B. Tech in Engineering Physics, IIT Indore

1st Semester

Course Code	Course Name	(L-T-P)	Credit
MA105	Calculus	3-1-0	4
PH101	Basics of Physics	2-1-0	3
CH103	Chemistry	2-1-0	3
ME106	Basic Mechanical engineering	1-1-0	2
EE104	Basic electrical and electronics engineering	1-1-0	2
PH 156	Physics Lab-I	0-0-2	1
CH153	Chemistry lab	0-0-2	1
HS159	English language and communication	0-2-0	2
HSXXX	HSS Flex XXX	1-0-0	1
		10-7-4	**19**

2nd Semester

Course Code	Course Name	(L-T-P)	Credit
MA106	Linear algebra and ordinary differential equations I	2-1-0	3
BSE102	Bio Sciences	2-1-0	3
CS103	Computer programming	2-0-0	2
*XXX	First year elective -I	1-0-0	1
*XXX	First year elective-II	1-0-0	1
IC151	Computer programming lab	0-0-3	1.5
MSXXX	Hands on XXX	1-0-6	4
HS108	Fundamentals of economics	2-0-0	2
HS XXX	Environmental Studies	2-1-0	3
HSXXX	HS flex XXX	1-0-0	1
NO102	National sports organization	0-0-0	P/NP
		14-3-9	**21.5**

3rd Semester

Course Code	Course Name	(L-T-P)	Credit
ZZXXX	Course -I for minor program	X-X-X	3
MA 203	Complex analysis and Differential Eqns-II	3-1-0	4
PH 201	Classical Mechanics	2-1-0	3
PH 241 (AA)	Wave Phenomena and Optics	2-1-0	3
PH 291 (AA)	Electronics-I	2-1-0	3
PH 221	Fundamental Concepts of Solid State Engineering	2-1-0	3
PHXXX	Elective-I	2-1-0	3
PH 293	Physics Lab-II (General Physics Lab)	0-0-3	1.5

4th Semester

Course Code	Course Name	(L-T-P)	Credit
ZZXXX	Course II for minor program	X-X-X	3
MA 204	Numerical Methods	2-0-2	3
PH 210	Quantum Mechanics-I	2-1-0	3
PH 222	Thermal Physics	2-1-0	3
PH 290 (AA)	Electronics -II	2-1-0	3
PH 301 (AA)	Electrodynamics	1-1-0	2
PHXXX	Elective -II	2-1-0	3
PH 292	Electronics Lab-II	0-0-3	1.5

PH 295	Electronics Lab-I	0-0-3	1.5	IE XXX	Open elective -I	2-1-0	3
		13-6-6	**22/25**			**13-6-5**	**21.5/24.5**

ELECTIVES

Semester 3				Semester 4			
S. No.	Courses	Credits	Direction	S.No.	Course	Credits	Direction
1	Vacuum and Thin Films Technology	3	Energy Conversion and Storage, Spintronics and Memory Devices, Optoelectronics, Materials and Device Modelling	1	Later Physics	3	Optoelectronics and Photonics Quantum Technology
2	Detector Physics	3	Experimental HEP, Detector Technology, Nuclear Engineering, Theoretical HEP, Medical Physics	2	X Ray Spectroscopy	3	Energy Conversion and Storage Spintronics and Memory Devices
3	General Theory of Relativity	3	Theoretical HEP	3	Classical Field Theory	3	Theoretical HEP, Experimental HEP
4	Theory of Complex Systems	3	Data Science	4	Accelerator Physics	1	Experimental HEP, Nuclear Engineering, Medical Physics
				5	Relativistic Kinematics	1	Theoretical HEP, Experimental HEP
				6	Python Programming	1	Experimental HEP, Quantum Technology

5th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
ZZXXX	Course III for minor program	X-X-X	3
PH 361	Nuclear Science and Engineering	2-1-0	3
PH 311	Quantum Mechanics - II	2-1-0	3
PH 313	Advanced Classical Mechanics	1-0.5-0	1.5
PH 351	Topics in Mathematical Physics	1-0.5-0	1.5
PH XXX	Multiscale Modelling	2-0-2	3
PH XXX	Elective-III	2-1-0	3
PH 391	Physics Lab III (Advanced Physics Lab)	0-0-3	1.5
IEXXX	Open elective -II	2-1-0	3
		12-5-5	**19.5/22.5**

6th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
PH 322	Cooperative Phenomena in Solids	2-1-0	3
PH 320	Statistical Mechanics	2-1-0	3
PH 340	Atomic and Molecular Spectroscopy	2-1-0	3
PH 390	UG seminar	0-1-0	1
PH XXX	Elective-IV	2-1-0	3
PH XXX	Elective-V	2-1-0	3
PH 392	Physics Lab IV (Solid State Engineering Lab)	0-0-3	1.5
PH 394	Physics lab V (Spectroscopy and Microscopy)	0-0-3	1.5
IE XXX	Open elective -III	2-1-0	3
		12-7-4	**22**

Semester 5				Semester 6			
S. No.	Course	Credits	Direction	S.No.	Course	Credits	Direction
1	Advanced Crystal Physics and Engineering	2	Materials and Device modelling	1	Quantum Transport Theory and Applications	3	Spintronics and Memory Devices
2	Physics of Semiconductor Devices	3	Energy Conversion and Storage	2	Characterization of Surfaces and Interfaces of Materials	3	Spintronics and Memory Devices
3	Topics in Advanced Quantum Mechanics	3	Theoretical HEP, Quantum Technology	3	Principles and applications of Optical Spectroscopy	3	Optoelectronics,
4	Computation Methods in High Energy Physics	3	Experimental HEP	4	Solar Photovoltaics: Fundamentals, Technologies and Applications	3	Energy Conversion and storage
5	Signal Processing	3	Quantum Technology	5	Quantum Field theory -1	3	Theoretical HEP, Experimental HEP
6	Advanced Materials	3	Spintronics and Memory Devices	6	Applications of Group Theory in Particle Physics	3	Theoretical HEP
				7	Introduction to String Theory	3	Theoretical HEP
				8	Deep Inelastic Scattering and Parton Model	3	Theoretical HEP, Experimental HEP
				9	Experimental and theoretical aspects of Heavy Ion Collisions	3	Experimental HEP, Theoretical HEP
				10	Statistical Methods in physical Sciences	3	Experimental HEP, Data Science, Theoretical HEP
				11	Basics of Quantum Computing	3	Quantum Technology
				12	Machine Learning in Physical problems	3	Data Science, Quantum Technology, Experimental HEP
				13	Quantum Information	3	Quantum Technology

ELECTIVES

7th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
PH 499	B. Tech project	0-0-32	16
	Internship-I		1
	Internship-II		1
		0-0-32	**18**

8th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
PH 4XX	PH elective VI	2-1-0	3
PH 4XX	PH elective VII	2-1-0	3
IE4XX	Open elective IV	2-1-0	3
IE4XX	Open elective V (or course IV for minor program)	2-1-0	3
IE4XX	Open elective VI (or course V for minor program)	2-1-0	3
		10-5-0	**15**

