Two years Master of Science (M.Sc.) curriculum in Physics

Program Overview

Open to students with bachelor's degree in Physics, qualified through all India entrance examination JAM. There is a wide range of core-courses that emphasize the fundamentals of the subject while keeping in mind the continuous evolution of the subject. A strong experimental hands-on component in the form of the laboratory courses allow the students to explore a range of experiments from classic ones to those that are more recent and advanced. Variety of baskets of advanced elective courses offer a glimpse as well as in-depth understanding into frontier areas of the current research field and help the students to choose a topic for the master's project spans over the last two semesters. The objective of the present curriculum is to empower students with the knowledge and exposure required to contribute to the community as a potential human resource for the country, who could address the challenging problems of the future and contribute to nation-building.

Structure of the Program

The program consists of 4 semesters. The first two semesters consist of core courses. The third and fourth semesters are largely elective courses in both theory as well as experiments in addition to that of the master's project.

M.Sc. Physics course structure			
1st Semester	2nd Semester	3rd semester	4th semester
Mathematical Physics 3-1-0-4 (PH501)	Statistical Physics 3-1-0-4 (PH507)	Atomic and Molecular Spectroscopy 3-0-0-3 (PH513)	Thesis Project Stage-II 0-0-24-12 (PH604)
Classical Mechanics 3-1-0-4 (PH502)	Quantum Mechanics-II 2-1-0-3 (PH508)	Program Elective-I 3-0-0-3	Program Elective-II 3-0-0-3
Quantum Mechanics-I 2-1-0-3 (PH503)	Condensed Matter Physics 3-0-0-3 (PH509)	Advanced Experimental Lab 0 - 0 -4 -2 (PH602)	Program Elective-III 3-0-0-3
Electrodynamics 3-1-0-4 (PH504)	Nuclear and Particle Physics 3-0-0-3 (PH510)	Thesis Project Stage-I 0 - 0 -12- 6 (PH603)	Open Elective * x - x - x - 3
Experimental Physics-I 0-0-4-2 (Lab) (PH505)	Computational Physics 1-0-4-3 (Th+Lab) (PH511)	Open Elective * x - x - x- 3	
Electronics 3-0-0-3 (PH506)	Experimental Physics-II 0-0-4-2 (Lab) (PH512)		
	Research Communication, Ethics and Methods (HS600) 3-0-0-3 (P/NP) #		
Credits = 20	21	17	18
Total Credits=76			

#: Research communication, ethics and methods (HS600) [3-0-0-3] (P/NP): The 3 credits will count in the calculations of the total credits, however, only "Pass (P)/No Pass (NP)" grade will be given instead of the alphabet grade.

Program Elective: The elective courses (i.e Program Elective- I, II and III) are offered in the form of groups or baskets. Students will choose the basket in the 3rd semester and the corresponding courses (in both 3rd and 4th semester) of that basket will be offered to that student. Student will conduct the "Advanced experimental lab" in the similar field of chosen basket.

***** Open Elective: One slot of "Open elective" is provided in the 3rd semester. If any student is unable to do/opt an open elective in 3rd semester, then that student have to complete it in the 4th semester. The genesis of the open elective is to obtain the exposures of the courses offered by other schools, however SPS will shortlist the suitable courses for the MSc Physics students from the available institute level open elective courses in that particular semester.

Tentetive List of currently available program electives [$]:

- Quantum Information Theory (PH605)
- Advanced High Energy Nuclear Theory (PH813)
- Advanced Quantum Condensed Matter Physics (PH808)
- Non-Equilibrium Statistical Mechanics (PH804)
- Advanced Quantum Mechanics (PH803)
- Field Theory (PH806)
- Physics of Materials (PH807)
- Nanophotonics (PH811)

Tentetive List of open electives [$]:

- Nanomaterials Characterization, Properties and Applications (CM604)
- Structure and Properties of Materials (CM605)
- Numerical Approximation of Partial Differential Equations: Finite Difference Method (MA523)
- Light-Matter Interaction (CH873/874)
- Numerical simulations and its applications (IE601)

Semester-I

1.	Title of the Course	**Mathematical Physics**
2.	Course Number	PH501
3.	Status of the Course	Core
4.	Structure of Credits	3-1-0-4
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Vector space and matrices Vector space, matrix algebra, eigenvalues and eigenvectors, introduction to tensor 2. Group theory Groups-subgroups, point groups, reducible and irreducible representations, continuous groups, Lie groups, Unitary and Orthogonal groups 3. Complex analysis Schwarz inequality, function of a complex, limit and continuity, differentiation Cauchy-Riemann equations and their applications, analytic and harmonic function, complex integrals, Cauchy's theorem, Cauchys Integral Formula, Taylor and Laurent expansion, Classification of singularities, branch point and cut, residue theorem and applications 4. Theory of second order linear homogeneous differential equations Regular and irregular singular points, Frobenius method; Fuch's theorem; inhomogeneous differential equations: Green's functions 5. Special functions and Integral transforms Bessel, Legendre, Hermite and Laguerre polynomials functions, Fourier and Laplace transforms and their inverse transform, solution of differential equations using integral transforms.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5010 (IITM), PH 407/408 (IITB), PH41013/PH 41008 (IITKgp), PHY 421/422 (IITK)	
10.	**Text book(s):** 1. G Aafken and H J Weber, Mathematical Methods for Physicists, Academic Press, 7th edition, Indian Edition, (2008). ISBN No: 9789381269558 2. K F Riley, M P Hobson and S J Bence, Mathematical Methods for Physicists and Engineering, Cambridge University Reference Books: Press (Cambridge Low-priced Edition) (1999). ISBN No: 9780521679718 3. M. Boas, Mathematical Methods in Physical Sciences, 2nd Ed. Wiley International Ed (1983). ISBN No: 9780471099604 4. Mathews, J., & Walker, R. L. (1970). *Mathematical methods of physics* (2nd ed.). Benjamin/Cummings. ISBN No : 9780805370027	
11.	**Reference(s):** 1. Dennery, P., & Kryzwicki, A. (2005). *Mathematics for physicists* (Indian ed.). Dover Publications. ISBN NO: 9780486691930	

