Course structure of B. Tech. Engineering Physics of IIT Patna

Semester	Course Code	Course name	L-T-P-Credit	Offering Department
Semester I	CE111	Engineering Drawing	1-0-3-5	Civil
	EE101	Electrical Sciences	3-1-0-8	Electrical
	HS103	Communicative English for Engineers	2-0.5-1-6	Humanities and Social Science
	MA101	Mathematics I	3-1-0-8	Mathematics
	ME110	Workshop-I	0-0-3-3	Mechanical
	PH103	Physics –I	3-1-0-8	Physics
	PH 110	Physics Laboratory	0-0-3-3	Physics
	NSS/NSO/Cultural	NSS/NSO/Cultural	P/NP	
			Total credits: 41	
Semester II	CB102&CE102	Biology and Environmental Studies	3-0-0-6	CB & CE
	CH103	Introductory Chemistry	3-1-0-8	Chemistry
	CH110	Chemistry Laboratory	0-0-3-3	Chemistry
	CS102	Programming and Data structure	3-0-0-6	CS
	CS112	Programming & data structure laboratory	0-0-3-3	CS
	EE103	Basic Electronics Laboratory	0-0-3-3	EE
	MA102	Mathematics –II	3-1-0-8	Mathematics
	ME102	Engineering Mechanics	3-1-0-8	ME

	NSS/NSO/Cultural	NSS/NSO/Cultural	P/NP	
			Total credits: 45	
Semester III	EP201	Quantum Mechanics-I	3-1-0-8	PH
	MA201	Mathematics-III	3–1–0–8	Mathematics
	EP203	Electromagnetic Theory	2–1–0–6	PH
	EP205	Classical Mechanics and Special Theory of Relativity	2–1–0–6	PH
	EP207	Thermal Physics	2–1–0–6	PH
	EP261	Modern Physics Lab	0–0–3–3	PH
	HS2XX	HSS Elective	3-0-0-6	HSS
			Total credits: 43	
Semester IV	EP202/PH4XX	Introduction to Nuclear and Particle Physics	2-1-0-6	PH
	EP204	Mathematical Physics	2–1–0–6	PH
	HS2XX	HSS Elective	3-0-0-6	HSS
	EP206/PH201	Optics & Lasers	3-0-0-6	PH
	EP208/PH203	Vacuum Science and Techniques	3–0–0–6	PH
	EP262	Modern Optics Lab	0-0-3-3	PH
	EP264	Vacuum Techniques Lab	0–0–3–3	PH
			Total credits: 36	
Semester V	EP301	Numerical Techniques	2–0–2–6	PH
	EP303	Nonlinear Physics	2-1-0-6	PH

	EP305	Semiconductor devices and applications	3-0-0-6	PH
	YY3XX	Open Elective I	3-0-0-6	Science / Engineering Deptt.
	EP3XX	Department Elective I	3-0-0-6/ x-y-z-6	PH
	EP3XX	Department Elective II	3-0-0-6/ x-y-z-6	PH
	EP361	Semiconductor devices Laboratory	0-0-3-3	PH
			Total credits: 39	
	<u>Department Electives</u> 1. EP321: Semiconductor Physics 2. EP323/PH402: Solid State Devices 3. EP325/PH301: Engineering Optics 4. EP327: Cryogenic Engineering 5. EP329: Laser Physics 6. EP331: Interfacing and data analysis 7. EP333: Computer aided engineering physics 8. EP335/PH527: Measurement Techniques			
Semester VI	HS3XX	HSS Elective	3-0-0-6	HSS
	EP302/ PH420	Quantum Mechanics II	3-1-0-8	PH
	EP304/PH424	Statistical Physics	3-1-0-8	PH
	EP306/PH428	Computational Physics	2-0-3-7	PH
	EP362	Advanced Physics Lab	0-0-3-3	PH
			Total credits: 32	
Semester VII	EP401/PH521	Atomic & Molecular Physics	3-1-0-8	PH
	EP403/PH523	Solid State Physics	3-1-0-8	PH

	EP461	Quantum Techniques Lab	0-0-3-3	PH
	YY4XX	Open Elective II	3-0-0-6	Science / Engineering Deptt.
	EP497	B. Tech. Project	0-0-6-6	PH
			Total credits: 34	
Semester VIII	EP498	B. Tech Project	0-0-12-12	PH
	EPXXX	Department Elective III	3-0-0-6	PH
	EPXXX	Department Elective IV	3-0-0-6	PH
	EPXXX	Department Elective V	3-0-0-6	PH
			Total credits: 30	
	Department Electives (1) EP410/PH403: Photovoltaics & Fuel Cell Technology (2) EP412: Renewable Energy for Electric Vehicles (3) EP414/PH503: Nanophotonics (4) EP416/PH609: Fourier Optics and Holography (5) EP418: Micro- and Nano-scale Photonic Devices: Fabrication, Theory, and Their Applications (6) EP420: Advanced Techniques in Condensed Matter Physics (7) EP422: Modern microscopy techniques (8) EP424/PH605: Medical physics (9) EP426: Physics of nanomaterials (10) EP428: Transport properties of the materials (11) EP430/PH606: Magnetic materials and application (12) EP432: Structure of the materials (13) EP434: Materials preparation (14) EP436: Ultrafast Spectroscopy (15) EP438: Soft-condensed matter Physics (16) EP440: Nanoelectronics (17) EP442: Spintronics (18) EP444: Quantum Materials (19) EP446: Quantum field theory (20) EP448: Particle physics			

	(21) EP450: Experimental techniques in high energy physics (22) EP452/PH601: Nanoscience (23) EP454/PH602: Quantum Optics & Quantum Information (24) EP456/PH603: Physics of Ultracold Atoms (25) EP458/PH604: Biophotonics (26) EP460/PH607: Materials for Engineering Applications (27) EP462/PH608: Atomic collision physics (28) EP464/PH610: Introductory Biophysics	

Total credits: 300

Detailed Syllabus

Semester I

CE111	Engineering Drawing	1-0-3-5	Civil

Geometrical construction of simple plane figure:Bisecting the line, draw perpendicular, parallel line, bisect angle, trisect angle, construct equatorial triangle, square, polygon, inscribed circle.

Free hand sketching:prerequisites for freehand sketching, sketching of regular and irregular figures.

Drawing scales:Engineering scale, graphical scale, plane scale, diagonal scale, comparative scale, scale of chord.

Orthographic projection:Principle of projection, method of projection, orthographic projection, plane of projection, first angle of projection, third angle of projection, reference line.

Projection of points, lines and plane: A point is situated in the first quadrant, point is situated in the second quadrant, point is situated in the third quadrant, point is situated in the fourth quadrant, projection of line parallel to both the plane, line contained by one or both the plane, line perpendicular to one of the plane, line inclined to one plane and parallel to other, line inclined to both the plane, true length of line.

Missing views:Drawing of missing front view of a solid, missing top view of solids, missing side view of solids, Orthographic projection of simple solid: Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

Orthographic projection of simple solid:Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

Text and Reference Books:

1. B. Agrawal and CM Agrawal, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2008.
2. D. A. Jolhe, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2006.
3. K. Venugopal, Engineering Drawing and Graphics, 2nd ed., New Age International, 1994.

EE101	Electrical Sciences	3-1-0-8	Electrical

Circuit Analysis Techniques, Circuit elements, Simple RL and RC Circuits, Kirchoff's law, Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Thevnin's and Norton's Theorems, Time Domain Response of RC, RL and RLC circuits, Sinusoidal Forcing Function, Phasor Relationship for R, L and C, Impedance and Admittance.

Semiconductor Diode, Zener Diode, Rectifier Circuits, Clipper, Clamper, Bipolar Junction Transistors, Transistor Biasing, Transistor Small Signal Analysis, Transistor Amplifier, Operational Amplifiers, Op-amp Equivalent Circuit, Practical Op-amp Circuits, DC Offset, Constant Gain Multiplier, Voltage Summing, Voltage Buffer, Controlled Sources, Instrumentation Circuits, Active Filters and Oscillators.