8th Semester electives			
S.No.	Course	Credits	Direction(s)
1	Spintronics and Applications	3	Spintronics and Memory Devices
2	Advanced Computational Methods for Materials	3	Materials and Device modelling
3	Weak Interaction and the Standard Model	3	Theoretical HEP, Experimental HEP
4	Flavor Physics and Neutrino Oscillations	3	Theoretical HEP
5	Introduction to Gauge Gravity Duality	3	Theoretical HEP
6	Quantum Field theory -II	3	Theoretical HEP
7	Introduction to Cosmology	3	Theoretical HEP
8	Collider Physics	3	Theoretical HEP, Expt HEP
9	Physics of Dark Matter	3	Theoretical HEP
10	Astroparticle Physics and Neutrino Astronomy	3	Theoretical HEP
11	Machine Learning in Physical problems	3	Data Science, Quantum Technology, Experimental HEP

Detailed Syllabus (Yearwise)

1st Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
MA105	Calculus	3-1-0	4
PH101	Basics of Physics	2-1-0	3
CH103	Chemistry	2-1-0	3
ME106	Basic Mechanical Engineering	1-1-0	2
EE104	Basic electrical and electronics engineering	1-1-0	2
PH 156	Physics Lab-I	0-0-2	1
CH153	Chemistry lab	0-0-2	1
HS159	English language and communication	0-2-0	2
HSXXX	HSS Flex XXX	1-0-0	1
		10-7-4	**19**

2nd Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
MA106	Linear algebra and ordinary differential equations I	2-1-0	3
BSE102	Bio Sciences	2-1-0	3
CS103	Computer programming	2-0-0	2
*XXX	First year elective -I	1-0-0	1
*XXX	First year elective-II	1-0-0	1
IC151	Computer programming lab	0-0-3	1.5
MSXXX	Hands on XXX	1-0-6	4
HS108	Fundamentals of economics	2-0-0	2
HS XXX	Environmental Studies	2-1-0	3
HSXXX	HS flex XXX	1-0-0	1
NO102	National sports organization	0-0-0	P/NP
		14-3-9	**21.5**

Course code	**PH 101**
Title of the course	**Basics of Physics**
Credit structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Prerequisites	Nil
Scope of the course	
Course syllabus	**Quantum Mechanics & Applications**: Review of quantum concepts, Inadequacies of Classical Mechanics – black body radiation, Particle nature of light, Photoelectric effect, Compton effect, Waves, Wave packets, Phase and Group velocity, Davisson Germer Experiment, Heisenberg uncertainty principle. Schrodinger equation, Probabilistic interpretation of wave function. One dimensional problems- Particle in a box, Potential well, Potential barrier and Tunnelling, Harmonic oscillator. **Electrostatics:** Coulomb's law, Gauss theorem, electric potential, Laplace's equation, Poisson's equation, electrostatics with conductors, capacitors, Dielectrics and Capacitance: Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. The permittivity of dielectric materials, Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solutions and applications of Laplace and Poisson's equation. **Magnetostatics**: Biot Savart's law, Ampere's law, Lorentz force. **Magnetic Induction:** Faraday's law, Lenz's law, self and mutual inductance, energy in a magnetic field, Conductors, Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.
Suggested references	1. A. Beiser, S. Mahajan, S.R. Choudhury, **Concepts of Modern Physics** (6th Edition), McGraw Hill Inc., 2009. 2. S.H. Patil, **Elements of Modern Physics**, Tata McGraw Hill, 1989. 3. K.S. Krane, **Modern Physics** (2nd Edition), John Wiley and Sons, 1996. 4. H.S. Mani and G.K. Mehta, **Introduction to Modern Physics**, East West Books Madras Pvt. Ltd., 1988. 5. D. Griffiths, **Introduction to Electrodynamics**, (2nd edition), Prentice Hall of India, New Delhi, 1989. 6. A.S. Mahajan and A. Rangawala, **Electricity and Magnetism**, Tata McGraw Hill, New Delhi, 1989 **7.** D. N. Vasudeva, **Fundamentals of magnetism and electricity,** S. Chand and Company, ISBN: 978-8121909556 8. E. M. Purcell and David Morin, **Electricity and Magnetism,** Cambridge University Press, ISBN: 978-1107014022 9. H. C. Verma, **Classical Electromagnetism**, ISBN: 978-9388704823

Course Code	**PH 156**
Course Title	**Physics lab -I (General Physics Lab)**
Credit Structure	L-T-P-Credits (0-0-2-1)
Name of the Dept.	Physics
Pre-requisite if any	None
Scope of the course	This course enhances experimental skills and concepts using a variety of physics experiments.
Course Syllabus	1. Effect of magnetic field on materials (Hall Effect and Universal B-H Curve Tracer) 2. Frank Hertz Experiment. 3. LCR Circuit 4. Thermal & Electrical Conductivity 5. Kundt's Tube 6. Fresnel's Bi-prism 7. Grating Spectrometer 8. Hydrogen Spectrum 9. Specific Charge of Electron (e/m) 10. Newton's Rings
Suggested References	1. Lab Manual 2. G. L. Squires, Practical Physics, University Press, Cambridge, 1998

3rd Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
ZZXXX	Course -I for minor program	X-X-X	3
MA 203	Complex analysis and Differential Eqns-II	3-1-0	4
PH 201	Classical Mechanics	2-1-0	3
PH 241	Wave Phenomena and Optics	2-1-0	3
PH 291	Electronics-I	2-1-0	3
PH 221	Fundamental Concepts of Solid State Engineering	2-1-0	3
PHXXX	Elective-I	2-1-0	3
PH 293	Physics Lab-II (General Physics Lab)	0-0-3	1.5
PH 295	Electronics Lab-I	0-0-3	1.5
		13-6-6	**22/25**

4th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
ZZXXX	Course II for minor program	X-X-X	3
MA 204	Numerical Methods	2-0-2	3
PH 210	Quantum Mechanics-I	2-1-0	3
PH 222	Thermal Physics	2-1-0	3
PH 290	Electronics -II	2-1-0	3
PH 301	Electrodynamics	1-1-0	2
PHXXX	Elective -II	2-1-0	3
PH 292	Electronics Lab-II	0-0-3	1.5
IEXXX	Open Elective -I	2-1-0	3
		13-6-5	**21.5/24.5**

