<u>**Detailed Syllabus**</u>

Lecture-wise Breakup

<table>
<tr><td>Course Code</td><td>19M21PH111</td><td colspan="2">Semester: Odd</td><td colspan="2">Semester: I Session
Month from: July to December</td></tr>
<tr><td>Course Name</td><td colspan="5">Classical Mechanics</td></tr>
<tr><td>Credits</td><td colspan="2">4</td><td colspan="2">Contact Hours</td><td>3+1</td></tr>
<tr><td rowspan="2">Faculty (Names)</td><td>Coordinator</td><td colspan="4">Anuraj Panwar</td></tr>
<tr><td>Teacher</td><td colspan="4">Anuraj Panwar</td></tr>
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COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Relate terminology and concepts of Newtonian Mechanics, Lagrangian and Hamiltonian approach, Central field, Rotational motion, small oscillations, and special theory of relativity.	**Remember Level (Level 1)**
CO2	Explain various mechanism, models, derivations, and approaches associated with classical mechanics.	**Understand Level (Level 2)**
CO3	Solve numerical problems for various situations in classical mechanics.	**Apply Level (Level 3)**
CO4	Analyze the results obtained for various physical problems of classical mechanics.	**Analyze Level (Level 4)**

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	**Introduction**	Newton's Laws, Dynamical Systems, Stability Analysis, Phase-space Dynamics.	2
2.	**Lagrangian Dynamics**	Generalised coordinates, Holonomic and nonholonomic systems. Scleronomic and rheonomic systems, D'Alembert's principle, Lagrange's equations, Energy equation for conservative fields, Cyclic (ignorable) coordinates, Generalised potential, Variational Calculus and Principle of Least Action.	8

3.	**Hamiltonian formulations:**	Legendre transformations, Hamilton equations, cyclic coordinates and conservation theorems, principle of least action, canonical transformations, Poisson brackets, Hamilton-Jacobi theory, Action-angle variables.	10
4.	**Two Body Central Force Problem**	Equivalent one body problem and effective potential; classification of orbits; differential equation for orbits, Virial Theorem , Inverse Square Law of Force : Bound state problem : Kepler problem; Kepler's laws and planetary motion; Kepler's equation; Laplace – Lenz vector. Scattering Problem: elastic scattering, scattering cross section, centre of mass and laboratory frames, Rutherford scattering.	5
5.	**Rigid Body Dynamics**	Kinematics: degrees of freedom; space–fixed and body-fixed set of axes and orthogonal transformations from one set to another; Euler's angles; Euler's theorem on the motion of a rigid body; infinitesimal rotations; moments of inertia, inertia tensor and principal axes transformations; Euler's equations of motion. Force free motion of a rigid body; symmetrical top, Larmor precession; gyroscope asymmetrical top.	6
6.	**Small Oscillations**	Formulation of the problem; eigenvalue equations; frequencies of free vibrations and normal coordinates; forced vibrations and the effect of dissipative forces; simple examples.	4
7.	**Special relativity**	Internal frames, Principle and postulate of relativity, Lorentz transformations, Length contraction, time dilation and the Doppler effect, Velocity addition formula, Four- vector notation, Energy-momentum four-vector for a particle. Relativistic invariance of physical laws, Minkowski space.	5
		Total number of Lectures	**40**
Evaluation Criteria			

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 [Attendance (07 M), Class Test, Quizzes, *etc* (07 M), Assignments in PBL mode (06 M), and Internal assessment (05 M)]
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Goldstein, Classical Mechanics –Narosa
2.	Landau and Lifshitz, Mechanics - Pergamon
3.	Rana and Joag, Classical Mechanics – Tata McGraw Hill
4.	Whittaker, Analytical Dynamics of Particles and Rigid Bodies - Cambridge
5.	Raychaudhuri, Classical Mechanics – Oxford
6.	Sankara Rao, Classical Mechanics, Prentice hall of India

Project based Learning (PBL): Students groups may be asked to submit reports on various physical problems on Newtonian mechanics, Lagrangian and Hamiltonian dynamics, central field problems, rotational motion, small oscillations and special theory of relativity. Students may be asked to make presentations on recently published articles on classical mechanics. Students may be asked to solve classical mechanics problems by using their expertise in computer language.

