List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : ***Pure and applied physics***

Programme Name : **Master of Science in Physics**

Academic Year : 2021-22

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	PPPATT2	Quantum Mechanics
02.	PPPALT2	Quantum Mechanics Lab
03.	PPPATT3	Electronic and Experimental Methods
04.	PPPALT3	Electronic and Experimental Methods Lab
05.	OPNPPT1	Nanomaterials and its Applications
06.	OPNPPL1	Nanomaterials and its Applications Lab
07.	PPPBTD1	Computational Physics and Programming
08.	PPPBLD1	Computational Physics and Programming Lab

विभागाध्यक्ष/H.O.D.
शुद्ध एवं अनुप्रयुक्त भौतिकी विभाग
Dept. of Pure & Applied Physics
गुरु घासीदास विश्वविद्यालय
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Scheme and Syllabus

Sem	Course Opted	Course Code	Name of the course	Credit	L:T:P	Internal	External	Total
I	Core-1	PPPATT1	Classical Mechanics	5	4+1+0	30	70	100
	Core -2	PPPATT2	Quantum Mechanics	4	3+1+0	30	70	100
		PPPALT2	Quantum Mechanics Lab	1	0+0+1	30	70	100
	Core -3	PPPATT3	Electronic and Experimental Methods	3	3+0+0	30	70	100
		PPPALT3	Electronic and Experimental Methods Lab	2	0+0+2	30	70	100
	Open Elective		Opted from the pool and offered by other departments	5		30	70	100
	Other if any							
			TOTAL	**20**				**500**
			Open Elective offered by department					
	Open Elective	OPNPPT1	Nanomaterials and its Applications	3	3+0+0	30	70	100
		OPNPPL1	Nanomaterials and its Applications Lab	2	0+0+2	30	70	100
	Open Elective	OPNPPT2	Advanced characterization and computational techniques in Physics	3	3+0+0	30	70	100
		OPNPPL2	Advanced Characterization and Computational Techniques in Physics Lab	2	0+0+2	30	70	100
II	Core-4	PPPBTT1	Concepts of Mathematical Physics	5	4+1+0	30	70	100
	Core -5	PPPBTT2	Advanced Quantum Mechanics	4	3+1+0	30	70	100
		PPPBLT2	Advanced Quantum Mechanics Lab	1	0+0+1	30	70	100
	Core -6	PPPBTT3	Statistical Mechanics	5	4+1+0	30	70	100
	Discipline Specific elective 1	PPPBTD1	Computational Physics and Programming	3	3+0+0	30	70	100
		PPPBLD1	Computational Physics and Programming Lab	2	0+0+2	30	70	100
	Other if any							
			TOTAL	**20**				**1000**
III	Core-7	PPPCTT1	Nuclear and Particle Physics	5	4+1+0	30	70	100
	Core-8	PPPCTT2	Condensed Matter Physics	3	3+0+0	30	70	100
		PPPCLT2	Condensed Matter Physics Lab	2	0+0+2	30	70	100
	Research Methodology	PPPCTR1#	Research Methodology in Physics	2	2+0+0	30	70	100
	Discipline Specific elective 2	PPPCTD1	Molecular Physics and Group Theory	5	4+1+0	30	70	100
	Discipline Specific elective - 3	PPPCTD2	i. Advanced Condensed Matter Physics-I	3	3+0+0	30	70	100
			ii. Advanced Nuclear Physics –I		3+0+0	30	70	100
			iii. Astronomy and Astrophysics-I		3+0+0	30	70	100
			iv. Molecular Spectroscopy-I		3+0+0	30	70	100
			v. Material Science –I		3+0+0	30	70	100
			vi. Accelerator Physics-I		3+0+0	30	70	100
		PPPCLD2	Respective Discipline Specific elective Lab - 3	2	0+0+2	30	70	100
	*Certificate/ FC/UEC			2		30	70	100
	Other if any							
			TOTAL	**22+2 ***				**1300**

Semester – I

Core –2: Quantum Mechanics
Course Code: PPPATT2 **Credits = 4 (3+1+0)**

Course Objectives:

- To introduce the modern concepts of quantum mechanics in a stimulating, elegant, exhaustive and explanatory manner.
- To explore the nature of the microscopic world into substantial depth in terms of meaning and interpretation so as to acquaint the learners to initiate thinking and analyzing the physically observable phenomena quantum mechanically without exceeding the mathematical level of complexity.
- To lay down the foundation and enhance capabilities of students to pursue various aspects of modern physics and interdisciplinary fields confidently.