Course Code	**PH 201**
Title of the Course	**Classical Mechanics-I**
Credit Structure	L-T-P-Credits (2-1-0-3)
Name of the Department	Physics
Pre–requisite, if any	Nil
Scope of the Course	This course provides basic knowledge of classical physics, fluid dynamics and non linear dynamics.
Course Syllabus	System of particles, Center of mass, equation of motion of the CM, conservation of linear and angular momentum, conservation of energy, variable mass systems. Elastic and inelastic collisions. Central Force: uniformly rotating frame, centrifugal and Coriolis forces, Motion under a central force, Kepler's laws, Gravitational Law and field, Conservative and non-conservative forces. Introduction to Lagrangian mechanics. Mechanics of Rigid Body: Rigid body motion, fixed axis rotations orthogonal transformations and rotations (finite and infinitesimal); Euler's theorem, Euler's angles; moments of Inertia tensor, parallel and perpendicular axes theorem, Principal moments and axes; Euler's equation; Small Oscillations, normal modes and frequencies Fluid Mechanics: Kinematics of moving fluids, equation of continuity, Euler's equation, Bernoulli's theorem Nonlinear Dynamics: Introduction, maps and flows, stability, phase space, fixed point analysis, logistic maps, chaos.
Suggested Reference:	1. N. Rana and P. Jog, **Classical Mechanics**, Mcgraw Hill, 2017, ISBN: 978-0074603154 2. K . C Gupta, **Classical Mechanics of Particles and Rigid Bodies**, New age Education, ISBN: 978-9386649782 3. David Morin, I**ntroduction to Classical Mechanics,** Cambridge Univ. Press, 2009, ISBN: 978-0521185028 4. M. R. Spiegel**, Theoretical Mechanics**, McGraw-Hill Inc., US; Metric S.I. Edition, ISBN 13: 978-0070843578. 5. R. Feynman, **The Feynman Lectures on Physics – Vol I**, Addison-Wesley, ISBN: 978-0071074582. 6. S. H. Strogatz**, Nonlinear Dynamics and Chaos**, Taylor & Francis, ISBN: 978-1138329454 7. Goldstein, Poole, Safko, **Classical Mechanics**, Pearson, 2017, ISBN: 978-0201657029 8. Kleppner and Kolenkow, **An Introduction to Mechanics**, Cambridge Univ. Press, 2013, ISBN: 978-0521198110

Course code	**PH 241**
Title of the course	**Wave Phenomena and Optics**
Credit structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Prerequisites	None
Scope of the course	The students will be introduced to the basics of waves and oscillations, including optics and lasers
Course syllabus	**Oscillations:** Harmonic motion (simple, damped, critical). Driven oscillation, resonance. Harmonic motion in 2- and 3-dimensions. Oscillations of two particle systems and modes. Oscillations of n particle systems. Oscillation modes. Longitudinal and transverse oscillations. Applications. **Waves:** Equation of motion for waves, standing waves and traveling waves in 1 dimension. Properties of waves in two and three dimensions. Harmonics and their superpositions. Applications of Fourier analysis and Fourier coefficients. Doppler effect. **Geometrical Optics**: Fermat's Principle, Refraction at Spherical Surfaces, Thick Lens and Lens Combination, Matrix Method in Paraxial Optics, Aberrations: Seidel and Chromatic, Optical Instruments: Telescopes and Microscopes. **Wave Optics:** Light as an electromagnetic wave, Electromagnetic Spectrum, Huygen's Principle, Interference of Light, Young's Experiment, Fresnel's Biprism, Lloyd's Mirror, Newton's Rings, Applications; Interferometers: Michelson and Fabry-Perot; Coherence: Temporal and Spatial; Diffraction: Fresnel and Fraunhoffer, Single Slit Diffraction, Double Slit Diffraction, Circular apperture, Diffraction Grating, Resolving power, Telescope and Microscope, Applications **Polarization:** Brewster's Law, Double refraction or Birefringence, Dichroism, Babinet's Compensator, Polarimeters, Optical Activity, Applications **Lasers and holography:** Coherence (spatial and temporal), spontaneous and stimulated emission, Gaussian wave propagation and its diffraction. Holography.
Suggested references	1. Ajoy Ghatak, **Optics,** MacGraw Hill, 2020, ISBN: 978- 9390113590 2. N. Bajaj, **The physics of waves and oscillations,** McGraw Hill, 2017, ISBN: 978-0074516102 3. Frank S. Crawford, **Waves**, MacGraw Hill Education, ISBN: 978-0070702172 4. Kleppner and Kolenkow, **An Introduction to Mechanics**, Cambridge Univ. Press, 2013, ISBN: 978-0521198110 5. David J. Griffiths, **Introduction to Electrodynamics**, Cambridge Univ. Press, 2017 ISBN: 978-1108420419 6. M. Born and E. Wolf, **Principles of Optics,** Cambridge univ. Press, 2019 ISBN: 978-1108477437 7. Francis Jenkins and Harvey White**, Fundamentals of Optics**, McGraw Hill Education; 4th edition, 2017, ISBN: 978-1259002298

Course code	**PH 290**
Title of the course	**Electronics-I**
Credit structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Prerequisites	
Scope of the course	
Course syllabus	**Semiconductor devices:** Principles of operation, Diode, Transistors, Transistor Characteristics, BJT, MOSFET, their structures, principle of operations, electrical characteristics and their low frequency models Biasing schemes for BJT and FET amplifiers, bias stability, configurations (CE/CS, CB/CG, CC/CD) and their features Small signal analysis: Estimation of voltage gain, input resistance, output resistance etc. for CE/CS, CB/CG, CC/CD amplifiers, and design procedure for particular specifications. **High frequency analysis:** Miller's theorem, high frequency transistor models, frequency response of single stage amplifer (CE/CS, CB/CG, CC/CD amplifiers) **Differential amplifier:** Basic structure and principle of operation, calculation of differential gain, common-mode gain, CMRR and ICMR. **Operational amplifier:** Design of two-stage amplifier, frequency compensation, generalized structure of multistage amplifier, frequency response of amplifiers, concept of negative feedback and virtual short, analysis of simple operational amplifier circuits **Oscillators:** Basic criteria for oscillation, Phase-shift, and Wien Bridge, oscillators, multivibrators (astable, monostable, bistable), timers
Suggested references	1) B. Razavi, **Fundamentals of Microelectronics**, 2nd Edition. 2) A. S. Sedra and K. C. Smith, **Microelectronic Circuits**, 7th Edition 3) Gray, Hurst, Lewis, and Meyer, **Analysis and Design of Analog Integrated Circuits**, 5th Edition 4) J. Millman and A. Grabel, **Microelectronics**, Tata McGraw-Hill, New Delhi, 1999 5) R. Gayakwad, **Op-amps and Linear Integrated circuits**, Prentice Hall, New Delhi, 1988.