	2. Bell, W. W. *Special functions for scientists and engineers*. Dover Publications. ISBN No: 9780486435213 3. Tinkham, M. (2003). *Group theory and quantum mechanics*. Dover Publications. ISBN No: 9780486432472 4. Potter, M. H., & Goldberg, L. *Mathematical methods for physicists* (2nd ed.). Academic Press. ISBN No: 9780135611845 5. Churchill, R. V., & Brown, J. W. (2009). *Complex variables and applications* (8th ed.). McGraw-Hill. ISBN No: 978-0073383170 6. Spiegel, M. R. (1964). *Theory and problems of complex variables*. McGraw-Hill. ISBN No: 9780070843820 7. Joshi, A. W. (2004). *Matrices and tensors in physics* (1st ed.). Wiley Eastern. ISBN No: 9780470234389 8. Joshi, A. W. (1997). *Elements of group theory for physicists* (2nd ed.). Wiley Eastern. ISBN No : 9780470990629
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Classical Mechanics**
2.	Course Number	PH502
3.	Status of the Course	Core
4.	Structure of Credits	3-1-0-4
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Lagrangian formalism Generalized coordinates, D'Alambert's principles, Lagrangian and Lagrange's equation of motion, generalized momenta, cyclic coordinate, Some specific applications of Lagarange's equations. 2. Hamilton's principle Calculus of variations; Hamilton's principle, Legendre transformation and Hamilton's canonical equations; Canonical equations from a variational principle; Principle of least action. 3. Canonical transformations Canonical transformations; Integral variants of Poincare; Lagrange and Poisson brackets; Infinitesimal canonical transformations; Poisson bracket formalism; Jacobi's identity; Angular momentum Poisson bracket relations. 4. Hamilton-Jacobi theory The Hamilton Jacobi equation for Hamilton's principle function, Hamilton's characteristic function; Action angle variables. 5. Rigid bodies Independent coordinates, orthogonal transformations and rotations (finite and infinitesimal); Euler's theorem, Euler's equations and Euler angles; Inertia tensor; Heavy symmetrical top with precession and nutation. 6. Classical field theory: Lagrangian and Hamiltonian formulation of continuous system 7. Special theory of relativity Lorentz transformations, 4-dimensional vectors Covariant equations of motion; Relativistic kinematics, Lagrangian and Hamiltonian of a relativistic particle.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5030 (IITM), PH401 (IITB), PH40027(IITKgp), PHY 401 (IITK)	
10.	**Text book(s):** 1. Goldstein, H. (1980). *Classical mechanics* (2nd ed.). Addison-Wesley. ISBN No: 978-0201029185 2. Rana, N. C., & Joag, P. S. (1991). *Classical mechanics*. Tata McGraw-Hill. ISBN No: 978-0074603154 3. Raychaudhuri, A. K. (2000). *Classical mechanics: A course of lectures*. Oxford University Press. ISBN No: 9780195613438 4. Marion, J. B., & Thornton, S. T. (1995). *Classical dynamics of particles and systems* (4th ed.). Brooks/Cole. ISBN No: 9780030973024 5. Percival, I. C., & Richards, D. (1982). *Introduction to dynamics*. Cambridge University Press. ISBN No: 978-0521281492	

11.	**Reference(s):** 1. Strauch, D. (2009). *Classical mechanics: An introduction* (4th ed.). Springer. ISBN No: 978-3642092763 2. Moore, E. N. (1965). *Theoretical mechanics*. McGraw-Hill. ISBN No: 9780471874881 3. Spiegel, M. R. (1967). *Theoretical mechanics*. Schaum's Outline Series, McGraw-Hill. ISBN No: 9780070602328 4. Landau, L. D., & Lifshitz, E. M. (1976). *Mechanics* (3rd ed.). Pergamon Press. ISBN No: 9780080171753 5. French, A. P. (1968). *Special relativity*. W. W. Norton & Company. ISBN No: 9780393097931 6. J. V. Jose & E. J. Saletan, Classical Dynamics, Cambridge University Press (1998); ISBN No: 978-0521636360
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Quantum Mechanics-I**
2.	Course Number	PH503
3.	Status of the Course	Core
4.	Structure of Credits	2-1-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Recapitulation of Basic Concepts Coordinate and Momentum space representations, Operators, Complete set of eigenfunctions; Stern-Gerlach experiment, Schrodinger, Heisenberg and interaction pictures of quantum mechanics. 2. Vector space & Operator method Linear vector spaces, product space, Dirac bra-ket notation, Hilbert space, Quantum Mechanics in vector space language, Harmonic oscillator by operator method. 3. Three-dimensional problems Three dimensional problems in cartesian and spherical polar coordinates, 3-d well, 3-d harmonic oscillator by series solution, H-atom problem. 4. Angular momentum Rotation operators, orbital and spin angular momentum algebra, Pauli matrices, raising and lowering operators, total angular momentum, matrix representation for j = 1/2 and j = 1; Clebsch-Gordan coefficients with examples. 5. Symmetries in quantum mechanics Conservation laws, space and time translations, rotation group, SO(3) and SU(2); representation for j = 1/2 and j = 1, Wigner-Eckart theorem; parity and time reversal symmetries. 6. Identical Particles Symmetric and antisymmetric wavefunctions, Slater determinant, spin wavefunctions, collisions of identical particles.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5100/ PH5170 (IITM), PH403/ PH 422 (IITB), PH41011/PH41010 (IITKgp), PHY 431/ PHY 432 (IITK)	
10.	**Text book(s):** 1. Gasiorowicz, S. (2003). *Quantum physics* (3rd ed.). Wiley. ISBN No: 9780471057000 2. Griffiths, D. J. (2018). *Introduction to quantum mechanics* (3rd ed.). Cambridge University Press. ISBN No: 978-1108791106 3. Cohen-Tannoudji, C., Diu, B., & Laloe, F. (2005). *Quantum mechanics* (Vol. 1 & 2). Wiley. ISBN No: 9780471164326 4. Bransden, B. H., & Joachain, C. J. (2000). *Quantum mechanics* (2nd ed.). Pearson. ISBN No: 978-8131708392	