Detailed Syllabus

Lecture-wise Breakup

Course Code	19M21PH112	**Semester: Odd**	**Semester: I Session: 2021-2022** **Month from: July to December**	
Course Name	Mathematical Physics			
Credits	4		**Contact Hours**	3+1
Faculty (Names)	**Coordinator**	Manoj Kumar		
	Teacher	Manoj Kumar		

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Recall basics of matrices, complex analysis, differential equations, special functions, Fourier and Laplace transformations etc	Remembering (C1)
CO2	Explain elements of linear vector space, complex analysis and methods of solving differential equations of various type	Understanding (C2)
CO3	Apply concepts of matrices, complex analysis, differential equations, Fourier and Laplace transformations, and group theory to physical problems	Applying (C3)
CO4	Evaluate solution of physical problems using matrices, complex analysis, differential equations, Fourier and Laplace transformations and group theory	Evaluating (C5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Vector Analysis, Matrices and Tensor Analysis	Vector algebra, gradient, divergence and Curl, Integral theorems, curvilinear coordinates and coordinate transformation, Eigen values and eigen vectors, diagonalization of matrix, coordinate transformation, summation convention, classification of tensors, rank of a tensor, contravariant, covariant and mixed tensors, symmetric and antisymmetric tensors, contraction of tensor, metric tensor. Curvilinear coordinates	8
2.	Complex Analysis	Algebra of complex numbers, continuity and differentiability of complex functions, Cauchy-Riemann equations, Analyticity and singularity points, complex integration, Cauchy integral theorem, evaluation of residues and definite integrals, Taylor and Lorentz Series.	12
3.	Differential Equations and Special functions	Differential operators, second order linear ordinary differential equations, Power series solution of differential equations Bessel's equation and solutions, Bessel's functions, recurrence formula, orthogonality of Bessel functions, General solutions to: Legendre, Laguere, Hermite, Beta and gamma functions and their properties and inter relationships. Green's Function and its applications.	8
4.	Fourier and Laplace Transforms	Fourier series, Dirichlet's conditions, Fourier integral theorem, Fourier sine and cosine transforms, Fourier Transforms of Dirac Delta function, solution of partial differential equation, Integral Transforms, Laplace transform: Conditions for L.T., Simple properties of L.T., First and Second shifting theorems, L.T. of derivatives,	8

		solution of ordinary differential equation by L.T.	
5.	Group theory	Groups, Subgroups, Normal Subgroups, Quotient Groups, Isomorphism Theorems, Simple Groups, Jordan Holder Theorems, Sylow Probability Theory, Random variable, Binomial, Poisson, and normal distribution, and central limit theorem.	4
		Total number of Lectures	**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [Attendance (07 M), Class Test/Quizzes, *etc* (07 M), Assignments in PBL mode (06 M), and Internal assessment (05 M)]
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Mathematical Methods for Physicists, by G. Arfken, *Academic Press.*
2.	Introduction to Mathematical Physics, by Charlie Harper, Phi Learning.
3.	Advanced Engineering Mathematics by Creyszig
4.	Advanced Engineering Mathematics by R K Jain and S R K Iyengar
5.	Mathematical Physics, by H.K. Dass.
6.	Mathematical Methods in Classical and Quantum Physics by Tulsi Das and S K Sharma

Project Based Learning: Students will be given small projects in groups to enhance their understanding and interest in the course by corelating topics taught and their applications in solving different physical problems of real worlds. Students will be asked to submit the report of given project and give presentations of the same.

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M21PH113	**Semester: ODD**	**Semester: I Session:** 2021 -2022 **Month from: July to December**
Course Name	Quantum Mechanics		
Credits	4	**Contact Hours**	3+1

Faculty (Names)	**Coordinator(s)**	Dr Ashish Bhatnagar
	Teacher(s) (Alphabetically)	Dr Ashish Bhatnagar

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Recall basic requirement of Quantum Mechanics such as inadequacy of classical physics in black body radiation, photoelectric effect etc.	Remembering (C1)
CO2	Demonstrate the general structure of Quantum Mechanics such as vector space, Dirac's bra-ket notation, operator algebra, angular momentum algebra, uncertainty relation etc.	Understanding (C2)
CO3	Schrödinger equation and its applications as potential well cases, harmonic oscillator, hydrogen atom and in hydrogen like systems etc.	Applying (C3)
CO4	Analyzing the applicability of different Approximation Techniques such as WKB approximations, perturbation theory, variational methods for Anharmonic oscillator, Helium atom, Stark effect etc.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Introduction**	Inadequacy of classical Physics and advent of quantum physics (with specific attention to Planck's law, photoelectric effect, Compton effect, Specific heat, wave nature of mater, Davisson-Germer experiment, Stern–Gerlach, and Franck-Hertz experiment). Brief discussion on Schrodinger equation and solution of some simple problems.	3
2.	**General structure of Quantum Mechanics**	Basic ideas of linear algebra: vector space, inner product, Hilbert-space, Dirac's bra-ket notation for state vectors, bases and linear independence, eigen values and eigen vectors (with their physical meaning). Hermitian, normal, unitary and positive operators, Postulates of quantum mechanics, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method. Commutators and Heisenberg's uncertainty principle.	10
3.	**Schrödinger equation and its applications**	Schrodinger wave equation (time-dependent and time-independent) and probability interpretation, Simple potential problems–wells, tunneling through a barrier and harmonic oscillator (One and three dimensional). Wave-function in coordinate and momentum representations.	10

