Curriculum and Syllabi of

B.Tech.
in
Engineering Physics

School of Basic Sciences
IIT Bhubaneswar

Table of Contents

Curriculum Structure
1st Semester to 8th Semester

Subject Name	Subject Code	L-T-P	Credit	Contact Hour
Semester – I				
Mathematics-1	MA1L001	3-1-0	4	4
Physics/Chemistry	PH1L001/ CY1L001	3-1-0	4	4
Mechanics /English for Communications or Learning English	ME1L001 / HS1L001 or HS1L002	3-1-0/ 3-0-2 or 3-1-0	4	4/5 or 4
Electrical Technology/Introduction to Programing and Data Structures	EE1L001 / CS1L001	3-1-0	4	4
Physics Laboratory/Chemistry Laboratory	PH1P001/ CY1P001	0-0-3	2	3
Introduction to Manufacturing Processes/ Engineering Drawing and Graphics	ME1P001/ CE1P001	0-0-3/ 1-0-3	2/3	3/4
Electrical Technology Laboratory/Introduction to Programming and Data Structures Laboratory	EE1P001/ CS 1P001	0-0-3	2	3
Extra Academic Activity-1	ID1T001	0-0-3	1	3
		Total	**23/24**	**25/27 or 26+3**
Semester – II				
Mathematics-2	MA1L002	3-1-0	4	4
Chemistry/Physics	CY1L001/ PH1L001	3-1-0	4	4
English for Communication or Learning English/ Mechanics	HS1L001 or HS1L002/ ME1L001	3-0-2 or 3-1-0/ 3-1-0	4	5 or 4/ 4
Introduction to Programming and Data Structures/ Electrical Technology	CS1L001/ EE1L001	3-1-0	4	4
Chemistry Laboratory/Physics Laboratory	CY1P001/ PH1P001	0-0-3	2	3
Engineering Drawing and Graphics/Introduction to Manufacturing Processes	CE1P001/ ME1P001	1-0-3/ 0-0-3	3/2	4/3
Extra Academic Activity -2	ID1T002	0-0-3	1	3
		Total	**22/23**	**27 or 26/25 +3**
Semester – III				
Mathematical Methods for Physics	EP2L001	3-1-0	4	4
Classical Mechanics and Special Relativity	EP2L002	3-0-0	3	3
Thermal Physics	EP2L003	3-0-0	3	3
Engineering Physics Lab-I	EP2P001	0-0-6	4	6
Introduction to Material Science and Engineering	ID2L001	2-0-0	2	2
Introduction to Bioscience and Technology	ID2L002	2-0-0	2	2
Basic Electronics	EC2L005	3-1-0	4	4
Basic Electronics Laboratory	EC2P005	0-0-3	2	3

		Total	**24**	**27**
Semester – IV				
Electromagnetic Theory and Applications	EP2L004	3-0-0	3	3
Elements of Quantum Mechanics	EP2L005	3-0-0	3	3
Statistical Physics	EP2L006	3-0-0	3	3
Numerical Techniques and Computational Physics	EP2L007	2-0-2	3	4
Engineering Physics Lab-II	EP2P002	0-0-6	4	6
Environmental Science Technology and Management	ID2L003	2-0-0	2	2
Lateral-1			3	3
Breadth-1			3	3
		Total	**24**	**27**
Semester – V				
Applied Optics	EP3L001	3-0-0	3	3
Solid State Physics	EP3L002	4-0-0	4	4
Physics of Atomic and Molecules	EP3L003	3-0-0	3	3
Advanced Quantum Mechanics	EP3L004	3-0-0	3	3
Engineering Physics Lab-III	EP3P001	0-0-6	4	6
Lateral-2			3/4	3/4
Breadth-2			3/4	3/4
		Total	**23/25**	**25/27**
Semester – VI				
Experimental techniques in Physics	EP3L005	3-0-0	3	3
Introduction to Nuclear and Particle Physics	EP3L006	3-0-0	3	3
Product Development Lab	EP3P002	0-0-9	6	9
Seminar	EP3S001	0-0-2	2	2
Elective-1		3-0-0	3	3
Lateral-3			3/4	3/4
Breadth-3			3/4	3/4
		Total	**23/25**	**26/28**
Semester –VII				
Elective-2		3-0-0	3	3
Elective-3		3-0-0	3	3
Elective-4		3-0-0	3	3
Elective-5		3-0-0	3	3
Industrial Training Defence	EP4T001	0-0-0	2	0
Project-I	EP4D001	0-0-0	4	6
Breadth-4			3/4	3/4
		Total	**21/22**	**21/22**
Semester-VIII				
Elective-6		3-0-0	3	3
Elective-7		3-0-0	3	3
Elective-8		3-0-0	3	3
Elective-9		3-0-0	3	3
Project-II	EP4D001	0-0-0	6	9
		Total	**18**	**21**
Cumulative total			**178/183**	**199/204**

Total Credit for proposed curriculum: 179/183 (Total Contact Hours: 198/204)

List of Elective Courses from the Discipline:

