetism and paramagnetism, Curie law	1	1,2	1,2,3
43.	Weiss theory of ferromagnetism and magnetic domains	1	1,2	1,2,3

44.	Discussion on B-H curve, Magnetic hysteresis and energy loss	1	2	1,2,3
45.	Soft and hard magnetic materials	1	2	1,2,3

Recommended Resources

8. Introduction to Solid State Physics, Charles Kittel, 8th edition, 2004, John Wiley & Sons
9. Elementary Solid-state Physics, M Ali Omar, Revised Edition, 2015, Pearson

Other Resources

10. Solid State Physics, Neil W. Ashcroft, N. Mermin, Reprint edition, Brooks/Cole 1976.

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		40%		70%		30%	
Level 2	Apply Analyse	60%		40%		60%		30%		70%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Course Designers

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p. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

PHY 303L	LABORATORY: SOLID STATE PHYSICS		L	T	P	C
			0	0	4	2
Co-requisite:	PHY 303					
Prerequisite:	PHY 201L, PHY 202L, PHY 212L					
Data Book / Codes/Standards	NIL					
Course Category		CORE	LABORATORY: SOLID STATE PHYSICS			
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose is to introduce the sophisticated and best experimental characterization tools to obtain the basic attributes of solids, such as, crystallinity, optical, electronic, magnetic, plasmonic, nano form of matter. Introduce to the current state-of-the art research facilities to carry research projects. Demonstrate the power of century old basic fundamental laws existence in the present technology.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Measure the lattice parameter, lattice crystal structure, electronic properties, bandgap, plasmonic, carrier densities of any kind of state of matter. Which are all the fundamental and basic attributed of any matter.							
2.	Develop new characterization tools and techniques for advanced materials.							
3.	Can handle state-of-the-art instruments and appreciate the importance of research and development in the everyday life.							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Determine lattice parameter of crystals using X-ray diffractometer	6	I,O		1
2.	Measurement of resistivity of a semiconductor by Four-probe method and determination of Energy Band Gap	3	I,O		2
3.	To determine the type of charge carrier, carrier density and Hall coefficient of a given semiconductor	3	I,O		2
4.	a) To measure the photo-current as a function of the irradiance at constant voltage b) Current-voltage and current-load characteristics of a solar cell as a function of the irradiance	6	I,O		2
5.	Study optical absorption of liquid samples using UV-VIS spectrometer	6	I,O		3
6.	To study optical absorption of different nanoparticles and obtain their plasmonic peaks	6	I,O		3
7.	To measure the ionic conductivity of ionic conductors as a function of temperature using impedance spectroscopy.	6	LO		4
	Total contact hours (Experiments +Demo + Extra class)	36			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	C. Suryanarayana, M. Grant Norton, " X-Ray Diffraction, A Practical Approach" Springer US, 1998 [ISBN: 978-1-4899-0148-4]
2	John Singleton, "Band Theory and Electronic Properties of Solids" Oxford University Press UK, 2014 [ISBN: 978-0198506447]
3	Trügler, Andreas, "Optical Properties of Metallic Nanoparticles", Springer Series in Materials Science, 2016 [ISBN: 978-3-319-25074-8]
4	Evgenij Barsoukov, J. Ross Macdonald, Impedance Spectroscopy: Theory, Experiment, and Applications, Second Edition, [ISBN: 9780471716242]

Course nature				**Practical**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/Observation note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage :	**50%**

PHY 304	**NON-LINEAR OPTICS**		**L** 3	**T** 0	**P** 0	**C** 3
Co-requisite:	NIL					
Prerequisite:	PHY 202, PHY 212, PHY 213					
Data Book / Codes/Standards	NIL					
Course Category	CORE	NON-LINEAR OPTICS				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The course aims to cover the fundamental concepts of non-linear processes in materials with light and some of the advanced developments in non-linear optics							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	This introductory course on nonlinear optics is proposed to train the B.Sc. students after they gone through basic optics course and the modern applications of optics in spectroscopy and photonics.							
2.	The lectures in this course are intended to provide theoretical background to understand and predict a host of optical phenomena							