Course Outcomes:
After the completion of course, students should be able to understand and grasp.

- The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamical variables and applying wave mechanics to various situations in terms of boundary value problems so as to understand the quantum well, barriers and particle motion in different types of force field (potentials).

Unit – I: Introduction to Schrodinger equation; probability interpretation, probability current, continuity equation; Ehrenfest theorem; Admissible wave functions; Stationary states, Schrodinger equation in one dimensional problems, wells and barriers; Harmonic oscillators by Schrodinger Equation
Unit – II: Uncertainty relation of x and p, States with minimum uncertainty product; General Formalism of wave mechanics; Commutation Relations; Representation of states and dynamical variables; Completeness of eigen functions; Dirac delta function; Bra and ket Notation; Matrix representation of an operator; Unitary transformation. Solution of Harmonic oscillator by operator method.
Unit – III: Angular momentum in QM, Central force problems: Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom problem.

Unit – IV: Time independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect etc.

Reference Books:

1. Quantum mechanics, by L I Schiff
2. Quantum physics by S Gasiorowicz
3. Quantum mechanics by B Craseman and J D Powell

Core –3: Electronics and Experimental Methods
Course Code: PPPATT3 **Credits = 3 (3+0+0)**

Course Objectives:

- The course mainly focuses on developing the Electronics, experimental and instrumentation skills of the students.
- To develop the understanding of physics of semiconductor, semiconductor junctions, metal-semiconductor, homo-junction, and hetero-junction and metal-oxide semiconductor contacts.

Course Outcomes:

- Students understand the basic of semiconductor and electronics devices.
- Students understand the current voltage characteristics of semiconductor devices, metal-semiconductor, homo-junction, and hetero-junction and metal-oxide semiconductor contacts.

Unit – I: Energy band in semiconductors, Carrier concentration in intrinsic and extrinsic semiconductors, Fermi levels in intrinsic and doped semiconductors, Concept of degenerate and non-degenerate semiconductors, temperature and doping dependent energy band gap of semiconductors.

Unit – II: Carrier mobility and drift velocity, Resistivity and conductivity, diffusion current, Einstein's relationship, Generation and recombination of carriers, Continuity equation, Carrier Injection and excess carriers, Decay of carriers.

Unit – III: P-N junction; device structure, energy band diagram, depletion region (abrupt junctions), depletion capacitance and C-V characteristics, I-V characteristics, Varactor diode, Tunnel diode principle of operation and I-V characteristics, Semiconductor hetero-junctions, Metal-semiconductor junction, Ohmic contacts. Solar cells, Photo-detectors, LEDs.

Unit – IV: Precision and Accuracy, Error Analysis, Types of errors,Propagation of errors, Curve fitting: Least square fitting, chi-square test. Measurement techniques: Sensors and Transducers (Temperature, vacuum, optical, particle and radiation detectors etc.), Signal and Noise.

References:

1. Semiconductor devices- Physics and Technology by S.M.Sze
2. Electronic Devices and Circuit Theory by Boylestad and Nashelky
3. Integrated Electronics : Milliman and Halkias
4. Measurement, Instrumentation, and Experimental design in Physics and Engineering: Michael Sayer, AbhaiMansingh
5. Transducers and Instrumentation:DVSMurty

Core –3: Electronics and Experimental Methods Lab
Course Code: PPPALT3 **Credits = 2 (0+0+2)**

1. Study the operational Amplifier as inverting and non-inverting amplifier
2. Study the operational Amplifier as a summing amplifier (Voltage adder and voltage subtraction).
3. Study the operational Amplifier as a differentiator and integrator.
4. A study of V-I characteristics of light emitting diode (LED).
5. A study of V-I characteristics of Tunnel diode.
6. Study of Solar Cell characteristics
7. Photoconductivity (Photocurrent as a function of irradiance at constant voltage)
8. Design of regulated Power Supply
9. Verification of De Morgan's Theorem
10. To design a digital to analog converter (DAC) of given specifications

Open Elective: Nanomaterials and Its Applications
Course Code: OPNPPT1 **Credits = 3**
(3+0+0)

Course Objectives:
The objective of the subject is that the student acquires knowledge

- To foundational knowledge of the Nanomaterials and related fields.
- To understand the influence of dimensionality of the object at nanoscale on their properties

Learning Outcomes:
After completing this course students will be able to:

- Understand the various synthesis methods of Nanomaterials and their application and the impact of Nanomaterials on environment
- Apply their learned knowledge to develop new Nanomaterial's.