Name	Code	L-T-P	Credit	Contact Hours
Courses in the pool of Devices and Technology				
Vacuum Science and Thin Films Technology	EP4L010	3-0-0	3	3
Semiconductor Device Physics	EP4L011	3-0-0	3	3
Device Fabrication Technology	EP4L012	3-0-0	3	3
Nanoscale Transport Phenomena	EP4L013	3-0-0	3	3
Magnetism and Spintronic Devices	EP4L014	3-0-0	3	3
Selected Topics in Devices and Technology	EP4L015	3-0-0	3	3
Courses in the pool of Optics and Photonics				
Fiber and Integrated Optics	EP4L020	3-0-0	3	3
Optoelectronics Devices and Systems	EP4L021	3-0-0	3	3
Introduction to Nonlinear optics	EP4L022	3-0-0	3	3
Introduction to Quantum Optics	EP4L023	3-0-0	3	3
Selected Topics in Optics and Photonics	EP4L024	3-0-0	3	3
Courses in the pool of Quantum Information and Technology				
Concepts of Quantum Computing & Quantum Algorithms	EP4L030	3-0-0	3	3
Quantum Communications, Cryptography, and Error Correction	EP4L031	3-0-0	3	3
Architecture and Hardware for Quantum Computer	EP4L032	3-0-0	3	3
Open Quantum Systems and Quantum Devices	EP4L033	3-0-0	3	3
Courses in the pool of Biophysics and Soft Matter				
Biomaterials and its Applications	EP4L040	3-0-0	3	3
Introduction to Soft Matter	EP4L041	3-0-0	3	3
Polymer Physics	EP4L042	3-0-0	3	3
Medical Physics	EP4L043	3-0-0	3	3
Other Courses				
Advanced Statistical Mechanics	EP4L050	3-0-0	3	3
Plasma Science and Technology	EP4L051	3-0-0	3	3
Advanced Modelling Techniques	EP4L052	3-0-0	3	3
Experimental High Energy Physics	EP4L053	3-0-0	3	3
Physics and Applications of Accelerators	EP4L054	3-0-0	3	3
Selected Topics in Condensed Matter Physics	EP4L055	3-0-0	3	3
Selected Topics in Theoretical Physics	EP4L056	3-0-0	3	3
Econophysics	EP4L057	3-0-0	3	3
Physics of Financial Markets	EP4L058	3-0-0	3	3
MSc Physics Elective courses				
Non Equilibrium Phenomena in Physics	PH7L003	3-0-0	3	3
General Relativity and Cosmology	PH7L006	3-0-0	3	3
Quantum Field Theory	PH7L007	3-0-0	3	3
Particle Physics	PH7L009	3-0-0	3	3
Quantum Field Theory II	PH7L015	3-0-0	3	3

List of Electives Courses from Other Schools:

Subject Name	Subject Code	L-T-P	Credit	Contact Hours
Power Electronics	EE3L004	3-1-0	4	4
Control Systems	EE3L003	3-1-0	4	4
Biomedical Systems	EC3L004	3-0-0	3	3
Artificial Intelligence	CS6L019	3-0-0	3	3
Semiconductor Devices	EC4L001	3-0-0	3	3
Statistical Signal Processing	EC6L005	3-0-0	3	3
Energy Storage Systems	EE6L011	3-0-0	3	3
Machine Learning and Data Analytics- I	ID6L004	3-0-0	3	3
3Natural Language Processing	CS6L027	3-0-0	3	3
Crystallography and x-ray diffraction	ML4L007	3-0-0	3	3
Robotics	ME3L014	3-0-0	3	3
Micro Electro Mechanical Systems	ML4L008	3-0-0	3	3
Data Analytics	ID6L001	3-0-0	3	3
Industrial Instrumentation	EE6L007	3-0-0	3	3
Optical Communication	EC6L012	3-0-0	3	3
Photonic Network	EC6L014	3-0-0	3	3
Semiconductor Device Modeling	EC6L017	3-0-0	3	3
Fiber Optic Sensors	EC6L019	3-0-0	3	3
Internet of Things	CS6L024	3-0-0	3	3
Artificial Intelligence	CS6L019	3-0-0	3	3
Machine Learning & Data Analytics-II	ID6L005	3-0-0	3	3
MEMS & Microsystems Technology	ME6L062	3-0-0	3	3
Microfluidics	ME6L160	3-0-0	3	3
High Performance Computing	CS4L019	3-0-0	3	3

Baskets of Electives for Each Semester [suggested]

Basket of Courses for Elective-1 (for semester VI):
Vacuum Science and Thin Films Technology (EP4L010; 3-0-0; 3)
Fiber and Integrated Optics (EP4L020; 3-0-0; 3)
Advanced Statistical Mechanics (EP4L050; 3-0-0; 3)
Plasma Science and Technology (EP4L051; 3-0-0; 3)
Introduction to Soft Matter (EP4L041; 3-0-0; 3)
Concepts of Quantum Computing & Quantum Algorithms (EP4L030; 3-0-0)

Basket of Courses for Elective-2 (for semester VII):
Semiconductor Device Physics (EP4L011; 3-0-0; 3)
Introduction to Nonlinear optics (EP4L022 8; 3-0-0; 3)
Advanced Modelling Techniques (EP4L052; 3-0-0; 3)
Quantum Communications, Cryptography, & Error Correction (EP4L031; 3-0-0)
Physics and Applications of Accelerators (EP4L052; 3-0-0; 3)
Quantum Field Theory (PH7L007; 3-0-0; 3)

Basket of Courses for Elective-3 (for semester VII):
Device Fabrication Technology (EP4L012; 3-0-0; 3)-E3
Optoelectronic Devices and Systems (EP4L021; 3-0-0; 3)
Polymer Physics (EP4L042; 3-0-0; 3)
Econophysics (EP4L057; 3-0-0; 3)
Particle Physics (PH4L009; 3-0-0; 3)

Basket of Courses for Elective-4 (for semester VII):
Power Electronics (EE3L004 (3-1-0; 4)
Biomedical Systems (EC3L004; 3-0-0; 3)
Artificial Intelligence (CS6L019; 3-0-0; 3)
Energy Storage Systems (EE6L011; 3-0-0; 3)
Machine Learning and Data Analytics- I (ID6L004; 3-0-0; 3)
Crystallography and x-ray diffraction (ML4L007; 3-0-0; 3)

Basket of Courses for Elective-5 (for semester VII):
Control Systems (EE3L003; 3-1-0; 4)
Semiconductor Devices (EC4L001; 3-0-0; 3)
Statistical Signal Processing (EC6L005; 3-0-0; 3)
Natural Language Processing (CS6L027; 3-0-0; 3)
Robotics (ME3L014; 3-0-0; 3)
Micro Electro Mechanical Systems (ML4L008; 3-0-0; 3)

Basket of Courses for Elective-6 (for semester VIII):
Magnetism and Spintronic Devices (EP4L014; 3-0-0; 3)
Introduction to Quantum Optics (EP4L023; 3-0-0; 3)
Experimental High Energy Physics (EP4L053; 3-0-0; 3)
Biomaterials and its Applications (EP4L040; 3-0-0; 3)
Architecture & Hardware for Quantum Computer (EP4L032; 3-0-0)