	that become possible when nonlinearity in the optical response of a material is included in the description.							
3.	The course includes a detailed description of several of non-linear optical phenomena along with their experimental observation.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – Introduction to non-linear optics	**9**			
1.	Introduction – Linear vs Non-Linear optics	1	C		1,2
2.	Linear Optics in homogeneous and isotropic media	1	C		1,2
3.	Wave propagation in homogeneous media	1	C		1,2
4.	Optical waves in anisotropic media	1	C		1,2
5.	Non-linear optical processes	1	C		1,2
6.	Non-linear susceptibility and classical anharmonic oscillator	1	C-D		1,2
7.	Properties of non-linear susceptibility	1	C-D		1,2
8.	Time domain description of optical non linearities	1	C		1,2
9.	Kramers–Kronig Relations in Linear and Nonlinear Optics	1	C-D-I		1,2
	UNIT II – Non-linear optical interactions				
10.	Wave equation for non-linear optical media	1	C-D		1,2
11.	The coupled wave equation	1	C-D		1,2
12.	Sum frequency generation	1	C		1,2
13.	Phase matching conditions	1	C		1,2
14.	Quasi phase matching	1	C-D		1,2
15.	The Manley Rowe relations	1	C-D		1,2
16.	Difference frequency generation and second harmonic generation	1	C		1,2
17.	Optical Parametric oscillators	1	C-D		1,2
18.	Non-linear interactions with focused Gaussian beams	1	C-D		1,2
	UNIT III – Quantum Mechanical Description	**9**			
19.	Introduction	1	C		1,2
20.	Schrödinger Calculation of Nonlinear Optical Susceptibility	1	C		1,2
21.	Density Matrix Formulation of Quantum Mechanics	1	C-D-I		1,2
22.	Perturbation Solution of the Density Matrix Equation of Motion	1	C-D-I		1,2
23.	Density Matrix Calculation of the Linear Susceptibility	1	C-D		1,2

24.	Density Matrix Calculation of the Second-Order Susceptibility	1	C-D		1,2
25.	Density Matrix Calculation of the third-Order Susceptibility	1	C-D		1,2
26.	Electromagnetically Induced Transparency	1	C		1,2
27.	Local-Field Corrections to the Nonlinear Optical Susceptibility	1	C		1,2
	UNIT IV - Intensity Dependent refractive index	**9**			
28.	Intensity Dependent refractive index	1	C		1,2
29.	Tensor Nature of the Third-Order Susceptibility	1	C		1,2
30.	Non-resonant Electronic Nonlinearities	1	C		1,2
31.	Nonlinearities Due to Molecular Orientation	1	C-D-I		1,2
32.	Thermal Nonlinear Optical Effects	1	D-I		1,2
33.	Self-Focusing of Light and Other Self-Action Effects	1	D-I		1,2
34.	Optical Phase Conjugation	1	C		1,2
35.	Optical Bi-stability and Optical Switching	1	D		1,2
36.	Two-Beam Coupling	1	C		1,2
	UNIT V - Electro-Optic and photo refractive effects	**9**			
37.	Introduction to the Electrooptic Effect	1	C		1,2
38.	Linear Electrooptic Effect	1	C		1,2
39.	Electrooptic Modulators	1	C-D		1,2
40.	Introduction to the Photorefractive Effect	1	D		1,2
41.	Photorefractive Equations	1	C		1,2
42.	Two-Beam Coupling in Photorefractive Materials	1	C		1,2
43.	Optically Induced Damage	1	C-D		1,2
44.	Multiphoton Absorption	1	C-D		1,2
45.	Avalanche-Breakdown Model	1	C-D		1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Non-linear optics, Fourth edition (2020) – Robert Boyd (Publisher – Academic Press)
2	Fundamentals of Non-linear optics –P. E. Powers; 2nd Edition, 2017, CRC Press

Course nature		**Theory**			
Assessment Method – Theory Component (Weightage 100%)					
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
					End semester examination Weightage :	**50%**

PHY 305L	LABORATORY: INTRODUCTION TO LAB VIEW			L	T	P	C
				0	0	4	2
Co-requisite:	NIL						
Prerequisite:	PHY 211, PHY 211L						
Data Book / Codes/Standards	NI Labview online tutorials						
Course Category	CORE	LABVIEW					
Course designed by	Department of Physics						