Number Systems, Logic Gates, Boolean Theorem, Algebraic Simplification, K-map, Combinatorial Circuits, Encoder, Decoder, Combinatorial Circuit Design, Introduction to Sequential Circuits.

Magnetic Circuits, Mutually Coupled Circuits, Transformers, Equivalent Circuit and Performance, Analysis of Three-Phase Circuits, Electromechanical Energy Conversion, Introduction to Rotating Machines.

Text and Reference Books:

1. C. K. Alexander and M. N. O. Sadiku, Fundamentals of Electric Circuits, 3rd Edition, McGraw-Hill, 2008.
2. W. H. Hayt and J. E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill, 1993.
3. Donald A Neamen, Electronic Circuits; analysis and Design, 3rd Edition, Tata McGraw-Hill Publishing Company Limited.
4. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.
5. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 6th Edition, PHI, 2001.
6. M. M. Mano, M. D. Ciletti, Digital Design, 4th Edition, Pearson Education, 2008.
7. Floyd and Jain, Digital Fundamentals, 8th Edition, Pearson.
8. A. E. Fitzgerald, C. Kingsley Jr. and S. D. Umans, Electric Machinery, 6th Edition, Tata McGraw-Hill, 2003.
9. D. P. Kothari and I. J. Nagrath, Electric Machines, 3rd Edition, McGraw-Hill, 2004.

HS103	Communicative English for Engineers	2-0.5-1-6	HSS

In today's 'global village', there are many who believe that 'Communication is like breathing and life would cease to continue without it'. This particular course on communication skills imbibes the same and therefore, it aims to equip the students with getting the basics right of communication and presentation skills for academic and professional purposes. It is designed to help the second language learners acquire fluency in both spoken and written English to communicate information with clarity, precision and confidence especially in the professional sphere. It will introduce learners not only to the basic concepts in communication but also focus on providing them a hands-on experience of the same. It is hoped that after commanding the skills required in spoken and written English, learners will be able to express themselves more effectively.

The course will have ten units and shall focus on the following topics:

Unit 1: Language and Communication

What is Communication
Nature, Style and Process of Communication
Communication Barriers
Objectives and Importance of Communication
Formal and Informal Communication
Verbal and Non Verbal Communication

Unit 2: English Language Remedial Skills

Construction of Sentences
Subject-Verb Agreement
Tenses
Active and Passive Voice
Direct and Indirect Speech
Common Errors

Unit 3: Oral Skills

Public Speaking
Dealing with lack of confidence
Making an Effective Presentation
Telephone Etiquette
Understanding GD
Why conduct a GD?
How to gear up for a GD?
Different Phases ofGD

Unit 4: Listening Skills

Meaning of Listening
Different Types of Listening
Barriers to Listening and Methods to overcome them
Various strategies to develop effective Listening
Semantic Markers

Unit 5: Reading Skills

What is Reading?
Types of Reading
Reading Comprehension

Unit 6: Writing Skills

Business Correspondence
Element and Style of Writing
Report Writing
Notice, Agenda and Minutes

Unit 7: Interview Techniques

How to prepare for an Interview
An Interview

Text and Reference Books:

1. V. S. Kumar, P.K. Dutt and G. Rajeevan, A Course in Listening and Speaking-I, Foundation books, 2007.
2. V.Sasikumar, P.KiranmaiDutt, GeethaRajeevan, "A Course in Listening and Speaking-II', Foundation books, 2007.
3. Rizvi, Ashraf, Effective Technical Communication, Tata McGraw Hill, 2005.
4. Nitin Bhatnagar and Mamta Bhatnagar, 'Communicative English for Engineers and Professionals, Pearson, 2010.

MA101	Mathematics I	3-1-0-8	Mathemaitics

Properties of real numbers. Sequences of real numbers, montone sequences, Cauchy sequences, divergent sequences. Series of real numbers, Cauchy's criterion, tests for convergence. Limits of functions, continuous functions, uniform continuity,

montoneand inverse functions. Differentiable functions, Rolle's theorem, mean value theorems and Taylor's theorem, power series. Riemann integration, fundamental theorem of integral calculus, improper integrals. Application to length, area, volume, surface area of revolution. Vector functions of one variable and their derivatives. Functions of several variables, partial derivatives, chain rule, gradient and directional derivative. Tangent planes and normals. Maxima, minima, saddle points, Lagrange multipliers, exact differentials. Repeated and multiple integrals with application to volume, surface area, moments of inertia. Change of variables. Vector fields, line and surface integrals. Green's, Gauss' and Stokes' theorems and their applications.

Text Books:

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 6th Ed/9th Ed, Narosa/ Addison Wesley/ Pearson, 1985/ 1996.
2. T. M. Apostol, Calculus, Volume I, 2nd Ed, Wiley, 1967. T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969.

Reference Books:

1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 5th Ed, Wiley, 1999.
2. J. Stewart, Calculus: Early Transcendentals, 5th Ed, Thomas Learning (Brooks/ Cole), Indian Reprint, 2003.

ME110	Workshop-I	0-0-3-3	Mechanical

Sheet Metal Working:
Sheet material: GI sheets, aluminium, tin plate, copper, brass etc; Tools: steel rule, vernier calipers, micrometer, sheet metal gauge, scriber, divider, punches, chisels, hammers, snips, pliers, stakes etc.; operations: scribing, bending, shearing, punching etc; Product development: hexagonal box with cap, funnel etc.
Pattern Making and Foundry Practice:
Pattern material: wood, cast iron, brass, aluminium, waxes etc.; Types of patterns: split, single piece, match plate etc; Tools: cope, drag, core, core prints, shovel, riddle, rammer, trowel, slick, lifter, sprue pin, bellow, mallet, vent rod, furnace etc. Moulding sands: green sand, dry sand, loam sand, facing sand etc., Sand casting: Sand preparation, mould making, melting, pouring, and cleaning. Joining:
Classifications of joining processes; Introduction to Arc welding processes; power source; electrodes; edge preparation by using tools bench vice, chisels, flat file, square file, half round file, round file, knife edge file, scrapers, hacksaws, try squares; cleaning of job, Job: lap and butt joints using manual arc welding. Machining centre:
Introduction to different machine tools; Working principle of lathe, milling, drilling etc.;
Setting and preparation of job using lathe and milling; Performing different operations

namely, straight turning, taper turning, knurling, thread cutting etc.; Introduction to dividing head, indexing, Performing operation in milling using indexing mechanism.
CNC centre:
Introduction to CNC machines; Fundamentals of CNC programming using G and M code; setting and operations of job using CNC lathe and milling, tool reference, work reference, tool offset, tool radius compensation.

Text and Reference Books:

1. H. Choudhury, H. Choudhary and N. Roy, Elements of Workshop Technology, vol. I,Mediapromoters and Publishers Pvt. Ltd., 2007.
2. W. A. J. Chapman, Workshop Technology, Part -1, 1st South Asian Edition, Viva Book Pvt Ltd., 1998.
3. P.N. Rao, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill PublishingCompany, 2009.
4. B.S. Pabla, M.Adithan, CNC machines,New Age International, 2012.
5. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 6th Ed/9th Ed, Narosa/Addison Wesley/Pearson, 1985/1996.
6. T. M. Apostol, Calculus, Volume I, 2nd Ed, Wiley, T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969/1967.

PH103	Physics-I	3–1–0–8	PH

Orthogonal coordinate systems and frames of reference, conservative and non-conservative forces, work-energy theorem, potential energy and concept of equilibrium; Rotation about fixed axis, translational-rotational motion, vector nature of angular velocity, rigid body rotation and its applications, Euler's equations; Gyroscopic motion and its application; Accelerated frame of reference, centrifugal and Coriolis forces.

Harmonic oscillator, damped and forced oscillations, resonance, coupled oscillations, small oscillation, normal modes, longitudinal and transverse waves, wave equation, plane waves, phase velocity, superposition wave packets and group velocity, two and three dimensional waves.

