MANIPAL UNIVERSITY JAIPUR

INSPIRED BY LIFE

Department of Physics
B. Sc. (Hons) Physics

1. Course Scheme and syllabus

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I	PY1101	Mechanics	3	1	0	4	PY1201	Mathematical Physics-I	3	1	0	4
	PY1102	Waves and Optics	3	1	0	4	PY1202	Electricity and Magnetism	3	1	0	4
	PY1130	General Physics Lab	0	0	4	2	PY1203	Analog Systems and Applications	3	1	0	4
	PY1131	Waves and Optics Lab	0	0	4	2	PY1230	Electricity and Magnetism Lab	0	0	4	2
	LN1106	Communicative English	2	0	0	2	PY1231	Analog Systems and Applications Lab	0	0	4	2
	CY1003	Environmental Science	3	0	0	3	XXXX	**GE-II (A)	3	1	0	4
	CA1170	Fundamentals of Computer	1	1	0	2	XXXX	**GE-II (B)	2	1	0	3
	CA1175	Fundamentals of Computer Lab	0	0	2	1		**GE-II (B) Lab	0	0	2	1
	XXXX	GE-I (A)	2	1	0	3						
	XXXX	GE-I (A) Lab	-	-	2	1						
			14	4	12	24			14	5	10	24
	Total Contact Hours (L + T + P)		30				Total Contact Hours (L + T + P)		29			
II	THIRD SEMESTER						FOURTH SEMESTER					
	PY2101	Thermal Physics	3	1	0	4	PY2201	Mathematical Physics-II	3	1	0	4
	PY2102	Digital Systems & Applications	3	1	0	4	PY2202	Quantum Physics and Quantum Mechanics	3	1	0	4
	PY2130	Thermal Physics Lab	0	0	4	2	PY2203	Electro-Magnetic Theory	3	1	0	4
	PY2131	Digital Systems and applications Lab	0	0	4	2	PY2204	Classical Mechanics	3	1	0	4
	PYxxxx	SEC	2	0	0	2	PY2230	Modern Physics Lab	0	0	4	2
	PYxxxx	SEC	2	0	0	2	PY2231	Electro-magnetic Lab	0	0	4	2
	XXXX	**GE-III (A) + Lab	2	1	2	4	PYxxxx	DSE-I	3	1	0	4
	XXXX	**GE-III (B)	3	1	0	4	PY****	Open elective	2	1	0	3*
			15	4	10	24			17	6	8	24+3*=27
	Total Contact Hours (L + T + P)		29				Total Contact Hours (L + T + P)		31			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	PY3101	Atomic and Molecular Physics	3	1	0	4	PY3201	Nuclear and Particle Physics	3	1	0	4
	PY3102	Solid State Physics	3	1	0	4	PY3202	Classical Dynamics	3	1	0	4
	PY3130	Atomic and Molecular Physics Lab	0	0	4	2	PY3276	Seminar	0	0	4	2
	PY3131	Solid State Physics Lab	0	0	4	2	PY3230	Nuclear Physics Lab	0	0	4	2
	PYxxxx	DSE-II	2	1	0	3	PY3250	DSE-IV	2	1	0	3
	PYxxxx	DSE-III	2	1	0	3	PYxxxx	DSE-V	2	1	0	3
	PY3170	Project	0	0	0	6	XXXX	**GE-IV (A)	2	1	0	3
							XXXX	**GE-IV (A) Lab	-	-	2	1
			10	4	8	24	PY***	Open elective	2	1	0	3*
	Total Contact Hours (L + T + P)		22						14	6	10	22+3*=25
							Total Contact Hours (L + T + P)		30			

Discipline Specific Electives (DSE)	Generic Electives (GE)	Open Electives (OE)
DSE-I 1. PY2250: Semiconductor Optoelectronics 2. PY2251: Fusion energy **DSE-II** 1. PY3150: Nano-materials and Applications 2. PY3151: Low temperature Physics **DSE-III** 1. PY3152: Thin Film Technology 2. PY3153: Advanced mathematical Physics **DSE-IV** 1. PY3250: Statistical Mechanics **DSE-V** 2. PY3251: Introduction to Astrophysics 3. PY3252: Physics of Diagnostics & Therapeutic Systems **Skill Enhancement Courses (SEC)** 1. PY2140: Basic Instrumentation Skills 2. PY2141: Renewable Energy and Energy harvesting 3. PY2142: Computational Physics	**GE-I (A) & Lab** 1. MA1141: Differential & Integral Calculus 2. CY1160: General Chemistry-I 3. CY1138: Organic Chemistry Laboratory **GE-II (A)** 1. MA1242: Elementary Differential Equations 2. MA1243: Algebra **GE-II (B) & Lab** 1. CY1260: General Chemistry-II 2. CY1238: Inorganic Chemistry Laboratory 3. CY1261: General Chemistry-III 4. CY1239: Physical Chemistry Laboratory **GE-III (A) & Lab** 1. CY2160: Analytical Chemistry 2. CY2138: Analytical Chemistry Laboratory 3. CY2161: Structure of Materials 4. CY2139: Material Chemistry Laboratory **GE-III (B)** 1. MA2144: Real Analysis 2. MA2145: Probability Theory and Numerical Analysis **GE-IV & Lab** 1. CY3260: Biophysical Chemistry 2. MA3244: Complex Analysis 3. CY3238: Applied Chemistry Laboratory	1. PY2080: Introduction to Nanoscience and its Applications 2. PY2081: Technological Applications of Plasma 3. PY2082: Bioinformatics for Engineers 4. PY2083: Magnetic Materials and Applications 5. PY2084: Structural Properties of Materials and X-ray Diffraction 6. PY2085: 2D-Materials and Applications

B Sc (Hons) Syllabus

First Semester

PY1101: MECHANICS [3 1 0 4]

Dynamics of a System of Particles: Centre of mass, conservation of momentum, idea of conservation of momentum from Newton’s third law, impulse, motion of rocket. potential energy, stable and unstable equilibrium, elastic potential energy, work-energy theorem, work done by non-conservative forces, law of conservation of energy, elastic and inelastic collisions between particles. Rotational Dynamics: Angular momentum of a particle and system of particles, conservation of angular momentum, rotation about a fixed axis, moment of inertia, kinetic energy of rotation, motion involving both translation and rotation. Gravitation and Central Force Motion: Law of gravitation, inertial and gravitational mass, gravitational potential energy, potential and field due to spherical shell and solid sphere, motion of a particle under central force field, two body problem and its reduction to one body problem and its solution, the energy equation and energy diagram, orbits of artificial satellites, relation between elastic constants, twisting torque on a cylinder or wire. Inertial and Non-inertial systems: Reference frames, inertial frames and Galilean transformations non-inertial frames and fictitious forces, uniformly rotating frame, physics laws in rotating coordinate systems, centrifugal forces, Coriolis force, components of velocity and acceleration in cylindrical and spherical coordinate systems. Special Theory of Relativity:

Postulates, Michelson-Morley experiment, Lorentz transformations, simultaneity and order of events, Lorentz contraction, variation of mass with velocity, rest mass, massless particles, mass-energy equivalence, relativistic Doppler effect, transformation of energy and momentum.

References:

1. D. Kleppner, R. J. Kolenkow, An Introduction to Mechanics, Tata McGraw-Hill, 2007.
2. D. S. Mathur, Mechanics, S. Chand & Company Limited, 2014.
3. M. R. Spiegel, Theoretical Mechanics, Tata McGraw-Hill, 2017.
4. C. Kittel, W. Knight, M. Ruderman, C. Helmholz, B. Moyer, Mechanics, Berkeley Physics course, Vol.-I, Tata McGraw-Hill, 2010.
5. F. W. Sears, M. W. Zemansky, H. D. Young, University Physics, Narosa Pub. House, 2013.
6. M. Alonso, E. Finn, Physics Addison-Wesley, 2000.

PY1102: WAVES AND OPTICS [3 1 0 4]

Simple Harmonic Motion: Simple harmonic oscillations, oscillations having equal frequencies and oscillations having different frequencies (beats), superposition of n-collinear harmonic oscillations with equal phase differences and equal frequency differences, superposition of two mutually perpendicular simple harmonic motions with frequency ratios 1:1 and 1:2 using graphical and analytical methods. Damped Oscillations: Log decrement, forced oscillations, transient and steady states, amplitude, phase, resonance, sharpness of resonance, power dissipation and quality factor, Helmholtz resonator. Standing Waves in a String: Fixed and free ends, analytical treatment, phase and group velocities, changes w.r.t position and time, energy of vibrating string, transfer of energy, normal modes of stretched strings. Wave Optics: Electromagnetic nature of light, definition and properties of wave front, Huygens principle, coherence. Interference: Division of amplitude and wavefront, Young's double slit experiment, Lloyd's Mirror, Fresnel's biprism, interference in thin films (parallel and wedge-shaped), fringes of equal inclination and thickness, Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Diffraction: Fresnel diffraction, Fresnel's half-period zones, theory of a zone plate, multiple foci, comparison of a zone plate with a convex lens, Fresnel's integrals, Cornu's spiral, Fresnel diffraction pattern due to a straight edge, a slit, and a wire, diffraction due to a single slit, a double slit and a plane transmission grating, Rayleigh's criterion, resolving power, dispersive power of grating. Polarization: Light polarization by reflection, refraction, Brewster's Law, Malus Law, double refraction.

References:

1. F. A. Jenkins, H. Elliott White, Fundamentals of Optics, Tata McGraw-Hill, 2013.
2. A. Ghatak, Optics, Tata McGraw-Hill, 2015.
3. S. Subrahmaniyam, B. Lal, M. N. Avadhanulu, A Textbook of Optics, S. Chand, 2010.
4. E. Hecht, A. R. Ganesan, Optics, Pearson Education, 2002.
5. Al-Azzawi, Light and Optics: Principles and Practices, CRC Press, 2007.
6. M. Alonso, E. Finn, Physics Addison-Wesley, 2000.

PY1131: WAVES AND OPTICS LAB [0 0 4 2]

To determine the frequency of an electric tuning fork by Melde's experiment and verify λ_2–T law, To investigate the motion of coupled oscillators, To study Lissajous Figures, familiarization with: Schuster`s focusing; determination of angle of prism, To determine refractive index of the Material of a prism using sodium source, To determine the dispersive power and Cauchy constants of the material of a prism using mercury source, To determine the wavelength of sodium source using Michelson's interferometer, To determine wavelength of sodium light using Fresnel Biprism, To determine wavelength of sodium light using Newton's rings, To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film, To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating, to determine dispersive power and resolving power of a plane diffraction grating.

References:

1. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L Arora, BSc Practical Physics, S. Chand Publication, 2012.

3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

LN1106: COMMUNICATIVE ENGLISH [2 0 0 2]

Communication- Definition, Process, Types, Flow, Modes, Barriers; Types of Sentences; Modal Auxiliaries; Tenses and its Usage; Voice; Reported Speech; Articles; Subject-Verb Agreement; Spotting Errors; Synonyms and Antonyms; One Word Substitution; Reading Comprehension; Précis Writing; Essay Writing; Formal Letter Writing; Email Etiquettes; Résumé & Curriculum Vitae; Statement of Purpose; Presentations

References:

1. Collins English Usage. Harpers Collins, 2012.
2. Hobson, Archie Ed. The Oxford Dictionary of Difficult Words. Oxford, 2004.
3. Jones, Daniel. English Pronouncing Dictionary. ELBS, 2011.
4. Krishnaswamy, N. Modern English: A Book of Grammar Usage and Composition, Macmillan India, 2015.
5. Longman Dictionary of Contemporary English. Pearson, 2008.
6. McCarthy, M. English Idioms in Use. Cambridge UP, 2002.
7. Mishra, S. and C. Muralikrishna. Communication Skills for Engineers. Pearson, 2004.
8. Oxford Dictionary of English. Oxford UP, 2012.
9. Turton, N. D. and J.B. Heaton. Longman Dictionary of Common Errors. Pearson, 2004.