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how to use LabView programming technique through properly designed experiments.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
5.	Use LabVIEW graphical interface							
6.	Build various waveforms, use various commands							
7.	Communicate with equipment using VIs and perform automated measurements							
8.	Save measurements and plot live data							

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Ref-erence
1.	Creating a Labview Vis (Virtual Instrument): Project, block diagram and tablets in front panel, using various pallets	5	I,O		1,2
2.	Creating VIs with various math functions, Boolean logics and perform analysis	5	I,O		1,2
3.	Creating VIs using loops, time functions, building waveforms	5	I,O		1,2

4.	Communication with an equipment: Hardware/software, using instrument drivers, making your own driver	5	I,O		1,2
5.	I-V measurements with Tektronics source meter, data collection, data saving, and live plot	5	I,O		1,2
6.	C_p-D measurements with Tektronics source meter, data collection, data saving, and live plot	5	I,O		1,2
	Total contact hours (Experiments +Demo + Extra class)	**30**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	LabVIEW for Everyone, Jeffrey Travis, Jim Kring
2	LabVIEW Graphical Programming, Johnson Gary

Course nature		**Practical**			
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage:	**50%**

CODE	**OPEN ELECTIVE – I**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category					
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

SEMESTER – VI

PHY 311R	PROJECT 2	L	T	P	C
		0	0	10	5
Co-requisite:	NIL				
Prerequisite:	PHY 301R, ALL CORE PHYSICS COURSES				
Data Book / Codes/Standards	NIL				
Course Category	CORE	**Dissertation**			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The project provides students with the opportunity to explore a particular problem of interest and address it through focused study and applied research under the direction of a faculty member. The Dissertation demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real problems. This Dissertation affirms students' ability to think critically and creatively, to solve practical problems, to make ethical and wise decisions, and to communicate effectively

LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.							
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.							
3.	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help							

	solve these issues.							
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	The project is a major component of our Physics curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the last three years				
2.	Each student must register to the Dissertation course				
3.	Dissertation course consists of one semester and allow to be registered only during the final year of study.				
4.	Students enrolled in Dissertation course are grouped with a maximum of 3 students in one group.				
5.	Each Dissertation topic is assigned a faculty, who will act as the supervisor.				
6.	Each group must document and implement a management structure.				
7.	Each group is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session.				
8.	Salient points discussed at meetings with the supervisor (i.e. suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.				
9.	The contribution of each individual student in a group will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.				
10.	A project report is to be submitted on the topic which will be evaluated during the final review.				
11.	Assessment components will be as spelt out in the regulations.				
12.	The Dissertation report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level,				

PHY 312	STATISTICAL PHYSICS	L	T	P	C
		3	1	0	4

Co-requisite:	NIL	
Prerequisite:	PHY 111, PHY 112, PHY 302	
Data Book / Codes/Standards	NIL	
Course Category	CORE	STATISTICAL PHYSICS
Course designed by	Department of Physics	

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about elementary as well advanced concepts of statistical physics using elements of classical and quantum statistics.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand Elementary statistical concepts							
2.	Learn statistical descriptions of system of particles							
3.	Learn Statistical properties of Macroscopic systems							
4.	Learn micro-canonical, canonical and grand-canonical systems and Equipartition theorem							
5.	Fundamental concepts of Quantum Statistics							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - Elementary statistical concepts and examples	**12**			
1.	The simple random walk problem in one dimension	1	C		1,2
2.	Random walk problem in two dimensions	1	C		1,2
3.	Problem and Review of Random walks	1	C		1,2
4.	Tutorial-I	1	I		1,2
5.	Examples of Brownian motion	1	C		1,2
6.	Calculation of mean values	1	C		1,2
7.	Binomial distribution – theory and examples	1	C		1,2
8.	Tutorial-II	1	I		1,2