Failure of classical concepts, Black body radiation, photo-electric effect, Compton effect, Davison and Germer's experiment, Frank-Hertz experiment, Bohr's theory, Sommerfeld's model, correspondence principle, Planck hypothesis, De Broglie's hypothesis, Hilbert space, observables, Dirac notation, principle of superposition, wave packets, phase and group velocities, probability & continuity equation, eigenvalues and eigenfunctions, orthonormality, expectation values, uncertainty principle, postulates of Quantum Mechanics, Schrodinger equation & its applications to 1D potentials, field quantization, periodic potential wells: Kronig Penny model and origin of band gap.

Textbooks:

1. D. Kleppner and R. J. Kolenkow, An introduction to Mechanics, Tata McGraw-Hill, New Delhi, 2000.
2. David Morin, Introduction to Classical Mechanics, Cambridge University Press, NY, 2007.
3. Frank S. Crawford, Berkeley Physics Course Vol 3: Waves and Oscillations, McGraw Hill, 1966.
4. Eyvind H. Wichmann, Berkeley Physics Course Vol 4: Quantum physics, McGraw Hill, 1971.

Reference Books:

5. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol I, Narosa Publishing House, New Delhi, 2009.
6. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol III, Narosa Publishing House, New Delhi, 2009.
7. R. Eisberg and R. Resnick, Quantum Physics of atoms, molecules, solids, nuclei and particles, John Wiuley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
8. A. J. Dekker, Solid State Physics, Macmillan Pub. India Ltd., New Delhi, 2009
9. David J. Griffith, Introduction to Quantum Mechanics, Pearson Education Ltd, New Delhi, 2009.
10. B.H. Bransden& C.J. Joachain, Quantum Mechanics, Pearson Education Ltd, New Delhi, 2008.

PH110	Physics Laboratory	0-0-3-3	PH

The list of experiments is as follows:

- Instructions to Students
- Introduction to Error Analysis

Ex 1 Decay of Current in A Capacitive Circuit

Ex 2 Q-Factor of an LCR Circuit

Ex 3 Study of Hall Effect

Ex 4 Speed of Sound in Air

Ex 5 ‘g’ by A Compound Pendulum

Ex 6 Speed of Light in Glass

Ex 7 Determination of e/m

Ex 8 Interference of Light: Newton’s Ring

Ex 9 Surface Tension of Water by Method of Capillary Ascent

Ex 10 Determination of Plank’s constant by Photoelectric Effect

NSS/NOS/Cultural	**NSS/NOS/Cultural**	**P/NP**

Semester II

CB102&CE102	**Biology and Environment Studies**	**3-0-06**	**CB & CE**

Module 1 - Biology: 1.Cell – Structure and logic of optimization; 2. Blood – The following tissue – Basis and rationale; 3. Organs – Structure, function, interactions, failure; 4. Molecular basis of disorders – example: Diabetes; 5. Modern techniques of evaluations and corrections; 6. Open discussions – Feedback from students

Module 2 – Environmental Science / Studies: 1.Ecology and Sustainable Development – Ecosystems, Natural cycles, Biodiversity, Man and environment; 2. Water Resources – Hydrologic cycle and its components, Groundwater and surface water, Water quality; 3. Environmental Sanitation: Conventional and ecological sanitation; 4. Environmental

Pollution and Control – Air, Water, Soil, Noise Pollution, Solid and Hazardous Waste, Biomedical Waste, E-waste: Sources, effect, treatment and control; 5. Environmental Legislations and Standards; 6.Current Environmental Issues: Greenhouse gases and global warming, Acid rain, Ozone layer depletion, Climate change

Text Books:

1. Any basic Biology Book of CBSE Curriculum at +2 Level/ E-text Books
2. Davis, M.L. and Masten,S.J., Principles of Environmental Engineering and Science,2nd Edition, McGraw-Hill, 2013.
3. Kaushik, A. and Kaushik, C.P., Perspectives in Environmental Studies, 4thEdition, New Age International, 2014.

Reference Books:

4. Botkin,D.B. and Keller,E.A., Environmental Science,8th Edition, Wiley, 2012.
5. Cunningham, W.P. and Cunningham, M.A., Environmental Science: A Global Concern, 13thEdition, McGraw-Hill, 2015

CH103 Introductory Chemistry 3-1-0-8 Chemistry

PHYSICAL CHMEISTRY

Thermodynamics: The fundamental definition and concept, the zeroth and first law. Work, heat, energy and enthalpies. Second law: entropy, free energy and chemical potential. Change of Phase. Third law. Chemical equilibrium, Chemical kinetics: The rate of reaction, elementary reaction and chain reaction.

Electrochemistry: Conductance of solutions, equivalent and molar conductivities and its variation with concentration. Kohlrausch's law-ionic mobilities, Transference number of ions. activities, application of Debye-Huckel theory. The Walden's rule. Debye-Huckel-Onsager treatment. Electrochemical cells, Nernst equation. Application of EMF measurements. Liquid junction potential, commercial cells – the primary and secondary cells. Fuel cells.

INORGANIC CHEMISTRY

Coordination chemistry: ligand, nomenclature, isomerism, stereochemistry, valence bond, crystal field and molecular orbital theories. Bioinorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin; organometallic chemistry.

ORGANIC CHEMISTRY

Stereo and regio-chemistry of organic compounds, conformers. Bioorganic chemistry: amino acids, peptides, proteins, enzymes, carbohydrates, nucleic acids and lipids. Modern techniques in structural elucidation of compounds (UV – Vis, IR, NMR). Solid phase synthesis and combinatorial chemistry. Green chemical processes.

Textbooks:

P. W. Atkins, Physical Chemistry, ELBS, 5th Ed, 1994.
J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 and 2, Kluwer Academic, 2000.
K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India, 2nd Ed, 1986.
F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern Ltd, New Delhi, 3rd Ed, 1972 (reprint in 1998).
D. J. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, ELBS, 2nd Ed, 1994.
S. H. Pine, Organic Chemistry, McGraw Hill, 5th Ed, 1987

Reference Books:

Levine, Physical Chemistry, McGraw Hill, 4th Ed, 1995.
J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principle, structure and reactivity, Harper Collins, 4th Ed, 1993.
L. G. Wade Jr., Organic Chemistry, Prentice Hall, 1987

CH110	Chemistry Laboratory	3-1-0-8	Chemistry

Estimation of metal ion: Determination of total hardness of water by EDTA titration. Experiments based on chromatography: Identification of a mixture containing two organic compounds by TLC. Experiments based on pH metry.: Determination of dissociation constant of weak acids by pH meter. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. Synthesis and characterization of inorganic complexes: e.g. Mn(acac)3, Fe(acac)3, cis-bis(glycinato)copper(II) monohydrate and their characterization by m. p. IR etc. Synthesis and characterization of organic compounds: e.g. Dibenzylideneacetone. Kinetics: Acid catalyzed hydrolysis of methylacetate. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution. Experiments based on electrogravimetry and electroplating. Experiments based on magnetometry.

CS101	Introduction to Computing	3-0-0-6	CS

Digital computer fundamentals: flowcharts, the von Neumann architecture, programs, assembly language, high level programming languages, text editors, operating

systems. Imperative programming (Using C): data types, variables, operators, expressions, statements, control structures, functions, arrays and pointers, recursion, records (structures), files, input/output, some standard library functions and some elementary data structures.

Program development: programming tools, testing and debugging.

Textbooks:

1. A. Kelley and I. Pohl, A Book on C, 4th Ed, Pearson Education, 1998

Reference Books:

2. B. W. Kernighan and D. Ritchie, The C Programming Language, 2nd Ed, Prentice Hall of India, 1988

CS101	Computing Laboratory	0-0-3-3	CS

Laboratory experiments will be set in consonance with the material covered in CS 101. This will include assignments in a programming language like C.

Reference Books:

1. B. Kernighan and D. Ritchie, The Programming Language, Prentice Hall India, 1995.

EE103	Basic Electronics Laboratory	0-0-3-3	EE

Experiments using diodes and bipolar junction transistor (BJT): design and analysis of half -wave and full-wave rectifiers, clipping circuits and Zener regulators,
BJT characteristics and BJT amplifiers; experiments using operational amplifiers (op-amps): summing amplifier, comparator, precision rectifier, astable and monostablemultivibrators and oscillators; experiments using logic gates: combinational circuits
such as staircase switch, majority detector, equality detector, multiplexer and demultiplexer; experiments using flip-flops: sequential circuits such as non-overlapping pulse generator, ripple counter, synchronous counter, pulse counter and numerical display.