Basket of Courses for Elective-7 (for semester VIII):
Nanoscale Transport Phenomena (EP4L013; 3-0-0; 3)
Medical Physics (EP4L043; 3-0-0; 3)
Open Quantum Systems and Quantum Devices (EP4L033; 3-0-0)
Selected Topics in Theoretical Physics (EP4L056; 3-0-0; 3)
Physics of Financial Markets (EP4L058; 3-0-0; 3)

Non Equilibrium Phenomena in Physics (PH7L003; 3-0-0; 3)
Quantum Field Theory-II (PH7L015; 3-0-0; 3)

Basket of Courses for Elective-8 (for semester VIII):

Data Analytics (ID6L001; 3-0-0; 3)
Photonic Network (EC6L014; 3-0-0; 3)
Fiber Optic Sensors (EC6L019; 3-0-0; 3)
Artificial Intelligence (CS6L019; 3-0-0; 3)
Microfluidics (ME6L160; 3-0-0; 3)
High Performance Computing (CS4L019; 3-0-0; 3)

Basket of Courses for Elective-9 (for semester VIII):

Industrial Instrumentation (EE6L007; 3-0-0; 3)
Optical Communication (EC6L012; 3-0-0; 3)
Semiconductor Device Modeling (EC6L017; 3-0-0; 3)
Internet of Things (CS6L024; 3-0-0; 3)
Machine Learning & Data Analytics-II (ID6L005; 3-0-0; 3)
MEMS & Microsystems Technology (ME6L062; 3-0-0; 3)

Syllabi of the First Year Courses
(Common to all B.Tech. students)

Subject Name: Mathematics-1 (Pre-requisite(s): Nil)
Subject Code: MA1L001
L-T-P: 3-1-0
Credits: 4
Syllabus: Calculus: Rolle's theorem, Lagranges theorem, Cauchy's mean value theorem (Taylor's and Maclaurin theorems with remainders), Indeterminate forms, Concavity and convexity of a curve, points of inflexion, maximum, minimum of a function, 2nd derivative test for max min, Asymptotes and curvature, Cartesian curve tracing, polar curve tracing. Calculus of Several Variables: Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables, maxima and minima of functions of several variables, Lagrange's method of multipliers. Vector Calculus: Double and triple integrals, Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, line and surface integrals, theorems of Green, Gauss and Stokes. Beta and Gamma functions. Ordinary Differential Equations: First order differential equations, exact, linear and Bernoulli's form, second order differential equations with constant coefficients, Euler's equations, particular integrals by: variation of parameters, undetermined coefficients, operator method, system of differential equations.
Text Books:
1. Narayan S. and Mittal P. K. Differential Calculus and Integral Calculus, S. Chand & Company Ltd.
2. Thomas G. B. and Finney R. L. Calculus and Analytic Geometry, Pearson
3. Kreyszig E. Advanced Engineering Mathematics, John Wiley & Sons
5. Simmons G. F. and Robertson J. S. Differential Equations with applications and Historical notes, Tata McGraw-Hill Publishing Company Limited, New Delhi, India
Reference Books:
1. Bartle R. G. and Sherbert D. R. Introduction to Real Analysis, Wiley India
2. Jain R. K. and Iyengar S. R. K. Advanced Engineering Mathematics, Narosa
3. Apostol T. M. Calculus - Vol.2, Wiley India
4. Ross S. L. Differential Equations, Wiley India
5. Coddington E. A. An Introduction to Ordinary Differential Equations, Prentice Hall

Subject Name: Physics (Pre-requisite(s): Nil**)**
Subject Code: PH1L001
L-T-P: 3-1-0
Credit: 4
Syllabus: Classical Physics: Review of Newtonian mechanics, Lagrangian mechanics, constraints, principle of virtual work, D'Alembert's principle, Action Principle and Lagrange's

equations, Velocity dependent potentials, Legendre Transformation and Hamiltonian equations, Central forces, Kepler's problem, Waves and Oscillations, Damped and Forced Oscillations, normal modes, Basics of Special Relativity, Galilean and Lorentz transformations, Time dilation and length contraction, relativistic kinematics and mass- energy equivalence. Electromagnetic Waves and Optics: Maxwell's equations, wave equation, plane electromagnetic waves, longitudinal and transverse waves, superposition, wave packets, two and three dimensional waves, energy- momentum, Poynting's theorem, electromagnetic boundary conditions, Laser, Young's experiment, interferometers, diffraction, Fraunhofer diffraction (single slit), dispersion. Wave Mechanics: Failure of classical physics, qualitative review of relevant experiments, de Broglie waves, uncertainty principle, wave function and Schrodinger equation, probability interpretation, particle on a chain, potential barrier and quantum tunneling, potential well, Harmonic oscillator, operator algebra, Hydrogen atom and angular momentum algebra.

Text/Reference Books:

1. Crawford F.S. Waves, Vol. 3, Berkely Physics Series.
2. Goldstein, Classical Mechanics, Pole and Safko, Pearson Education Inc.
3. Saleh and Teich. Fundamentals of Photonics, Wiley-Interscience.
4. Ghatak A. Optics, McGraw-Hill.
5. Griffiths D.J. Introduction to Quantum Mechanics, Pearson Education Inc.
6. Pain H. J. The Physics of Vibrations and Waves, Wiley.
7. Resnick R. Introduction to Special Relativity, John Wiley (Asia).
8. Landau L. and Lifshitz E. Mechanics, Oxford
9. Zweibach B. A First Course in String Theory, Cambridge University Press
10. Hecht E. Introduction to Optics, Addison-Wesley.
11. Feynmann Lecture series on Physics.
12. Sakurai J. J. Modern Quantum Mechanics, Benjamin-Cummings.