9.	Continuous probability distribution	1	C		1,2
10.	Gaussian probability distribution	1	C		1,2
11.	Review and problems on probability distributions	1	C		1,2
12.	Tutorial-III	1	I		1,2
	UNIT II – Statistical descriptions of system of particles	**12**			
13.	Specification of the state of a statistical system	1	C		1,2
14.	statistical ensemble - basic postulates and probability calculations	1	C		1,2
15.	Review and problems on statistical ensembles	1	C		1,2
16.	Tutorial-I	1	I		1,2
17.	Density of states of statistical ensembles	1	C		1,2
18.	Problems on density of states	1	I		1,2
19.	Thermal and mechanical interaction between macroscopic systems.	1	C		1,2
20.	Tutorial-II	1	I		1,2
21.	Discussion on constraints of thermal and mechanical interaction between macroscopic systems.	1	C, D		1,2
22.	Discussion on equilibrium, non-equilibrium, reversibility, and irreversibility in thermodynamic systems	1	C, D		1,2
23.	Review and problems on thermal and mechanical interaction, its constraints and Problems & examples on Equilibrium/non-equilibrium and reversibility /irreversibility of thermodynamic systems.	1	C, D		1,2
24.	Tutorial-III	1	I		1,2
	UNIT III - Statistics of Macroscopic systems	**12**			
25.	Distribution of energy between macroscopic systems	1	C		1,2
26.	Discussion on the approach to thermal equilibrium	1	C		1,2
27.	Examples and problems on thermal equilibrium	1	C		1,2
28.	Tutorial-I	1	I		1,2
29.	Temperature, mean energy, and mean pressure of an ideal gas	1	C		1,2
30.	Introduction of the concept of entropy & discussion of second and third law of thermodynamics involving entropy.	1	C		1,2
31.	Review of all thermodynamic laws and basic statistical relations & related problems	1	C		1,2
32.	Tutorial-II	1	I		1,2

33.	The partition function and its properties – relevant problems	1	C		1,2
34.	Calculation of thermodynamic quantities for an ideal monatomic gas – relevant problems.	1	D, I		1,2
35.	Discussion of the Gibbs paradox involving relevant examples	1	C		1,2
36.	Tutorial-III	1	I		1,2
	UNIT IV: Equipartition theorem	**12**			
37.	Introduction various thermodynamics systems – Isolated, adiabatic, Isobaric, Isochoric etc.	1	C		1,2
38.	Examples and problems on important thermodynamic systems.	1	I		1,2
39.	Discussion on Canonical ensemble – comparison with micro-canonical ensemble	1	C		1,2
40.	Tutorial-I	1	I		1,2
41.	Applications, examples and problems on the canonical ensemble	1	I		1,2
42.	Maxwell distribution and the Equipartition theorem	1	C		1,2
43.	Simple applications of the Equipartition theorem	1	I		1,2
44.	Tutorial-II	1	I		1,2
45.	The grand canonical ensemble – comparison with micro-canonical and canonical ensemble	1	C		1,2
46.	Introduction of the chemical potential	1	C		1,2
47.	Review and problems on Equipartition theorem and canonical and grand-canonical ensemble	1	D, I		1,2
48.	Tutorial-III	1	I		1,2
	UNIT V: Quantum statistics	**12**			
49.	Introduction of concept of Identical particles and symmetry requirements	1	C		1,2
50.	Discussion on quantum states of a single particle	1	C		1,2
51.	Introduction of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics	1	C		1,2
52.	Tutorial-I	1	I		1,2
53.	Equation of states for Bose and Fermi gases	1	C		1,2
54.	PV = (2/3) E – the ideal gas in the classical limit	1	C		1,2
55.	Evaluation of the partition function	1	I		1,2
56.	Tutorial-II	1	I		1,2
57.	partition function of ideal monatomic Boltzmann gas	1	I		1,2

58.	Simple ideas for Bose- Einstein condensation and recent observations	1	C		1,2
59.	Problems and examples on Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics & partition function	1	D,I		1,2
60.	Tutorial-III	1	I		1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Statistical Physics (In Si Units): Berkeley Physics Course - Vol.5, F Reif, 1 edition, 2017, McGraw Hill Education
2	Statistical Physics F. Mandl, 2nd Edition, 2003, Wiley

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 313	**NUCLEAR AND PARTICLE PHYSICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Code	PHY 313	**Course Category**	Core Course (CC)	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	PHY 213	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the basic properties of Nucleus and Nuclear Models

Objective 2: To discuss Nuclear Radioactivity, it’s classifications and applications