	5. Zettili, N. (2009). *Quantum mechanics: Concepts and applications* (2nd ed.). Wiley. ISBN No: 9780470026793
11.	**Reference(s):** 1. Merzbacher, E. (1998). *Quantum mechanics* (3rd ed.). Wiley. ISBN No: 9780471887027 2. Sakurai, J. J., & Napolitano, J. (2017). *Modern quantum mechanics* (2nd ed.). Cambridge University Press. ISBN No: 978-1108422413 3. Schiff, L. I. (1968). *Quantum mechanics* (3rd ed.). McGraw-Hill. ISBN No: 9780070856431 4. Mathews, P. M., & Venkatesan, K. (1976). *A textbook of quantum mechanics*. Tata McGraw-Hill. ISBN No: 978-0070965102 5. Messiah, A. (1999). *Quantum mechanics* (Vols. 1 & 2). Dover Publications. ISBN No: 9780486409245 6. Shankar, R. (1994). *Principles of quantum mechanics* (2nd ed.). Springer. ISBN No: 978-0306447907
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Electrodynamics**
2.	Course Number	PH504
3.	Status of the Course	Core
4.	Structure of Credits	3-1-0-4
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Recapitulation of Electrostatics and Magnetostatics Scalar and vector potentials; Gauge transformations; Poisson and Laplace equations, Boundary value problem, Multipole expansion of charge and current distribution, magnetic induction for a circular current carrying loop, . 2. Introduction to Electrodynamics: Electric and magnetic field in matter, Maxwell's equations, Gauge transformations, Poynting's theorem, Maxwell's stress tensor. Electromagnetic waves equations free space and in medium, Reflection and refraction at dielectric and conductor interfaces, Polarization, Fresnel's law, Total internal reflection Brewster's angle, complex refractive index. Frequency dependence of permittivity, permeability and conductivity, Electromagnetic waves in conducting medium: skin depth, reflection and transmission; Wave Guides 3. Radiating Systems and Multipole fields: Radiation from time-dependent sources of charges and currents, Radiation from localized sources and multipole expansion in the radiation zone. Radiation from moving point charges, Radiation from an oscillating dipole, Lienard-Wiechert potentials, ~~ields~~ due to a charge moving with uniform velocity; fields due to an accelerated charge, Bremsstrahlung 4. Relativistic electrodynamics Euler-Lagrange equation for the classical field, field momentum and the Hamiltonian density, Electromagnetic field tensor, Lorentz invarience of Maxwell's equations, relativistic formulation of radiation by single moving charge, relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5020 (IITM), PH424/ PH510 (IITB), PH40023 (IITKgp), PHY 552 / PHY 553 (IITK)	
10.	**Text book(s):** 1. Jackson, J. D. (1999). *Classical electrodynamics* (3rd ed.). Wiley. ISBN NO: 978-0306447907 2. Griffiths, D. J. (2017). *Introduction to electrodynamics* (4th ed.). Cambridge University Press. ISBN NO: 978-1108420419 3. Greiner, W. (2006). *Classical electrodynamics*. Springer. ISBN NO: 978-8181284570 4. Panofsky, W. K. H., & Phillips, M. (2005). *Classical electricity and magnetism* (2nd ed.). Dover Publications. ISBN NO: 978-0486439242 5. Reitz, J. R., Milford, F. J., & Christy, R. W. (2008). *Foundations of electromagnetic theory* (4th ed.). Pearson. ISBN NO: 978-0321581747	
11.	**Reference(s):** 1. Brau, C. A. (2003). *Modern problems in classical electrodynamics*. Oxford University Press. ISBN No: 9780195146653 2. Smith, G. S. (1997). *Classical electromagnetic radiation* (3rd ed.). Cambridge University Press. ISBN NO: 978-0521586986	

	3. Müller-Kirsten, H. J. W. (2011). *Electrodynamics*. World Scientific Publishing. ISBN NO: 978-9814340731 4. Bittencourt, J. A. (2004). *Fundamentals of plasma physics* (3rd ed.). Springer. ISBN NO: 9781475740301 5. Landau, L. D., & Lifshitz, E. M. (1984). *(i) Electrodynamics of continuous media* (2nd ed.). Pergamon Press. ISBN NO: 978148329375 6. Landau, L. D., & Lifshitz, E. M. (1975). *(ii) The classical theory of fields* (4th ed.). Butterworth-Heinemann. ISBN NO: 9780750627689 7. Schwinger, J., DeRaad, L. L., Milton, K. A., & Tsai, W.-Y. (1998). *Classical electrodynamics*. Westview Press. ISBN NO: 978-0738200569
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Experimental Physics-I**
2.	Course Number	PH505
3.	Status of the Course	Core
4.	Structure of Credits	0-0-4-2 (Lab Course)
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective is to provide students with advanced practical experience, deepening their understanding of fundamental concepts, enhance experimental skills, data analysis, and interpretation while fostering a hands-on understanding of physical phenomena.	
8.	**Course Content:** General Introduction on Lab Safety and Data Analysis, (01) Photoelectric Effect, (02) Millikan Oil Drop Experiment, (03) Michelson Interferometer, (04) Franck–Hertz Experiment, (05) Determination of Stefan's Constant, (06) Coupled Pendulum Experiment, (07) Diffraction Grating, (08) Measurement of the Common-Emitter Transistor Amplifier, (09) Operational Amplifier, (10) JFET and MOSFET Characteristics, (11) Spatial and temporal Coherence of laser, (12) Specific Charge of Electron.	
9	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5060 (IITM), PH512/441/527/ PH435/PH570/PH446 (IITB), PH49005/PH49006(IIT Kgp), PHY315/PHY461/ PHY462/PHY441 (IITK), PHY411/PHY412/PHY511/PHY512/PHY516 (IITG), PH49005/PH49006/PH49007/PH49008/PH49009/ PH49010/PH49016/ PH49019(IITKgp)	
10.	**Text book(s):** Manual and the relevant study materials will be provided as per the requirements.	
11.	**Reference(s):** 1. Dunlop, R. A. (1988). *Experimental Physics*. Oxford University Press. ISBN NO: 978-0195049497 2. Melissinos, A. C., & Napolitano, J. (2003). *Experiments with Modern Physics* (2nd ed.). Academic Press. ISBN NO: 9780124898516 3. Beiser, A. (2003). *Concepts of Modern Physics*. McGraw-Hill. ISBN NO: 978-0072448481 4. Zbar, P. B., & Malvino, A. P. (1983). *Basic Electronics: A Text-Lab Manual*. Tata McGraw-Hill. ISBN NO: 978-0074624982 5. Leach, D. P. (1986). *Experiments in Digital Principles*. McGraw-Hill. ISBN NO: 978-0070369184 6. Gaonkar, R. S. (1999). *Microprocessor Architecture: Programming and Applications with the*	