Subject Name: Chemistry (Pre-requisite(s): Nil**)**
Subject Code: CY1L001
L-T-P: 3-1-0
Credit: 4

Syllabus: Energetics & Kinetics: (a) Basic Concepts and Laws of Thermodynamics; Entropy; Engineering Devices: Efficiency & Conversion; Thermochemistry; Bioenergetics. (b) Basic Rate Laws; Multistep Reactions; Activation Energy. (c) Transport of Ions and Gases in biofluids and across biomembranes; Equilibrium: Proton Equilibrium (aqueous & non- aqueous) including Buffers. Phase Equilibrium. Redox & Electrochemistry: Basic Concepts & Laws; Battery (Automobile to Ni-Cd and beyond); Fuel Cells; Latimer, Frost, and Pourbaix diagram; Corrosion. Bonding Models & Properties: (a) In Molecules, Supramolecules, Metals and Metal Complexes; (b) Implications on electrical, magnetic, and optical properties, (c) Absorption and Emission Spectroscopy. Functional Materials - Design & Application: (a) Synthetic Polymers (carbon framework, silicon framework, fluorinated polymer), Bio & biodegradable polymers. (b) Surfactants. (c) Nanostructures, Soft materials and Thin Films. (b) Emerging applications in Energy harvesting, Memory Storage and Micro-fabrication. Industrial & Bio-inspired Chemistry: (a) Case studies on Industrial organics with emphasis to Drugs (b) Oxidation, Reduction, Catalytic hydrogenation and Electron transfer. Molecules in Daily Life: A short tour on molecules behind taste, smell, pain, colour and sex.

Text/Reference Books:

1. Brown L. and Holme, T. Chemistry for Engineering Students, Thomson Brooks.
2. Atkins P. and Paula J. D. Atkins' Physical Chemistry, Oxford.
3. Shriver, D. F. and Atkins, P. W. Atkins' Inorganic Chemistry, Oxford.
4. Morrison R. T. and Boyd R. N. Organic Chemistry, Prentice Hall.
5. Steed J. W. and Atwood J. L. Supramolecular Chemistry, John-Wiley.
6. Caruther W. Reagents in Organic Chemistry, Cambridge University Press.
7. Wiseman P. An Introduction to Industrial Organic Chemistry, Applied Science.
8. Hall N. The New Chemistry, Cambridge University Press.
9. Atkins P. Atkins' Molecules Cambridge University Press.
10. Cengel Y. A. and Boles M. A. Thermodynamics-An Engineering Approach, Tata McGraw-Hill

Subject Name: Mechanics (Pre-requisite(s): Nil**)**
Subject Code: ME1L001
L-T-P: 3-1-0
Credit: 4
Syllabus: Force systems: Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple. Equilibrium: Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses. Friction: Laws of Coulomb friction, problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance. Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion. Properties of areas: Moments of inertia and product of inertia of areas, polar moment of inertia, principal axes and principal moments of inertia. Concept of stress and strain: Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; analysis of axially loaded members. Torsion: Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation. Flexural loading: Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams. Transformation of stress and strain: Transformation of stress and strain, principal stresses, principal strains, Mohr's circle for stress and strain. Combined loading: Axial and torsional; axial and bending; axial, torsional and bending. Column: Buckling of slender columns, Euler bucking load for different end conditions.
Text/Reference Books:

1. Vector Mechanics for Engineers: Statics and Dynamics - Ferdinand P. Beer, E. Russell Johnston, Jr. (TMH)
2. Engineering Mechanics: Statics and Dynamics - I.H. Shames (Pearson)
3. Engineering Mechanics - S. Timoshenko, D. H. Young (TMH)
4. Mechanics of Materials - Ferdinand Beer , E. Russell Johnston, Jr., J. DeWolf (TMH)
5. Elements of Strength of Materials - S. Timoshenko, D. H. Young (East West Press)
6. Mechanics of Materials - James M. Gere, Barry J. Goodno (CL Engg)
7. Engineering Mechanics - Stephan Timoshenko, D. Young (TMH)
8. Strength of Materials (Part 1) – S P Timoshenko (CBS)

Subject Name: English for Communication (Pre-requisite(s): Nil**)**
Subject Code: HS1L001
L-T-P: 3-1-0
Credit: 4
Syllabus: English for Communication is an amalgamation of Literature, Language and Communication. The Literature component of the course comprises of Prose and Poetry. Poetry: A selection of poetry pieces spanning from 16th century to the Post-Modern Period in English, American and Indian Literature are chosen to introduce to the students to the different poets from different ages and countries and also to acquaint them with the various poetic forms like Sonnet, Ballad, Elegy, Didactic, Dramatic, Nature, Lyric, Romantic, etc. The list is an indicative one. 16th century- 17th century- Geoffrey Chaucer, William Shakespeare, Edmund Spenser, Ben Johnson, Thomas Wyatt. 17th century- 18th century- John Milton, John Donne, George Herbert, John Dryden, Oliver Goldsmith. 18th century- 19th century- Alexander Pope, Thomas Gray, Robert Burns, William Blake, William Wordsworth, Samuel Taylor Coleridge, Lord Byron, P.B. Shelley, John Keats, Robert Bridges, Robert Southey, Samuel Johnson. 19th century- 20th century- Alfred Tennyson, Robert Browning, Walter de la Mare, Thomas Hardy, A.E. Housman, Rudyard Kipling, D.H. Lawrence, Wilfred Owen, D.G. Rossetti, Christina Rossetti, Emily Dickinson, Gerald Manley Hopkins, Charlotte Bronte, Lewis Caroll, Edward Fitzgerald, Walt Whitman. 20th century- Present- Ted Hughes, Louis MacNeice, W.B. Yeats, Stephen Spender, W.H. Auden, Nissim Ezekiel, Sarojini Naidu, Jayanta Mahapatra, Robert Frost, , Ezra Pound, E.E. Cummings, T.S. Eliot, Walt Whitman, A.K. Ramanujan, Kamala Das, Rabindranath Tagore, Jack Prelutsky, Chinua Achebe, Maya Angelou, Margaret Atwood, Leonard Cohen, Louise Erdrich, Leslie Marmon Silko.
Prose:
A selection of fictional and non-fictional prose pieces spanning from 17th century to the Post-Modern Period. Fiction and non-fictional pieces from English, American, Russian and Indian Literature are chosen to introduce the students to different writings from different ages and countries. The list is an inclusive one consisting of short stories, essays, excerpts, extracts from novels, biographies and memoirs, history, travel and other forms. 17th century-18th century: Charles Dickens, William Makepeace Thackeray, George Eliot, Thomas Hardy, Lewis Carroll, Arthur Conan Doyle, John Bunyan, Rudyard Kipling, H.G. Wells, R.L, Stevenson, Jane Austen, Emily Bronte, Charles Lamb, F.M. Dostoyevsky, Nikolai Gogol, Daniel Dafoe, Jonathan Swift, Lewis Carroll; 19th century- 20th century: Oscar Wilde, O Henry, H.H. Munro, Mark Twain, Somerset Maughaum, Nathaniel Hawthorne, G.B. Shaw, G.K. Chesterton, Agatha Christie, Gerald Durrell, Will Durant, E.M. Forster, Aldous Huxley, Henry David Thoreau, Anton Chekov, Maxim Gorky, Leo Tolstoy, George Orwell, Rabindranath Tagore, M.K. Gandhi, J. Nehru, Virginia Woolf, Guy De Maupassant, Washington Irving, Margaret Fuller, Charles Darwin, Arthur Conan Doyle, F. Scott Fitzgerald, Ernest Hemingway, Edgar Allan Poe. 20th century- Present: J.M. Coetzee, R.K. Narayan, R.K. Laxman, A.P.J. Abdul Kalam, Khushwant Singh, Anita Desai, Yann Martel, Ken Kesey, Stephen King, Thomas King, Richard Wright, N Scott Momaday, Chetan Bhagat, J. Krishnamurthy, Virginia Woolf, Gerald Vizenor, Alice Walker, Chinua Achebe, Jeffrey Archer, Issac Asimov, Roald Dahl, J.R.R. Tolkien, D.H. Lawrence, James Joyce, Oran Pamuk, Salman Rushdie, Bertrand Russell, Ruskin Bond, A.G. Gardiner, John