Objective 3: To review fundamental forces of Nature and discuss the physics of elementary particles

Objective 4: To introduce Nuclear Reactions, Reactors and Particle Accelerators

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the properties of a Nucleus and discuss nuclear models.	2	70%	65%
Outcome 2	Discuss the origin of radioactive decays, classify them and predict the decay profile of a given nucleus.	3	70%	65%
Outcome 3	Categorize elementary particles based on their quantum numbers and calculate the rates of physical processes involving these elementary particles.	4	70%	65%
Outcome 4	Assess nuclear reactions and discuss the working principle of nuclear detectors and particle accelerators.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, lticultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	1	2	1						2	2	2	2
Outcome 2	3	3	3	3	3	1	2		2			2	2	2	3
Outcome 3	3	3	3	3	3	2	1		2			2	3	2	3
Outcome 4	3	3	3	3	3	2	3		2			2	3	2	3
Course Average	**3**	**3**	**3**	**3**	**3**	**2**	**3**		**2**			**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basic Properties of Nucleus**	**9**		
	Composition, Charge, size, density of nucleus	1	1	1, 2
	Nuclear Spin and Parity, Isobars, isotopes and isotones	1	1	1, 2
	Mass defect, Binding energy, Packing fraction	1	1	1, 2
	Liquid drop model, Semi-empirical mass formula	1	1	1,2
	Nuclear Shell Model	1	1	1, 2
	Classification of nuclei, stability of nuclei (N Vs Z Curve)	1	1	1, 2
	Magnetic moments, Nuclear magnetic dipole moment	1	1	1, 2
	Electric Quadrupole moment	1	1	1, 2
	Nuclear excited states, Collective model (qualitative)	1	1	1, 2
Unit 2	**Radioactivity**	**9**		
	Radioactivity disintegration, natural and artificial radioactivity, Half-life	1	1,2	1, 2
	Alpha decay, measurement of velocity and energy of alpha particles, Geiger-Nuttall law	1	2	1, 2
	Alpha particle spectra, nuclear energy levels, qualitative theory of alpha decay	1	2	1, 2
	Beta decay: velocity and energy of beta particles, beta spectra, Neutrino	1	2	1, 2
	Position emission and orbital electron capture	1	2	1, 2
	Gamma rays: Nature of gamma rays, Passage through matter, Photo-electric absorption, Compton scattering, Pair production,	1	2	1, 2
	Nuclear energy levels and gamma ray spectra	1	2	1, 2
	Determination of gamma ray energies	1	1,2	1, 2
	Application of radioactivity (Agricultural, Medical, Industrial, Archaeological)	1	2	1, 2
Unit 3	**Nuclear Reactions**	**9**		
	Neutron: mass, lifetime, energy	1	4	1,2
	Artificial transmutation, types of Nuclear reactions, conservation laws	1	4	1, 2
	Compound nuclear Q-value equation	1	4	1, 2
	Exothermic and Endothermic, reaction Threshold energy	1	4	1, 2
	Nuclear cross-section, reaction yield	1	4	1, 2
	Nuclear fission, chain reaction and critical mass	1	4	1, 2
	Nuclear reactor and its basic components; Homogeneous and heterogeneous reactors	1	4	1, 2
	Power reactor, fast breeders	1	4	1, 2
	Nuclear fusion, Nucleosynthesis (Qualitative)	1	4	1, 2

Unit 4	**Elementary particle physics**			
	Properties of nuclear forces and other fundamental forces	1	1,3	1,2,3
	Meson exchange theory	1	1,3	2,3
	Baryon number, Lepton number, Isospin	1	1,3	2,3
	Quark Model	1	3	2,3
	Mesons and Hadrons	1	3	2,3
	Electroweak interaction, W/Z bosons, Photon	1	3	2,3
	Neutrinos, mixing and oscillation	1	3	2,3
	Symmetry breaking and Higgs boson (Qualitative)	1	3	3
	Dark Matter (Qualitative)	1	3	3
Unit 5	**Particle Detectors and Accelerator**	**9**		
	Gas filled Detectors (G. M. counter)	1	2,4	1,2
	Solid-state detectors (scintillation counter)	1	2,4	1,2
	Photo-multiplier tube (PMT)	1	2,4	1,2
	Semi-conductor detector	1	2,4	1,2
	Cherenkov detector	1	2,3,4	1,2
	Van-de Graaff generator	1	3,4	1,2
	Particle Accelerators, Cyclotrons	1	3,4	2,3
	Synchrotrons	1	3,4	2,3
	Linear accelerators	1	3,4	2,3