CY1003: ENVIRONMENTAL SCIENCE [3 0 0 3]

Introduction: Multidisciplinary nature, scope and importance, sustainability and sustainable development. Ecosystems: Concept, structure and function, energy flow, food chain, food webs and ecological succession, examples. Natural Resources (Renewable and Non-renewable Resources): Land resources and land use change, Land degradation, soil erosion and desertification, deforestation. Water: Use and over-exploitation, floods, droughts, conflicts. Energy resources: Renewable and non-renewable energy sources, alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation: Levels, biogeographic zones, biodiversity patterns and hot spots, India as a mega-biodiversity nation; Endangered and endemic species, threats, conservation, biodiversity services. Environmental Pollution: Type, causes, effects, and controls of Air, Water, Soil and Noise pollution, nuclear hazards and human health risks, fireworks, solid waste management, case studies. Environmental Policies and Practices: Climate change, global warming, ozone layer depletion, acid rain, environment laws, environmental protection acts, international agreements, nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment: Human population growth, human health and welfare, resettlement and rehabilitation, case studies, disaster management, environmental ethics, environmental communication and public awareness, case studies. Field Work and visit.

References:

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2016.
2. A. K. De, Environmental Studies, New Age International Publishers, New Delhi, 2007.
3. E. Bharucha, Text book of Environmental Studies for undergraduate courses, Universities Press, Hyderabad, 2013.
4. R. Carson, Silent Spring, Houghton Mifflin Harcourt, 2002.
5. M. Gadgil & R. Guha, This Fissured Land: An Ecological History of India, University of California Press, 1993.
6. M. J. Groom, K. Meffe Gary and C. R. Carroll, Principles of Conservation Biology, OUP, USA, 2005.

CA1170 FUNDAMENTALS OF COMPUTERS [1 1 0 2]

Computer Fundamentals, Definition and Purpose, Data, Information and Knowledge, Characteristics of Computers, Classification of Computers, Generations of Computer, Basic organization of Computer, System Software and Application Software. Operating Systems and Multimedia, Types of Operating System, Windows v/s Linux, Mobile based OS, Multimedia, Definition and Types , Multimedia Software, Computer Networks, Applications of Networking, Network Topologies- Mesh, Bus, Star, Ring, Types of Network (LAN, MAN, WAN), Network Cables- Optical Fiber, Twisted, Co-axial, Network Devices- Hubs, Switch, Router, Network Interface Card, Ethernet, Internet, Introduction and Usage of Internet, Internet Connectivity Options (Wired and Wireless), IP Addressing and DNS, Website, URL, HTML, Web Browser and Search Engines, Operational Guideline of Computer Usage, Do's and Don'ts of Computer, E-mails, Email Etiquettes, Cyber Security, Internet Frauds, Secure Password Formation , Computer Security, Malware, Virus, Ransomware, Social Media and its Impact.

References:

1. R. Thareja, Fundamental of Computer, (1e) Oxford Publications, 2014.
2. K. Atul, Information Technology, (3e) Tata McGraw Hill Publication, 2008.

CA1175 FUNDAMENTALS OF COMPUTERS LAB [0 0 2 1]

Computer Peripheral and Windows operations, MS WORD- Creating and formatting of a document, Introduction of cut, copy and paste operations, to explore various page layout and printing options, creating. Formatting, editing Table in MS word, Introduction of Graphics and print options in MS word, Introduce the student with mail merge option. MS EXCEL- creation of spreadsheet and usage of excel, Formatting and editing in worksheet, Sorting, Searching in Excel sheets, using formula and filter in MS excel, printing and additional features of worksheet, maintaining multiple worksheet and creating graphics chart. MS POWER POINT – creation of presentation, Power point views, creating slides and other operations, Using design, animation, and transition in slides, Internet Tools, Using Email and Outlook facilities, Google Drive, Google Forms, Google Spreadsheet, Google groups.

References:

1. R. Thareja, Fundamental of Computer, (1e) Oxford Publications, 2014.
2. K. Atul, Information Technology, (3e) Tata McGraw Hill Publication, 2008.

Second Semester

PY1201: MATHEMATICAL PHYSICS-I [3 1 0 4]

Linear Vector Spaces: Abstract systems, binary operations and relations, introduction to groups and fields, vector spaces and subspaces, linear independence and dependence of vectors, linear transformations, algebra of linear transformations, non-singular transformations. Matrices: Addition and multiplication of matrices, types of matrices, transpose and conjugate of a matrix, Hermitian and Skew-Hermitian matrices, adjoint of a matrix, inverse of a matrix by adjoint method, similarity transformations, orthogonal and unitary matrices, trace of a matrix, inner product, eigen-values and eigenvectors, Cayley-Hamilton theorem, diagonalization of matrices, solutions of coupled linear ordinary differential equations, bilinear and quadratic forms, functions of a matrix. Partial Differential Equations: General solution of wave equation in 1 dimension, transverse vibrations of stretched strings, oscillations of hanging chain, wave equation in 2 and 3 dimensions, vibrations of rectangular and circular membranes, heat flow in one, two and three dimensions, rectangular systems of finite boundaries, temperature inside circular plate, Laplace equation in cartesian, cylindrical and spherical coordinate systems, problems of steady flow of heat in rectangular and circular plate.

References:

1. A. W. Joshi, Matrices and Tensors in Physics, New Age Int. Pub., 2014.
2. F. Ayres Jr., Matrices, McGraw-Hill 2010.
3. N. M. Kapoor, A Text Book of Differential Equations, Pitambar Publishing, 2010.
4. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publishers, 2012.
5. E. Kreyszig, Advanced Engineering Mathematics, Wiley Eastern, 2011.

PY1202: ELECTRICITY AND MAGNETISM [3 1 0 4]

Electric Field and Electric Potential: Electric field and lines, electric flux, Gauss's law, Gauss's law in differential form, calculation of E due to various charge distribution, electric potential difference and electric potential v, potential and electric field due to various charge distribution force and torque on a dipole, conductors in an electrostatic field, description of a system of charged conductors, an isolated conductor and capacitance, electrostatic energy due to various charge distribution. Electric Field in Matter: Dielectric Constant, parallel plate capacitor with a dielectric, polarization charges and polarization vector, electric susceptibility, Gauss's law in dielectrics, displacement vector d, relations between the three electric vectors, capacitors filled with dielectrics. Magnetic Effect of Currents: Magnetic field B, Magnetic force between current elements and definition of B, magnetic flux, Biot-Savart's law: calculation of B due to various charge distribution, magnetic dipole and its dipole moment, Ampere's circuital law, B due to a solenoid and a toroid, curl and divergence of B, vector potential. forces on an isolated moving charge, magnetic force on a current carrying wire, torque on a current loop in a uniform magnetic field, Gauss's law of magnetism, magnetic intensity (H), relation between B, M and H, stored magnetic energy in matter, B-H curve, Faraday's law, Lenz's law, self and mutual induction, single phase transformer, energy stored in a magnetic field, potential energy of a current loop. Ballistic Galvanometer: Current and charge sensitivity, electromagnetic damping, logarithmic damping, critical damping.

References:

1. D. J. Griffiths, Introduction to Electrodynamics, PHI learning, 2015.
2. E. M. Purcel, Electricity and Magnetism, Tata McGraw-Hill Education, 2011.
3. J. H. Fewkes, J. Yarwood, Electricity and Magnetism, Oxford University Press, 1991.
4. D. C. Tayal, Electricity and Magnetism, Himalaya Publishing House, 2014.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

PY1203: ANALOG SYSTEMS AND APPLICATIONS [3 1 0 4]

Network theorems: Fundamentals of AC and DC networks, Thevenin, Norton, superposition, maximum power transfer theorem. Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and mobility, drift velocity, p-n junction, barrier formation in p-n junction diode, static and dynamic resistance. Two-terminal Devices and their Applications: Rectifiers, half wave, full wave and bridge, ripple factor, Zener Diode and Voltage Regulation, Principle and structure of LEDs, Photodiode, tunnel diode, Solar Cell. Bipolar Junction transistors: n-p-n and p-n-p transistors, characteristics of CB, CE and CC configurations, current gains α and β, relations between α and β, load Line analysis, DC Load line and Q-point, active, cutoff, saturation region. Amplifiers: Transistor Biasing and Stabilization Circuits, fixed Bias and Voltage Divider Bias, Transistor as 2-port Network, h-parameter, Equivalent Circuit, analysis of a single-stage CE amplifier using Hybrid Model, input and output Impedance, current, voltage and power Gain, class A, B & C amplifiers, coupled amplifier, RC-coupled amplifier and its frequency response; Feedback in Amplifiers: effects of positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's criterion for self-sustained oscillations, RC Phase shift oscillator, determination of Frequency, Hartley & Colpitts oscillators. Operational Amplifiers and its Applications: Characteristics of an ideal and practical Op-Amp, open-loop and closed-loop gain, frequency response, CMRR, slew rate and concept of virtual ground, inverting and non-inverting amplifiers, adder, subtractor, differentiator, integrator, log amplifier, zero crossing detector Wein bridge oscillator. Three-terminal Devices (UJT and FETs): Characteristics and equivalent circuit of UJT and JFET, advantages of JFET, MOSFET.

References:

1. B. G. Streetman, S. Banerjee, Solid state electronic devices, Pearson Prentice Hall, 2015.
2. R. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, India, 2014.
3. A. B. Gupta, N. Islam, Solid State Physics and Electronics, Books & Allied Ltd, 2012
4. D. Chattopadhyay, P. C. Rakshit, Electronics: Fundamentals and Applications, New Age international (P) Ltd, 2018.
5. J. Millman, C. C. Halkias, Integrated Electronics, Tata McGraw-Hill, 2017.
6. A. P. Malvino, Electronic Principals, McGraw-Hill, 2015.

7. A. Mottershead, Electronic Circuits and Devices, PHI, 1997.
8. N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta, Basic Electronics and Linear Circuits, Tata Mc-Graw-Hill, 2012.

PY1230: ELECTRICITY AND MAGNETISM LAB [0 0 4 2]
To determine a low resistance by Carey Foster's bridge, to determine a low resistance by a potentiometer, to determine high resistance by leakage of a capacitor, to determine the charge sensitivity, current sensitivity, logarithmic decrement of Ballistic Galvanometer (B.G.), to determine the ratio of two capacitances by de Sauty's bridge, to determine the dielectric constant of a dielectric placed inside a parallel plate capacitor using a B.G., to determine self-inductance of a coil by Anderson's bridge using ac, to determine self-inductance of a coil by Rayleigh's method, to determine the mutual inductance of two coils by absolute method using a B.G., to study the response curve of a series and parallel LCR circuit and determine its resonant frequency, impedance at resonance and quality factor and band width.
References:
1. D. Chattopadhyay & P. C. Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, *BSc Practical Physics*, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, *Practical Physics*, New Age Publisher, 2006.
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi, 2000.
5. G. Sanon, *B. Sc. Practical Physics*, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, 2002.