		Spherically Symmetric potentials: The hydrogen atom and hydrogen like systems (e.g., Hydrogen molecular ion). A brief idea of open quantum systems.	
4.	**Angular Momentum Algebra**	The angular momentum operator and their representation in spherical polar coordinates, eigen values and eigen functions of L^2 and L_z operators, ladder operators L+ and L-, Pauli's theory of spins (Pauli's matrices), angular momentum as a generator of infinitesimal rotations, matrix representation of J in ljm> basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases (J1=1/2, J2=1/2) Central forces with an example of hydrogen atom.	7
5.	**Approximation Techniques**	Time-independent perturbation theory for non-degenerate and degenerate states. Applications: Anharmonic oscillator, Helium atom, Stark effect in hydrogen atom, Variational methods: Helium atom. WKB approximations and their applications to 2 electron systems.	10
		Total number of Lectures	**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [2 Quiz (7M), Attendance (7M), project (6M), Class performance (5 M)]
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Quantum Mechanics, L. I. Schiff, McGraw-Hill Book Co.
2.	Quantum Mechanics, E Merzbacher. John Wiley and Sons.
3.	Quantum Mechanics, A. Ghatak and S. Lokanathan, Macmillan
4.	Quantum Physics: Berkeley Physics Course, Vol. 4, E H Wichman, Tata McGrawhill,
5.	Feynman Lectures on Physics, Vol-3, Narosa
6.	Quantum Mechanics Concepts and Applications, Nouredine Zettili. John Wiley and Sons.

Project based Learning (PBL): Students will make some individual projects on selected Topics of Quantum Mechanics like some approximation techniques depending on its applicability for specific simulation like solving different molecular systems with the help of Hartree fock, Density functional Methods etc. Example: For drug designing different quantum mechanical approximation techniques are used. Each project work will describe the detail about the specific approximation technique. Students will take help from available internet sources, current research papers, Text books for preparing the project. Throughout the preparation of the whole project and by presenting the project work students will gather deep learning about the applicability of different approximation techniques for the requirement of current Industry. The overall knowledge will help them to prepare themself as an efficient Physicist according to the requirements of current Industry.

Detailed Syllabus

Lecture-wise Breakup

Course Code	19M21PH114	**Semester: Even**	**Semester: I Session** **Month from: July to December**
Course Name	Electronics		
Credits	4	**Contact Hours**	3+1
Faculty (Names)	**Coordinator**	Dr. Bhubesh Chander Joshi	
	Teacher	Dr. Bhubesh Chander Joshi	

COURSE OUTCOMES		**COGNITIVE LEVELS**
C305-6.1	Recall the basic concepts of electronics devices like diodes, LEDs, BJT, FET, MOSFET, oscillators, OP-AMPS, digital GATES, and Flip flops.	Remembering (C1)
C305-6.2	Explain the various physical parameters involved in designing and working of electronic devices & circuits.	Understanding (C2)
C305-6.3	Solve various network related problems. Develop design competence in Analog and digital electronics.	Applying (C3)
C305-6.4	Develop analytical capability to analyze electronics networks, circuits and components.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Basic electronics**	Network theorems and network analysis; Semiconductors, intrinsic and extrinsic semiconductors, Diode theory, forward and reverse-biased junctions, reverse-bias breakdown, load line analysis, diode applications - Limiters, clippers, clampers, voltage multipliers, half wave & full wave rectification, Zener diode, Varactor diode. Transistor fundamentals, transistor configurations, DC operating point, BJT characteristics & parameters, fixed bias, emitter bias with and without emitter resistance, analysis of above circuits and their design, variation of operating point and its stability.	10
2.	**Amplifier, Feedback & Oscillator Circuits**	Small Signal BJT amplifiers: AC equivalent circuit, hybrid, re model and their use in amplifier design. Multistage amplifiers, frequency response of basic & compound configuration, Power amplifiers: Class A, B, AB, C and D stages, IC output stages. Effect of positive and negative feedbacks, basic feedback topologies & their properties, Analysis of practical feedback amplifiers, Sinusodial Oscillators (RC, LC and Crystal), Multivibrators.	10
3.	**Operational Amplifiers**	Op-Amp Basics, practical Op-Amp circuits, differential and common mode operation, Inverting &Non-Inverting Amplifier, differential and cascade amplifier, Op-Amp applications.	6
4.	**Field-Effect Transistors (FET)**	JFET- current-voltage characteristics, effects in real devices, high-frequency and high-speed issues. Basics of MOSFET.	2
5.	**Digital Electronics**	Decimal, binary, octal, hexadecimal number system and conversion , binary weighted codes, signed numbers, 1s and 2s	12