Reference Books:

1. A. P. Malvino, Electronic Principles. New Delhi: Tata McGraw-Hill, 1993.
2. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits. New Delhi: Prentice Hall of
   India, 2002.
3. R.J. Tocci: Digital Systems; PHI, 6e, 2001.

MA102	Mathematics-II	3-1-0-8	MA

Linear Algebra: Vector spaces (over the field of real and complex numbers). Systems of linear equations and their solutions. Matrices, determinants, rank and inverse. Linear transformations. Range space and rank, null space and nullity. Eigenvalues and eigenvectors. Similarity transformations. Diagonalization of Hermitian matrices. Bilinear and quadratic forms.

Ordinary Differential Equations: First order ordinary differential equations, exactness and integrating factors. Variation of parameters. Picard's iteration. Ordinary linear differential equations of n-th order, solutions of homogeneous and non-homogeneous equations. Operator method. Method of undetermined coefficients and variation of parameters.

Power series methods for solutions of ordinary differential equations. Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kind.

Systems of ordinary differential equations, phase plane, critical point, stability.

Textbooks:

1. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall, 1996.
2. T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969.
3. S. L. Ross, Differential Equations, 3rd Ed, Wiley, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall, 1995.
5. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 7th Ed, Wiley, 2001.

Reference Books:

6. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.

ME102	Engineering Mechanics	3-1-0-8	ME

1. Rigid body statics: Equivalent force system. Equations of equilibrium, Freebodydiagram, Reaction, Static indeterminacy.
2. Structures: 2D truss, Method of joints, Method of section. Beam, Frame, types ofloading and supports, axial force, Bending moment, Shear force and TorqueDiagrams for a member:
3. Friction: Dry friction (static and kinetic), wedge friction, disk friction (thrustbearing), belt friction, square threaded screw, journal bearings, Wheel friction, Rolling resistance.
4. Centroid and Moment of Inertia
5. Virtual work and Energy method: Virtual Displacement, principle of virtual work,mechanical efficiency, work of a force/couple (springs etc.), PotentialEnergyandequilibrium, stability.

6. Introduction to stress and strain: Definition of Stress, Normal and shear Stress.Relation between stress and strain, Cauchy formula.
7. Stress in an axially loaded member,
8. Stresses due to pure bending,
9. Complementary shear stress,
10. Stresses due to torsion in axi-symmetric sections:
11. Two-dimension state of stress, Mohr's circle representation, Principal stresses

Text and Reference books:

1. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002.
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, 3rd Ed, TataMcGraw Hill, 2000.
3. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I - Statics, 5th Ed, John Wiley, 2002.
4. E.P. Popov, Engineering Mechanics of Solids, 2nd Ed, PHI, 1998.
5. F. P. Beer and E. R. Johnston, J.T. Dewolf, and D.F. Mazurek, Mechanics of Materials, 6th Ed, McGraw Hill Education (India) Pvt. Ltd., 2012.

NSS/NOS/Cultural	**NSS/NOS/Cultural**	**P/NP**

Semester III

EP201 (Core)	**Quantum Mechanics - 1**	**3–1–0–8**	**PH**

Physical implications of the Schrödinger equation, derivation of Ehrenfest's theorem; Quantum operators & generators, orthonormal & complete basis, quantum superposition, generalized uncertainty principle; Observables and the concept of quantum measurements; Schrödinger, Heisenberg and interaction pictures.

Solution of Schrodinger equation for solvable potentials: harmonic oscillator, hydrogen atom; Concept of field quantization, Fock state basis, vacuum fluctuation; Coherent states: their properties & physical significances, photon-number distribution.

Angular momentum algebra, angular momentum & rotations, matrix representation, raising and lowering operators; orbital & spin angular momentum, Stern-Gerlach experiment, spin-1/2 system, Pauli matrices; addition of angular momenta, Clebsch-Gordancoefficients, spin-orbit coupling.
Variational technique: Helium atom; Stationary perturbation theory, first and second order corrections, application to one-electron system. Stark effect, normal & anomalous Zeeman effect.

Textbooks:

1. C. Cohen-Tannoudji, B. Diu and F. Laloẽ, Quantum Mechanics (Vol-I), Herman & John Wiley & Sons Asia, 2005.
2. J. J. Sakurai,Modern Quantum Mechanics, Pearson Education, 2002.
3. L. I. Schiff, Quantum Mechanics, McGraw-Hill, 1968.

Reference Books

4. R. Shankar, Principles of Quantum Mechanics, Springer India, 2008.
5. S. Gasiorowicz,Quantum Physics, Wiley India, 2007.
6. Quantum Mechanics, V.K. Thankappan, Wiley Eastern (1985).
7. R.P. Feynman, R.B. Leighton and M.Sands,The Feynman Lectures on Physics, Vol.3, Narosa Pub. House, 1992.
8. P.A.M. Dirac, The Principles of Quantum Mechanics, Oxford University Press, 1991.
9. L.D. Landau and E.M. Lifshitz, Quantum Mechanics -Nonrelativistic Theory, 3rd Edition, Pergamon, 1981.
10. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education, 2005.
11. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed., 2004.

MA201	Mathematics-III	3–1–0–8	Mathematics

Complex Analysis: Complex numbers, geometric representation, powers and roots of complex numbers. Functions of a complex variable: Limit, Continuity, Differentiability, Analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, Harmonic conjugates. Elementary Analytic functions (polynomials, exponential function, trigonometric functions), Complex logarithm function, Branches and Branch cuts of multiple valued functions. Complex integration, Cauchy's integral theorem, Cauchy's integral formula. Liouville's Theorem and Maximum-Modulus theorem, Power series and convergence, Taylor series and Laurent series. Zeros, Singularities and its classifications, Residues, Rouches theorem (without proof), Argument principle (without proof), Residue theorem and its applications to evaluating real integrals and improper integrals. Conformal mappings, Mobius transformation, Schwarz-Christoffel transformation.

Fourier series: Fourier Integral, Fourier series of 2p periodic functions, Fourier series of odd and even functions, Half-range series, Convergence of Fourier series, Gibb's phenomenon, Differentiation and Integration of Fourier series, Complex form of Fourier series.

Fourier Transformation: Fourier Integral Theorem, Fourier Transforms, Properties of Fourier Transform, Convolution and its physical interpretation, Statement of Fubini's theorem, Convolution theorems, Inversion theorem

Partial Differential Equations: Introduction to PDEs, basic concepts, Linear and quasi-linear first order PDE, Second order PDE and classification of second order semi-linear PDE, Canonical form.. Cauchy problems. D' Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace and Poisson equations, Maximum principle with application, Fourier method for IBV problem for wave and heat equation, rectangular region. Fourier method for Laplace equation in three dimensions.

Text Books:

1. R. V. Churchill and J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, 1990.
2. K. Sankara Rao, Introduction to Partial Differential Equations, 2nd Edition, 2005.

Reference Books:

3. J. H. Mathews and R. W. Howell, Complex Analysis for Mathematics and Engineering, 3rd Edition, Narosa, 1998.
4. I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957.
5. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.

EP203 (Core)	Electromagnetic Theory	2–1–0–6	PH

Electrodynamics before Maxwell, Maxwell's Correction, Maxwell's equations, Magnetic charge, Maxwell's equation in matter, Boundary conditions, Newton's Third Law in electrodynamics, Electromagnetic (EM) wave equation for E and B in vacuum, Monochromatic plane waves, The continuity equation, Energy and momentum in EM waves; Poynting'stheorem, Propagation of EM waves in linear media, Reflection and transmission of EM waves; EM waves in conductors, reflection at a conducting surface, Skin effect, Frequency dependence of permittivity; Wave guides: EM wave between two conducting planes, TM, TE and TEM waves and their transmission, Attenuation with planes of finite conductivity: TEM case, TM case and TE case.

Text Books:

1. D. J. Griffiths, Introduction to Electrodynamics, Third Edition, Pearson Education Inc., 2006.
2. J. D. Ryder, Networks, Lines and Fields, Second Edition, Prentice Hall of India, 2002.