PY1231: ANALOG SYSTEMS AND APPLICATIONS LAB [0 0 4 2]
Network theorems, rectifiers and filters, to design a semiconductor power supply of given rating using rectifiers and investigate the effect of filter, to study the forward and reverse characteristics of a Zener diode and its use as a voltage regulator, transistor characteristics and its application for amplification, to study the CE characteristics of a transistor and study the various transistor biasing configurations, to design a CE Amplifier of a given gain (mid-gain) using voltage divider bias, to study the frequency response of voltage gain of a RC-Coupled amplifier, to study the characteristics of a FET and design a common source amplifier, to investigate simple regulation and stabilization circuits using voltage regulator ICs, to design an inverting, non- inverting and differential amplifier using op-amp.
References:
1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

Third Semester

PY2101: THERMAL PHYSICS [3 1 0 4]
Thermodynamics: Thermodynamic equilibrium, Zeroth law of thermodynamics and concept of temperature, work and heat energy, state functions. Laws of Thermodynamics: First law of thermodynamics, differential form of first law, internal energy, first law and various processes, applications of first law, heat engines, Carnot cycle, carnot engine, second law of Thermodynamics-Kelvin-Planck and Clausius statements and their equivalence, Carnot Theorem. Applications of second law of thermodynamics: thermodynamic scale of temperature and its equivalence to perfect gas scale. Entropy: Change in entropy, entropy of a state, Clausius theorem, second law of thermodynamics in

terms of entropy, entropy of a perfect gas, entropy of the universe, entropy changes in reversible and irreversible processes, principle of increase of entropy. Impossibility of attainability of absolute zero: third law of thermodynamics, temperature-entropy diagrams, first and second order phase transitions. Thermodynamic Potentials: Extensive and Intensive thermodynamic variables, thermodynamic potentials U, H, F and G: their definitions, properties and applications, surface films and variation of surface tension with temperature, magnetic work, cooling due to adiabatic demagnetization, approach to absolute zero. Maxwell's Thermodynamic Relations: Derivations of maxwell's relations. Applications of maxwell's relations: Clausius-Clapeyron equation, Joule-Kelvin coefficient for ideal and Van der Waal gases. Kinetic Theory of Gases: Distribution of velocities, Maxwell-Boltzmann law of distribution of velocities in an ideal gas and its experimental verification, mean, RMS and most probable speeds, degrees of freedom, law of equipartition of energy, specific heats of gases, molecular collisions, mean free path, collision probability, estimates of mean free path. transport phenomenon in ideal gases: viscosity, thermal conductivity and diffusion, brownian motion and its significance; Real gases: Behavior of real gases, Van der Waal's equation of state for real gases, values of critical constants, Joule's experiment, free adiabatic expansion of a perfect gas, Joule-Thomson porous plug experiment, Joule-Thomson effect for real and Van der Waal gases, temperature of inversion, Joule-Thomson Cooling.

References:

1. M. W. Zemansky, R. Dittman, Heat and Thermodynamics, McGraw-Hill, 2017.
2. S. C. Garg, R. M. Bansal, C. K. Ghosh, Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, McGraw-Hill, 2017.
3. E. Fermi, Thermodynamics, Snow Ball Publications, 2010.
4. F. W. Sears, G. L. Salinger, Thermodynamics Kinetic Theory and Statistical Thermodynamics, Narosa Publications, 1998.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

PY2102: DIGITAL SYSTEMS AND APPLICATIONS [3 1 0 4]

Digital Circuits: Difference between analog and digital circuits, binary numbers, decimal to binary and binary to decimal conversion, AND, OR and NOT Gates, NAND AND NOR Gates, Exclusive OR and Exclusive NOR Gates. Boolean algebra: De Morgan's theorems, boolean laws, simplification of logic circuit using Boolean Algebra, Fundamental Products, Minterms and Maxterms, Conversion of a Truth Table into an Equivalent Logic Circuit by (1) sum of products method and (2) Karnaugh Map. Data processing circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders, Parity Checkers. Memories: Read-only memories, PROM, EPROM; Arithmetic Circuits: Binary addition, binary subtraction using 2's Complement method, half adders and full adders and subtractors. Sequential Circuits: RS, D, and JK flip-flops, level clocked and edge triggered flip-flops, preset and clear operations, race-around conditions in JK Flip-Flops, Master-Slave JK Flip-Flop. Timers: 555 Timer and its applications: astable and monostable multivibrator. Shift registers: Serial-in-serial-out, serial-in-parallel-out, parallel-in-serial-out, and parallel-in-parallel-out shift registers (only upto 4 bits). Counters: Asynchronous and synchronous counters, ring counters, decade counter. D/A and A/D conversion: D/A converter– resistive network, accuracy and resolution. Computer Organization: Input/Output Devices, Data storage (idea of RAM and ROM), computer memory, memory organization & addressing, memory interfacing. memory map. Intel 8085 Microprocessor Architecture: Main features of 8085, block diagram, components, pin-out diagram, buses, registers, ALU, memory, stack memory, timing control circuitry, timing states, instruction cycle, timing diagram of MOV and MVI.

References:

1. D. P. Leach, A. P. Malvino, G. Saha, Digital Principles and Applications, Tata McGraw-Hill, 2014.
2. T. L. Floyd, Digital Fundamentals, Pearson, 2009.
3. M. Mano, Digital Logic & Computer Design, Pearson Education India, 2016.
4. R. F. Coughlin & F. F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, PHI. 2009.
5. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson Education Asia, 2007.

PY2130: THERMAL PHYSICS LAB [0 0 4 2]

To determine J by Callender and Barne's constant flow method, to determine the coefficient of thermal conductivity of copper by Searle's apparatus, to determine the coefficient of thermal conductivity of copper by Angstrom's method, to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method, to determine the temperature coefficient of resistance by platinum resistance thermometer, to calibrate a resistance temperature device to measure temperature in a specified range using Null Method/Off-Balance Bridge with Galvanometer based measurement, to study the variation of Thermo-emf of a thermocouple with difference of temperature of its two junctions, to calibrate a thermocouple to measure temperature in a specified range using null method.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PY2131: DIGITAL SYSTEMS AND APPLICATIONS LAB [0 0 4 2]

To verify and design AND, OR, NOT and XOR gates using NAND gates, to design a combinational logic system for a specified truth table, to convert a Boolean expression into logic gate circuit and assemble it using logic gate ICs, to minimize a given logic circuit, to study TTL ICs of Binary Decoder, 7-segment decoder, and Schmit Trigger, to design a seven-segment display driver, half adder, full adder and 4-bit binary adder, half subtractor, full subtractor, adder-subtractor using full adder I.C., to build flip-flop circuits using elementary gates (RS, Clocked RS, D-type, and JK Flip-Flop), to build a 4-bit Counter using D-type/JK Flip-Flop, to make a shift register from D-type/JK Flip-Flop, serial and parallel shifting of data.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

Fourth Semester

PY2201: MATHEMATICAL PHYSICS-II [3 1 0 4]

Vector Calculus: Vector differentiation: - scalar and vector fields, gradient of a scalar field, divergence and curl of a vector field, del and Laplacian operators, vector identities, vector integration, line, surface and volume integrals, flux of a vector field, Gauss' divergence theorem, Green's theorem and Stokes theorem. Orthogonal Curvilinear Coordinates: cartesian, spherical and cylindrical coordinate systems. Multiple Integrals: Double and triple integrals, change of order of integration, change of variables and Jacobian. Some Special Integrals: Beta and Gamma functions and relation between them, error function (probability integral); Fourier series: Fourier series, Dirichlet conditions (statement only), Kronecker's method for computation of Fourier coefficients, even and odd functions, sine and cosine series; Tensors: Transformation of Co-ordinates, Einstein's summation convention, relation between direction cosines, algebra of tensors, sum, difference and product of two tensors, contraction, quotient law of tensors, symmetric and anti-symmetric tensors, pseudo-tensors, invariant tensors, Kronecker and alternating tensors, association of antisymmetric tensor of order two.

References:

1. M. R. Spiegel, Vector Analysis, McGraw-Hill, 2009.
2. A.W. Joshi, Matrices and Tensors in Physics, New Age International Publications, 1995.
3. C. Harper, Introduction to Mathematical Physics, Prentice-Hall of India Pvt. Ltd, 1995.
4. E. Kreyszig, Advanced Engineering Mathematics, Wiley, 2015.
5. H. K. Dass, R. Verma, Mathematical Physics, S. Chand, 2012.
6. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2010.

PY2202: QUANTUM PHYSICS AND QUANTUM MECHANICS [3 1 0 4]

Particles and Waves: Inadequacies in classical physics, blackbody radiation, photoelectric effect, Compton effect, Franck-Hertz experiment, wave nature of matter, wave packets, group and phase velocities, two-slit experiment with electrons, probability, wave functions, Heisenberg's uncertainty principle, derivation from wave packets, γ-ray microscope. Quantum Mechanics: Basic postulates and formalism, energy, momentum and Hamiltonian operators, time-independent Schrödinger wave equation for stationary states, conditions for physical acceptability of wave functions, expectation values, wave function of a free particle. Applications of Schrödinger Wave Equation: Eigen functions and eigenvalues for a particle in a one dimensional box. bound state problems: general features of a bound particle system, (1) one dimensional simple harmonic oscillator, scattering problems in one dimension: (1) finite potential step: reflection and transmission, stationary solutions, probability current, attractive and repulsive potential barriers (2) quantum phenomenon of tunneling: tunnel effect, tunnel diode (qualitative description) (3) finite potential well (square well). Operators in Quantum Mechanics: Hermitian operator, commutator brackets-simultaneous Eigen functions, commutator algebra, commutator brackets using position, momentum and angular momentum operator, concept of parity, parity operator and its Eigen values.

References:

1. A. Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Laxmi Publications, 2016.
2. D. J. Griffith, Introduction to Quantum Mechanics, Pearson Education, 2015.
3. L. I. Schiff, J. Bandhyopadhyay, Quantum Mechanics, McGraw-Hill Book, 2010.
4. E. Merzbacher, Quantum Mechanics, John Wiley & Sons, Inc, 2007.
5. J. L. Powell, B. Crasemann, Quantum Mechanics, Addison-Wesley Pubs. Co., 2010.
6. E. M. Lifshitz, L. D. Landau, Quantum Mechanics: Non-Relativistic Theory, Butterworth-Heinemann, 2009.

PY2203: ELECTROMAGNETIC THEORY [3 1 0 4]

Maxwell's Equations: Maxwell equations, displacement current, vector and scalar potentials, Lorentz and Coulomb gauge, boundary conditions at interface between different media, Poynting theorem and Poynting vector, electromagnetic energy density, physical concept of electromagnetic field energy density, momentum density and angular momentum density. Reflection and Refraction of Electromagnetic Waves: Reflection and refraction of a plane wave, Fresnel formulae, total internal reflection, Brewster's angle, waves in conducting media, skin depth, Maxwell's equations in microscopic media (plasma), characteristic plasma frequency, refractive index, conductivity of an ionized gas, propagation of e.m. waves in ionosphere. Polarization of Electromagnetic Waves: Description of linear, circular and elliptical polarization, propagation of EM waves in anisotropic media, symmetric nature of dielectric tensor, Fresnel's formula, uniaxial and biaxial crystals, double refraction, polarization by double refraction, Nicol prism, production and detection of plane, circularly and elliptically polarized light, phase retardation babinet compensator and its uses, Biot's sevart Laws for rotatory polarization, Fresnel's theory of optical rotation, calculation of angle of rotation, specific rotation, Laurent's half-shade polarimeter. Optical Fibers: Numerical aperture, step and graded indices, single and multiple mode fibers.