Recommended Resources

1. Introductory Nuclear Physics, Kenneth S. Krane, Wiley (Student edition)
2. Nuclear Physics, S. N. Ghosal, S Chand Publishing, Revised edition
3. Introduction to Elementary Particles, David Griffiths, Wiley-VCH; 2nd edition

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		40%		60%		30%	
Level 2	Apply Analyse	60%		40%		60%		40%		70%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Course Designers

1. *Dr. Amit Chakraborty, Asst. Professor. Dept. of Physics. SRM University - AP*
2. *Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras*
3. *Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad*

PHY XXXL	**Laboratory: Introduction to Impedance spectroscopy and ZView**		**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Co-requisite:	NA					
Prerequisite:	Basic electronics and Lab					
Data Book / Codes/Standards	Zview online tutorials					
Course Category	CORE	ZVIEW				
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The purpose of this course is to introduce students about how to use ZView analysis to understand impedance, equivalent circuits and analysis in real materials.

	LEARNING OBJECTIVES	**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Use ZVIEW graphical interface							
2	Build various equivalent circuits using resistance, capacitance etc and verify using ZVIEW							
3	Model impedance data using equivalent circuits and fitting							
4	Implement impedance spectroscopy in oxide materials							

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1	Introduction to impedance. Functionalities of ZIEW.	5	I,O		
2	Impedance measurements using LCR meter and data collection using labview program	5	I,O		

3	Simulating impedance data for various equivalent circuits	5	I,O		
4	Making parallel, series circuits using capacitance, resistance, inductance and verify the equivalent circuits using impedance measurements	5	I,O		
5	Impedance spectroscopy of oxide materials and analysis using ZVIEW. Materials insight: grain, grain-boundary and electrode response	5	I,O		
6	Deriving dielectric properties of $BaTiO_3/SnF_2$ from impedance data.	5	I,O		
	Total contact hours (Experiments +Demo + Extra class)	30 HOURS+			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Impedance Spectroscopy: Theory, Experiment, and Applications by James Ross MacDonald, Yevgen Barsukov 2nd edition Wiley
2	ZVIEW manual

Course nature				**Practical**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Experiments	Record/ Observation Note	Viva Voce + Model examination	**Total**
	Weightage	**20%**	**10%**	**20%**	**50%**
				End semester examination Weightage:	**50%**

PHY 314	**DEPARTMENT SEMINAR/INDUSTRY-ACADEMIC VISIT**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**2**
Co-requisite:	NIL				
Prerequisite:	DEPARTMENT ELECTIVE - II				
Data Book / Codes/Standards					
Course Category					
Course designed by	Department of Physics				
Board of	19.07.2021	Academic			

Studies Approval Date		Council Approval Date	

PURPOSE	The project provides students with the opportunity to explore a particular problem of interest and address it through focused study and applied research under the direction of a faculty member. The Dissertation demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real problems. This Dissertation affirms students' ability to think critically and creatively, to solve practical problems, to make ethical and wise decisions, and to communicate effectively

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.							
2	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.							
3	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.							
4	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.							

PHY XXX	**DEPARTMENT ELECTIVE - II**		**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**
Co-requisite:	NIL					
Prerequisite:	DEPARTMENT ELECTIVE - II					
Data Book / Codes/Standards						
Course Category						
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

Course Name	**Code**	**L**	**T**	**P**	**C**

NANO DEVICE PHYSICS	**PHY 315E**	**3**	**1**	**0**	**4**
NANOTECHNOLOGY IN ENERGY CONVERSION AND STORAGE	**PHY 706E**	**4**	**0**	**0**	**4**
SOLID STATE IONICS	**PHY 708E**	**4**	**0**	**0**	**4**