Reference Books:

3. E. M. Purcell, Electricity and Magnetism (Berkeley Physics Course Vol 2) 2nd Ed, McGraw Hill Education.
4. A. Shadowitz, The Electromagnetic Field, Dover Publications, 2010.
5. Nathan Ida, Engineering Electromagnetics, 2nd Ed, Springer, 2007.
6. D. Chattopadhyay and P. C.Rakshit, Electricity and Magnetism, New Central Book Agency, 9th rev. Ed, 2011.
7. E. C. Jordan and K. G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall India, 2nd Ed, 1964.
8. J. D. Jackson, Classical Electrodynamics, Willey, 1999

EP205 (Core)	Classical Mechanics and Special Theory of Relativity	2–1–0–6	PH

Variational Principle and Lagrange's Equation: Constraints, D' Alembert's Principle and Lagrange's Equation, Hamilton's Principle, Symmetry and Conservation, Two body central force problem, Noether'sTheorem, Conserved quantities including Laplace-Runge-Lenz Vector, Scattering in a Central Force field, Special theory of relativity: Lorentz transformation, Lagrangian formulation of Relativistic Mechanics, The Hamilton Equation of Motion, The Hamiltonian formulation of Relativistic Mechanics, Canonical Transformations, Poisson Brackets, Hamilton-Jacobi Theory and Action and angle variable and their applications.

Text Books:

1. H. Goldstein, C. P. Poole and J. Safko, Classical Mechanics, Pearson Education; 3rd, International Economy Ed, 2011.
2. Kittelet al., Mechanics, Berkeley Physics Course Vol 1, McGraw Hill Education.

Reference Books:

3. N.C. Rana and P. S. Joag, Classical Mechanics, McGraw Hill Education (India) Private Limited, 2001
4. L. D. Landau and E. M. Lifshitz, Mechanics, Course on Theoretical Physics, Vol.1, 3rd Ed, Butterworth-Heinemann Books.

EP207 (Core) Thermal Physics 2–1–0–6 PH

Kinetic Theory of Gases, Maxwell-Boltzmann distribution, effusion, collision, equation of state, ideal gas, Equipartition of energy, real gas; Thermal Diffusion Equation; Laws of Thermodynamics, Temperature, Internal Energy, Entropy; Equivalence of Kelvin-Planck and Clausius Statements; Carnot Efficiency, Various thermodynamic cycles;Free energies, Path and State Functions, Gibb's-Duhem relations, Maxwell Relations, Clausius-Clapeyron Equation; Chemical Potential, Chemical Equilibrium, Phase Diagram, Gibb's Phase Rule, Phase Transitions, Stable and Metastable States, Phase Co-existence, Maxwell's Construction; Various modes of heat transfer;Saha-Ionization; Speed of Sound in Fluids, Shock Waves, Rankine-Hugoniot Conditions. Engineering applications -Heat Engines, Refrigeration, Heating-Ventilation and Air-conditioning (HVAC), Information Theory.

Text Books:

1. Stephen J. Blundell and Katherine M. Blundell, Concepts in Thermal Physics, 3rd Ed, Oxford University Press, 2014.
2. R. H. Dittman and M. W. Zemansky, Heat and Thermodynamics, McGraw-Hill College; Subsequent Ed, 1996.

Reference Books:

3. M. N. Saha and B. N. Srivastava, Treatise on Heat, 3rd Edition, The Indian Press, Allahabad, 1950.
4. R.Baierlein, Thermal Physics, Cambridge University Press, 2005.

EP261 (Core) Modern Physics Lab 0–0–3–3 PH

The list of experiments is as follows:

1. Compton effect
2. Stern-Gerlach experiment
3. Frank Hertz experiment
4. Blackbody spectra
5. X-ray spectra of tungsten at various accelerating potentials
6. Scattering of alpha particle by a thin gold foil: Rutherford Scattering,
7. Determination of Rydberg constant from atomic spectra
8. Scanning tunneling microscopy of HOPG surface
9. Auger effect
10. X-ray diffraction
11. UV-Visible absorption spectra of molecules
12. Fluorescence and phosphorescence spectra of molecules
13. Verificationof Stefan-Boltzman law
14. Verification of Weidemann-Franz law
15. Determination of size of nanoparticle using scanning electron microscope

HS2XX	**HSS Elective**	**3-0-0-6**	**HSS**

Semester IV

EP202	**Introduction to Nuclear and Particle Physics**	**2-1-0-6**	**PH**

Nuclear properties: mass, radius, spin, parity, binding energy, electric and magnetic moments, excited states; Nuclear models: liquid drop model, semi-empirical mass formula, nuclear shell model - validity and limitations, magic numbers, Collective models; Nature of the nuclear force: form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces;Radioactive decay: radioactive decay law, radioactive dating, alpha, beta and gamma decays and their selection rules;Nuclear reactions: reaction mechanism, Fission and fusion, compound nuclei and direct reactions, elementary ideas about nuclear reactors.

Particle Phenomenology: Fundamental interactions; Elementary particles and their quantum numbers (charge, lepton number, baryon number, spin, parity, isospin,

strangeness, etc.); Gellmann-Nishijima formula, Quark model, baryons and mesons; C, P, and T invariance, Symmetries and conservation laws - application of symmetry arguments to particle reactions; Parity non-conservation in weak interaction; Elementary idea about electroweak unification, Higgs boson and origin of mass; Elementary introduction to accelerators; Relativistic kinematics.

Text Books:

1. D. J. Griffiths, Introduction to Elementary Particles, Wiley, 2008.
2. K. S. Krane, Introductory Nuclear Physics, Wiley, 2008.
3. S.N. Ghoshal, Nuclear Physics, S Chand, 1994.
4. A. Das and T. Ferbel, Introduction to Nuclear and Particle Physics, World Scientific, 2003.

Reference Books:

5. B. R. Martin and G. P. Shaw, Particle Physics, Wiley 4th Ed, 2017.
6. K. Kleinknecht, Detectors for Particle Radiation, Cambridge University Press, 1998.
7. R. L. William, Techniques for Nuclear and Particle Physics Experiments: A How-To Approach, Springer 2nd rev. Ed, 1994.
8. R. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, New Age, 1996.
9. I. S. Hughes, Elementary Particles,Cambridge University Press, 1991.
10. J. Lilley, Nuclear Physics, Wiley, 2006.
11. D. H. Perkins, Introduction to High Energy Physics, 4th Ed, Cambridge University Press, 2000.
12. F. Halzen and A. D. Martin, Quarks and Leptons, Wiley India Ed,1984.
13. V. K. Mittal, R. C. Verma, S. C. Gupta, Introduction to Nuclear and Particle Physics, Prentice-Hall of India Pvt. Ltd., 2011.

EP204 (Core) Mathematical Physics 2–1–0–6 PH

Vector Space: Gram-Schmidt Orthonormalization, Self-adjoint operators, completeness of eigen functions, Complex Analysis: Physical Applications (fluid flow, electrostatics, heat flow etc.), Polynomials and Special Functions: Legendre, Hermite, Laguerre, Chebyshev, Jacobi, Bessel,Neumann, Hankel; Green's function: 1,2,3 dimensional problems (Laplace, wave, heat equations etc.), Integral Equations, Integral Transforms, Basic Introduction to Tensors, Covariant formalism of electrodynamics; Group Theory: Definition, Subgroups and Classes, representations, Characters, applications, Group symmetry like SU(2), SU(3), O(3) etc.

Text Book:

1. G. B. Arfken and H. J. Weber, Mathematical methods for physicists, Elsevier; 7th Ed, 2012.

2. J. Brown and R. Churchill, Complex Variables and Applications, McGraw Hill Education, 8th Ed, 2017.
3. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions, Ane Books, 1stEd, 2017.