Steinbeck. Communication: Because communication is so important in business, businesses want and need people with good communication skills. Business communication is a blend of skills like writing and speaking well, displaying proper etiquettes and listening attentively. Communications through technology greatly enhances one's ability to communicate effectively and articulately. For example, E-mails often result in a sender's language skills being placed in front of different people simultaneously; while audio and video will reveal the calibre of one's verbal and diplomatic strengths. The communication aspect of the English for Communication Course includes:

1. The Basics of Business Communication
2. Importance of Listening
3. Barriers in the Communication Process
4. Business Letters (Letter of Inquiry, Complaint, Cover Letter)
5. Resume Writing
6. Memo and Memo Reports
7. Report Writing
8. Fax and E Mail

English Laboratory:

Objective: The laboratory component included in the course provides an ideal platform for students to prepare themselves into confident and self-assured individuals. The Lab course is designed to inculcate confidence and clarity in presentation and expression of thought, views and ideas through practice and exercises. It constitutes six basic components to improve listening, reading and writing skill of the students.

Lessons:

1. Pronunciation (Basic sounds of English like Long/Short Vowels; All consonants)
2. Stress Intonation (Rising and Falling)
3. Speaking- Oral Presentations, Group Discussions, Story Telling, Role Plays
4. Listening – Importance and Practice
5. Reading- Practice
6. Writing (Paragraph writing, good writing and bad writing with samples, Indianism), Grammar (Basic- Articles, Prepositions, Verbs, Common Errors , etc)

Text/Reference Books:

1. John Seely, The Oxford Guide to Writing and Speaking, OUP
2. Krishna Mohan and Meenakshi Raman, Effective English Communication, TMH
3. R.W.Lesikar and John.D. Pettit, Business Communication: Theory and Application, All India Traveller Bookseller
4. Francis Soundaraj, Speaking and Writing for Effective Business Communication, Macmillan.
5. Herta A. Murphy, et al., Effective Business Communication, Tata Mc-Graw Hill: New Delhi
6. Ronald B. Adler and George Rodman, Understanding Human Communication, Oxford University Press: New York

Subject Name: Learning English (Pre-requisite(s): Nil**)**
Subject Code: HS1L002
L-T-P: 3-1-0
Credit: 4

Syllabus: The Learning English Course is designed to improve the English Listening, Speaking, Reading and Speaking skills of students.

I. Prose

A selection of fictional and non-fictional prose pieces spanning from 17th century to the Post-Modern Period. Fiction and non-fictional pieces from English, American, Russian and Indian Literature are chosen to introduce the students to different writings from different ages and countries. The list is an inclusive one consisting of short stories, essays, excerpts, extracts from novels, biographies and memoirs, history, travel and other forms.

17th century- 18th century- Charles Dickens, William Makepeace Thackeray, George Eliot, Thomas Hardy, Lewis Carroll, Arthur Conan Doyle, John Bunyan, Rudyard Kipling,

H.G. Wells, R.L, Stevenson, Jane Austen, Emily Bronte, Charles Lamb, F.M. Dostoyevsky, Nikolai Gogol, Daniel Dafoe, Jonathan Swift, Lewis Carroll.

19th century- 20th century- Oscar Wilde, O Henry, H.H. Munro, Mark Twain, Somerset Maughaum, Nathaniel Hawthorne, G.B. Shaw, G.K. Chesterton, Agatha Christie, Gerald Durrell, Will Durant, E.M. Forster, Aldous Huxley, Henry David Thoreau, Anton Chekov, Maxim Gorky, Leo Tolstoy, George Orwell, Rabindranath Tagore, M.K. Gandhi, J. Nehru, Virginia Woolf, Guy De Maupassant, Washington Irving, Margaret Fuller, Charles Darwin, Arthur Conan Doyle, F. Scott Fitzgerald, Ernest Hemingway, Edgar Allan Poe.

20th century- Present- J.M. Coetzee, R.K. Narayan, R.K. Laxman, A.P.J. Abdul Kalam, Khushwant Singh, Anita Desai, Yann Martel, Ken Kesey, Stephen King, Thomas King, Richard Wright, N Scott Momaday, Chetan Bhagat, J. Krishnamurthy, Virginia Woolf, Gerald Vizenor, Alice Walker, Chinua Achebe, Jeffrey Archer, Issac Asimov, Roald Dahl,

J.R.R. Tolkien, D.H. Lawrence, James Joyce, Oran Pamuk, Salman Rushdie, Bertrand Russell, Ruskin Bond, A.G. Gardiner, John Steinbeck.