CODE	**OPEN ELECTIVE – II**		**L**	**T**	**P**	**C**
			4	**0**	**0**	**4**
Co-requisite:						
Prerequisite:						
Data Book / Codes/Standards						
Course Category						
Course designed by	Department of Physics					

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

SEMESTER – VII

PHY 401R	**Research Degree Project 1**		**L**	**T**	**P**	**C**
			0	**0**	**24**	**12**
Co-requisite:	NIL					
Prerequisite:	ALL PHYSICS CORE COURSES					
Data Book / Codes/Standards	NIL					
Course Category	Departmental Elective	**Dissertation**				
Course designed by	Department of Physics					

Board of	19.07.2021	Academic	

Studies Approval Date		Council Approval Date	

PURPOSE	The project provides students with the opportunity to explore a particular problem of interest and address it through focused study and applied research under the direction of a faculty member. The Dissertation demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real problems. This Dissertation affirms students' ability to think critically and creatively, to solve practical problems, to make ethical and wise decisions, and to communicate effectively

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.							
2	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.							
3	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.							
4	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1	The project is a major component of our Physics curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the last three years				
2	Each student must register to the Dissertation course				
3	Dissertation course consists of one semester and allow to be registered only during the final year of study.				
4	Students enrolled in Dissertation course are grouped with a maximum of 3 students in one group.				
5	Each Dissertation topic is assigned a faculty, who will act as the supervisor.				
6	Each group must document and implement a management structure.				
7	Each group is expected to maintain a log book that				

	would normally be used to serve as a record of the way in which the project progressed during the course of the session.				
8	Salient points discussed at meetings with the supervisor (i.e.,suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.				
9	The contribution of each individual student in a group will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.				
10	A project report is to be submitted on the topic which will be evaluated during the final review.				
11	Assessment components will be as spelt out in the regulations.				
12	The Dissertation report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level				

PHY XXX	RESEARCH ELECTIVE - I		L	T	P	C
			3	1	0	4
Co-requisite:	NIL					
Prerequisite:						
Data Book / Codes/Standards						
Course Category						
Course designed by	Department of Physics					
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date				

PHY XXX	RESEARCH ELECTIVE - II		L	T	P	C
			3	1	0	4
Co-requisite:	NIL					
Prerequisite:						
Data Book / Codes/Standards						
Course Category						
Course designed by	Department of Physics					
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date				

PHY XXX	RESEARCH ELECTIVE - III		L	T	P	C
			3	1	0	4
Co-requisite:	NIL					
Prerequisite:						
Data Book / Codes/Standards						
Course Category						
Course designed by	Department of Physics					
Board of Studies Approval Date	19.07.2021	Academic Council Approval Date				

SEMESTER – VIII

PHY 411R	Research Degree Project 2	L	T	P	C
		0	0	24	12
Co-requisite:	NIL				
Prerequisite:	ALL PHYSICS CORE COURSES				
Data Book / Codes/Standards	NIL				
Course Category	Departmental Elective	**Dissertation**			
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	

PURPOSE	The project provides students with the opportunity to explore a particular problem of interest and address it through focused study and applied research under the direction of a faculty member. The Dissertation demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real problems. This Dissertation affirms students' ability to think critically and creatively, to solve practical problems, to make ethical and wise decisions, and to communicate effectively

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.							
2	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.							
3	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.							
4	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.							

Session	Description of Topic	Contact	C-	IOs	Reference

		hours	D-I-O		
1	The project is a major component of our Physics curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the last three years				
2	Each student must register to the Dissertation course				
3	Dissertation course consists of one semester and allow to be registered only during the final year of study.				
4	Students enrolled in Dissertation course are grouped with a maximum of 3 students in one group.				
5	Each Dissertation topic is assigned a faculty, who will act as the supervisor.				
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8	Salient points discussed at meetings with the supervisor (i.e.,suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.				
9	The contribution of each individual student in a group will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.				
10	A project report is to be submitted on the topic which will be evaluated during the final review.				
11	Assessment components will be as spelt out in the regulations.				
12	The Dissertation report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level,				

PHY XXX	RESEARCH ELECTIVE - IV	L	T	P	C
		3	1	0	4
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards					
Course Category					
Course designed by	Department of Physics				

Board of Studies Approval Date	19.07.2021	Academic Council Approval Date	