Reference Books:

4. L. A. Pipes and L. R. Harvill, Applied Mathematics for Engineers and Physicists, Dover Publications Inc., 3rd rev. Ed, 2014.
5. I. S. Gradshteyn and I. M. Ryzhik, Tables of Integrals, Series and Products, Edited by A. Jeffrey and D.Zwillinger, Academic Press is an imprint of Elsevier 7th Ed, 2007.
6. Abramowitz and Stegun, Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables, United States Department of Commerce, National Institute of Standards and Technology (NBS), 1964.
7. E. Kreyszig, Advanced Engineering Mathematics, Wiley India 10th Ed, 2011.
8. M. L. Boas, Mathematical Methods in the Physical Sciences, Wiley, 3rd Ed, 2005.
9. Charlie and Harper, Introduction to Mathematical Physics, Prentice Hall India, 1978.

HS2XX	HSS Elective	3-0-0-6	HSS

EP206/PH201	Optics & Lasers	3-0-0-6	PH

Review of basic optics: Polarization, Reflection and refraction of plane waves. Diffraction: diffraction by circular aperture, Gaussian beams.

Interference: two beam interference-Mach-Zehnder interferometer and multiple beam interference-Fabry-Perot interferometer. Monochromatic aberrations. Fourier optics, Holography. The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion. Laser rate equations, three level and four level systems; Optical Resonators: resonator stability; modes of a spherical mirror resonator, mode selection; Q-switching and mode locking in lasers. Properties of laser radiation and some laser systems: Ruby, He-Ne, CO_2, Semiconductor lasers. Some important applications of lasers, Fiber optics communication, Lasers in Industry, Lasers in medicine, Lidar.

Text Books:

1. R. S. Longhurst, Geometrical and Physical Optics, 3rd Ed, Orient Longman, 1986.
2. E. Hecht, Optics, 4th Ed, Pearson Education, 2004.
3. M. Born and E. Wolf, Principles of Optics, 7th Ed, Cambridge University Press, 1999.
4. T. S. William, Laser Fundamentals, 2nd Ed, Cambridge University Press, 2004.
5. K. Thyagarajan and A. K. Ghatak, Lasers: Theory and Applications, Macmillan, 2008.

EP208/PH203	Vacuum Science and Techniques	3-0-0-6	PH

Fundamentals of vacuum, units of pressure measurements, Gas Laws (Boyles, Charles), load-lock chamber pressures, Partial and Vapor Pressures, Gas flow, Mean free path, Conductance, Gauges, Capacitance Manometer, Thermal Gauges, Thermocouple, Pirani Gauge, Penning Gauge, High Vacuum Gauges, Leak Detection, Helium Leak Detection, Cold Cathode Gauge, Roughing (Mechanical) Pumps, Pressure ranges, High Vacuum Pumps: Oil Diffusion Pump, Tolerable fore line pressure System configuration, Oils, Traps Crossover pressure calculations, Pump usage and procedures, Turbomolecular pump, Cryopumps, Pump usages, Out gassing and Leak Testing.

Introduction to Deposition, Anti Reflection (AR) Coatings, Mono-dimensionally modulated (MDM) Filters, Vacuum Coatings, High reflectors, e-beam deposition systems, Film Stoichiometry, Sputtering, Itching and Lithography, Chemical Vapour deposition and Pulse Laser deposition, Mass Flow control, Reactive sputtering, Film growth control.

Text Books:

1. M.Ohring, Materials Science of Thin Films, Second Edition, Academic Press, 2001.
2. K.L. Chopra and S.R. Das, Thin Film Solar Cells, Springer, 1983.
3. N. Yoshimura, Vacuum Technology: Practice for Scientific Instruments, Springer, 2008.

Reference Books:

4. A. Roth, Vacuum Technology, North Holland, 1990.
5. D. Smith, Thin-Film Deposition: Principles and Practice, McGraw-Hill Professional, 1995.
6. K.Shesan, Handbook of Thin Film Deposition, William Andrew, 2002.

EP262	Modern Optics Lab	0-0-3-3	PH

The list of experiments is as follows:

1. External Cavity Diode Laser: Assembly and Characteristics
2. Michelson Interferometer
3. Haidinger fringes for measuring thickness of the film
4. Diffraction using gratings
5. Polarization of Light
6. Optical fiber characteristics
7. Spatial Light Modulator(SLM) for generation of Optical Angular Momentum (OAM)
8. Recording and reconstruction of Hologram
9. Saturation Absorption Spectroscopy: Observation of Hyperfine Splitting
10. Demonstration of Faraday rotation principle
11. TE and TM propagation modes in a Wave guide
12. Generation of Second Harmonics inside a Non-linear crystal
13. Demonstration of Pulse shaping
14. Experiment on Q-Switching
15. Optical tweezers for trapping of dielectric particles
16. Polarizing optical microscope

EP264	Vacuum Techniques Lab	0-0-3-3	PH

The list of experiments is as follows:

1. Hands-on Introduction to a Pumping system
2. Pumping speed measurements using the constant volume method
3. Pumping speed measurements using the constant pressure method
4. Leak valve calibration and roughing line conductance determination
5. Outgassing rate measurements for Ultra High Vacuum scenario
6. Helium Leak Detector and Residual Gas Analyzer
7. Deposition of Aluminum and Gold Thin films
8. Thickness measurement
9. Designing Anti-reflection coating: Simulation Lab
10. Zinc Oxide film deposition

Reference Books:

1. J. M. F. dos Santos, doi:10.1016/j.vacuum.2005.07.043
2. M.Ohring, Materials Science of Thin Films, 2nd Ed, Academic Press, 2001.
3. A. Roth, Vacuum Technology, North Holland, 1990.

Semester V

EP301 (Core)	Numerical Techniques	2–0–2–6	PH

Preliminaries of Computing; Roots of Non Linear Equations and solution of system of Linear Equations:- Fixed-point iteration, Bisection, Secant, Regula-falsi method, Newton Raphson method, Gauss Elimination method by pivoting, Gauss – Jordan method, Gauss – Seidel method, Relaxation method, Convergence of iteration methods, LU and Choleskydecomposition.Interpolation and approximations:-Lagrange and Newton interpolation, Spline interpolation, Rational approximations, Least square approximations.Numerical Integration:-Newton-Cote's rule, Gaussian quadrature. Numerical Optimisation:- Newton's method, Golden section search, Conjugate gradient method.Numerical Solution of Ordinary and Partial Differential Equations:- Taylor series method, Runge-Kutta methods, Crank-Nicolson method, Split operator technique; Eigen value problems:- Jacobi transformation Fourier Transform:- Discrete Fourier Transform and Fast Fourier Transform in two or more dimensions; Engineering applications.

Textbooks:

1. W. H. Press, S. A. Teukolsky, W T. Vetterling and B. P. Flannery, Numerical Recipes in C: The Art of Scientific Programming, 2nd Ed, Cambridge University Press, 1997
2. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education India; 7 Ed, 2007.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI learning Pvt. Ltd., 5th Ed, 2012.
4. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International (P) Ltd., 2014.

Reference Books:

5. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.
6. B. S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2014.
7. Y. Kanetkar, Let us C, 13th edition, BPB publication 2013.
8. Programming in ANSI C, Tata McGraw-Hill Education, 2008.
9. Programming with C (Schaum's Outlines Series), McGraw Hill Education (India) Private Limited; 3rdEd, 2010.

EP303 (Core)	Nonlinear Physics	2–1–0–6	PH

Concept of nonlinearity in physical systems, Damped and Driven Nonlinear Oscillator; Nonlinear Oscillations and Bifurcations; Dynamical Systems as Coupled First-Order Differential Equations: Phase Space/Phase Plane and Phase Trajectories; Limit cycles, concept of integrability; Poincare Map, attractor, KAM Theorem;

Bifurcations and Onset of Chaos in Dissipative Systems; Bifurcation Scenario in Duffing Oscillator; Fractals, Spatio-temporal patterns, Nonlinear Electronic Circuits; Hamiltonian systems, Quantum & semi-classical chaos; Time series–analysis and characterization, Lyapunov exponents; Nonlinear wave equations, solitons, nonlinear Schrödinger equation, sine-Gordon equation, KdV equation, waves in nonlinear Kerr media; High-harmonic generation; Quantum dynamics of systems with nonlinear energy spectrum; Optical fibers; Nonlinear Matter wave, bright & dark solitons; Applications to plasma and atmospheric sciences; Nonlinear Physics for Technology.