	8085. ISBN NO: 978-8187972884 7. Ghatak, A., & Thyagarajan, K. (1998). *Introduction to Fiber Optics*. Cambridge University Press. ISBN NO: 978-0521577854 8. Ghatak, A. (1999). *Optics*. McGraw-Hill. ISBN NO: 978-9339220907
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**

1.	Title of the Course	**Electronics**
2.	Course Number	PH506
3.	Status of the Course	Core
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Semiconductor basics and devices: Crystal structure, electronic bands and Fermi-level, generation and recombination of carriers, Ohmic and Schottky contacts, physics of diodes (p-n, Schottky, etc.) and their current-voltage (I-V) characteristics, physics of Transistors (BJT, JFET, MOSFET, etc.) and devices characteristics; Heterojunctions and nanostructures. 2. Analog electronic circuits: Survey of network theorems and network analysis, transistors biasing, and classes (A, AB, B, etc.) of amplifiers, difference amplifiers, operational amplifiers, feedback, and current amplifier. 3. Negative-resistance and devices: Tunnelling phenomena, tunnelling devices characteristics, and applications of tunnelling devices as amplifiers and oscillators; 4. Signal recovery, filters and Lock-in-amplifier: Measurements/amplification signal/noise, passive and active filters, low pass, high pass, band pass and band reject filters, lock-in amplifiers. 5. Digital electronics: Logic gates, Boolean algebra, flip-flops, shift registers, adders, counters, multiplexers, Analog-to-Digital (A/D) and Digital-to-Analog (D/A) Converters, 6. Microprocessors: Elementary introduction of microprocessors, microcontroller and CMOS technology.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH 5040 (IITM), PH405 (IITB), PH41015 (IIT Kgp), PHY 441 (IITK)	
10.	**Text book(s):** 1. Streetman, B. G., & Banerjee, S. (2015). *Solid state electronic devices* (7th ed.). Pearson Education. ISBN NO: 978-9332555082 2. Millman, J., & Halkias, C. (1972). *Integrated electronics: Analog and digital systems*. McGraw-Hill. ISBN NO: 978-0070423152 3. Malvino, A. P. (1979). *Electronic principles*. Tata McGraw-Hill. ISBN No : 9780070634244 4. Boylestad, R., & Nashelsky, L. (2008). *Electronic devices and circuit theory* (11th ed.). Pearson. ISBN No : 9780135029039	

11.	**Reference(s):** 1. Millman, J., & Taub, H. (1956). *Pulse and digital circuits*. McGraw-Hill. ISBN NO: 0-07-085512-9 2. Ryder, J. D. (1993). *Electronic fundamentals and applications* (5th ed.). Prentice Hall. ISBN No: 9780135072936 3. Sze, S. M., & Ng, K. K. (2007). *Physics of semiconductor devices* (3rd ed.). John Wiley & Sons. ISBN NO: 978-8126517022 4. Floyd F, (2005). Digital Fundamentals. (9th Ed.) Prentice Hall. ISBN No : 9780131931985
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

Semester-II

1.	Title of the Course	**Statistical Physics**
2.	Course Number	PH507
3.	Status of the Course	Core
4.	Structure of Credits	3-1-0-4
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Revision of Thermodynamics: Laws of thermodynamics, Entropy, thermodynamic potentials, response functions, Maxwell's relations. 2. Elementary aspects of probability theory: Probability distributions functions, equal a priori probabilities, cumulant generating function. Transformation of variables and corresponding distributions. Central limit theorem, asymptotic analysis of integrals. 3. Introduction to Statistical Mechanics Objective of statistical mechanics, macrostates, microstates, phase space and ensembles. Ergodic hypothesis, postulate of equal a-priori probability. Boltzmann's postulate of entropy. Gibbs' paradox. Liouville's theorem. 4. Statistical Ensembles Canonical ensemble, expression of entropy, partition function, Helmholtz free energy, fluctuation of internal energy. Grand Canonical Ensemble, chemical potential, grand canonical partition function, fluctuation of particle number. 5. Classical ideal and non-ideal gas Idea gas equations, Mean field theory and Van der Wall's equation of state, Cluster expansion and Mayer-Ursell expansion. 6. Quantum statistical mechanics Density Matrix and Liouville theorem, density matrices for different ensembles, examples of density matrices – one electron in a magnetic field, particle in a box; Identical particles – B-E and F-D distributions. 7. Interacting and non-interacting Bose and Fermi gas Equation of states, Bose-Einstein condensation, blackbody radiation, phonons, Cluster expansion of classical gas, virial coefficient 8. Phase Transition Ising and Heisenberg model, one and higher dimensional cases, phase transitions-first order and continuous, Scaling relation	