II. Writing- Paragraph, Essay, Précis, Dictation, Comprehension, Letter Writing

III. English Tutorial- Practice Listening and Speaking English

IV. English Practice- Grammar Assignments and Workbook (Everyday English Level I/II)

Text/Reference Books:

1. John Seely, The Oxford Guide to Writing and Speaking, OUP
2. Krishna Mohan and Meenakshi Raman, Effective English Communication, TMH
3. R.W.Lesikar and John.D. Pettit, Business Communication: Theory and Application, All India Traveller Bookseller
4. Francis Soundaraj, Speaking and Writing for Effective Business Communication, Macmillan.
5. Herta A. Murphy, et al., Effective Business Communication, Tata Mc-Graw Hill: New Delhi
6. Ronald B. Adler and George Rodman, Understanding Human Communication, Oxford University Press: New York

Subject Name: Electrical Technology (Pre-requisite(s): Nil**)**

Subject Code: EE1L001

L-T-P: 3-1-0

Credit: 4

Syllabus: Introduction: Sources of energy; General structure of electrical power systems, Power transmission and distribution via overhead lines and underground cables, Steam, Hydel, and Nuclear power generation; DC Networks: Kirchhoff’s laws, node voltage and mesh current methods, Delta-star and star-delta conversion, Superposition principle, Thevenin’s, Norton’s theorems and Maximum power transfer theorem; Single phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances, phasor diagram, power factor, power in complex notation, solution of parallel and series– parallel circuits; Three phase AC Circuits: Three phase EMF generation, delta and Y – connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits, Three phase four wire circuits; Magnetic Circuits: Ampere's circuital law, B – H curve, solution of magnetic circuits, hysteresis and eddy current losses; Transformers: Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto- transformers; DC Machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters; Electrical Measuring Instruments: DC PMMC instruments, shunt and multipliers, multimeters, Moving iron ammeters and voltmeters, dynamometer, wattmeter, AC watthour meter, extension of instrument ranges.

Text/Reference Books:

1. E. Hughes, "Electrical Technology," Pearson Education, 2010.
2. V. Del Toro, "Electrical Engg Fundamentals," PHI Learning, 2009.
3. I. J. Nagrath and D. P. Kothari, 'Basic Electrical Engineering' TATA Mc Graw Hill Education, 2009.
4. D. A. Bell, "Electric Circuits," 7th Ed., Oxford Higher Education, 2009.

Subject Name: Introduction to Programming and Data Structure (Pre-requisite(s): Nil**)**
Subject Code: CS1L001
L-T-P: 3-1-0
Credit: 4

Syllabus: Digital computer fundamentals, concepts of algorithms and introduction to programming – examples; Constants and variables – data types, operators and expressions - type conversions, types of expressions; Assignment statements, input-output statements - concepts of data formats; Control statements: branching – if-else statements; iteration – while, do-while, for statements. nested control structures, switch, break and continue statements; Functions and recursion – examples; concepts of parameter passing by values and by reference; Arrays – single and multidimensional, examples – searching and sorting; Introduction to pointers, character strings and arrays, pointers and arrays; Structures, linked lists, dynamic allocation, stacks and queues, binary trees and tree traversals; Data files – creating, opening, closing and operating data files; (The programming language C to be used as the basis language).

Text Books:

1. B. Gottfried, "Schaum' s Programming with C," Tata McGraw-Hill.
2. E. Balaguruswamy, "Programming in ANSI C," Tata McGraw-Hill.
3. Y. Kanetkar, "Let us C," BPB Publications.
4. S. Lipschutz, "Data Structures, Schaum's Outlines Series," Tata McGraw-Hill.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language," Prentice Hall of India.
2. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, "Fundamentals of Data Structures in C," W. H. Freeman and Company.

Name: Introduction to Manufacturing Processes (Pre-requisite(s): Nil**)**
Subject Code: ME1P001
L-T-P: 0-0-3
Credit: 2
Syllabus: Machining:

- Introducing to various machine tools and demonstration on machining
- Making a steel pin as per drawing by machining in centre lathe
- External screw thread on lathe
- Making a cast iron Vee block by shaping
- Making a regular polygon prism (MS)/ hexagon by milling machine
- Slot fitting by milling machine
- Study of machining in machining in machining centre (CNC)
- Study of Electro discharge machining (EDM)

Foundry Practice:

- Orientation, demonstration and practice on metal casting
- Practicing sand moulding using split and uneven parting line pattern
- Practice on CO2 moulding and machine moulding
- Mechanised sand preparation and melting practice

Welding Practice:

- Practice on electric arc welding
- Practice on oxy-acetylene gas welding
- Introduction and demonstration on submerged arc welding

Metal Forming:
Demonstration of deep drawing and other forming process

Text/Reference Books:

1. Chapman W.A.J., Workshop Technology - Part I, CBS Publishers.
2. Chapman W.A.J., Workshop Technology - Part II, CBS Publishers.
3. Hajra Choudhury S.K., Elements of workshop Technology Vol. I, Media Promoters.
4. Hajra Choudhury S.K., Elements of workshop Technology Vol. II, Media Promoters.

Subject Name: Engineering Drawing and Graphics (Pre-requisite(s): Nil**)**
Subject Code: CE1P001
L-T-P: 1-0-3
Credit: 3
Syllabus: Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines – traces, true length; Projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Text/Reference Books:

1. Bhatt N.D.Elementary Engineering Drawing, Charotar Publishing House.
2. Gill P.S. Engineering Drawing & Engg. Graphics, S. K. Kataria & Sons.
3. Lakshminarayan L.V. and Vaish R.S.Engineering Graphics, Jain Brothers.

Subject Name: Physics Laboratory (Pre-Requisite(s): Nil**)**
Subject Code: PH1P001
L-T-P: 0-0-3
Credit: 2
Syllabus: To determine the damping constant of the pendulum for different eddy damping current. To verify Malus's Law of polarization of light. To determine the wave length of the prominent lines of mercury source by a plane transmission diffraction grating and to calculate the resolving power and dispersive power of the grating. To study the intensity distribution of Fraunhofer diffraction pattern by a single slit and measure the width of the slit for a given wavelength of laser light. To determine the wavelength of the given source using the Michelson interferometer. To determine the wave length of the given source using Fresnel's biprism. To find out the resonance and beat time period of the coupled pendulum and find out the spring constant. To study the interference pattern and determine the radius of curvature of the plano convex lens using Newton's rings apparatus.
Text/Reference Books:
1. Ghatak A. Optics, McGraw-Hill.
2. Pain H. J. The Physics of Vibrations and Waves, Wiley.