Textbooks:

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability, chaos, and patterns, Springer, 2003.
2. Govind Agrawal, Nonlinear Fiber Optics, Academic Press, 2012.
3. S. H. Strogatz, Nonlinear Dynamics & Chaos, CRC Press, 2018.
4. R. Boyd, Nonlinear Optics, Academic Press, 2008.

Reference Books:

5. R. H. Enns and G. C. McGuire, Nonlinear Physics with Mathematica for Scientists and Engineers, Birkhäuser, Boston, 2001.
6. P. D. Drummond and M. Hillery, The Quantum Theory of Nonlinear Optics, Cambridge University Press, 2014.

EP305 (Core)	Semiconductor Devices and Applications	3-0-0-6	PH

Introduction to band theory; device architecture(s), physics of operation and device modeling, I-V characteristics and application of the following semiconductor devices: p-n junction diode, Zener diode, Schottky diode, photovoltaic cell, photodiode, tunnel diode, unijunction transistor, bipolar junction transistor, junction field effect transistor, metal oxide semiconductor field effect transistor and insulated gate bipolar transistor.

Device fabrication, introduction to cleanroom processes including wafer cleaning, deposition, lithography, diffusion, etching and bonding.

Textbooks:

1. B. G. Streetman and S. Banerjee, Solid State electronic devices, 6th Ed, PHI, 2006.
2. D. A. Neamen, Semiconductor physics and devices, 4th Ed, McGrawHill, 2012.

Reference Books:

3. S. M. Sze and Kwok Ng, Physics of Semiconductor Devices, 3rdEd, Wiley, 2006.
4. U. K. Mishra and J. Singh, Semiconductor Device Physics and Design, Springer, 2008.

EP361	Semiconductor Device Laboratory	0-0-3-3	PH

The list of experiments is as follows:

1. I – V characteristics of a Zener diode and voltage regulation by a Zener diode
2. I – V characteristics of a Schottky diode
3. I – V characteristics of a Tunnel diode
4. I – V characteristics of a Solar cell
5. I – V characteristics of a Silicon controlled rectifier
6. I – V characteristics of a Unijunction transistor
7. I – V characteristics of BJT in CE, CB and CC mode of operation
8. I – V characteristics of a JFET
9. I – V characteristics of a MOSFET, both for enhancement and depletion mode
10. I – V characteristics of a IGBT
11. Soldering semiconductor devices on PCB for making a circuit

YY3XX	Open Elective I	3-0-0-6	Science/Engineering Deptt.

EP3XX	Department Elective I	3-0-0-6	PH

EP3XX	Department Elective II	3-0-0-6	PH

Department Electives

1. EP321: Semiconductor Physics
2. EP323/PH402: Solid State Devices
3. EP325/PH301: Engineering Optics
4. EP327: Cryogenic Engineering
5. EP329: Laser Physics
6. EP331: Interfacing and data analysis
7. EP333: Computer aided engineering physics
8. EP335/PH527: Measurement Techniques

Semester VI

HS3XX	HSS Elective	3-0-0-6	HSS

EP302/PH420	Quantum Mechanics - II	3–1–0–8	PH

WKB Approximation, Bohr-Sommerfeld quantization condition; Time dependent perturbation theory, interaction picture; Constant and harmonic perturbations Fermi's Golden rule;

Scattering theory: Laboratory and centre of mass frames, differential and total scattering cross-sections, scattering amplitude; Born approximation, Greens functions, scattering for different kinds of potentials; Partial wave analysis;

Special topics in radiation theory: semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers; Symmetries in quantum mechanics: Conservation laws and degeneracy associated with symmetries; Continuous symmetries, space and time translations, rotations; Rotation group, Wigner-Eckart theorem; Discrete symmetries; parity and time reversal.

Relativistic quantum mechanics, Klein-Gordon equation, Interpretation of negative energy states and concept of antiparticles; Dirac equation, covariant form, adjoint equation; Plane wave solution and momentum space, spinors; Spin and magnetic moment of the electron.

Textbooks:

1. C. Cohen-Tannoudji, Quantum Mechanics (Vol-II), John Wiley & Sons (Asia), 2005.
2. J. J. Sakurai,Advanced Quantum Mechanics, Pearson Education, 2007.
3. R. Shankar, Principles of Quantum Mechanics, Springer (India), 2008.
12. C. Cohen-Tannoudji, B. Diu, F. Laloẽ, Quantum Mechanics (Vol-I), Herman & John Wiley & Sons (Asia), 2005.
13. J. J. Sakurai, Modern Quantum Mechanics, Pearson Education, 2002.
14. L. I. Schiff, Quantum Mechanics, McGraw-Hill, 1968.

Reference Books:

15. L. I. Schiff, Quantum Mechanics, McGraw-Hill, 1968.
16. E. Merzbacher, Quantum Mechanics, John Wiley (Asia), 1999.
17. V.K. Thankappan, Quantum Mechanics, Wiley Eastern, 1985.
18. R.P. Feynman, R.B. Leighton and M.Sands, The Feynman Lectures on Physics, Vol.3, Narosa Publication House, 1992.
19. P.A.M. Dirac, The Principles of Quantum Mechanics, Oxford University Press, 1991.
20. L.D.Landau and E.M. Lifshitz, Quantum Mechanics -Nonrelativistic Theory, 3rd Ed, Pergamon, 1981.
21. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Parson Education 2nd Ed, 2004.

EP304/PH424	Statistical Physics	3–1–0–8	PH

Review on Canonical and Grand Canonical Ensemble: Ideal Gases, Equation of state for ideal quantum gas, Einstein's derivation of Planck's Law: Maser and Laser ; Partition function Z: Translational, Rotational and Vibrational; Application of Z: Vapour pressure, Real gas and van der Waal gas; Ideal Bose-Einstein (BE) gas: BE distribution and condensation, Thermodynamic properties, Phase space distribution function and Liouville theorem, Ergodicity and H-theorem; Liquid He, Two fluid model of liquid He II, Superfluid phases of 3He; Ideal Fermi-Dirac (FD) gas: FD distribution and degeneracy, Equation of state of FD gas, Landau Diamagnetism, De-Haas van Alfen Effect, Quantized Hall effect, Pauli Paramagnetism, Magnetic properties of imperfect gas, Thermionic emission; Transport theory: Transport processes and distribution functions, Boltzmann equation in absence of collision, Calculation of electrical conductivity (s) and coefficient of viscosity (h), Boltzmann Differential Transport (BTE) equation, Scattering cross-section and symmetry properties, Reformulation of BTE, Approximation methods for solving BTE, Evaluation of s and h.

Textbooks:

1. F.Reif, Fundamentals of Statistical and Thermal Physics, Levant Books, 2010.

2. K.Huang, Introduction to Statistical Physics, Chapman and Hall/CRC, 2nd Ed, 2009.
3. R. K. Pathria and Paul D. Beale, Statistical Mechanics (Elsevier, 3rd Edition, 2011.

Reference Books:

4. F. Mandl, Statistical Physics, Wiley-Blackwell, ELBS Ed, 1988.
5. D. Chandler, Introduction to Modern Statistical Physics, Oxford University Press, 1987.
6. M.Pilschke and B.Bergerson, Equilibrium Statistical Physics,World Scientific, 1994.
7. B. P. Agarwal and M. Eisner, Statistical Mechanics, Wiley Eastern Limited, 1988.
8. C. M. van Vliet, Equilibrium and Non-equilibrium Statistical Mechanics,World Scientific, 2008.

EP306/PH428 Computational Physics 2-0-3-7 PH

Recapitulation of numerical techniques and errors of computation (rounding, truncation); Classical molecular dynamics simulations, Verlet algorithm, predictor corrector method, Continuous systems, hydrodynamic equations, particle in a cell and lattice Boltzmann methods; Schrodinger equation in a basis: numerical implementation of Numerov method, matrix methods and variational techniques; applications of basis functions for atomic, molecular, solid-state and nuclear calculations; Elements of Density functional theories; Monte Carlo simulations, Metropolis, critical slowing down and block algorithms with applications to classical and quantum lattice models; Tractable and intractable problems; P, NP and NP complete problems with examples; Shor and Grover algorithms; Quantum parallelism;

Textbooks:

1. T. Pang, An Introduction to Computationl Physics, Cambridge University Press, 2nd Ed, 2006.
2. S. E. Kooning and D. C. Meredith, Computational Physics, Westview Press, 1990.