9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5080 (IITM), PH410 (IITB), PH41023 (IIT Kgp), PHY 552 / PHY 412 (IITK)
10.	**Text book(s):** 1. Reif, F. (1965). *Fundamentals of statistical and thermal physics*. McGraw-Hill. ISBN No: 9780070518001 2. Pathria, R. K., & Beale, P. D. (2011). *Statistical mechanics* (3rd ed.). Academic Press. ISBN No: 9780123821881 3. Huang, K. (1987). *Statistical mechanics* (2nd ed.). Wiley. ISBN NO: 978-0471815181 4. Landau, L. D., & Lifshitz, E. M. (1980). *Statistical physics* (Vol. 5, 3rd ed.). Butterworth Heinemann. ISBN No: 9780750633727 5. Greiner, W., Neise, L., & Stöcker, H. (1995). *Thermodynamics and statistical mechanics*. Springer. ISBN NO: 978-0387942995
11.	**Reference(s):** 1. Kardar, M. (2007). *Statistical physics of particles*. Cambridge University Press. ISBN No: 9780521873420 2. Mandl, F. (1988). *Statistical physics* (2nd ed.). Wiley. ISBN No. 978-1118723432 3. Bhattacharjee, J. K. (1996). *Statistical mechanics*. Allied Publishers. ISBN No: 9788181477903 4. Salinas, S. R. A. (2001). *Introduction to statistical physics*. Springer. ISBN No. 978-0387951195 5. Callen, H. B. (1985). *Thermodynamics and an introduction to thermostatics* (2nd ed.). Wiley. ISBN NO: 978-0471862567 6. 7 Amit, D. J., & Verbin, Y. (1999). *Statistical physics: An introductory course*. World Scientific Publishing. ISBN No : 9789810231927
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Quantum Mechanics-II**
2.	Course Number	PH508
3.	Status of the Course	Core
4.	Structure of Credits	2-1-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	Quantum Mechanics -I (PH503)
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Approximate Methods Degenerate and non-degenerate time independent perturbation theory, first and second order corrections of energy eigenvalues and eigenvector with examples. Time dependent perturbation theory, sudden and adiabatic approximations. Variational method with example. WKB Approximation, quantization rule, tunneling and decay. 2. Scattering theory Scattering cross-sections, scattering by spherically symmetric potentials, Ramsauer-Townsend effect, scattering by a rigid sphere and square well, Coulomb scattering; Green's function, Lippman-Schwinger equation; Born approximation. 3. Radiation theory: Semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, Harmonic perturbation and transition rates, dipole selection rule, spin and helicity of photon. 4. Relativistic Quantum Mechanics Klein-Gordon equation, concept of antiparticles, Dirac equation, covariant form, plane wave solution, momentum space spinors, Helicity and chirality, properties of Gamma matrices.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH5100/ PH5170 (IITM), PH403/ PH 422 (IITB), PH41011/PH41010 (IITKgp), PHY 431/ PHY 432 (IITK)	
10.	**Text book(s):** 1. Griffiths, D. J. (2018). *Introduction to quantum mechanics* (3rd ed.). Cambridge University Press. ISBN NO: 978-1108791106 2. Cohen-Tannoudji, C., Diu, B., & Laloe, F. (2005). *Quantum mechanics* (Vol. 1 & 2). Wiley. ISBN NO: 978-0471164333 3. Bransden, B. H., & Joachain, C. J. (2000). *Quantum mechanics* (2nd ed.). Pearson. ISBN NO: 978-8131708392 4. Zettili, N. (2009). *Quantum mechanics: Concepts and applications* (2nd ed.). Wiley. ISBN NO: 978-0470026793 5. Greiner, W. (1997). *Relativistic quantum mechanics: Wave equations* (3rd ed.). Springer. ISBN NO: 978-3540674573 6. Landau, L. D., & Lifshitz, E. M. (1977). *Relativistic quantum mechanics* (Vol. 4, 2nd ed.). Pergamon Press. ISBN NO: 978-0080171753	
11.	**Reference(s):** 1. Merzbacher, E. (1998). *Quantum mechanics* (3rd ed.). Wiley. ISBN NO: 978-0471887027 2. Sakurai, J. J., & Napolitano, J. (2017). *Modern quantum mechanics* (2nd ed.). Cambridge University Press. ISBN	

	NO: 978-1108422413 3. Schiff, L. I. (1968). *Quantum mechanics* (3rd ed.). McGraw-Hill. ISBN NO: 978-0070856431 4. Mathews, P. M., & Venkatesan, K. (1976). *A textbook of quantum mechanics*. Tata McGraw-Hill. ISBN NO: 978-0070965102 5. Messiah, A. (1999). *Quantum mechanics* (Vols. 1 & 2). Dover Publications. ISBN NO: 978-0486409245 6. Bjorken, J. D., & Drell, S. D. (1964). *Relativistic quantum mechanics*. McGraw-Hill. ISBN No: 9780070054936 7. Shankar, R. (1994). *Principles of quantum mechanics* (2nd ed.). Springer. ISBN NO: 978-0306447907
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Condensed Matter Physics**
2.	Course Number	PH509
3.	Status of the Course	Core
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Crystal Structure and Chemical Bonding of solids Bravais lattices, Wigner-Seitz cell, symmetry operations, point and space group; X-ray diffraction, structure factors, Brillouin zone, Ewald construction, electron and neutron scattering. Chemical bonding: ionic, covalent, metallic, H-bond and van der waals, Madelung constants. 2. Band theory of solids Bloch equation, electronic band structures, nearly free electron model, tight binding method, quantization of orbits in a magnetic field, de Haas-van Alphen effect; Boltzmann transport equation - relaxation time approximation. 3. Lattice dynamics and Specific heat Lattice vibration under harmonic approximation, monatomic and diatomic cases, concept of phonon, inelastic scattering, lattice heat capacity, Debye and Einstein model, anharmonic effects in crystals - thermal expansion. 4. Dielectric properties of solids Electronic, ionic, and orientational polarization; static and complex dielectric constant, relaxation time, Debye equations; ferroelectricity, pyroelectricity, pizoelectricity, Landau theory of phase transition. 5. Semiconductors: Intrinsic and extrinsic semiconductors, mobilities, impurity levels, Gr III-V alloys, drift and diffusion, effect of temperature and doping, energy band diagram for p–n junctions, effect of bias. 6. Magnetic properties of solids Quantum theory of diamagnetism, paramagnetism and ferromagnetism, Landau diamagnetism, Van-Vleck and Pauli paramagnetism, Curie-Weiss law, Heisenberg's exchange interaction, Ising model, Ferromagnetic domains, ferrimagnetism, antiferromagnetism, concept of magnon and excitations. 7. Magnetic resonances Nuclear magnetic resonances, paramagnetic resonance, electron-spin resonance. 8. Superconductivity Phenomenological description of superconductivity, Meissner effect, type-I and type-II superconductors, heat capacity, energy gap and isotope effect, BCS theory, tunnelling, Josephson effect, vortex state, high Tc superconductors. 9. Imperfections in solids Frenkel and Schottky defects, electrical conductivity, dislocations, colour centers and photoconductivity, luminescence and phosphors, Bragg - Williams theory	