References:

1. D. J. Griffith, Introduction to Electrodynamics, Pearson Education India Learning, 2015.
2. M. N. O. Sadiku, S. V. Kulkarni, Elements of Electromagnetics, Oxford University Press, 2015.
3. J. D. Jackson, Classical Electrodynamics, Wiley, 2007.
4. L. D. Landau, M. Lifshitz, Classical Theory of Fields, Butterworth-Heinemann, 1987.
5. T. L. Chow, Introduction to Electromagnetic Theory, Jones & Bartlett Learning, 2005

PY2204: CLASSICAL MECHANICS [3 1 0 4]

System of Particles: Centre of mass, total angular momentum and total kinetic energies of a system of particles, conservation of linear momentum, energy and angular momentum. Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized co-ordinates, example of a disk rolling on the horizontal plane, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind, uniqueness of the Lagrangian, Simple applications of the Lagrangian formulation, Single free particle in Cartesian Co-ordinates, Plane polar co-ordinates, Atwood's machine, A bead sliding on a uniformly rotating wire in a force-free space, motion of block attached to a spring, Simple Pendulum, symmetries of space and time, conservation of linear momentum energy and angular momentum; Hamiltonian formalism: Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equation of motion, Examples of the Hamilton of a particle in a central force field, the simple harmonic oscillator, Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle. Central forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem; Scattering in a central force field: General description of scattering, cross-section, impact parameter, Rutherford scattering, center of mass and laboratory co-ordinate systems, their transformations of the scattering angle and cross-section.

References:

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, Pearson Education, 2011.
2. N. C. Rana, P. S. Joag, Classical Mechanics, McGraw-Hill. 2017.
3. R. G. Takwale, P.S. Puranic, Classical mechanics, McGraw-Hill. 2017.
4. S. N. Biswas, Classical Mechanics, Books & Allied Ltd, 2000.
5. pA. Ray Choudhary, Classical Mechanics, Oxford University Press, 1983.
6. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 2017.

PY2230: MODERN PHYSICS LAB [0 0 4 2]

To determine the value of Boltzmann constant by studying forward characteristics of a diode, to determine the value of Planck's constant by using a photoelectric cell, to determine the value of Planck's Constant by using LEDs of at least 4 different wavelengths, to determine the value of e/m by bar magnet, to determine the wavelength and the angular spread of a He-Ne laser, to determine the value of Stefan's constant, to determine the wavelength and the velocity of ultrasonic waves in a liquid by studying the diffraction of light through an ultrasonic grating, to study the characteristics of a photo-diode.

R**eferences:**

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PY2231: ELECTROMAGNETIC LAB [0 0 4 2]

To verify the law of Malus for plane polarized light, to determine the specific rotation of sugar solution using Polarimeter, to analyze elliptically polarized light by using a Babinet's compensator, to study dependence of radiation on angle for a simple dipole antenna, to determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating, to study the reflection, refraction of microwaves, to study polarization and double slit interference in microwaves, to determine the refractive index of liquid by total internal reflection using Wollaston's air-film, to determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece, to study the polarization of light by reflection and determine the polarizing angle for air-glass interface.

References:
1. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

Fifth Semester

PY3101: ATOMIC AND MOLECULAR PHYSICS [3 1 0 4]
Emission and absorption spectra of X-rays: Bohr's atomic model, ionizing power, critical potentials, X-Rays-Spectra, continuous and characteristic X-rays, Moseley Law. Atoms in Electric and Magnetic Fields: Electron angular momentum, space quantization, electron spin and spin angular momentum, Larmor's theorem, spin magnetic moment, Stern-Gerlach experiment. Zeeman Effect: electron magnetic moment and magnetic energy, gyromagnetic ratio and Bohr magneton. Atoms in External Magnetic Fields: Normal and anomalous Zeeman effect, Paschen back and Stark effect, Pauli's exclusion principle, fine structure, spin-orbit coupling, spectral notations for atomic states, total angular momentum, vector model, L-S and J-J couplings, Hund's rule, term symbols, spectra of hydrogen. Molecular Spectra: Rotational energy levels, selection rules and pure rotational spectra of a molecule, vibrational energy levels, selection rules and vibration spectra. Raman Effect: Quantum theory of Raman Effect, Characteristics of Raman Lines, Stoke's and Anti-Stoke's Lines, complimentary character of Raman and infrared Spectra. Lasers: Einstein's A and B coefficients, metastable states, spontaneous and stimulated emissions, optical pumping and population inversion, three-level and four-level lasers, Ruby laser and He-Ne laser, semiconductor laser.
References:
1. J. B. Rajam, Atomic Physics, S. Chand, 2008.
2. B. H. Bransden, J. C. Joachein, Physics of Atoms and Molecules, Prentice Hall India 2003.
3. C. N. Banwell, E. M. McCash, Molecular Spectroscopy, McGraw-Hill 2017.
4. A. Beiser, Concepts of Modern Physics, Tata McGraw-Hill, 2015.
5. J. H. Fewkes, J. Yarwood, Atomic Physics. Oxford University Press, 1991.
6. Raj Kumar, Atomic and Molecular Spectra: Laser, Kedarnath Ram Nath publication, 2007.

PY3102: SOLID STATE PHYSICS [3 1 0 4]
Crystal Structure: Solids, amorphous and crystalline materials, lattice translation vectors, primitive unit cell, symmetry operations, different types of lattices, Bravais lattices, Miller indices, SC, BCC and FCC structures, lattice with a basis, unit cell, reciprocal lattice, Brillouin Zones. X-Ray Diffraction Technique: Introduction, crystal as a grating, Bragg's law and Bragg's diffraction condition, Ewald's construction, Debye Scherrer method, analysis of cubic structure by powder. Elementary Lattice Dynamics: Lattice vibrations and phonons, linear monoatomic and diatomic chains, acoustical and optical phonons, qualitative description of the phonon spectrum in solids, Einstein and Debye theories of specific heat of solids, T_3 Law. Electrical Properties of Materials: Band theory of solids, Bloch theorem, Kronig-Penney Model, effective mass of electron, concept of holes, band gaps, energy band diagram, law of mass action, insulators, and semiconductors. Magnetic Properties of Matter: Dia-, Para-, Ferri- and ferromagnetic materials, classical Langevin theory of dia– and paramagnetic domains, Curie's law, Weiss's theory of ferromagnetism and ferromagnetic domains, B-H curve, hysteresis and energy loss, Curie temperature. Dielectric Properties of Materials: Polarization, local electric field at an atom, depolarization field, dielectric constant, electric susceptibility, polarizability, classical theory of electric polarizability, Clausius-Mosotti equation, normal and anomalous dispersion, complex dielectric constant. Superconductivity: Experimental results, critical temperature, critical magnetic field, Meissner effect, Type-I, Type-II superconductors, London's equation and penetration depth, isotope effect, idea of BCS theory, Cooper Pair and coherence length, Josephson effect.

References:
1. C. Kittel, Introduction to Solid State Physics, John Wiley, 2016.
2. A. J. Dekkar, Solid State Physics, Laxmi Publications, 2008.
3. S. O. Pillai, Solid State Physics, New Age International; Eighth edition, 2018.
4. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson Education, 2015.
5. N. W. Ascroft, N. D. Mermin, Solid State Physics, Harcourt Asia, 2003

PY3130: ATOMIC AND MOLECULAR PHYSICS LAB [0 0 4 2]
Interpretation of XRD data, to determine the wavelengths of hydrogen spectrum and hence to determine the value of Rydberg's Constant, to determine the Wavelength of H-alpha emission line of hydrogen atom, to determine the absorption lines in the rotational spectrum of iodine vapour, to determine wavelength of neon spectra, to determine wavelength of mercury spectra, to study of splitting of spectral lines in magnetic field, interpretation of recorded IR spectra, interpretation of recorded FTIR spectra, interpretation of recorded UV-Vis spectra.
References:
1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PY3131: SOLID STATE PHYSICS LAB [0 0 4 2]
To measure the field strength B and its variation in a Solenoid (Determination of dB/dx), to draw the B-H curve of iron by using a Solenoid and to determine the energy loss due to Hysteresis, to measure the Resistivity of a Ge Crystal with Temperature by Four-Probe Method (from room temperature to 200^0C) and to determine the Band Gap E_g, to determine the Hall Coefficient and the Hall angle of a semiconductor, to study the PE Hysteresis loop of a ferroelectric crystal, to measure the magnetic susceptibility of solids and liquids, to determine the characteristics of p-n junction of a solar cell, to determine the coupling coefficient of a piezoelectric crystal.
References:
1. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

Sixth Semester

PY3201: NUCLEAR & PARTICLE PHYSICS [3 1 0 4]
Structure of Nuclei: Basic properties of nuclei, mass, radii, charge, angular momentum, spin, magnetic moment (μ), stability, binding energy. Radioactivity: Law of radioactive decay, half-life, theory of successive radioactive transformations, radioactive series, binding energy, mass formula. α-decay, range of α-particles, Geiger-Nuttal law and α-particle spectra, Gamow theory of alpha decay, β-decay, energy spectra and Neutrino hypothesis, γ-decay, Origin of γ-rays, nuclear isomerism and internal conversion; Nuclear Reactions: Types of reactions and conservation laws, concept of compound and direct reaction, compound nucleus, fission and fusion; Nuclear Models: Liquid drop model, mass

formula, Shell model, Meson theory of nuclear forces and discovery of Pion; Accelerators: Van de Graaff generator, linear accelerator, cyclotron, betatron, and light and heavy ion synchro-cyclotron, idea of large hadron collider; Detectors of Nuclear Radiations: Interaction of energetic particles with matter, ionization chamber, GM Counter, cloud chambers, Wilson cloud chamber, bubble chamber, scintillation detectors, semiconductor detectors, detectors used in large hadron collider; Elementary Particles: Fundamental interactions, classification of elementary particles, particles and antiparticles, Baryons, Hyperons, Leptons, and Mesons, elementary particle quantum numbers, Baryon Number, Lepton Number, strangeness, electric charge, hypercharge and isospin. supermultiplets of Mesons and Baryons, conservation laws and symmetry, different types of Quarks and Quark- Contents of Spin ½ Baryons, photons, gravitons, gluons, charms and intermediate vector bosons, idea of standard model, Higg's Boson and Baryons.

References:

1. S. N. Ghoshal, Nuclear Physics, S. Chand, 2010.
2. I. Kaplan, Nuclear Physics, Narosa Publications, 2002.
3. D. C. Tayal, Nuclear Physics, Himalaya Publishing House, 2005.
4. A. Beiser, S. Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill, 2017.
5. B. L Cohen, Concepts of Nuclear Physics, McGraw-Hill, 2017.
6. D. J. Griffith, Introduction to Elementary Particle Physics, Wiley-VCH, 2008.

PY3202: CLASSICAL DYNAMICS [3 1 0 4]

Classical Mechanics of Point Particles: Generalized coordinates and velocities, Hamilton's Principle, Lagrangian and Euler-Lagrange equations, applications to simple systems such as coupled oscillators, Canonical momenta & Hamiltonian, Hamilton's equations of motion, applications in Hamiltonian for a harmonic oscillator, particle in a central force field, Poisson brackets, Canonical transformations. Special Theory of Relativity: Postulates of Special Theory of Relativity, Lorentz Transformations, Minkowski space, the invariant interval, light cone and world lines, Space-time diagrams, Time-dilation, length contraction & twin paradox. Four-vectors: space-like, time-like & light-like, Four-velocity and acceleration, Metric and alternating tensors, Four-momentum and energy-momentum relation, Doppler Effect from a four vector perspective, concept of four-force, conservation of four-momentum.