Reference Books:

3. J. M. Thijssen, Computational Physics, Cambridge University Press, 2nd Ed, 2007.
4. R. H. Landau, M. J. PáezMejía and C. C. Bordeianu, A Survey of Computational Physics: Introductory Computational Science, Vol1, Princeton University Press, 2008.

EP362 Advanced Physics Lab 0-0-3-3 PH

The list of experiments is as follows:

1. Normal and AnomalousZeeman effect
2. Reynolds Experiment
3. Stark effect
4. Pockel's effect
5. Thermoelectric effect
6. Nuclear magnetic resonance
7. Electron spin resonance
8. Particle Image Velocimetry (PIV) measurements
9. Phase transition of BarriumTitanate with temperature
10. Magnetic susceptibility of a paramagnetic salt using Quinck's Tube method
11. Magnetic hysteresis loop
12. Electric hysteresis loop
13. Magnetoresistance
14. Determination of bandgap of a semiconductor
15. Dusty Plasma experiment
16. Muon lifetime detection
17. Gamma correlation experiment
18. Piezoelectric effect
19. Belousov-Zhabotinsky (bz) reaction

Semester VII

EP401/PH521 Atomic & Molecular Physics 3-1-0-8 PH

One electron atoms , Schrodinger equation for one-electron atoms, Interaction of one electron atoms with electromagnetic radiation, Transition rates, The dipole approximation, The Einstein coefficients, Selection rules, Spectrum of one electron atoms, Line intensities and the life time of the excited states, Line shapes and widths, Fine structure and Hyperfine structure, The Lamb Shift, Zeeman and Stark effect, Many electron systems: central field approximation, Thomas Fermi model, Hartree-Fock method and the SCF, L-S coupling and j-j coupling, Introduction to the Density functional theory, Interaction of many electron atoms with electromagnetic radiation, Molecular structure, Born -Oppenheimer approximation, The rotation and vibration of diatomic molecules, Electronic structure of diatomic molecule, Rotational and Vibrational Spectra of diatomic molecules, Electronic spectra of diatomic molecules, The Franck-Condon principle.

Textbooks:

1. B.H. Bransden and C.J. Joachain, Physics of atoms and molecules, Longman Scietific and Technical, 1983.

2. W. Gordon and F.Drake, Springer handbook of atomic, molecular, and optical physics, Springer, 2006.
3. W. Demtroder, Atoms, Molecules and Photons, Springer, 2010.
4. H. Haken and H.C. Wolf, Physics of Atoms and Quanta, Springer, 2005.

Reference Books:

5. I. N. Levine, Quantum Chemistry, 6th Ed, PHI Learning Private Limited, New Delhi, 2009.
6. J. P. Lowe and K. A. Peterson, Quantum Chemistry, 3rd Ed, Academic Press 2009.
7. P. Atkins and R. Friedman, Molecular Quantum Mechanics, Oxford University Press, 4th Ed, 2012.
8. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed, Tata McGraw Hills, 2008.

EP403/PH523 Solid State Physics 3-1-0-8 PH

Crystal physics: Symmetry operations; Bravais lattices; Point and space groups; Miller indices and reciprocal lattice; Structure determination; diffraction; X-ray, electron and neutron; Crystal binding; Defects in crystals; Point and line defects.

Lattice vibration and thermal properties: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; phonons and quantization; Brillouin zones; thermal conductivity of metals and insulators.

Electronic & Magnetic properties: Free electron theory of metals; electrons in a periodic potential; Bloch equation; Kronig-Penny model; band theory; Semiconductor physics; Quantum Hall effect. Dielectric Response. Magnetic properties.

Superconductivity: General properties of superconductors, Meissner effect; London equations; coherence length; type-I and type-II superconductors.

Noncrystalline Solids: Glasses, Amorphous ferromagnets, Amorphous Semiconductors.

Quasicrystals: Stable quasicrystal, metastable quasicrystal.

Textbooks:

1. C. Kittel, Introduction to Solid State Physics, Wiley India, 2009.
2. M. A. Omar, Elementary Solid State Physics, Addison-Wesley, 2009.

Reference Books:

3. A. J. Dekker, Solid State Physics, Macmillan, 2009.
4. N. W. Ashcroft and N. D. Mermin, Solid State Physics, HBC Publication, 1976.
5. H. P. Myers, Introduction to Solid State Physics, Taylor and Francis, 1997.
6. R.Zallen, The Physics of Amorphous Solids, John Wiley and Sons Inc.,1983.
7. O. Madelung, Introduction to Solid-state theory, Springer Series in Solid-State Sciences, 1978.
8. S. H. Simon, The Oxford Solid State Basics, Oxford University Press, 2013.

EP461	Quantum Techniques Lab	0-0-3-3	PH

The list of experiments is as follows:

1. Quantum Entanglement Demonstrator
2. Absolute Efficiency Measurement System for Single Photon Counting Detectors
3. Two Photon Interferometer
4. Quantum Cryptography Analogy Demonstration
5. Experiment on Magnetic Levitation
6. Josephson Junction based Experiment
7. IBM Quantum Experiments for quantum computing
8. Break junction and quantum behavior in conductivity
9. Spectroscopy of various gas samples
10. DavissonGermer experiment
11. Macroscopic quantum state in high temperature superconductor(htsc): zeroresistivity and flux expulsion
12. Transition edge detectors using htsc superconducting films
13. dHvA measurement
14. AC susceptibility for magnetic phase transition
15. Demonstration of Coulomb blockade effect
16. Modification of spontaneous emission in micro-cavity environment
17. Surface plasmon polaritons

YY4XX	Open Elective II	3-0-0-6	Science/ Engineering Deptt.

EP497	B.Tech Project	0-0-6-6	PH

Semester VIII

EP498	B.Tech Project	0-0-12-12	PH

EPXXX	Department Elective III	3-0-0-6	PH

EPXXX	Department Elective IV	3-0-0-6	PH

EPXXX	Department Elective V	3-0-0-6	PH

Department Electives

(1) EP410/PH403: Photovoltaics & Fuel Cell Technology
(2) EP412: Renewable Energy for Electric Vehicles
(3) EP414/PH503: Nanophotonics
(4) EP416/PH609: Fourier Optics and Holography
(5) EP418: Micro- and Nano-scale Photonic Devices: Fabrication, Theory, and Their Applications
(6) EP420: Advanced Techniques in Condensed Matter Physics
(7) EP422: Modern microscopy techniques
(8) EP424/PH605: Medical physics
(9) EP426: Physics of nanomaterials
(10) EP428: Transport properties of the materials
(11) EP430/PH606: Magnetic materials and application
(12) EP432: Structure of the materials
(13) EP434: Materials preparation
(14) EP436: Ultrafast Spectroscopy
(15) EP438: Soft-condensed matter Physics
(16) EP440: Nanoelectronics
(17) EP442: Spintronics
(18) EP444: Quantum Materials
(19) EP446: Quantum field theory
(20) EP448: Particle physics
(21) EP450: Experimental techniques in high energy physics
(22) EP452/PH601: Nanoscience
(23) EP454/PH602: Quantum Optics & Quantum Information
(24) EP456/PH603: Physics of Ultracold Atoms
(25) EP458/PH604: Biophotonics
(26) EP460/PH607: Materials for Engineering Applications
(27) EP462/PH608: Atomic collision physics
(28) EP464/PH610: Introductory Biophysics

Annexure 2

List of additional electives for B. Tech Engineering Physics

Semester	Course Code	Course name	L-T-P-Credit	Offering Department
Semester V	EP337/PH422	Applied Optics	3-0-0-6	PH
	EP339	Science and Engg. of Energy storage	3-0-0-6	PH
	EP341			
	EP343			
	EP345			
	EP347			
	EP349			

Ayush Kanto Mukherjee