9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH 5160 (IITM), PH418 (IITB), PH41014 (IIT Kgp), PHY 543 (IITK)
10.	**Text book(s):** 1. Ashcroft, N. W., & Mermin, N. D. (1976). *Solid state physics*. Cengage Learning. ISBN No: 9780030839931 2. Christman, J. R. (1988). *Fundamentals of solid state physics*. Wiley. ISBN No : 9780471603437 3. Kittel, C. (2004). *Introduction to solid state physics* (8th ed.). Wiley. ISBN NO: 978-8126535187 4. Omar, M. A. (1993). *Elementary solid state physics: Principles and applications*. Pearson. ISBN NO: 978-0201607338 5. Madelung, O. (1978). *Introduction to solid-state theory*. Springer. ISBN NO : 9783540938033
11.	**Reference(s):** 1. Ibach, H., & Lüth, H. (2009). *Solid state physics: An introduction to principles of materials science* (4th ed.). Springer. ISBN No : 9783540938033 2. McKelvey, J. P. (1982). *Solid state and semiconductor physics* (2nd ed.). Krieger Publishing Company. ISBN NO: 978-0898743968 3. Dekker A. J. (1957) Solid State Physics. Prentice Hall. ISBN NO: 978-0333918333 4. Marder M. P. (2010) Condensed Matter Physics. Wiley. ISBN No : 9780470617984 5. Animalu, A. O. E. (1977). *Intermediate quantum theory of crystalline solids*. Prentice Hall. ISBN No: 9780134707990
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Nuclear and Particle Physics**
2.	Course Number	PH510
3.	Status of the Course	Core
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Basic facts about Nuclei Composition, mass, charge, density, radii, spin, parity, I-spin nuclear size, E.M. methods, electron scattering. 2. The two Nucleon problem and Nuclear Force Ground state of deuteron, rms radius, spin dependence of nuclear forces, magnetic dipole moment. Low energy neutron-proton scattering, concept of scattering length, elementary idea about proton-proton and neutron-neutron scattering. 3. Symmetries and Nuclear Force Exchange nature of nuclear force, phenomenological nucleon-nucleon potentials, elementary idea about Meson theory of nuclear force. 4. Nuclear structure Liquid drop model, Semi-empirical mass formula, Shell model and Collective model, Magic numbers 5. Nuclear reactions and fission Quantum mechanical theory of reaction, resonance scattering and reactions, Breit-Wigner dispersion relation, statistical theory of nuclear reactions, optical model, principle of detailed balance, transfer reactions, Nuclear fission: experimental features, spontaneous fission, liquid drop model, statistical model 6. Alpha-decay and weak interaction Energetics of various decays, V-A theory of allowed decay, selection rules for Fermi and Gamow- Teller transitions, parity non-conservation and Wu's experiment 7. Elementary Particles, symmetries and conservation laws Basic interactions and their characteristics, leptons, hadrons and gauge fields. Energy, momentum, angular- momentum, electric charge, lepton and baryon number, CPT, iso-spin, strangeness and hypercharge quantum numbers, the Gellman Nishijima scheme. Hadron classification by isospin and hypercharge. 8. Elementary discussion of the quark model Colour and flavour, basic characteristics of weak interaction, parity non-conservation in weak interaction, elementary ideas of electroweak unification and Standard Model. 9. Detection of particles and radiation Passage of radiation through matter, classical derivation of stopping power (dE/dx) of heavy charged particles, G.M. counter, semi-conductor detectors, bubble chamber and cloud chamber, spark counter.	

	10. Accelerators The Van-de Graff generator, cyclotron, synchrotron
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH 5410 (IITM), PH505 (IITB), PH41016 (IIT Kgp), PHY 524 (IITK)
10.	**Text book(s):** 1. Krane, K. S. (1987). *Introductory nuclear physics* (3rd ed.). Wiley. ISBN NO: 978-0471805533 2. Leon, M. (1995). *Particle physics: An introduction*. Academic Press. ISBN No :9780124438507 3. Roy, R. R., & Nigam, B. P. (1986). *Nuclear physics: Theory and experiment*. New Age International. ISBN No : 9788122434101 4. Ghoshal, S. N. (1994). *Atomic and nuclear physics* (Vol. 2). S. Chand Publishing. ISBN No: 9789352837274 5. Burcham, W. E., & Jobes, M. (1998). *Nuclear and particle physics*. Addison-Wesley. ISBN NO: 978-0582450882 6. Blatt J. M & Weisskopf V F. (1952). Theoretical Nuclear Physics, John Wiley. ISBN NO: 9780471080190
11.	**Reference(s):** 1. Wong, S. S. M. (1990). *Introductory nuclear physics*. Prentice Hall. ISBN No: 9780471239734 2. Cohen, B. L. (1988). *Concepts of nuclear physics*. McGraw-Hill. ISBN NO: 978-0070992498 3. Enge, H. A. (1971). *Introduction to nuclear physics*. Addison-Wesley. ISBN NO: 978-0201018707 4. Hyde, K. (2004). *Basic ideas and concepts in nuclear physics* (3rd ed.). CRC Press. ISBN NO: 978-0750309806 5. Elton, L. R. B. (1966). *Introductory nuclear physics*. Elsevier. ISBN NO: 978-1114802582 6. Griffiths, D. J. (2008). *Introduction to elementary particles* (2nd ed.). Wiley-VCH. ISBN No : 9783527406012
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Computational Physics**
2.	Course Number	PH511
3.	Status of the Course	Core
4.	Structure of Credits	1-0-4-3 (Th+Lab)
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective of computational physics is to equip students with the skills to use computational methods and numerical algorithms to solve complex physical problems that are difficult or impossible to address analytically. It focuses on developing proficiency in programming, simulations, and modeling to analyze and predict physical systems' behavior.	
8.	**Course Content:** Introduction to FORTRAN, Syntax's and control statements, Arrays, Subprograms, Introduction to the numerical methods, matrix, interpolation, Differentiation and integration, differential equation, algebraic equation and random numbers. Application of the FORTRAN programming to solve various physical problems. Python programming with modules and syntax, and the application of Python to solve various physical problems.	
9	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH41012 (IIT Kgp), PHY 473 (IITK), PH408 (IITG)	
10.	**Text book(s):** 1. Rajaraman, V. (2017). *Computer programming in FORTRAN 77*. Prentice Hall of India. ISBN NO: 978-8120311725 2. Xavir, C. (1999). *FORTRAN and numerical methods*. New Age International Publishers. ISBN No: 9788122406702 3. Rajaraman V. (2019), Computer Oriented Numerical Methods. Prentice Hall of India. ISBN NO: 978-9388028318 4. Python Crash Course (2nd Edition), Hands-on, project-based introduction to Programming – Eric Matthes ISBN NO: 978-1593279288	
11.	**Reference(s):** 1. Mccormic J. M & Salvadori M. G (1964). Numerical methods in Fortran (Prentice Hall). ISBN No : 9780136271581. ISBN NO: 9780136271581	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** Yes	