References:

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, Pearson Education, 2011.
2. N. C. Rana, P. S. Joag, Classical Mechanics, McGraw-Hill. 2017.
3. R. G. Takwale, P.S. Puranic, Classical mechanics, McGraw-Hill. 2017.
4. S. N. Biswas, Classical Mechanics, Books & Allied Ltd, 2000.
5. A. Raychoudhary, Classical Mechanics, Oxford University Press, 1983.
6. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 2017.

PY3230: NUCLEAR PHYSICS LAB [0 0 4 2]

Study of the characteristics of GM tube by single source method, to plot plateau region, to calculate % slope, to determine plateau length, to determine operating voltage, to study the nuclear counting statistics, to determine the standard deviation and the variance, to illustrate that the number of counts recorded being high, Poisson's distribution follows closely normal or Gaussian distribution, characteristics of scintillation counter.

References:

1. S. N. Ghoshal, Nuclear Physics, S. Chand, 2010.
2. I. Kaplan, Nuclear Physics, Narosa Publications, 2002.
3. D. C. Tayal, Nuclear Physics, Himalaya Publishing House, 2005.
4. A. Beiser, S. Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill, 2017.
5. L Cohen, Concepts of Nuclear Physics, McGraw-Hill, 2017.
6. J. Griffith, Introduction to Elementary Particle Physics, Wiley-VCH, 2008.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

DSE – I

PY2250: SEMICONDUCTOR OPTOELECTRONICS [3 1 0 4]
Elemental and compound semiconductors. Epitaxy of Semiconductors: bulk and epitaxial semiconductor growth techniques and their comparison. Semiconductor Physics: Introduction to basic physics of semiconductors, carrier transport phenomena, introduction to schottky barrier, ohmic contacts and P-N junction, overview of the factors affecting the optical and electronic properties of semiconductors (carrier scattering, non-radiative recombination, defect levels), semiconductor quantum structures (QWs and QDs). Characterisation: electrical and optical characterization of semiconductor materials and nanostructures (CV, PL, Hall, I-V, EL etc.). Devices: semiconductor optoelectronic devices (LED, photodetector, lasers, solar cells) with a special focus on the application of nanostructures in optoelectronics.

References:

1. P. Bhattacharya, Semiconductor optoelectronic Devices; Pearson, 2017.
2. B. Streetman, S. Banerjee, Solid State Electronic Devices, PHI, 2014.
3. P. Y. Yu, M Cardona, Fundamentals of Semiconductors, Springer, 2010.
4. D. K. Schroder, Semiconductor Material and Device Characterization, Wiley, 2015.

PY2251: FUSION ENERGY [3 1 0 4]
Sources of Energy: Fission and fusion, need for plasma, Lawson criterion, confinement problem, laser driven fusion, magnetic confinement, plasma concept, single particle motions in complex magnetic field geometries, equilibrium and stability, cross field transport, important heating schemes, Tokamak and magnetic mirror, reactor concepts, current status. Advanced fusion Energy: Tokamak confinement Physics, Particle motions in a tokamak, Toroidal equilibrium, Toroidal stability, High-beta Tokamak, experimental observations, fusion technology, commercial Tokamak fusion-power plant, tandem-mirror fusion power plant, other fusion reactors concepts, inertial confinement fusion reactors, reactor cavity, hybrid fusion/fission systems, process heat and synthetic fuel production. Plasma dynamics: Ponderomotive force, laser–plasma interaction, terahertz radiation generation, plasma based processing of materials plasma fluid equations, single particle motions, unmagnetized and magnetized plasma dynamics.

References:

1. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Plenum Press, 1983.
2. W. L. Kruer, The Physics of Laser Plasma Interaction, Addision-Weseley, 1988.
3. H. Hagler and M. Kristiansen, Introduction to Controlled Thermonuclear Fusion, Lexington, 1977.
4. T. H. Stix, The Theory of Plasma Waves, McGraw-Hill, 19624.
5. pA. Simon and W. B. Thompson, Advances in Plasma Physics, John Wiley and Sons, 1976.
6. W. M. Stacey, Fusion: An Introduction to the physics and technology of magnetic Confinement Fusion, Wiley-VCH Publication, 2010.
7. K. Miyamoto, Plasma Physics for Nuclear Fusion, MIT Press, 1980.

DSE – II

PY3150: NANO MATERIALS AND APPLICATIONS [2 1 0 3]
Nanoscale systems: Length scales in physics, nanostructures, 1d, 2d and 3d nanostructures, band structure and density of states of materials at nanoscale, size effects in nano systems, quantum confinement, applications of Schrödinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3d, 2d, 1d nanostructures and its consequences. Synthesis of Nanostructure Materials: Top down and bottom up approach, photolithography, ball milling, gas phase condensation, physical vapor deposition, thermal evaporation, e-beam evaporation, pulsed laser deposition, chemical vapor deposition (CVD), sol-gel, electro deposition, spray pyrolysis, hydrothermal synthesis, preparation through colloidal methods, molecular beam epitaxy. Characterization: x-ray

diffraction, optical microscope, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy. Optical Properties: Coulomb interaction in nanostructures, concept of dielectric constant for nanostructures and charging of nanostructure, quasi-particles and excitons. excitons in direct and indirect band gap semiconductor nanocrystals, quantitative treatment of quasi-particles and excitons, charging effects; Radiative Processes: general formalization-absorption, emission and luminescence, optical properties of heterostrctures and nanostructures. Electron Transport: carrier transport in nanostrcutures, coulomb blockade effect, thermionic emission, tunneling and hoping conductivity, defects and impurities, deep level and surface defects. Applications: applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices, single electron devices. CNT based transistors.

References:

1. C. P. Poole, Jr., F. J. Owens, Introduction to Nanotechnology, Wiley 2016.
2. S. K. Kulkarni, Nanotechnology: Principles & Practices, Capital Publishing Company, 2000.
3. K. K. Chattopadhyay, A. N. Banerjee, Introduction to Nanoscience and Technology, PHI Learning Private Limited 2005.
4. R. Booker, E. Boysen, Nanotechnology, John Wiley, 2000.
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook, Elsevier, 2007.
6. B. Bhushan, Springer Handbook of Nanotechnology, Springer-Verlag, 2004.

PY3151: LOW TEMPERATURE PHYSICS [2 1 0 3]

Production of Low Temperature Introduction, Joule Thomson effect, regenerative cooling, vacuum pumps, liquefaction of air, hydrogen, helium, maintenance of low temperature, production of temperature below 1 K, adiabatic demagnetization, evaporative cooling of He-3, dilution refrigeration, laser cooling nuclear demagnetization, Measurement of Low Temperature The gas thermometer and its corrections, secondary thermometers, resistance thermometers, thermocouples, vapour pressure thermometers- magnetic thermometers; Liquid and Solid Cryogens: liquid nitrogen, liquid oxygen, liquid hydrogen, liquid he -4 and he -3, solid he– 4 and he -3, lamda point, superfluidity, density, compressibility factor viscosity and thermal properties, velocity of sound in liquid helium. Electrical and Magnetic Properties: experimental observations, theories of Sommerfield and block, superconductivity, magnetic properties of superconductors, thermal properties of superconductors, penetration depth and high frequency resistance, ferromagnetism, diamagnetism, paramagnetism, paramagnetic saturation, Specific Heats, Spectroscopic And Hyperfine Properties specific heats, rotational specific heat of hydrogen, Einstein’s and Debye’s theories, Schottky effect, anomalies in specific heats at low temperature, infrared, visible spectra, Zeeman spectra at low temperature.

References:

1. C. Jacobus Gorter, D. F. Brewer, Progress in Low Temperature Physics, Elsevier Ltd, 2011.
2. E. Christian and Siegfried H, Low Temperature Physics, Springer, 2010.
3. J. Ekin, Experimental Techniques for Low-Temperature Measurements, OUP Oxford, 2006.
4. C. P. Poole Jr., H. A. Farach, R. J. Creswick, R. Prozorov, Superconductivity, Elsevier, 2007.
5. J. Wilks, Properties of Liquid and Solid Helium, Oxford University Press, 2007.
6. L. C. Jackson, Low Temperature Physics, Methuen and Company, 2002.

DSE – III

PY3152: THIN FILM TECHNOLOGY [2 1 0 3]

Thin film deposition techniques: Basics of vacuum science, creation of vacuum, Deposition of thin film by various PVD techniques such as evaporation, sputtering, MBE as well as chemical coating methods (CVD and ALD), Plasma technologies for thin films, Nucleation, growth and microstructural evolution during thin film formation: Fundamental physical and chemical processes, Effect of the substrate on the film growth and techniques for surface modification, Models for nucleation and film growth, morphology and texture and their impact on material properties. Thin film characterization: XRD, XRR, AFM, MFM and TEM techniques. Properties and applications of thin film materials: mechanical, electrical, magnetic and optical properties of films, applications in information storage, integrated circuits, micro-electromechanical systems, optoelectronics and photovoltaics.

References:

1. M. Ohring, The materials science of thin films- Deposition and Structure, Elsevier 2012.
2. A. Goswami, Thin Film Fundamentals, New Age International, 2010.
3. K. Seshan, Handbook of Thin Film Deposition, William Andrew, 2012.
4. K. L. Chopra, Thin Film Phenomena, McGraw-Hill Inc., 1995.
5. L. I. Maissel, R. Glang, Handbook of Thin Film Technology, McGraw-Hill, 1970.

PY3153: ADVANCED MATHEMATICAL PHYSICS [2 1 0 3]

Complex Analysis: Brief revision of complex numbers and their graphical representation, Euler's formula, De Moivre's theorem, roots of complex numbers, functions of complex variables. Analyticity and Cauchy-Riemann Conditions, examples of analytic functions, singular functions: poles and branch points, order of singularity, branch cuts, integration of a function of a complex variable. Cauchy's Inequality, Cauchy's Integral formula, simply and multiply connected region, Laurent and Taylor's expansion. Residues and Residue Theorem, Application in solving Definite Integrals. Integrals Transforms: Fourier Transforms, Fourier Integral theorem, Fourier Transform, Examples, Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms, three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations; Laplace Transforms: Laplace Transform (LT) of elementary functions. Properties of LTs, change of scale theorem, shifting theorem. LTs of 1st and 2nd order derivatives and integrals of functions. LT of unit step function, Dirac delta function, periodic functions, convolution theorem, inverse lt. application of Laplace transforms to 2nd order differential equations: damped harmonic oscillator, simple electrical circuits, coupled differential equations of 1st order.

References:

1. G. B. Arfken, H.J. Weber, F. E. Harris, Mathematical Methods for Physicist, Elsevier, 2015.
2. H. K. Dass, R. Verma, Mathematical Physics, S. Chand, 2018.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2016.
4. M. L. Boas, Mathematical Methods in the Physical Sciences, Wiely, 2006.