Subject Name: Chemistry Laboratory (Prerequisite(s): Nil**)**
Subject Code: CY1P001
L-T-P: 0-0-3
Credit: 2
Syllabus: Experiment-1: Determination of the surface tension and parachor of a homologous series. Experiment-2: Measurement of the coefficient of viscosity of ethanol & ethanol -water system. Experiment-3: Studies on acid-base conductometric titration. Experiment-4: Studies on PH metric titration of strong base with strong acid. Experiment-5: Estimation of sulphate ion in tap water by nepheloturbidimetric analysis. Experiment-6: Spectrophotometric determination of acid dissociation constant (pka) of methyl red (MR) an acid base indicator. Experiment-7: Determination of solubility and solubility product of a sparingly soluble salt at room temperature by conductometric method. Experiment-8: Potentiometric titration of a given sodium carbonate solution with aquesous hydrochloric acid solution. Experiment-9: kinetics of ester hydrolysis. Experiment-10: Detection of functional groups in an organic compound for solid sample. Experiment-11: Detection of functional groups in an organic compound for liquid sample. Experiment-12: Thin layer chromatography (TLC).
Text/Reference Books:
1. Nad, A. K.; Mahapatra, B. and Ghoshal A. An advanced course in practical chemistry, New Central Book Agency (P) Ltd.
2. Elias A. J. A collection of general chemistry experiments, University Press.
3. Maity S. and Ghosh N. Physical Chemistry Practical, New Central Book Agency (P) Ltd.

Subject Name: Electrical Technology Laboratory (Prerequisite(s): Electrical Technology**)**
Subject Code: EE1P001
L-T-P: 0-0-3
Credits: 2

Syllabus: Experiments as per the topics in the syllabus for the course `Electrical Technology' (EE1L001) will be conducted in the laboratory class.

Text Books:

1. E. Hughes, "Electrical Technology," Pearson Education, 2010.
2. V. Del Toro, "Electrical Engg Fundamentals," PHI Learning, 2009.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, 'Basic Electrical Engineering' TATA McGraw Hill Education, 2009.
2. D. A. Bell, "Electric Circuits," 7th Ed., Oxford Higher Education, 2009.

Subject Name: Introduction to Programming and Data Structures Laboratory
(Prerequisite(s): Introduction to Programing and Data Structures**)**
Subject Code: CS1P001
L-T-P: 0-0-3
Credit: 2

Syllabus: Familiarization of a computer and the environment; Execution of sample programs related to Expression evaluation, Conditionals and branching, Iteration, Functions, Recursion, Tail-recursion, Arrays, String manipulation, Structures, Linked lists, Doubly- linked lists and Binary Trees. Execution of programs involving abstract data types like Stacks and Queues.

Subject Name: Mathematics- II (The course is in second semester; Pre-requisite(s): Nil**)**
Subject Code: MA1L002
L-T-P: 3-1-0
Credit: 4

Syllabus: Linear Algebra: Vector spaces, subspaces, span, Linear dependence, independence of vectors, basis, dimension, linear transformations, range, kernel, rank, nullity of linear transformation, space of all linear transformations, Operator equations, matrix associated with a linear map, linear map associated with a matrix, elementary row operations, solution of algebraic equations, consistency conditions. Matrix inversion by row operations, Eigenvalues and eigenvectors, Hermitian and skew Hermitian matrices, orthogonal and unitary matrices, application to reduction of quadrics. Complex Analysis: Limit, continuity, differentiability and analyticity of functions Cauchy-Riemann equations (cartesian and polar), Harmonic functions, Elementary complex functions, Line integrals, upper bounds for moduli of contour integrals, Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Power
series, Taylor's series, Laurent's series, Zeros and singularities, Residue theorem, evaluation of improper integrals by residue theorem.

Text books:

1. Strang G. Linear Algebra and its applications, Cengage Learning
2. Churchill R.V. and Brown J.W. Complex Variables and Applications, Mc-Graw Hill
3. Kreyszig E. Advanced Engineering Mathematics, John Wiley & Sons

Reference Books:

1. Jain R. K. and Iyengar S. R. K. Advanced Engineering Mathematics, Narosa
2. Krishnamurthy V., Mainra V. P. and Arora J.L. An Introduction to Linear Algebra, Affiliated East-West Press Pvt Ltd New Delhi

3. Axler S. Linear Algebra Done Right, UTM, Springer
4. Poole D. Linear Algebra: A Modern Introduction, Brooks/Cole

Subject Name: Basic Electronics (Pre-requisite(s): None)
Subject Code: EC2L005
L-T-P: 3-1-0
Credits: 4
Syllabus: Semiconductor devices: Diode, BJT, MOSFET, their structures and principle of operations; Amplifiers: Functionality, specifications (voltage gain, current gain, input resistance, output resistance, dynamic range, bandwidth, linearity, power efficiency etc.), effect of cascading, various applications and typical circuits; Filters: Low pass, high pass, band pass and band stop filters, single and higher order passive filter topologies (RC and LC); Feedback: Basic concept of negative and positive feedback, application of negative feedback in amplifiers, effect on gain, bandwidth, input resistance, output resistance and desensitivity to parameter variations; Oscillators: Barkhausen criterion, sinusoidal and non-sinusoidal oscillators, applications and typical circuits; Operational amplifier: Differential mode of operation, common mode rejection, typical op-amp specifications, inverting amplifier, non-inverting amplifier, integrator, differentiator, summing amplifier etc., concept of active filters; Power electronics: Half wave and full wave rectification, filtering, regulation with zener diode and linear regulators, switched mode power supply; Digital electronics: Review of Boolean algebra and signed number representation schemes in binary, implementation of Boolean functions using various logic gates, concept of combinatorial and sequential circuits, registers and counters from functional viewpoint, concept of programmable processors and microcontrollers.
Text/Reference Books:
1. A. Malvino and D. J Bates “Electronic Principles,” Tata McGraw - Hill Education, 2006.
2. D. A. Neamen, “Electronic Circuits,” Tata McGraw - Hill Education, 2006.
3. Malvino and Brown, “Digital Computer Electronics,” Tata McGraw - Hill Education, 2001.
4. Samuel C. Lee, “Digital Circuits and Logic Design,” PHI Learning, 2009.
5. R. A. Gayakwad, “Op-Amps and Linear Integrated Circuits,” PHI Learning, 2009.