Title of the course	**PH 220**
Credit structure	**Fundamental concepts for Solid State Engineering**
Name of the department	L-T-P-Credits (2-1-0-3)
Prerequisites	Physics
Scope of the course	
Course syllabus	This course aims to provide a multidisciplinary introduction to solid state properties of matter.
Suggested references	**Introduction:** Periodic array of atoms, Symmetry operations, Point Groups in general, Index system for crystal planes, Lattices in 1 – 2 – and 3 D Bravais Lattices **Elastic Properties of Crystals:** Stress and Strain, Hooke's law, Analysis of Elastic Strains: Dilation and Stress Components, Elastic Compliance and Stiffness Constants, Elastic Waves in Cubic crystals, Crystal Binding. **Reciprocal lattice:** Diffraction of waves by crystals, Scattered Wave Amplitude, Brillouin zones, Wigner – Seitz Cells, Fourier analysis of the Basis. **Crystal Vibrations:** mono-atomic lattice, dia-atomic lattice, quantization of elastic waves, phonon-dispersions. **Thermal properties of Crystals:** Phonon density of states, Heat capacity, thermal expansion, thermal conductivity. **Electrons in Crystals:** Review of Free electron model**,** Periodic potential, Born–von Karman boundary conditions, Schrodinger equation in a periodic potential, Bloch's theorem, Electronic band structure, single electron energy state, degenerate electron levels, Consequences of the nearly free electron model, Fermi surface. **Structural Defects:** Point defects, Dislocations, Microcracks, Stacking faults, Grain boundaries, **Electronic properties of Materials:** Construction of Fermi surfaces, Reduced Zone Scheme, Periodic Zone Scheme, Reflectance and Absorption, Intrinsic and Extrinsic semiconductors, Effective mass and mobility of carriers, Hall Effect, , Semiconducting junctions, Metal-semiconductor contacts – Schottky barriers, Ohmic contacts, brief introduction to semiconductor device fabrication: .
Suggested references	1. C. Kittel, Introduction to Solid State Physics (7th Edition), John Wiley & Sons, ISBN: 9788126578436. 2. Ashcroft and Mermin, Solid State Physics, Thomson Press (India) Ltd. ISBN: 0030839939, 9780030839931 3. A. J. Dekker, Solid State Physics, MacMillan India Ltd. ISBN-13 : 978-0333918333 4. M. Ali Omar, Elementary Solid-State Physics: Principles and Applications (1st Edition), Pearson Education, ISBN-13: 978-8177583779 5. M. Tinkham, Introduction to superconductivity (2nd Edition), Dover Publications, ISBN-13: 978-0486435039

Course Code	**PH 291**
Course Title	Physics lab -II (General Physics Lab)
Credit Structure	L-T-P-Credits (0-0-3-1.5)
Name of the Dept.	Physics
Pre-requisite if any	None
Scope of the course	This course enhances experimental skills and concepts using a variety of physics experiments.
Course Syllabus	1. Moment of inertia of fly wheel 2. Verification of Bernoulli's theorem 3. Verification of Brewster's law 4. Determination of specific rotation of sugar solution by using Laurent's Half Shade Polarimeter. 5. Constant volume and pressure air thermometer 6. Measurement of dielectric constant 7. Helmholtz coil & measurement of Faraday's number 8. Verification of Curie-Wiess law using disc capacitor 9. Magnetic susceptibility of paramagnetic substance using Gouy's balance 10. Single and double slit diffraction with LASER and sodium lights. Determination of wavelength separation between the sodium doublet using a double slit set-up. 11. Davisson-Germer experiment to demonstrate wave-particle duality
Suggested References	1. Laboratory manual 2. Walter Fox Smith, **Experimental Physics: Principles and Practice for the laboratory,** CRC Press, 2020, ISBN: 978-1498778473 3. Louis Lyons, **A practical guide to data analysis for physical science students,** Cambridge Univ. Press, 1991, ISBN: 978-0415481519

Course code	**PH 295**
Title of the course	**Electronics lab-I**
Credit structure	L-T-P-Credits (0-0-3-1.5)
Name of the department	Physics
Prerequisites	None
Scope of the course	
Course syllabus	1. To measure the DC I-V Characteristics of diodes. 2. Analysis of diode circuits (Clipping Circuits, Voltage Doublers, Rectified Differentiator, Precision Rectifier). 3. To measure the reverse-bias capacitance of p-n junction capacitance 4. To measure the minority carrier lifetime in a semiconductor photodiode. 5. Transistor and Op-Amp characteristics - amplification, Op-Amp as summer, Integrator, Differentiator 6. Zener Diode - rectification, DC power supply 7. Characterization of basic and Cascode current mirror circuits (with BJT and MOSFET) 8. Design of single-stage amplifiers (common emitter and common drain) 9. Design of differential amplifier with resistive load (BJT) and active load (MOSFET) 10. 555 Timers - timer and oscillator functions
Suggested references	1. Oppenheim, A. V., Willsky, A. S., and Nawab, S. H. (1997). Signals & systems (2nd ed.). Upper Saddle River, N.J.New Delhi: Prentice Hall. 2. J. Millman and A. Grabel, Microelectronics, McGraw Hill, International, 1987. 3. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991. 4. R.T. Howe and C.G. Sodini, Microelectronics: An Integrated Approach, Prentice Hall International, 1997.

Course code	**PH 210**
Title of the course	**Quantum Mechanics -I**
Credit structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Prerequisites	None
Scope of the course	The students will be introduced to the basics of quantum mechanics
Course syllabus	Review of Introductory Quantum Physics Calculation of expectation values, Kets, bras and operators, Base kets and matrix representations, Measurements, observables and the uncertainty relations, change of basis, position, momentum and translation, wave functions in position and momentum space. Quantum dynamics: Time evolution and the Schrodinger equation, The Schrodinger versus the Heisenberg picture, Schrödinger equation, and its solution for one, two, and three-dimensional boxes. Solution of Schrödinger equation for the one-dimensional harmonic oscillator. Reflection and transmission at a step potential, Pauli exclusion principle. WKB approximation, Tunneling through a barrier, Structure of the atomic nucleus, mass, and binding energy. Hydrogen atom, Radioactivity and its applications. Laws of radioactive decay.
Suggested references	1) D. J. Griffiths and D. F. Schroeter, **Introduction to Quantum Mechanics**, Cambridge University Press, 2018, ISBN: 978-1107189638 2) R. Shankar, **Principles of Quantum Mechanics,** Springer, 2011, ISBN: 978-0306447907 3) P M Mathews and K Venkatesan, **A Textbook of Quantum Mechanics,** Springer, 2017, ISBN: 978-0070146174 4) J. Townsend, **A Modern Approach to Quantum Mechanics**, University Science Books, ISBN:978-1891389788. 5) Ashok Das, **Quantum Mechanics: A Modern Introduction**, CRC Press; 1st edition, ISBN: 978-2881240539

Course Code	**PH 221**
Course Title	**Thermal Physics**
Credit Structure	L-T-P-Credits (2 - 1 - 0 - 3)
Name of the Dept.	Physics
Pre-requisite if any	None
Scope of the course	This course introduces the basic concepts of heat and thermodynamics
Course Syllabus	**Kinetic Theory of Gases:** Ideal gas, Distribution of velocities, Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (statement only), Specific heats of Gases, Mean Free Path. Collision Probability, Transport phenomena (viscosity, thermal conductivity and diffusion), Real Gases, Virial equation, Boyle temperature, Van der Waal's Equation of State, Comparison with Experimental P-V Curves. **Laws of Thermodynamics:** Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, Internal Energy and First Law of Thermodynamics, Isothermal and Adiabatic Processes, Second Law of Thermodynamics, Reversible and Irreversible process with examples, Carnot's Cycle, Carnot engine & efficiency, Carnot's Theorem, Heat engines, Concept of Entropy, Clausius Theorem and Clausius Inequality, Principle of Increase of Entropy, Third Law of Thermodynamics. **Thermodynamic potentials:** Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, their Definitions, Properties and Applications, First and second order Phase Transitions, Clausius-Clapeyron Equation, Maxwell's Thermodynamic Relations, Joule-Kelvin coefficient, Joule- Thomson Effect. **Non-equilibrium Thermodynamics**: Entropy production, The kinetic coefficients, Proof of Onsager reciprocal relations, Thermoelectricity
Suggested References	1) M.W. Zemansky, Richard Dittman, **Heat and Thermodynamics**, McGraw-Hill, 1996 ISBN: 978-0070170599 2) S.J. Blundell and K.M. Blundell, **Concepts in Thermal Physics**, Oxford University Press, 2009, ISBN: 978-0199562107 3) E. Guha, **Basic Thermodynamics** Alpha Science 2001, ISBN: 978-1842650004 4) A. Kumar and S.P. Taneja, **Thermal Physics**, R. Chand Publications, 2018 5) M. Kaufman, **Principles of Thermodynamics**, CRC Press, 2002, ISBN: 978-0824706920