1.	Title of the Course	**Experimental Physics-II**
2.	Course Number	PH512
3.	Status of the Course	Core
4.	Structure of Credits	0-0-4-2 (Lab Course)
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective is to provide students with advanced practical experience, deepening their understanding of fundamental concepts, enhance experimental skills, data analysis, and interpretation while fostering a hands-on understanding of physical phenomena.	
8.	**Course Content:** (01) Zeeman effect (02) Characterization of Optical Fiber, (03) Faraday Effect, (04) Amplitude and Frequency Modulation, (05) Band Gap of Semiconductor Using Diode, (06) Study of Flip-Flops Using Logic Gates, (07) 8085 Microprocessor Kit (08) Dielectric Constant, (09) GM Counter, (10) Determination of Half-Life of a Given Radioactive Source, (11) Divergence and Intensity Profiling of Laser, (12) Magnetic Properties of Ferro and Paramagnetic Materials.	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH 5060 (IITM), PH512/441/527 PH435/PH570/PH446 (IITB), PH49005/PH49006/PH49007/PH49008/PH49009/ PH49010/PH49016/ PH49019(IITKgp), PHY315/PHY461/PHY462/PHY441(IITK), PHY411/PHY412/PHY511/PHY512/PHY516(IITG)	
10.	**Text book(s):** Manual and the relevant study materials will be provided as per the requirements.	
11.	**Reference(s):** 1. Dunlop, R. A. (1988). *Experimental Physics*. Oxford University Press. ISBN NO: 978-0195049497 2. Melissinos, A. C., & Napolitano, J. (2003). *Experiments with Modern Physics* (2nd ed.). Academic Press. ISBN NO: 9780124898516 3. Wiley. Knoll, G. F. (1999). *Radiation Detection and Measurement*. Wiley. ISBN NO: 978-0471073383	

	4. Varma, J. (2001). *Nuclear Physics Experiments*. New Age Publishers. ISBN NO: 978-8122412987 5. Krane, K. S. (1988). *Introductory Nuclear Physics*. Wiley. ISBN NO: 978-0471805533 6. Roy, R. R., & Nigam, B. P. (2001). *Nuclear Physics: Theory and Experiment*. New Age. ISBN NO: 978-8122449884 7. Beiser, A. (2003). *Concepts of Modern Physics*. McGraw-Hill. ISBN NO: 978-0072448481 8. Zbar, P. B., & Malvino, A. P. (1983). *Basic Electronics: A Text-Lab Manual*. Tata McGraw-Hill. ISBN NO: 978-0074624982 9. Leach, D. P. (1986). *Experiments in Digital Principles*. McGraw-Hill. ISBN NO: 978-0070369184 10. Gaonkar, R. S. (1999). *Microprocessor Architecture: Programming and Applications with the 8085*. ISBN NO: 978-8187972884 11. Ghatak, A., & Thyagarajan, K. (1998). *Introduction to Fiber Optics*. Cambridge University Press. ISBN NO: 978-0521577854 12. Ghatak, A. (1999). *Optics*. McGraw-Hill. ISBN NO: 978-9339220907
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** NA

Semester-III

1.	Title of the Course	**Atomic and Molecular Spectroscopy**
2.	Course Number	PH513
3.	Status of the Course	Core
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** This is a fundamental subject with the objective of building a strong foundation in physics, covering both theoretical principles and practical applications, while promoting a problem-solving approach.	
8.	**Course Content:** 1. Interaction of radiation with matter Interaction of an atom with electromagnetic wave, selection rules, strong and weak coupling limit, non-resonant excitation, resonant excitation. 2. Fine and Hyperfine structure Dirac equation in a central field, relativistic corrections, fine structure, selection rules, Lamb shift. Effect of external magnetic field, Hyperfine interaction, nuclear spin, isotope shift, Hyperfine splitting, selection rules. 3. Many electron atom Independent particle model, central field approximation, Slater determinant; L-S and j-j coupling, energy levels and spectra, spectroscopic terms; Hunds rule; Alkali spectra. 4. Molecular Electronic States Born-Oppenheimer approximation, LCAO approach, hydrogen molecular ion, Coulomb, Exchange and Overlap integral, symmetries of electronic wavefunctions, shapes of molecular orbital and bond, term symbol for simple molecules. 5. Rotation and Vibration of Molecules Molecular rotation and vibration, symmetric top molecules, harmonic and anharmonic oscillator approximation, Morse potential and transition matrix elements, pure and combined vibrational and rotational transitions, Franck-Condon principle, Infrared and Raman spectroscopy. 6. Group Theory in spectroscopy: Molecular symmetry, reducible and irreducible representations, character tables for relevant point groups 7. Laser Physics Einstein coefficients of absorption and spontaneous and stimulated emissions, Optical pumping, population inversion, and rate equations, Examples of gas and solid-state lasers. Optical resonator and coherence length	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH 5410 (IITM), PH515 (IITB), PH52002 (IIT Kgp), PHY 524 (IITK)	
10.	**Text book(s):** 1. Bransden, B. H., & Joachain, C. J. (2003). *Physics of atoms and molecules* (2nd ed.). Pearson. ISBN NO:	

	978-0582356924 2. Banwell, C. N., & McCash, E. M. (1994). *Fundamentals of molecular spectroscopy* (4th ed.). McGraw-Hill . ISBN No : 9780077079765 3. Barrow, G. M. (1988). *Molecular spectroscopy* (2nd ed.). McGraw-Hill. ISBN No: 9780070859043 4. Thyagarajan, K., & Ghatak, A. K. (2010). *Lasers: Theory and applications* (2nd ed.). Springer. ISBN No: 9781441964410 5. Svelto, O. (2010). *Principles of lasers* (5th ed.). Springer. ISBN No: 9781441913012 6. Gupta, M. C. (2001). *Atomic and molecular spectroscopy*. New Age International. ISBN NO: 978-8122413007
11.	**Reference(s):** 1. Donald A McQuarrie, (2003). *Quantum Chemistry*. Viva Books (Indian Ed.). ISBN No: 9788130918945 2. Eyring, H., Walter, J., & Kimball, G. E. (1944). *Quantum chemistry*. John Wiley & Sons. ISBN No: 9780471249818 3. Thorne, A., Litzen, U., & Johnson, J. (1999). *Spectrophysics*. Springer. ISBN NO: 978-3540651178 4. Graybeal, J. D. (1988). *Molecular spectroscopy*. McGraw-Hill. ISBN NO: 9780070243910 5. Demtröder, W. (2008). *Molecular physics: Theoretical principles and experimental methods* (2nd ed.). Wiley-VCH. ISBN NO: 978-3527405664 6. Foot, C. J. (2005). *Atomic physics*. Oxford University Press. ISBN NO: 978-0198506966 7. Bernath, P. F. (2005). *Spectra of atoms and molecules* (2nd ed.). Oxford University Press. ISBN NO: 978-0195177596 8. Herzberg, G. (1950). *Spectra of diatomic molecules*. Van Nostrand Reinhold. ISBN NO: 978-0442033859 9. Laud, B. B. (2011). *Lasers and nonlinear optics* (3rd ed.). New Age International. ISBN No : 9788122430561
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** **YES**