		complement codes, Binary arithmetic, Positive and negative logic designations, OR gate, AND gate, NOT gate, NAND gate, NOR gate, XOR gate, Introduction of digital logic families: Logic levels, propagation delay time, power dissipation fan-out and fan-in, noise margin, logic families (RTL, DTL, TTL etc).Circuits and Boolean identities associated with gates, Boolean algebra- De-Morgans Laws, Sum of products and product of sums expressions, Karnaugh maps, two, three and four variable Karnaugh maps, simplification of expressions, Minterm, Maxterm, deriving SOP and POS expressions from truth tables.	
6.	**Combinational and Sequential Logic**	Binary adders, half adders, full adders, decoders, multiplexer, demultiplexer, encoders, ROM and applications, Digital comparator, Parity checker and generator, Flip-Flops- RS, JK, master slave JK, T-type and D-type flip flops, Shift-register and applications, Asynchronous counters and applications. A/D and D/A converters.	10
		Total number of Lectures	**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [Attendance (07 M), Class Test, Quizzes, *etc* (07 M), Assignments in PBL mode (06 M), and Internal assessment (05 M)]
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Textbooks, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Robert L. Boylestad& Louis Nashelsky, Electronic Devices & Circuit Theory.
2.	A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications
3.	William Kleitz, Digital Electronics, Prentice Hall International Inc.
4.	Digital Principles and Applications – 5th Edition, Albert Paul Malvino Donald P.Lcach, Tana Mc-Graw-Hill Publishing Company Ltd., New Delhi, 1994
5.	M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons Inc.
6.	Michael Shur, Introduction to Electronic Devices, John Wiley & Sons Inc., 2000.
7.	Jacob Millman, and C.C. Halkias, "Electronic devices and circuits", TMH Publications.
8	Ben G. Streetman, SolidState Electronic Devices, PHI, 5th Ed, 2001.
9	Digital Design – 4th edition, M.Morris Mano, Prentice Hall, 2006.
10	Basic Electronics, B.L. Theraja, S. Chand & Co. Ltd., 2008

Project Based Learning: Students will have to submit a working project based on p-n diodes, Zener diodes, LEDs, BJT, FET, MOSFET, oscillators, OP-AMPS, digital GATES, and Flip flops. At the end of the semester, students will be asked to submit and present their projects on the basis of which PBL marks will be awarded.

Detailed Syllabus

Lab-wise Breakup

Course Code	**19M25PH111**	**Semester: ODD**	**Semester: 1st Session:** 2021 -2022 **Month from: July to December**
Course Name	**Laboratory-1**		
Credits	4	**Contact Hours**	8

Faculty (Names) **Coordinator(s)** Navneet Kumar Sharma

Teacher(s) (Alphabetically) Anirban Pathak, Navendu Goswami, Navneet Kumar Sharma, Papia Chowdhury

COURSE OUTCOMES		**COGNITIVE LEVELS**
C170.1	Recall optics, solid state physics and modern physics principles behind the experiments.	Remembering (C1)
C170.2	Explain the experimental setup and the principles involved behind the experiments performed.	Understanding (C2)
C170.3	Plan the experiment and set the apparatus and take measurements.	Applying (C3)
C170.4	Analyze the data obtained and calculate the error.	Analyzing (C4)
C170.5	Interpret and justify the results.	Evaluating (C5)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Optics	1. Wavelength measurement of Na-source using Michelson interferometer. 2. Determination of coherence & width of spectral lines using Michelson interferometer 3.To determine the wavelengths of Balmer series in the visible region from hydrogen emission and to determine the Rydberg constant	1-5
2.	Modern Physics	4. Measurement of critical potential using Franck-Hertz tube. 5. To observe the Zeeman spitting of the green mercury line using Fabry-Perot etalon for normal transverse and longitudinal configuration.	1-5
3.	Solid State Physics	6. Determination of band gap of semiconductor from temperature dependence of Resistivity using Four Probe	1-5

		Method 7. To study B-H loop for a given sample by CRO 8. Study of Dielectric constant and determination of Curie temperature of ferroelectric ceramics 9. Study of Hall Effect and determination of allied coefficients 10. Study of magneto resistance of given semiconductor material 11. Study of Magnetostriction using Michelson Interferometer 12. Study of electron spin resonance and determination of line width, electron spin, magnetic moment of an electron and electron g factor.	

Evaluation Criteria

Components	**Maximum Marks**
Mid Term Viva (V1)	20
End Term Viva (V2)	20
D2D	60
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1. Experiment hand-outs.