Course Code	PH 290
Course Title	**Electronics -II**
Credit Structure	L-T-P-Credits (2-1-0-3)
Name of Dept.	Physics
Pre-requisite,	
Scope	This course makes students familiar with the working and mechanism of widely used electronic systems and circuit components
Course Syllabus	Number System and Codes: Decimal, Binary, Octal and Hexadecimal number systems and arithmetic, base conversions. Representation of signed and unsigned numbers, addition, subtraction by 2's complement method, multiplication. Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Basic postulates and fundamental theorems of Boolean algebra. Combinational Logic Analysis and Design: Standard representation of logic functions Arithmetic Circuits: Binary Addition. Half and Full Adder. Half and Full Subtractor, 4- bit binary Adder/Subtractor. Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, circuit and working. Accuracy and Resolution. A-D conversion characteristics, successive approximation ADC Signal Acquisition and Manipulation: Sampling and Reconstruction of signals; Nyquist sampling, reconstruction of bandlimited signals, Fourier Transform, Discrete FT (DFT), Fast Fourier transform (FFT), Sampling theorem Fourier methods, FFT implementations, leakage, windowing, convolution, correlation.
References	1. D.P. Leech and A.P. Malvino, Digital Principles and Applications, TMH, 7th ed., 2011. 2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989. 3. A. Papoulis, Probability, Random Variables and stochastic processes, 2nd Ed., McGraw Hill, 1983. 4. Oppenheim, A. V., Willsky, A. S., and Nawab, S. H. (1997). Signals & systems (2nd ed.). Upper Saddle River, N.J.New Delhi: Prentice Hall. 5. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principle, Algorithms and Applications, Prentice Hall, 1997. 6. Lecture Notes on Signal Processing for Physics and Engineering

Course code	PH 208/AA 208

Title of the course	**Electrodynamics /Engineering Electromagnetics**
Credit Structure	L - T - P – Credits 2-0-0-2
Name of the Discipline	Department of Physics /Astronomy, Astrophysics and Space Engineering
Prerequisite, if any	Basic Physics Course from Year 1
Scope of the course	
Course Syllabus	**Module 1:** Review of Electrostatics and Magnetostatics. **Module 2:** Time-Varying Fields and Maxwell's Equations: Faraday's law for Electromagnetic induction, Displacement current, Integral and differential forms of Maxwell's equations, and Motional Electromotive forces. Boundary Value Problems, multipole expansion. **Module 3:** Electromagnetic Waves: Derivation of Wave Equation, Coulomb and Lorentz gauges; Plane waves in free space and in a homogenous material. non-conducting and conducting media; reflection and transmission at normal and oblique incidences, Skin effect, Poynting theorem. Polarization. **Module 4:** Relativistic Electrodynamics: Special Theory of Relativity, Lorentz Invariance of Maxwell's Equation, Radiation by moving charges, retarded potentials. Dipole antenna radiation, Introduction to wave guides.
Suggested Books	1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014, ISBN-0199321388 2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009, ISBN-8120334655 3. D. J. Griffiths, Introduction to Electrodynamics, Cambridge University Press, 2020, ISBN: 978-1108822909 4. A. K. Raychaudhuri, Classical theory of Electricity and Magnetism, Springer-Verlag, 2022, ISBN: 978-9811681387 5. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012., ISBN-9339203275

1.	Course Code	PH 292
2.	Course Title	**Electronics Lab -II**
3.	Credit Structure	L-T-P-Credits (0-0-3-1.5)
4.	Name of the concerned Dept.	Physics
5.	Pre-requisite, if any	
6.	Scope of the course	This course imparts hands on training to students with the working and mechanism of widely used electronic systems and circuit components
7.	Course Syllabus	1. Introduction to Logic Circuits: To gain familiarity with digital integrated circuits by setting up simple logic circuits. 2. Combinational Logic Circuits: Use of TTL adder, multiplexer and decoder. 3. Sequential building blocks 4. Digital to Analog and Analog to Digital Conversion 5. Sampling and Reconstruction of Continuous-Time Signals and Interpolation with Decimation. 6. Implementation of a (4 X 4) multiplier using registers and a down-counter. 7. MOSFET inverting amplifiers and first-order circuits 8. Introduction to VHDL and FPGA 9. Simple sequential circuits and VHDL 10. Half adder and full adder implementation in FPGA using VHDL 11. Electronics Design Project
8.	References	1. Wakerly, **Digital Design: Principles And Practices**, Pearson India; 4th edition ISBN-13 : 978-9332508125 2. S. Salivahanan, S. Arivazhagan, **Digital circuits and design**, Oxford University Press; Fifth edition, ISBN : 978-0199488681 3. S. Franco, **Design with Operational Amplifiers and Analog Integrated Circuits**, McGraw-Hill, 4th edition, ISBN: 978-9352601943 4. Millman, Grabel, **Microelectronics**, McGraw Hill Education, 2nd edition, ISBN: 978-0074637364 5. https://www.fftw.org/#documentation

5th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
ZZXXX	Course III for minor program	X-X-X	3
PH 361	Nuclear Science and Engineering	2-1-0	3
PH 311	Quantum Mechanics - II	2-1-0	3
PH 313	Advanced Classical Mechanics	1-0.5-0	1.5
PH 351	Topics in Mathematical Physics	1-0.5-0	1.5
PH XXX	Multiscale Modelling	2-0-2	3
PH XXX	Elective-III	2-1-0	3
PH 391	Physics lab III (Advanced Physics Lab)	0-0-3	1.5
IEXXX	Open elective -II	2-1-0	3
		12-5-5	**19.5/22.5**

6th Semester

Course Code	Course Name	Weekly Contact Hr (L-T-P)	Credit
PH 322	Cooperative Phenomena in Solids	2-1-0	3
PH 320	Statistical Mechanics	2-1-0	3
PH 340	Atomic and Molecular Spectroscopy	2-1-0	3
PH 390	UG seminar	0-1-0	1
PH XXX	Elective-IV	2-1-0	3
PH XXX	Elective-V	2-1-0	3
PH 392	Physics Lab IV (Solid State Engineering Lab)	0-0-3	1.5
PH 394	Physics lab V (Spectroscopy and Microscopy)	0-0-3	1.5
IE XXX	Open elective -III	2-1-0	3
		12-7-4	**22**

