List of Revised Courses

Department : *Pure and Applied Physics*

Program Name : *M.Sc. (Physics)*

Academic Year : 2021-22

List of Revised Courses

Sr. No.	Course Code	Name of the Course
01.	PPPATT1	Classical Mechanics
02.	PPPATT3	Electronics and Experimental Methods
03.	PPPBTT3	Statistical Mechanics

Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2021-22	
School :	*School of Physical Sciences*
Department :	*Pure and Applied Physics*
Date and Time :	*March 10, 2022 – 02:00 PM*
Venue :	*Smart Class Room*

The scheduled meeting of member of Board of Studies (BoS) of Department of Pure and Applied Physics, School of Studies of Physical Sciences, Guru Ghasidas Vishwavidyalaya, Bilaspur, was held to design and discuss the M. Sc. (Physics), scheme and syllabi.

The following members were present in the meeting:

1. Dr. M. N. Tripathi
2. Prof. P. K. Bajpai
3. Prof. D. C. Gupta, External Member (Professor & Head, School of Studies in Physics, Jiwaji University, Gwalior)
4. Dr. A. K. Singh
5. Mr. P. Rambabu
6. Dr. R. P. Patel
7. Dr. M. P. Sharma

The committee discussed and approved the scheme and syllabi. The following courses were revised in the M. Sc. (Physics):

- Classical Mechanics
- Electronic and Experimental Methods
- Statistical Mechanics

The following new courses were introduced in the M. Sc. (Physics):

- Quantum Mechanics Lab (PPPALT2)
- Electronic and Experimental Methods Lab (PPPALT3)
- Nanomaterials and its Applications (OPNPPT1)
- Nanomaterials and its Applications Lab (OPNPPL1)
- Advanced Quantum Mechanics Lab (PPPBLT2)
- Computational Physics and Programming Lab (PPPBTD1)

MNTripathi
विभागाध्यक्ष/H.O.D.
शुद्ध एवं अनुप्रयुक्त भौतिकी विभाग
Dept. of Pure & Applied Physics
गुरु घासीदास विश्वविद्यालय
Guru Ghasidas Vishwavidyalaya
बिलासपुर (छ.ग.)/Bilaspur (C.G.)

Signature & Seal of HoD

Scheme and Syllabus

Course Structure
M.Sc. Physics Syllabus 2021-22

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 –1: Classical Mechanics
Course Code: PPPATT1 **Credits = 5 (4+1+0)**

Course Objectives:
The course aims to develop an understanding of:
- To solve advanced problems involving the dynamic motion of classical mechanical systems.
- To use conservation of energy, linear and angular momentum to solve dynamics problems.
- To constructing the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
- The motion under central force and inverse square force.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- The significance of conservation of various physical quantities to discuss the motion of dynamical system.
- The constraints and their significance to solve the equations of motion of the dynamical system.
- The necessity of Lagrangian and Hamiltonian formulations for simplified treatments of many complex problems in classical mechanics.
- This course enables the students to model dynamical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.
- The essential features of a problem (like motion under central force and rigid body dynamics), use them to set up and able to solve the appropriate mathematical equations under central force and inverse force
- The theory of small oscillations and its importance in several areas of physics.

Unit–I Elementary Principles:
Mechanics of a Particle, Mechanics of a System of Particles, Conservation Laws, Work Energy Theorem, Constraints, Classification of Constraints, Degree of Freedom, Generalized Coordinates,Virtual displacement and virtual work, Principle of Virtual Work, D'Alembert's Principle, Lagrange's Equation from D'Alembert's Principle, Properties of Kinetic Energy Function.

Unit–II Lagrangian Formulation:
Lagrangian equation of motion from D'Alembert's Principle, Lagrangian equation of motion from Calculus of Variations, Properties of Kinetic Energy Function and Kinetic energy in terms of generalized coordinates. Gyroscopic Forces, Dissipative Forces, Rayleigh's Dissipation Function, Lagrangian equation of motion for Dissipative System, Linear Generalized Potential, Generalized Momenta and Energy, Jacobi Integral, Gauge Function for Lagrangian, Cyclic Coordinates, Integrals of Motion, Symmetry of Space and Time with Conservation Laws – Homogeneity and Isotropy, Invariance of Lagrangian equation of motion under Galilean Transformation.