1.	Title of the Course	**Advanced Experimental Lab**
2.	Course Number	PH602
3.	Status of the Course	Core
4.	Structure of Credits	0 - 0 -4 – 2 (Lab Course)
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective is to provide students with practical experience in an advanced subject that aligns with their interests and career goals, deepening their understanding of fundamental concepts while fostering a hands-on understanding of physical phenomena.	
8.	**Course Content:** (01) UV-Vis and Raman Spectroscopy, (02) Scanning Tunneling Microscopy (STM), (03) XRD and Crystallography, (04) Magnetic Susceptibility and Magnetoresistance & (05) Electron Spin Resonance (ESR), (06) Resistivity and Hall effect measurements, (07) Alpha and Beta Decays Spectroscopy, (08) Verification of the Inverse Square Law of Gamma Radiation, (09) Laser beam profiling (10) Quantum Erasure Experiment Using Nested Michelson Interferometer, (11) Quantum Entanglement Using SPDC Light. (12) Non-linear Phenomena and Down Conversion (13) Characterization of Picosecond Lasers	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH435/PH570/PH446 (IITB), PH52002/PH59008/PH49009 (IITM), PH49005/PH49006/PH49007/PH49008/PH49009/ PH49010/PH49016/ PH49019(IITKgp), PHY315/PHY461/PHY462/PHY441(IITK), PHY411/PHY412/PHY511/PHY512/PHY516(IITG)	
10.	**Text book(s):** Manual and the relevant study materials will be provided as per the requirements.	
11.	**Reference(s):** 1. Dunlop, R. A. (1988). *Experimental Physics*. Oxford University Press. ISBN NO: 978-0195049497 2. Melissinos, A. C., & Napolitano, J. (2003). *Experiments with Modern Physics* (2nd ed.). Academic Press. ISBN NO: 9780124898516 3. Scully, M. O., & Zubairy, M. S. (2012). *Quantum Optics*. Cambridge University Press. ISBN NO: 978-0524235959	

	4. Gerry, C. C., & Knight, P. L. (2005). *Introductory Quantum Optics*. Cambridge University Press. ISBN NO: 978-0521527354 5. Kittel, C. (2005). *Introduction to Solid State Physics*. Wiley. ISBN NO: 978-0471415268 6. Ashcroft, N. W., & Mermin, N. D. (1976). *Solid State Physics*. Holt, Rinehart and Winston. ISBN NO: 978-0030493461 7. Demtröder, W. (2004). *Laser Spectroscopy: Basic Concepts and Instrumentation* (3rd ed.). Springer. ISBN NO: 978-3540652250 8. Stenholm, S. (1999). *Foundations of Laser Spectroscopy*. ISBN NO: 978-0486444987 9. Knoll, G. F. (1999). *Radiation Detection and Measurement*. Wiley. ISBN NO: 978-0470131480 10. Varma, J. (2001). *Nuclear Physics Experiments*. New Age Publishers. ISBN NO: 978-8122412987 11. Krane, K. S. (1988). *Introductory Nuclear Physics*. Wiley. ISBN NO: 978-0471805533 12. Roy, R. R., & Nigam, B. P. (2001). *Nuclear Physics: Theory and Experiment*. New Age. ISBN NO: 978-8122449884
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:** NA

1.	Title of the Course	**Thesis Project Stage-I**
2.	Course Number	PH603
3.	Status of the Course	Core
4.	Structure of Credits	0 - 0 -12- 6
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective of Project Stage-I involves the initial phases of the project, where foundational work is conducted. This stage emphasizes a literature review, problem definition, and the development of methodologies.	
8.	**Course Content:**	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH49025 (IITKgp), PHY /563566/568/500/502 (IITK), PH5291 (or) DPE4 (IITM), PH5965 (IITB)	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	

1.	Title of the Course	**Program Elective-I**
2.	Course Number	PH xxx
3.	Status of the Course	Program Elective
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:**	
8.	**Course Content:**	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad**	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	

1.	Title of the Course	**Open Elective**
2.	Course Number	
3.	Status of the Course	Open Elective
4.	Structure of Credits	3 - 0 - 0 - 3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective of an open elective is to give students the opportunity to study subjects outside their main discipline, encouraging interdisciplinary learning and broadening their academic perspectives. These courses foster intellectual curiosity, critical thinking, and the acquisition of a diverse range of skills. School will shortlist the available open electives for a particular semester.	
8	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad**	
9.	**Number of modules with description of lectures** (Please give description and number of lectures)	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	

Semester-IV

1.	Title of the Course	**Thesis Project Stage-II**
2.	Course Number	PH604
3.	Status of the Course	Core
4.	Structure of Credits	0 - 0 -24 - 12
5.	Offered To	IV Semester MSc Physics
6.	Prerequisite	None
7.	**Course Objective:** The objective of Project Stage-II involves the implementation of methodology, data collection and analysis, testing hypotheses, documentation, and reporting findings, along with planning for the next stages of the project.	
8.	**Course Content:**	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad** PH57004 (IITkgp), PHY /563566/568/500/502 (IITK), PH5292 (or) DPE5 & DPE6 (IITM), PH596 (IITB)	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	

1.	Title of the Course	**Program Elective-II**
2.	Course Number	
3.	Status of the Course	Program Elective
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:**	
8.	**Course Content:**	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad**	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	

1.	Title of the Course	**Program Elective-III**
2.	Course Number	
3.	Status of the Course	Program Elective
4.	Structure of Credits	3-0-0-3
5.	Offered To	MSc Physics
6.	Prerequisite	None
7.	**Course Objective:**	
8.	**Course Content:**	
9.	**Details of the similar courses offered in 1st generation IITs and reputed Institutions abroad**	
10.	**Text book(s):**	
11.	**Reference(s):**	
12.	**Comments on the standard of the textbook, and the textbooks widely followed in the reputed Institutions abroad and other 1st gen. IITs:**	