Course Code	**PH 361**
Title of the Course	**Nuclear Science and Engineering**
Credit Structure	L-T- P-Credits (3-1-0-4)
Name of the department	Physics
Pre–requisite, if any	Nil
Scope of the Course	To introduce students with the concepts and important developments in our understanding of nucleus and elementary particles and their interactions.
Course Syllabus	**Nuclear Properties through experiments:** Rutherford scattering, Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, Nature of the nuclear force, form of nucleon-nucleon potential; Charge- independence and charge-symmetry of nuclear forces; Deuteron problem **Nuclear Models:** Liquid drop model, semi-empirical mass formula; Electric and magnetic moments; Fermi gas model of nucleus; nuclear shell model; Collective model **Radioactivity:** Radioactive decays, Gamow model, Fermi theory and Selection rules, Electromagnetic transitions in nuclei multipole radiation **Fission and Fusion:** Fission Reactors, Fission explosives, Controlled Fusion reactor. **Accelerators and Detectors:** Gas filled counters, Scintillation detectors, Semiconductor detectors, Mass spectroscopy with accelerators, **Elementary Particles:** Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); quark model; Symmetries and Conservation laws; Spin and parity assignments, isospin, strangeness, Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction
Suggested Reference	1. K. Krane, **Introductory Nuclear Physics**, Wiley, 2022, ISBN: 978-9354640834 2. W. S. C. Williams, **Nuclear and Particle Physics**, Oxford University Press, USA. 3. A. Das and T. Ferbel, **Introduction to Nuclear and Particle Physics**, World Scientific Publishing Company, 2003. 4. B. R. Martin and G. Shaw, Particle Physics, John Wiley and sons, Chicester,1996. 5. F. Halzen and A. D. Martin, Quarks and Leptons: An introductory Course in particle physics, John Wiley and Sons, New York, 1984. 6. D. Griffiths, Introduction to Elementary Particles, Wiley-vch Verlag Gmbh, 2008.

Course code	**PH 311**
Title of the course	**Quantum Mechanics -II**
Credit structure	L-T-P-Credits (2-1-0-3)

Name of the department	Physics
Prerequisites	Quantum Mechanics -I
Scope of the course	The students will be introduced to more concepts and some important applications of quantum mechanics
Course syllabus	Stern-Gerlach experiment, Dirac notation for state vectors. **Quantum dynamics**: Time evolution and the Schrodinger equation, **Theory of angular momentum**: Rotation and angular momentum commutation relations, spin ½ systems and finite rotations, SO(3), SU(2) and Euler rotations, Eigenvalues and eigenstates of angular momentum, Orbital angular momentum, addition of angular momenta, Wigner-Eckart theorem, Tensor operators. **Approximation methods**: Time independent perturbation theory (Non degenerate case), Time-independent perturbation theory (The dependent case), hydrogen like atoms (Fine structure and Zeeman effect), Variational methods, Time dependent potentials (The interaction picture), Fermi's Golden Rule; Selection rules; Time dependent perturbation theory, Energy shift and decay width **Identical particles:** Pauli's exclusion principle, spin-statistics connection
Suggested references	1) J. J. Sakurai, **Modern Quantum Mechanics** (2nd edition), Addison Wesley, ISBN:978-0805382914. 2) R. Shankar, **Principles of Quantum Mechanics,** Springer, 2011, ISBN: 978-0306447907 3) J. Townsend, **A Modern Approach to Quantum Mechanics**, University Science Books, ISBN:978-1891389788. 4) Ashok Das, **Quantum Mechanics: A Modern Introduction**, CRC Press; 1st edition, ISBN: 978-2881240539 5) L. Landau and L. Liftshitz, **Quantum mechanics - Vol. 3** (3rd edition), Butterworth-Heinemann, ISBN: 978-0750635394. 6) C. Cohen-Tannoudji, B. Diu and F. Laloë, **Quantum Mechanics Vol. 2**, Wiley-VCH, 2019, ISBN: 978-3527345540

Course Code	**PH 202**
Title of the Course	**Advanced Classical Mechanics**
Credit Structure	L-T-P-Credits (1-0.5-0-1.5)
Name of the department	Department of Physics
Pre–requisite, if any	PH 201
Scope of the Course	This course provides advanced concepts and techniques in classical mechanics and special theory of relativity
Course Syllabus	**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. Noether's theorem and conservation of charges. **Canonical transformations**: Generating functions; example of canonical transformations; group property; Integral variants of Poincare; Lagrange and Poisson brackets; Infinitesimal canonical transformations; Conservation theorem in Poisson bracket formalism; Jacobi's identity; Angular momentum Poisson bracket relations Hamilton-Jacobi theory: The Hamilton Jacobi equation for Hamilton's principle function; The harmonic oscillator problem; Hamilton's characteristics; Action angle variables. **Special Theory of Relativity**: Lorentz transformations; 4-vectors, 4-dimensional velocity and acceleration; 4-momentum and 4-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle.
Suggested Books	1. H. Goldstein, C. P. Poole and J. L.. Safko, **Classical Mechanics** (3rd edition), Addison Wesley, 2001. 2. J. R. Taylor, **Classical Mechanics**, Uni. Science Books, 2005. 3. L. D. Landau, E. M. Lifshitz**, Course of Theoretical Physics - Vol. 1** (3rd edition), Butterworth-Heinermann, 1976. 4. V. I. Arnold, **Mathematical Methods of Classical Mechanics** (2nd edition), Springer, 1988. 5. J. B. Marion and S. T. Thornton, **Classical Dynamics of Particles and Systems** (4th edition), Holt Rinehart & Winston, 1995 6. A. K. Raychaudhuri**, Classical Mechanics: A Course of Lectures** (1st edition), Oxford University Press, 1984. 7. E. C. G. Sudarshan, **Classical Dynamics: A Modern Perspective** (1st edition), John Wiley & Sons, 1974. 8. D. Morin, **Introduction to Classical Mechanics**, Cambridge Univ. Press, 2009, ISBN: 978-0521185028

Course Code	**PH 351**
Course Title	**Topics in Mathematical Physics**
Credit Structure	L - T - P – Credits (1-.5-0-1.5)
Name of the department	Physics
Pre-requisite, if any	MA 106 and MA 203
Scope of the course	This course introduces some physics specific advanced concepts of mathematics
Course Syllabus	**Group theory:** Abelian and nonabelian groups, discrete and continuous groups, reducible and irreducible representations, generators and Lie algebra, applications of Lie groups. **Special functions and applications:** Legendre, Bessel**,** Laguerre, Hermite, Chebyshev, Hypergeometric Functions, Spherical Harmonics. **Tensors and their applications:** Introduction to Tensors, Covariant derivative, tensor transformations and applications to geometry
Suggested References	1. G. B. Arfken and H. J. Weber, **Mathematical Methods for Physicists** (6th edition), Academic Press, 2005. 2. S. Hassani, **Mathematical Physics: A modern introduction to its foundations**, Springer-Verlag, 1999. 3. K. F. Riley, M.P. Hobson and S.J. Bence**, Mathematical Methods for Physics and Engineering: A Comprehensive Guide** (3rd edition), Cambridge University Press. 4. E. Kreyszig**, Advanced Engineering Mathematics** (8th edition), John Wiley & Sons. 5. M.L. Boas**, Mathematical Methods in the Physical Sciences** (3rd edition), John Wiley & Sons.