Unit–III Rotating Frames, Central Force and Rigid Dynamics:
Inertial and Rotating Frames, Inertial Forces in Rotating Frame, Pseudo forces – centrifugal, Coriolis and Euler forces and their derivation from Newtonian and Lagrangian Formulation,Definition and Properties of Central Force, Two–body Central Force Problem, General Featuresof Central Force Motion and its Orbits, Stability of Orbits and Conditions for Closure, Motion under Inverse Square Force (Kepler's Problem) and Shapes of Orbits, Unbound Motion - Rutherford Scattering. Euler's angles, Inertial forces, Angular momentum of rigid body, Euler's equation of rigid body, free motion of rigid body.

Unit–IV Hamiltonian Formulation and Small Oscillations:
Hamilton's Variational Principle Hamilton's Variational Principle from Lagrangian equation of motiom, Hamilton's Canonical Equations of Motion, Hamilton's Canonical Equations from Hamilton's Variational Principle, Principle of Least Action, Canonical Transformations and Generating Functions, Example of Canonical Transformations, Condition for Canonical Transformations, Hamilton – Jaccobi Equation, Hamilton's Principal and Characteristic Functions, Poison Bracket, Invariance of Poisson Brackets with Respect to Canonical Transformations, Equations of Motion in Poisson Bracket Form, Poisson's Theorem, Angular Momentum in Poisson Bracket, Small Oscillations, Normal Modes and Normal Coordinates.

References:
1. Classical Mechanics, N.C. Rana and P.S. Joag, (TATA McGraw-Hill, 1991).
2. Classical Mechanics, H. Goldstein, (Addition Wesley, 1980).
3. Classical Mechanics, H. Goldstein, C. Poole, and J. Safko, (Pearson Education, Inc, 2002).
4. Classical Mechanics, J.C. Upadhaya (Himalaya Publishing House)
5. Classical Mechanics, Gupta, Kumar and Sharma (PragatiPrakashan)
6. Classical Mechanics by P.V. Panat, (Narosa Book Distributors Private Ltd)

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.
- Semiconductor photonic devices and hetero-structures for detection and production of optical radiation.
- To understand the concept of Data Interpretation and Analysis of results.

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.
- Student understands the basic mechanism involves in optoelectronics devices.
- Understanding of sensors and transducers for temperature, vacuum, optical and vibration measurements

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

Semester – II

Core –6: Statistical Mechanics
Course Code: PPPBTT3
Course Objectives:

- To understand connection between Thermodynamics and Statistical Mechanics.
- To understand different Ensemble and their applications.
- To understand different distribution law
- To learn the Application of different distribution function
- To understand phase transition

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

- Concept of ensemble theory
- Fundamental difference of classical and quantum statistical distribution
- Application of Fermi distribution function and B-E distribution function to calculate various physical parameters
- Concept of different Phase

Unit – I: Review of Thermodynamic potentials and Macrostate& Microstate, Concept of distribution function of Microcanonical Ensemble, Canonical ensemble, Grand Canonical ensemble, Phase Space, Dynamical variable, Relation of partition function with thermodynamic Functions, application of partition function, Motion of the point in phase space (Liouville equation), fluctuations of energy in canonical ensemble and no. of particles in grand canonical ensemble (15 Lectures)

Unit – II: Maxwell-Boltzmann Distribution Law, B-E distribution law, Fermi-Dirac Distribution Law, Derivation of Ideal Quantum gas equation, adiabatic quantum gas relations. (10 Lectures)

Unit – III: Application of Fermi-Dirac Statistics: Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Fermi sphere, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. Application of B-E statistics: Bose Einstein condensation, properties of liquid He (qualitative description), Blackbody Radiation, heat capacity (20Lectures)

Unit – IV: Phase transition, (P, T), (V, T) and (P. V) Phase diagram, Real gas equation, tie line, order parameter, Landau theory with example. Ising Model(15 Lectures)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical Mechanics, By K Huang.
4. Statistical Physics, By Landau and Lifshitz.
5. *Statistical Mechanics* by *Donald* A. *Mc Quarrie* (Harper & Row, New York, 1976)