DSE - IV

PY3250: STATISTICAL MECHANICS [2 1 0 3]

Classical Statistics: Entropy and thermodynamic probability, Maxwell-Boltzmann distribution law, ensemble concept, partition function, thermodynamic functions of finite number of energy levels, negative temperature, thermodynamic functions of an ideal gas, classical entropy expression, Gibbs Paradox, law of equipartition of energy–applications to specific heat and its limitations. Classical Theory of Radiation: Properties of thermal radiation, blackbody radiation, pure temperature dependence, Kirchhoff's Law, Stefan-Boltzmann law and Wien's displacement law, Saha's ionization formula. quantum theory of radiation, Bose-Einstein statistics, Application to radiation – Planck's law, Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a Completely Degenerate Bose Gas, Bose-Einstein condensation, properties of liquid He (qualitative description), Radiation as photon gas, Bose's derivation of Planck's law. Fermi-Dirac Statistics: Fermi-Dirac distribution law, thermodynamic functions of an ideal completely degenerate Fermi gas, Fermi energy, electron gas in a metal, specific heat of metals, white dwarf stars, Chandrasekhar mass limit.

References:

1. F. Reif, Statistical Physics: Berkeley Physics Course, Vol.5, McGraw-Hill, 2017.
2. B. B. Laud, Fundamentals of Statistical Mechanics, New Age Publisher, 2014.
3. B. K. Agarwal, M. Eisner, Statistical Mechanics, New Age Publisher, 2007.

4. B. Lal, N. Subrahmanyan, P. S. Hemne, Heat Thermodynamics and Statistical Physics, S. Chand, 2017.
5. K. Huang, Statistical Mechanics, Wiley, 1987.
6. R. K. Pathria, P. D. Beale, Statistical Mechanics, Academic Press, 2011.

DSE – V

PY3251: INTRODUCTION TO ASTROPHYSICS [2 1 0 3]

Astronomical Scales: Astronomical distance, mass and time, radiant flux and luminosity, measurement of astronomical quantities, basic concepts of positional astronomy: celestial sphere, geometry of a sphere, astronomical coordinate systems, geographical coordinate systems, horizon system, equatorial system, diurnal motion of the stars, conversion of coordinates, measurement of time, sidereal time, apparent solar time, mean solar time, equation of time, calendar. basic parameters of stars: determination of distance by parallax method; brightness, radiant flux and luminosity, apparent and absolute magnitude scale, distance modulus, determination of temperature and radius of a star, determination of masses from binary orbits, Stellar spectral classification. The Sun: Solar parameters, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, basics of solar magneto-hydrodynamics, helioseismology. solar system: facts and figures, origin of the solar system, The Nebular Model, tidal forces and planetary rings, extra-solar planets, stellar spectra and classification structure, atomic spectra revisited, stellar spectra, spectral types and their temperature dependence, black body approximation, H R diagram, luminosity classification. The Milky way: Basic structure and properties of the milky way, nature of rotation of the milky way, star clusters of the milky way, properties of and around the galactic nucleus. Galaxies: Galaxy morphology, Hubble's classification of galaxies, elliptical galaxies, spiral and lenticular galaxies.

References:

1. K.D. Abhyankar, Astrophysics: Stars and Galaxies, Universities Press, India 2001.
2. V.B. Bhatia, Astronomy and Astrophysics with elements of cosmology, Narosa Publication, India 2001.
3. B. Basu, An introduction to Astrophysics, Prentice Hall of India Private limited, India, 2001.
4. M. Zeilik and S.A. Gregory, Introductory Astronomy and Astrophysics, Saunders College Publishing, 1997.
5. H. Karttunen, Fundamental of Astronomy, Springer 2007.
6. K.S. Krishnasamy, Astro Physics a modern perspective, Reprint, New Age International (p) Ltd, New Delhi, 2002.
7. B.W. Carroll & D.A. Ostlie, Modern Astrophysics, Addison-Wesley Publishing Co, 2006.

PY3252: PHYSICS OF DIAGNOSTIC & THERAPEUTIC SYSTEMS [2 1 0 3]

X-rays: Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung- Characteristic x-ray, X-ray tubes, Coolidge tube, rotating anode x-ray tube, quality and intensity of x-ray, X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, high frequency generator, exposure time, HT cables. Radiation Physics: Radiation units, exposure, absorbed dose, units, rad, gray, relative biological effectiveness, effective dose, interaction of radiation with matter, radiation detectors Geiger counter, Scintillation counter, dosimeters, survey methods, area monitors, TLD and semiconductor detectors. Medical Imaging Physics: X-ray diagnostics and imaging, physics of nuclear magnetic resonance (NMR), NMR imaging, MRI radiological imaging, radiography, fluoroscopy, computed tomography scanner, mammography. Ultrasound imaging, magnetic resonance imaging, thyroid uptake system. Radiation Therapy Physics: Radiotherapy, deep therapy machines, medical linear accelerator, basics of teletherapy units, Telecobalt units, medical linear accelerator, radiation protection, external beam characteristics, percentage depth dose, tissue-air ratio, back scatter factor. Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, radioisotope imaging equipment, single photon and positron emission tomography, therapeutic nuclear medicine.

References:

1. K. Thayalan, Basic Radiological Physics, Jayapee Brothers Medical Publishing, 2003
2. F M Khan, Physics of Radiation Therapy, Williams and Wilkins publishing, 2003
3. J. R. Cameron & J.G. Skofronick, Medical Physics, Wiley, 2007.
4. J. T. Bushberg., J. A. Seibert, E. M. Leidholdt Jr, J. M. Boone, The Essential Physics of Medical Imaging, Lippincott Williams & Wilkins, 2013

SKILL ENHANCEMENT COURSES (SEC)

PY2140: BASIC INSTRUMENTATION SKILLS [2 0 0 2]

Basics of Measurements: Screw gauge, Vernier calipers, Travelling microscope, optical labelling, mechanical labelling, Instruments accuracy, Errors in measurements. Multimeter: Measurement of dc and ac voltage current, Electronic Voltmeter: Advantage over conventional multimeter, Principles of voltage measurement (block diagram only), Specifications of an electronic Voltmeter/Multimeter. AC millivoltmeter: Type of AC millivoltmeters, Amplifier-rectifier, and rectifier-amplifier. Cathode Ray Oscilloscope: Block diagram, construction and working principle. Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. Impedance Bridges & Q-Meters: Block diagram of bridge, working principles of basic, RLC bridge, Block diagram and working principles of a Q- Meter, Digital LCR bridges. Digital Instruments: Principle and working of digital meters, comparison of analog & digital instruments. Digital Multimeter: Block diagram and working of a digital multimeter. Hands on Training: CRO as a versatile measuring device, Use of digital multimeter/VTVM for measuring voltages, circuit tracing of laboratory electronic equipment, winding a coil/transformer, trouble shooting a circuit, balancing of bridges.

References:

1. B. L. Thereja, A text book in Electrical Technology, S Chand, 2010.
2. Venugopal, Digital Circuits and systems, Tata McGraw-Hill, 2011.
3. S. Ghoshal, Digital Electronics, Cengage Learning, 2012.
4. S. Salivahanan, N. S. Kumar, Electronic Devices and circuits, Tata McGraw-Hill, 2012.
5. U. Tietze, Ch. Schenk, Electronic circuits: Handbook of design and applications, Springer, 2008.

PY2141: RENEWABLE ENERGY AND ENERGY HARVESTING [2 0 0 2]

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, need and characteristics of photovoltaic (PV) systems. Wind Energy harvesting: Fundamentals of wind energy, wind turbines and different electrical machines in wind turbines. Ocean Energy: Ocean Energy Potential against Wind and Solar, Tide Energy Technologies, Ocean Thermal Energy, Bio-mass. Geothermal Energy: Geothermal resources, geothermal technologies; Hydro Energy: Hydropower resources, hydropower technologies. Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect; Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications Carbon captured technologies, cell, batteries, power consumption Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments

1. Demonstration of training modules on solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

References:

1. G. D. Rai, Non-conventional energy sources, Khanna Publishers, 2011.
2. M. P. Agarwal, Solar Energy, S. Chand, 1998.
3. G. Boyle, Renewable Energy, Power for a sustainable future, Oxford University Press, 2004.

4. S. P. Sukhative, Solar Energy, Tata McGraw-Hill, 2005.
5. H. Lund, Renewable Energy Systems, Academic Press, 2014.

PY2142: COMPUTATIONAL PHYSICS [2 0 0 2]
Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor, fundamental Linux Commands. Basics of C Programming: fundamental commands to solve basic physics problems. Scientific word processing: Introduction to LaTeX, TeX/LaTeX word processor, preparing a basic LaTeX file, document classes, preparing an input file for LaTeX, compiling LaTeX File. Equation representation: Formulae and equations, figures and other floating bodies. Visualization: Introduction to graphical analysis and its limitations, introduction to graphical software.
References:
1. E. Balaguruswami, Computer Concepts and Programming in C, McGraw Hill Education, 2011.
2. S. Das, Unix Concepts and Applications, McGraw-Hill 2017.
3. S. Kottwitz, LaTeX Beginner's Guide, Packt Publication, 2010.
4. B. W. Kernighan, D. Ritchie, The C Programming Language, Pearson Education India, 2015.
5. U. M. Ascher, C. Greif, A first course in Numerical Methods, PHI Learning, 2012.

GENERIC ELECTIVES (GE)

GE – I & LAB

MA1141: DIFFERENTIAL & INTEGRAL CALCULUS [3 1 0 4]
Limits, Continuity and Mean Value Theorem: Definition of limit and continuity, types of discontinuities, properties of continuous functions on a closed interval, differentiability, Rolle's theorem, Lagrange's and Cauchy's first mean value theorems, Taylor's theorem (Lagrange's form), Maclaurin's theorem and expansions, convexity, concavity and curvature of plane curves, formula for radius of curvature in cartesian, parametric, polar and pedal forms, centre of curvature, asymptotes, singular points, cusp, node and conjugate points, tracing of standard cartesian, polar and parametric curves; Partial Differentiation: First and higher order derivatives, Euler's theorem, total derivative, differentiation of implicit functions and composite functions, Taylor's theorem for functions of two variables; Integral Calculus: Reduction formulae, application of integral calculus, length of arcs, surface areas and volumes of solids of revolutions for standard curves in cartesian and polar forms; Beta and Gamma functions: Beta and Gamma functions and relation between them; evaluation of integrals using Beta and Gamma functions.
References:
1. S. Narayan and P. K. Mittal, Differential Calculus, S. Chand & Company Ltd., New Delhi, 2011.
2. P. Saxena, Differential Calculus, McGraw Hill, New Delhi, 2014.
3. S. Narayanan & T. K. Manicavachagom Pillay, Calculus I & II, S. Viswanathan Pvt. Ltd., Chennai, 2010.
4. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley Pvt. Ltd., Delhi, 2007

CY1160: GENERAL CHEMISTRY-I [2 1 0 3]
Structure and Bonding: Hybridization, interactions, resonance, aromaticity, H-bonds. Mechanism: Notations, bond cleavage, electrophiles and nucleophiles, intermediates, free radicals. Stereochemistry: Isomerism, symmetry, chirality, projections, D&L- E&Z- R&S- nomenclature. Basic Concepts of Inorganic Chemistry: Structure, periodicity, ionic solids. Bonding: Covalent bonds, hybridization, VSEPRT, VBT, MOT. s-block Elements: Comparison, diagonal relationships, hybrids. Miscellaneous: Oxidation and reduction, acids and bases, noble gasses, radioactivity.
References:
1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter & R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.
3. G. W. Solomon and B. F. Craig, Organic Chemistry, John Wiley & Sons, Inc., 2010.

4. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003

CY1138: ORGANIC CHEMISTRY LABORATORY [0 0 2 1]

Basics: Distillation, crystallization, decolourization and crystallization using charcoal, sublimation. Qualitative Analysis: Identification, functional group analysis, melting point, preparation of derivatives.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency,
2011.

GE – II (A)

MA1242: ELEMENTARY DIFFERENTIAL EQUATIONS [3 1 0 4]

Ordinary Differential Equations: Order and degree of a differential equation, linear and non-linear differential equations, formation of differential equations; Equations of First Order and First Degree: Variable separable method, homogeneous equations, equations reducible to homogeneous form, linear equations and equations reducible to linear form, exact equations, equations reducible to exact form, some applications of first order equations; Higher Order Linear Differential Equations: Higher order linear differential equations with constant coefficients – complementary function (C. F.), particular integral of the forms e^{ax}, $\sin ax$, $\cos ax$, x^m, $e^{ax}V$, $x^m V$, higher order linear differential equations with variable coefficients- Cauchy's homogeneous equation.

References:

1. J. L. Bansal, S. L. Bhargava and S. M. Agarwal, Differential Equations, Jaipur Publishing House, Jaipur, 2012.
2. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Comp., New Delhi, 2013.
3. S. L. Ross, Differential Equations, Wiley India, 2013.
4. E.A. Coddington, An Introduction to Ordinary Differential Equations, PHI, 2011.
5. R. K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, 4th Edition, Narosa Publishing House, 2014.
6. G. F. Simmons, Differential Equations, Tata McGraw-Hill, 2006.

MA1243: ALGEBRA [3 1 0 4]

Group Theory: Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n, cyclic groups from number systems, complex roots of unity, the general linear group GLn (n,R), the permutation group, Symmetric group, Group of quaternions. Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group, cosets, Index of subgroup, Lagrange's theorem, order of an element; Normal subgroups: their definition, examples, and characterizations, quotient groups; Ring Theory: Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains; Fields: Introduction, examples of fields: Zp, Q, R, and C, field of rational functions.

References:

1. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, 2nd Edition, Cambridge University Press,
1997.
2. N. S. Gopalakrishanan, University Algebra, New Age International (P) Ltd., 2004.
3. H. S. Hall and S. R. Knight, Higher Algebra, H. M. Publications, 1994.
4. pI. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 2013.
5. J. A. Gallian, Contemporary Abstract Algebra, Cengage learning, 2013.

GE – II (B) & LAB

CY1260: GENERAL CHEMISTRY-II [2 1 0 3]
Basic Concepts: Introduction to physical chemistry. Solid, Liquid, and Gaseous State: Ideal and real gas, kinetic theory of gas, PV isotherms, velocity distribution, intermolecular forces, liquid crustals, lattice, unit cell, crystallography. Thermodynamics: Heat and work, laws of thermodynamics, enthalpy, entropy, free energy, thermochemistry. p-block Elements: Comparison, hydrides, oxides, halides, boron chemistry, carbides, fullerenes, halogens. d-block Elements: Transition metals, coordination compounds, metal-ligand bonding;
References:
1. A. Bahl, S. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand, 2016.
2. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2010.
3. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
4. J. E. Huheey, E. A. Keiter & R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson
India, 2008.

CY1238: INORGANIC CHEMISTRY LABORATORY [0 0 2 1]
Inorganic: Qualitative analysis of inorganic salts, volumetric analysis of inorganic mixtures, synthesis of transition
metal complexes.
Reference:
1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency,
2011.

CY1261: GENERAL CHEMISTRY-III [2 1 0 3]
Hydrocarbons: Alkanes and cycloalkanes, Alkenes, cycloalkenes and dienes, alkynes, arenes and aromaticity. Derivatives: Alkyl and aryl halides, alcohols and phenols, aldehydes and ketones, carboxylic acids, ethers and epoxides. Chemical Equilibrium: Dynamic equilibrium, law of mass action, Le Chatelier's principle. Chemical Kinetics: Rate, order (0_{th},1_{st} & 2_{nd}), catalysis. Solution and Mixtures: Colloids, solutions, liquid mixtures, colligative properties, phase rule. Electrochemistry: Conductance, electrical transport, electrodes, Nernst equation, E.M.F and applications, corrosion. Miscellaneous: Organics compounds of nitrogen, heterocyclic compounds, organometallic chemistry.
References:
1. R. T. Morrison and N. Boyd, Organic Chemistry, Pearson India, 2016.
2. I. L. Finar, Organic Chemistry, Vol-1, Pearson Education, 2010.
3. A. Bahl, S. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand, 2016.
4. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2010

CY1239: PHYSICAL CHEMISTRY LABORATORY [0 0 2 1]
Physical: Determination of rate constants, conductometric titrations, thermochemistry, phase diagrams.
Reference:
1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – III (A) & LAB

CY2160: ANALYTICAL CHEMISTRY [2 1 0 3]
Basic Concepts: Introduction to analytical chemistry. Measurement Basics: Introduction, electrical components and circuits, operational amplifiers in chemical instrumentation. Atomic spectroscopy: Introduction to spectrometric methods, components of optical instruments, atomic absorption and atomic fluorescence spectrometry, atomic emission spectrometry, atomic mass spectrometry, atomic X-ray spectrometry. Molecular Spectroscopy: UV-Vis, IR, NMR, mass, Raman, fluorescence

spectroscopy, instrumentations and applications. Electroanalytical Chemistry: Introduction to electroanalytical chemistry, potentiometry, coulometry, voltammetry, instrumentation and application. Separation Methods: An introduction to chromatographic separations, gas chromatography, high-performance liquid chromatography, capillary electrophoresis and capillary electrochromatography, components of instruments and applications. Miscellaneous Methods: Thermal methods for analytical chemistry, instrumentation and applications.

References:

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Saunders College Publishing, 2013.
2. H. H. Willard, L. L. Merritt Jr., J. A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishing Company, 2012.
3. G.D. Christian, Analytical Chemistry, John Wiley, 2004.
4. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical chemistry, Brooks/Cole, 2004.

CY2138: ANALYTICAL CHEMISTRY LABORATORY [0 0 2 1]

Analytical: TLC, paper chromatography, determination of Rf values, separation techniques.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

CY2161: STRUCTURE OF MATERIALS [2 1 0 3]

Basic Concepts: Introduction to inorganic chemistry. Structure of crystalline solids: Classification of materials, crystalline and amorphous solids crystal. Structure, symmetry and point groups, Brvais lattice, unit cells, types of close packing - hcp and ccp, packing efficiency, radius ratios; crystallographic direction and plane. Ceramics: Classification, structure, impurities in solids. Electrical Properties: Introduction, basic concept of electric conduction, free electron and band theory, classification of materials, insulator, semiconductor, intrinsic & extrinsic semi-conductors, metal, superconductor etc., novel materials. Magnetic Properties: Introduction, origin of magnetism, units, types of magnetic ordering: dia-para-ferro-ferri and antiferro-magnetism, soft and hard magnetic materials, examples of some magnetic materials with applications. Special topics: Biomaterials, nanomaterials, composite materials.

References:

1. W. D. Callister, Material Science and Engineering, An introduction, 3rd Edition, Willey India, 2009.
2. H. V. Keer, *Principals of Solid State*, Willey Eastorn, 2011.
3. J. C. Anderson, K. D. Leaver, J. M. Alexander, & R. D. Rawlings, *Materials Science*, Willey India, 2013.

CY2139: MATERIAL CHEMISTRY LABORATORY [0 0 2 1]

Materials: Quantitative estimation of mixtures.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – III (B)

MA2144: REAL ANALYSIS [3 1 0 4]

Real Numbers as a Complete Ordered Field: Field structure and order structure, Order properties of R and Q, Characterization of intervals, bounded and unbounded sets, Supremum and Infimum, Order completeness property, Archimedean property, Characterization of intervals, Neighborhoods, Open sets, Closed sets, Union and intersection of such sets, Limit points of a set, Bolzano-Weierstrass theorem, Isolated points, Closure, Idea of countable sets, uncountable sets and uncountability of R; Real Sequences: Sequences, Bounded sequences, Convergence of sequences, Limit point of a sequence, Bolzano-Weierstrass theorem for sequences, Limits superior and limits inferior, Cauchy's general principle of convergence, Cauchy sequences and their convergence criterion, Algebra of sequences, Cauchy's first and second theorems and other related theorems, monotonic sequences, Subsequences; Infinite Series: Definition of infinite series, sequence of partial sums, convergence and divergence of infinite series, Cauchy's general principle of convergence for series, positive term series, geometric series, comparison series, comparison tests; Cauchy's n^{th} root test, Ratio test, Raabe's test, Logarithmic test, alternating series and Leibnitz's theorem, absolute and conditional convergence; Improper Integrals: Convergence of unbounded functions with finite limit of integration, Comparison tests at upper and lower limits, comparison Integrals, convergence of Beta and Gamma functions, absolute convergence for finite limit, comparison tests for convergence at infinity, absolute convergence for infinite limit.

References:

1. S. Narayan, Elements of Real Analysis, S. Chand & Co., New Delhi, 2017.
2. S. C. Malik and S. Arora, Mathematical Analysis, New Age Int. Pub., New Delhi, 2015.
3. W. Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw Hill, New York, 2013.
4. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Edition, John Wiley & Sons, 2011.
5. T. M. Apostal, Mathematical Analysis, Addison-Wesley, 2008.
6. H. L. Royden and P. M. Fitzpatrick, Real Analysis, 3rd Edition, Macmillan, New York, 2010.

MA2145: PROBABILITY THEORY AND NUMERICAL ANALYSIS [3 1 0 4]

Probability Theory: Dependent, independent and compound events, definitions of probability, addition and multiplication theorems of probability, conditional probability, Bayes theorem and its applications; Random Variable: Definition with illustrations, probability mass function, probability density function, distribution function and its properties, expectation and its properties, definition of variance and covariance and properties, raw and central moments, moment generating functions (m.g.f.) and cumulates generating functions (c.g.f.); Discrete Distributions: Binomial, Poisson and Geometric distributions and their properties; Continuous Distributions: Rectangular, Normal distributions and Exponential and their properties; Numerical Solution of Algebraic and Transcendental Equations: Bisection method, Regula Falsi method, Secant method, Newton-Raphson Method; Interpolation: Difference operators and relations between them, Newton's formulae for forward and backward interpolation, Lagrange's interpolation formula. Stirling's interpolation formulae; Numerical Differentiation and Integration: Numerical differentiation; Numerical integration by Trapezoidal rule, Simpson's one-third rule, Simpson's there-eighth rule; Numerical Solution of Initial Value Problems: Picard's Method, Euler's and modified Euler's method, Runge-Kutta method.

References:

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.
2. A. M. Mood, F. A. Graybill and D. C. Bose, Introduction to the Theory of Statistics, McGraw Hill, 2001.
3. B. S. Grewal, Numerical Methods, Khanna Publishers, 2006.
4. P. G. Hoel, Introduction to Mathematical Statistics, John Wiley & sons, 2000.
5. S. S. Shastri, An Introductory Methods in Numerical Analysis, PHI, 2005.
6. M. R. Spiegel, Theory and Problem of Statistics, Schaum's Publishing Series, 2008.
7. A. M. Goon, A. K. Gupta and B. D. Gupta, Fundamental of Statistics, Vol. I, World Press, Calcutta, 2016.