Course Code	**PH XXX**
Title of the Course	**Multiscale Modelling**
Credit Structure	L-T-P-C (1-1-2-3)
Name of the department	Physics
Pre–requisite, if any	Programming Language (Fortran/C/C++/Python)
Scope of the Course	
Course Syllabus	**Monte Carlo (MC) Techniques:** random number generators, sampling, importance sampling, integration, biased/unbiased Monte Carlo, Metropolis algorithm, Markov chain Monte Carlo, quantum Monte Carlo, kinetic Monte Carlo, convergence and central limit theorem, application of Monte Carlo method in Physics **Classical Molecular Dynamics(cMD):** classical force fields, Different algorithms for integrating Newton's equation of motion, stability of various solvers, pressure and temperature coupling, MD in NPT and NVT ensembles, application of cMD in condensed matter and biological systems. **Introduction to Density Functional Theory (DFT)**
Suggested Books	1. Monte Carlo Methods (2^{nd} Edition), Malvin H. Kalos and Paula A. Whitlock, Wiley-VCH , ISBN-13 : 978-3527407606 2. Computer Simulation of Liquids (2^{nd} Edition), Michael P. Allen, Dominic J. Tildesley, Oxford University Press, ISBN 978-0-19-880320-1 3. Understanding Molecular Simulation: From Algorithms to Applications, Daan Frenkel, ISBN-13 : 978-0122673511

Course Code	**PH 391**
Title of the Course	**Physics lab -III (Advanced Physics Laboratory)**
Credit Structure	L-T- P-Credits (0-0-3-1.5)
Name of the department	Physics
Pre–requisite, if any (for the students)	Nil
Scope of the course	To enhance experimental skills and concepts in physics by giving students exposure to a variety of different experiments
Course Syllabus	1. Gamma-ray detection using the Geiger-Muller counter 2. Rutherford Scattering Experiment 3. Muon lifetime determination using a scintillator detector 4. Metal-insulator and Metal-superconductor transitions 5. Chaos (Chua circuit) 6. Demonstration of quantification of charge using Millikan oil drop experiment 7. Gamma ray Spectroscopy 8. Alpha Spectroscopy 9. Visit to RRCAT : Accelerator Facility
Suggested books	1. Laboratory Manual 2. Walter Fox Smith, **Experimental Physics: Principles and Practice for the laboratory,** CRC Press, 2020, ISBN: 978-1498778473 3. Louis Lyons, **A practical guide to data analysis for physical science students,** Cambridge Univ. Press, 1991, ISBN: 978-0415481519

Course Code	**PH 322**
Title of the course	**Cooperative Phenomena in Solids**
Credit structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Prerequisites	Basic Knowledge of Quantum Mechanics and Electricity & Magnetism
Scope of the course	This course aims to provide an in-depth introduction
Course syllabus	**Electronic Quasiparticles:** Effective Mass, Excitons, Band-bending at interfaces and heterojunctions, Quantum confinement, Superlattices, Landau levels, De Haas – Van Aphen and Shubnikov – De Haas Oscillations, Quantum Hall Effect, Electron – Phonon interaction, Electron –Photon interaction, Phonon – Phonon interaction, Electron – electron interaction, Boltzmann Transport Equation; Mott Metal–Insulator Transition; Topological Insulators **Spontaneous Coherence in Matter:** Bose – Einstein Condensation, Superfluidity, Superconductivity, Phonon-Mediated Cooper Pairing Mechanism, brief introduction to BCS theory, Flux quantization, Single particle tunneling, Type–I, Type – II superconductors, D.C and A.C Josephson effect; SQUID and its applications. **Magnetism:** Para- and Ferro- magnetism, Ising Model, Magnetic Structures, Langevin theory of diamagnetism, Pauli Paramagnetism, Quantum mechanical considerations – Ferromagnetism, Domain wall energy, GMR in multilayers. **Opto-electronic properties:** Complex dielectric function and refractive index of solids, Optical Reflectance, Absorption, Kramer-Kronig Relations, Band-gap determination from optical spectra, Band – Band transitions, Band gap renormalization, Impurity levels – shall and deep states, Introduction to Polaritons and Plasmons. Optoelectronic devices **Ferroelectrics:** Dielectric constant and Polarizability, Structural Phase transitions, Ferroelectric Crystals, Displacive Transitions and theory of ferroelectric phase transition, Antiferroelectricity, Ferroelectric domains, Piezoelectric effect and other applications of ferroelectrics**.**
Suggested references	1. D. W. Snoke, Solid State Physics Essential Concepts, Cambridge University Press, ISBN: 9781107191983, 110719198X 2. C. Kittel, Introduction to Solid State Physics (7th Edition), John Wiley & Sons, ISBN: 9788126578436. 2. Ashcroft and Mermin, Solid State Physics, Thomson Press (India) Ltd. ISBN: 0030839939, 9780030839931 3. David Jiles, Electronic Properties of Materials (2nd Edition), Nelson Thornes, ISB: 0-787-6042-3 3. A. J. Dekker, Solid State Physics, MacMillan India Ltd. ISBN-13 : 978-0333918333 4. M. Ali Omar, Elementary Solid-State Physics: Principles and Applications (1st Edition), Pearson Education, ISBN-13: 978-8177583779 5. M. Tinkham, Introduction to superconductivity (2nd Edition), Dover Publications, ISBN-13: 978-0486435039

Course Code	**PH 320**
Title of the Course	**Statistical Mechanics**
Credit Structure	L-T-P-Credits (2-1-0-3)
Name of the department	Physics
Pre–requisite, if any	PH 311
Scope of the Course	This course imparts analytic techniques in classical and quantum statistical mechanics
Course Syllabus	**Formulation of thermodynamics using generalized coordinates:** Thermodynamic laws and potentials, approach to equilibrium and stability analysis, Gibbs-Duhem relation, generalized Maxwell's equations. **Statistical tools:** Probability theory, random variables, moments and cumulants, probability distributions, Wick's theorem, sums of random variables and the central limit theorem, rules for large numbers, Information theory and Shannon entropy. **Kinetic theory of gasses:** Concept of phase space, Liouville's theorem, Boltzmann equation. **Classical statistical mechanics:** Micro-canonical ensemble, two-level systems, ideal gas, mixing entropy and Gibbs paradox, canonical ensemble, Gibbs canonical ensemble, grand canonical ensemble, limitations of classical statistical mechanics and thermal wavelength. **Interacting particles:** Cluster expansion, van der Waals equation and virial coefficients, introduction to mean-field theory. **Quantum statistical mechanics:** Quantum macrostates and density matrices, Liouville's theorem using density matrix. Ideal quantum gases: Identical particles, canonical and grand canonical formulations, non-relativistic gas, degenerate Fermi and Bose gases, superfluidity of Helium.
Suggested Books	1. M. Kardar, Statistical Physics of Particles, Cambridge University Press. ISBN: 978-0521873420. 2. R. K. Pathria and P. D. Beale, Statistical Mechanics (4th edition), Academic Press, Elsevier. ISBN: 978-9351073970. 3. K. Huang, Statistical Mechanics (2nd edition), John Wiley & sons. ISBN: 978-9354247736. 4. James P. Sethna, Statistical mechanics: entropy, order parameters, and complexity (2nd edition), Oxford University Press. ISBN: 978-0198865254. 5. D. Chandler, Introduction to Modern Statistical Physics, Oxford University Press. ISBN: 978-0195042771.