Unit – I: History of nano- materials, Ancient Indian Culture and Nanotechnology, Role of Feynman in development of Present Nano-sciences, what are Nanoscience and Nanotechnology?Atomic structure and atom size and their effects, Types of 1D, 2D, 3D Nano-structured materials, Influence of nano over micro/macro.

Unit – II: Properties of Nano materials: Physical, Magnetic, Optical, Thermal, Mechanical, Electrical for nano materials and Chemical Properties, Size effects, Surface Effects and Surface to Volume ratio.

Unit – III : Type of Nanomaterials: different type of nano materials,Carbon nanotube, Fullerene, Type of CNT: SWNT (Single wall nano tube), Multi wall nano tubes. 2D nano material, Graphite and Graphene, metal nano particle silver and gold, ZnO and TiO_2 metal oxides, Semiconductors, Nano-composites,Creating nanoparticles by using software.

Unit – IV: Synthesis of nano materials**:** Top- down or bottom up approach, Physical Methods, PLD, Sputtering, Thermal evaporation, Chemical Methods – CVD, Sol-gel, Hydrothermal, Biological Methods – Green Synthesis, mechanical milling, sputtering and microwave plasma, chemical reduction and oxidation, hydrothermal, micelles, sol-gel processes, photolysis, and metal organic chemical vapor deposition.

Reference Books:

1. Introduction to Nano Science and Nano Technology – K.K. Chattopadhyay & A. N. Banerjee PHI Pvt. Ltd., 2009.
2. Nano technology: Principles and practices - Sulabha K. Kulkarni, Capital Publisher Co., 2015.
3. Introduction to nano technology: Charles P. Poole, Jr. Frank J. Owen, Wiley, Interscience Pub., May, 2003.
4. Nanostructures & Nanomaterials Synthesis Properties & Applications. Guozhong Cao, Imperials College Press London. 2004

Open Elective: Nanomaterials and Its Applications Lab
Course Code: OPNPPL1 **Credits = 2 (0+2+0)**

1. To determine the crystallite size of given sample and observe the influence of do-pants through given XRD data.
2. To analyze the particle size Scanning Electron Microscopy and Transmission Electron Microscopy images of given samples.
3. To determine the crystallinity and phase composition of the given sample through selective area electron diffraction.
4. To determine the electronic band-gap of given sample through Tauc plots derived from UV-Vis diffused reflectance spectroscopy.
5. To identify Hydrogen bond through FTIR spectroscopy.
6. To analyze the elemental species present in the given sample through X-ray Photoelectron Spectroscopy.

Semester - II

DSE – 1: Computational Physics and Programming **Credit: 3 (3+0+0)**
Course Code: PPPBTD1

Course Objectives:
The course aims to develop an understanding of:

- Basic methods, tools and techniques of computational physics with Fortran 90/95.
- Developing practical computational problem solving skills.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- identify modern programming methods and describe the extent and limitations of computational methods in physics,
- independently program computers using leading-edge tools,
- formulate and computationally solve a selection of problems in physics,

Unit – I: Basic in computer programming, programming preliminaries, Fortran 90 programming: Constants and Variables, Arithmetic expression, I/O statements, Conditional statements

Unit – II: Loops and Logical expressions, Functions and Subroutines, Arrays, Format specifications, Files Processing in Fortran 90

Unit – III: Numerical methods: solution of linear and nonlinear algebraic equations and transcendental equations, bisection method, false position method, Newton Raphson method, Solution of simultaneous linear equations, Matrix inversion, Gaussian elimination, iterative Method.

Unit – IV: Interpolation (with equally spaced and unevenly spaced point), Curve fitting, Numerical integration, Trapezoidal rule, Simpson's method, Numerical solution of ordinary differential equation by Runga-Kutta method.

Reference Books:

1. Sastry: Introductory methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis and Fortran Programming
3. *Numerical Recipes in FORTRAN: The Art of Scientific Computing*, Press, et al. (Cambridge University Press)
4. *Fortran 90 Programming*, Ellis, Philips and Lahey (Addison-Wesley)
5. *Fortran 90/95 Explained*, Metcalf and Reid (Oxford)
6. *Fortran 90/95 for Scientists and Engineers*, Chapman (McGraw-Hill Higher Education)

DSE – 1: Computational Physics and Programming Lab **Credit: 2 (0+0+2)**
Course Code: PPPBLD1

Name of the experiments
1. Implementation of solving the non algebraic equation using Fortran 90
2. Implementation of Numerical Integration using Fortran 90
3. Implementation of Solving Differential equation using Fortran 90
4. Implementation of Solving linear equations using Fortran 90