GE – IV & LAB

CY3260: BIOPHYSICAL CHEMISTRY [2 1 0 3]

Basic Concepts: Introduction to physical chemistry. General Biophysical Principles: Laws of biophysics, hydrogen bonding, van der Waals and hydrophobic interactions, disulphide bridges, role of water and weak interactions, energies, forces & bonds, kinetics of biological processes, electron transport & oxidative phosphorylation. Methods in Biophysics: Analytical ultracentrifugation, micro calorimetry, x-ray diffraction, spectroscopy – UV, IR, NMR, mass fluorescence, circular dichroism, microscopy, separation techniques. Molecular Biophysics: Principles of protein structure & confirmation, proteins structure and stability, structure of nucleic acids. Protein Engineering: Micro sequencing methods for proteins & engineering proteins for purification chemical approach to protein engineering & protein engineering for thermostability. Membrane Biophysics: Membrane structure & models, physical properties of membrane, membrane transport, molecular dynamics of membranes, Membrane potential and lipid membrane technology.

References:

1. D. L. Nelson, M. M. Cox, Lehninger's Principles of Biochemistry, W. H. Freeman, 2015.
2. Satyanarayana, Biochemistry, Elsevier, 2017.
3. J. M. Berg, J. L. Tymoczko, L. Stryer, Biochemistry, W. H. Freeman, 2011.

CY3238: APPLIED CHEMISTRY LABORATORY [0 0 2 1]

Applied chemistry: Water analysis, effluent analysis, pH-metric and conductometric titrations. Computational: Scientific software, data handling.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

MA3244: COMPLEX ANALYSIS [3 1 0 4]

Complex Numbers and Functions: Limit, continuity and differentiability of complex functions, analytic functions, Cauchy-Riemann equations, harmonic functions, contours, line integrals, Cauchy's integral theorem and its direct consequences, Cauchy's integral formula for the functions and derivatives, Morera's theorem, applications to the evaluation of simple line integrals, Cauchy's inequality, Liouville's theorem, fundamental theorem of algebra. Power Series: Taylors series, Laurent's series, circle and radius of convergence, sum functions; Singularities and Residues: Isolated singularities (removable singularity, pole and essential singularity), residues, residue theorem; Real definite integrals: Evaluation using the calculus of residues, integration on the unit circle; Transformations: Definition of conformal mapping, bilinear transformation, cross-ratio, properties, inverse points, elementary transformations e.g. the function.

References:

1. A. R. Vashishtha, Complex Analysis, Krishna Prakashan, Meerut, 2013.
2. R. V. Churchill and J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw Hill Co., 2013.
3. L. V. Ahlfors, Complex Analysis, Tata McGraw Hill, 3rd Edition, 2013.
4. S. Ponnusamy, Foundation of Complex Analysis, Narosa Pub. House, 2nd Edition, 2010.

OPEN ELECTIVES OFFERED BY THE DEPARTMENT

PY2080: INTRODUCTION TO NANOSCIENCE AND ITS APPLICATIONS [2 1 0 3]

Basic aspects of Nanosystems: Nanoscale dimensions and paradigm-Quantum mechanical treatment of 2D, 1D and 0D nanostructures and their density of states, widening of band gap in quantum dots, strong and weak confinement, fundamental concepts of artificial atomic clusters, buckyballs and carbon-nanotubes. Synthesis of nanostructures: Physical and chemical techniques to synthesize nanomaterials-bottom up vs top down techniques. Thin film processes: Spray pyrolysis, Physical Vapor deposition, Sputtering, CVD, Sol gel technique, self-assembly of nanostructures, etching and lithography techniques, importance of size distribution control, size measurement and size selection. Techniques for characterization of nanomaterials and nanostructures: Fundamentals of X-Ray Diffraction, Four Probe analysis, Fluorescence and FTIR spectroscopy, Transmission and Scanning Electron Microscopy, SPM, Atomic Force Microscopy- MFM. Properties of nanostructured materials and Applications: Nanostructure based opto-electronic devices like photodetectors, lasers, LEDs and solar cells, Single electron transistor, Nano-ferroelectric and Spintronic Memory devices and sensors, Applications in renewable energy sources.

References:

1. G. Cao, Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, 2011.
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PY2081: TECHNOLOGICAL APPLICATIONS OF PLASMA [2 1 0 3]

Introduction: Historical Development of Plasma Physics and Engineering, Saha Equation, Plasmas and Sheaths, Discharges, Maxwell's Equations, Conservation Equations, Boltzmann's Equation, Macroscopic Quantities, Equilibrium Properties, Debye Length, Quasi-neutrality, collective behavior, Charged Particle Motion in Electromagnetic Fields, Diffusive Transport in Plasmas Electron and resistivity, Collision Frequency. Nuclear Fusion: Nuclear fission and fusion, Lawson criterion, magnetic confinement fusion, magnetic mirror, toroidal confinement, poloidal confinement, tokomak, ITER, introductory idea inertial confinement fusion, National Ignition facility. Plasma based material processing: Particle and Energy balance in discharges, DC discharges, RF discharges - Capacitively and inductively coupled, microwave, ECR and helicon discharges, Etching for VLSI, film deposition, The plasma arc, the plasma as a heat source, the plasma as chemical catalyst plasma based metallurgy – ore enrichment, applications in ceramics, plasma assisted recycling; Atmospheric plasma air pollution control. solid waste and water treatment technology: Air pollution control, Solid waste treatment, Electro hydraulic water treatment, Engineering and economics.

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1. F. F. Chen, Fundamentals of Plasma Physics and Controlled fusion, Springer 1984.
2. J. R. Roth, Industrial Plasma Engineering: Principle, Institute of Physics, London, 1995.
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PY2082: BIOINFORMATICS FOR ENGINEERS [2 1 0 3]

Basic Biology: Basic principles of biochemistry, genetics, molecular biology, DNA, RNA, proteins, carbohydrates. Introduction to Bioinformatics: History of Bioinformatics, Introduction and application, Biological and their retrieval. Sequence Comparison and Alignment: Introduction, function, structure and evolutionary information, scoring matrices and gap penalties in sequence alignment, Dynamic programming, Needleman-Wunsch algorithm, BLAST and FASTA, Multiple sequence alignments, Phylogenetic Analysis and bioinformatics for evolution; Protein Structure-Analysis. Classification & Prediction: Introduction, primary, secondary, tertiary and protein stability and folding, protein folds' superposition of structures, protein classification, Chou-Fassman, GOR method, ROSETTA. Advanced Tools and Techniques in Bioinformatics: Clustering & Classification Algorithms- Hierarchical and non-hierarchical clustering, K-Means Clustering, Grid based clustering, Machine learning Techniques: Bayesian modeling, support vector machine & ant colony optimization applied to MSAs. Computational Structural Biology: Overview of molecular modeling, methods of molecular modeling, Ramachandran maps, *Ab-initio* methods, Semi-Empirical Methods, Empirical Methods, Molecular Dynamics and Simulations of Bio-macromolecules. Swiss-Model, Hex, DOCK and Autodock; Computer Aided Drug Discovery: Bioinformatics in drug discovery and development, structure and ligand based drug designing.

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1. C. Branden, John Tooze. Introduction to Protein Structure. Second Edition, Garland Pub, 1999
2. D. W. Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor, NewYork, 2004.
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PY2083: MAGNETIC MATERIALS AND APPLICATIONS [2 1 0 3]

Magnetism and properties of magnetic material: History of magnetism, magnetic units, origin of magnetism, Spontaneous magnetization, classification of magnetic materials, theory of diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, quantum theory of magnetism (qualitative discussion), origin of exchange interaction (qualitative discussion), development of domain theory, Bloch and Neel walls, magnetic anisotropy, magnetorestriction, hysteresis, superparamagnetism, Hard and soft magnetic materials, Amorphous and nanocrystalline magnetic materials, magnetic properties of bulk materials, magnetic properties of thin films and multilayers, Nanoparticles. Characterization techniques: MOKE, Vibration sample magnetometer, torque magnetometer, SQUID magnetometer. Application of magnetic materials: Magnetic materials application in transformer, Permanent magnets and motors, Magnetic materials for high frequency applications, recording and storage media, memristors, spintronic devices and their application, sensors, magnetooptics, magnetic materials in targeted disease treatment, Magnetic resonance imaging (MRI).

References:

1. B. D. Cullity and C. D. Graham, Introduction to Magnetic Materials. John Wily & Sons, Inc, 2011.
2. D. Jiles, Introduction to Magnetism and Magnetic Materials. Taylor and Francis, CRC Press 1998.
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4. S. Blundell, Magnetism in Condensed Matter. Oxford University Press, 2001.
5. J. M. D. Coey, Magnetism and Magnetic Materials, Cambridge University Press, 2010.

PY2084: STRUCTURAL PROPERTIES OF MATERIALS AND X-RAY DIFFRACTION [2 1 0 3]

Properties of X-rays: Introduction to X-rays, production of X-rays (continuous and characteristic X-ray), absorption, filters, production of X-ray, detection of X-ray; Geometry of crystal: Introduction to crystal geometry in 2-D and 3-D. lattice and crystal systems, atomic coordination in crystals, lattice planes and directions, primitive and non-primitive cell, symmetry in crystals, Bravias lattice and point groups. And introduction to space groups. Correlation of structural and physical properties of some real crystals; X-ray diffraction: Bragg's law, diffraction techniques, essentials of X-ray diffractometer, Scattering by an electron, atom and unit cell. Factors affecting diffraction intensities (structure, multiplicity, Lorentz, absorption, and temperature). Different experimental techniques and components for X-ray diffraction; Analysis of X-ray diffraction: Single crystal diffraction, diffraction from polycrystalline material, grain size, particle size, crystal imperfections, orientation, texture, Determination of crystal structure, indexing and atomic positions, An introduction to Rietveld refinement.

References:

1. B. D. Cullity and S.R. Stock, Elements of X-Ray Diffraction, Pearson, 2001.
2. Y. Waseda, E. Matsubara, K. Shinoda, X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems, Springer, 2011.
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5. H. Wondratschek, U. Muller, International Tables for Crystallography, Symmetry relations between space groups, Springer, 2004.

PY2085: 2D-MATERIALS AND APPLICATIONS [2 1 0 3]

Historical background of 2d-materials: discovery of graphene: challenges and opportunities, 2d structures and beyond graphene, elemental group iv two-dimensional materials beyond graphene, 2d boron nitride. Crystal structure: crystal translation vectors, unit cell and primitive cell, bravais lattices in two dimensions, number of atoms per unit cell and coordination number, packing fraction (sc, fcc, bcc, hcp and diamond, crystal diffraction, reciprocal lattice, brillouin zone, mermin-wagner theorem; synthesis of 2d-materials: mechanical exfoliation, electrochemical method, chemical vapour deposition, chemical methods. Properties of 2d-materials: electronic, transport, optical, mechanical, thermal and magnetic, effect of substrate on 2d crystals and their properties, hall effect (normal, anomalous and quantum), klein paradox, quantum tunneling. Applications of 2d-materials: electronic, optoelectronic, photonic, spintronic and medical

References:

1. F. Iacopi, John Boeckl, Chennupati Jagadish, 2D Materials, Vol. 95, Academic Press, 2016.

2. A. Tiwari, M. Syväjärvi, Advanced 2D Materials, Wiley, 2016.

3. L. W. T. Ng, G. Hu, R. C. T. Howe, X. Zhu, Z. Yang, C. G. Jones and T. Hasan, Printing of Graphene and Related 2D Materials: Technology, Formulation and Applications, Springer, 2018.

4. P. Avouris, T. F. Heinz and T. Low, 2D Materials: Properties and Devices, Cambridge University Press (MRS), 2017.