Course Code	**PH 340**
Title of the Course	**Atomic and Molecular Spectroscopy**
Credit Structure	L-T- P-Credits (2-1-0-3)
Name of the department	Physics
Pre–requisite, if any	Basic Knowledge of Quantum Mechanics and Mathematics.
Scope of the Course	To make the students to understand the physics of atomic and molecular structure and spectra, which are essential in terms of knowledge development in basic science and its applications.
Course Syllabus	**Review of atomic structure of Hydrogen:** Atomic structure of two electron system; Many electron atoms; Central field approximation; Alkali system; Hartree-Fock method**.** **Interaction of an atom with electromagnetic wave:** Induced absorption and emission; **Fine and Hyperfine structure**: The interaction Hamiltonian; Selection rules, Effect of external magnetic field; **Many-electron atom:** Central field approximation for many-electron atom, Slater determinant, L-S and j-j coupling, Equivalent and nonequivalent electrons, Energy levels and spectra, Spectroscopic terms, Hund's rule, Landé interval rule, Alkali spectra. **Molecular binding:** LCAO; LCMO; Valence Band (VB) theory; Hydrogen molecules; Molecular spectra (electronic, rotational, vibrational etc.); Raman effect; Modern experimental tools of spectroscopy**.** **Molecular Electronic States:** Concept of molecular potential, Separation of electronic and nuclear wavefunctions, Born-Oppenheimer approximation, Electronic states of diatomic molecules, Electronic angular momenta; The LCAO approach; States for hydrogen molecular ion, Coulomb, Exchange and Overlap integral, Symmetries of electronic wavefunctions, pi and sigma bond; **Rotation and Vibration of Molecules:** Centrifugal distortion, Symmetric top molecules, Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Morse potential ; **Spectra of Diatomic Molecules:** Transition matrix elements, Vibration-rotation spectra, Electronic transitions, Franck-Condon principle, Dissociation energy of molecules, Raman transitions and Raman spectra; **Vibration of Polyatomic Molecules:** Application of Group Theory.
Suggested Books	1. B.H. Bransden and C.J. Joachain, Physics of Atoms and Molecules, Pearson Education Limited, Second edition (2003). 2. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, Quantum Mechanics, vol. 1 and 2, Wiley-Vch (1977). 3. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, McGraw-Hill College (1994). 4. D.C. Harris, M.D. Bertolucci, Symmetry and Spectroscopy – An Introduction to Vibrational and Electronic Spectroscopy, Oxford University Press, USA, Dover publications (1989). 5. J.M Hollas, Modern Spectroscopy, Wiley (2004). 6. G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill, (1962). 7. H. Herzberg: Spectra of Diatomic Molecules

Course Code	**PH XXX**
Title of the Course	**Physics lab -XX (Solid State Engineering lab)**
Credit Structure	L-T- P-Credits (0-0-3-1.5)
Name of the department	Physics
Pre–requisite, if any (for the students)	Nil
Scope of the course	To enhance experimental skills and concepts in physics by giving students exposure to a variety of different experiments
Course Syllabus	1. Determination of Numerical Aperture and Acceptance angle of an optical fibre 2. Study of phase transitions and thermal behaviour of a sample using *DSC/TGA/DTA* *3.* IV characteristics of a *Silicon Solar Cell* 4. Optical and electrical characterization of a *Light Emitting Diode* 5. Study of solid-liquid interfaces using C*ontact-angle measurements* 6. Deposition of transparent conductive oxide and its conductivity measurement using the *Four-probe technique* 7. Fabrication and electrochemical characterization of *Lithium-ion battery* 8. Thin film deposition and its characterization for refractive index and thickness using *Ellipsometry* 9. Demonstration of Thermoluminescence of F-centres in Alkali Halide crystals 10. Surface plasmon resonance in a thin Gold film 11. Measurement of *Magneto-resistance* of Bismuth film
Suggested books	1. Laboratory Manual 2. Walter Fox Smith, **Experimental Physics: Principles and Practice for the laboratory,** CRC Press, 2020, ISBN: 978-1498778473 3. Louis Lyons, **A practical guide to data analysis for physical science students,** Cambridge Univ. Press, 1991, ISBN: 978-0415481519

Course Code	**PH XXX**
Title of the Course	**Physics lab -V (Spectroscopy and Microscopy)**
Credit Structure	L-T-P-Credits (0-0-3-1.5)
Name of the department	Physics
Pre–requisite, if any	
Scope of the course	Students will learn spectroscopy through experiments
Course Syllabus	1. Nature of semiconductor band-gap using optical spectroscopy 2. Deriving energy gap of a powdered semiconductor using Diffused Reflectance Spectroscopy. 3. Measuring intrinsic ‘g’ factor using Electron Spin resonance spectroscopy 4. Determination of Planck’s constant 5. Demonstration of Uncertainty principle using Laser diffraction 6. Demonstration of Raman effect 7. Demonstration of Zeeman Effect 8. Demonstration of Nuclear Magnetic Resonance using 1H and 11F nuclei in compound form 9. Demonstration of Photoluminescence in solids and liquids 10. Demonstration of X-ray diffraction in crystalline solids 11. Understanding molecular vibrations using ATR-FTIR 12. Understanding concept of grain-boundary and grain-size in polycrystalline solids using force/electron microscopy"
Suggested books	M. I Pergament, **Methods of experimental physics**, CRC Press, 2019, ISBN: 978-0367866426

7th Semester				8th Semester			
Course Code	**Course Name**	**Weekly**	**Credit**	**Course Code**	**Course Name**	**Weekly**	**Credit**

		Contact Hr (L-T-P)	
PH 499	B. Tech project	0-0-32	16
	Internship-I		1
	Internship-II		1
		0-0-32	**18**

		Contact Hr (L-T-P)	
PH 4XX	PH elective VI	2-1-0	3
PH 4XX	PH elective VII	2-1-0	3
IE4XX	Open elective IV	2-1-0	3
IE4XX	Open elective V (or course IV for minor program)	2-1-0	3
IE4XX	Open elective VI (or course V for minor program)	2-1-0	3
		10-5-0	**15**

S. No.		Credits	No. of Courses
1	Credits of 1st year physics courses:	4	02
2	Basic Engineering Flex module	2	2
3	Total DC credits (except 1st year courses):	43	16
4	Total DE credits	22	7+1(UG seminar)
5	Total DL credits:	10	6
6	Total Institute core credits:	41.5	17
7	Total IE credits	18	6
8	B. Tech Project & internships:	18	3
	Total credits	158.5	