Subject Name: Basic Electronics Lab (Pre-requisite(s): Basic Electronics)
Subject Code: EC2P005
L-T-P: 0-0-3
Credits: 2
Syllabus: Familiarization with electronic components; Familiarization and usage with oscilloscope, signal generator, multimeter; Frequency-response of R-C, C-R and R-L networks; Square-wave testing, V-I characteristics of PN junction diode and zener diode; Voltage Rectifiers; Common-Emitter amplifiers; Analog circuits using OP-AMP; logic gates.
Text/Reference Books:
1. A. Malvino and D. J Bates “Electronic Principles,” Tata McGraw - Hill Education, 2006.
2. D. A. Neamen, “Electronic Circuits,” Tata McGraw - Hill Education, 2006.
3. Malvino and Brown, “Digital Computer Electronics,” Tata McGraw - Hill Education, 2001.
4. Samuel C. Lee, “Digital Circuits and Logic Design,” PHI Learning, 2009.
5. R. A. Gayakwad, “Op-Amps and Linear Integrated Circuits,” PHI Learning, 2009.

Syllabi of the Core Courses

Subject name: Mathematical Methods for Physics (Prerequisites: Mathematics I & II)
Subject code: EP2L001
L-T-P: 3-1-0
Credits: 4

Objective: This course is an introduction to the mathematics commonly used in physics. The main topics discussed are complex analysis, solving differential equations, tensor analysis and probability distributions. It is an essential core course necessary to build the foundations for later courses like, classical, quantum and statistical mechanics. Upon completion of this course, students should be able to: (i) Apply series approximations to a host of physical problems, (ii) learn to handle and work with infinities, (iii) apply contour integration techniques to Green functions, (iv) use various approximations like Stirling formula, Error functions and WKB, (v) solve the equation of motion by solving ODEs and PDEs, (vi) understand stress tensors and moment of inertia tensors, and (v) work with probabilistic outcomes.

Syllabus: Infinite Series - convergence tests, transformation of series, accuracy. Complex Analysis - poles & branch cuts, power series convergence, residue, analytical continuation, Gamma function, Beta function, conformal mapping, contour integration, asymptotic expansions, saddle point approximations. Integral Transform - Fourier series & transforms, Dirac Delta function, Laplace transform. ODE - Autonomous systems, higher order ODEs, set of orthogonal functions, power series solutions, WKB method, Sturm-Liouville problems, degeneracy & completeness, inhomogeneous problems, Green functions. PDE - classification, separation of variables, integral transform methods, Green functions. Tensor analysis - Cartesian tensors, applications, orthogonal curvilinear coordinates, non-cartesian tensors. Probability & Statistics - sample space, discrete & continuous distributions, statistics & measurements.

Books/references:

1. M.L. Boas, "Mathematical Methods in Physical Sciences", John Wiley & Sons
2. P. Dennery and A. Krzywicki, "Mathematics for Physicists", Dover Publications.
3. G.B. Arfken, H.J. Weber, F.E. Harris, "Mathematical Methods for Physicists: A Comprehensive Guide", Academic Press.

Subject name: Classical Mechanics and Theory of Relativity
Subject code: EP2L002
L-T-P: 3-0-0
Credits: 3

Objective: The primary objective is to introduce the basic understanding and fundamental elements of classical mechanics. It is a fundamental subject that describes the behaviour of objects we are familiar with in our daily life to motion of planets, stars and galaxies. This course serves as the foundational step for many other areas of physics, and engineering and has far-reaching applications in various fields of science and technology.

Syllabus: Review of Newton's laws of motion. Frames of reference. Rotating frames. Centrifugal and Coriolis forces. Free and constrained motion, D'Alemberts principle and Lagrange's equation of first kind. Lagrangian formulation. Hamilton's equation of motion. Variational principles. Canonical transformation and Poisson Bracket. Hamilton Jacobi theory and action angle variables. Eulerian angles. Euler's equation. Motion in a non-inertial frame of reference. Periodic motion. small oscillations. normal coordinates. Rigid body motion. The inertia tensor. Central force. Kepler's Laws and Rutherford scattering. Galilean and Lorentz transformation, Length contraction, Time dilation, Proper time, Doppler effect, Mass-energy relation.

Books/references:

1. Classical Mechanics: J. R. Taylor
2. Classical Mechanics: David Morin
3. Introduction to Special relativity: R. Resnick
4. H. Goldstein, Classical Mechanics, Addison Wesley 1980

Subject name: Thermal Physics
Subject code: EP2L003
L-T-P: 2-0-0
Credits: 2

Objective: The main objective of this subject is to introduce the basic understanding and fundamental elements of thermodynamics. It is a fundamental subject that describes the behaviour of large collection of similar objects, spanning all scales from a collection of atoms to a collection of galaxies and everything in between. The laws of thermodynamics has been central to our understanding of the physical world and applies equally to an atom and a black hole. This course aims at developing the framework of these laws and emphasising on the generality of its applications focusing mainly on practical entities like heat engines and gases. This course has substantial interplay with many other areas of physics, chemistry, biology, and engineering and has far-reaching applications in various fields of science and technology.

Syllabus:

Thermal equilibrium, zeroth law and concept of temperature. First law and its consequences, reversible, irreversible and quasi-static processes. Second law: heat engines, concept of entropy and its statistical interpretation. Kinetic theory of gases. Thermodynamic potentials, Maxwell’s relations. Joule Kelvin effect. Phase transitions, order of phase transitions, order parameter, critical exponents and the Clausius-Clapeyron equation. Applications to magnetism, superfluidity and superconductivity. Introduction to Statistical Mechanics, Macrostate; Microstate. Elementary Concept of Ensemble and Ergodic Hypothesis. Phase Space and Liouville theorem. Microcanonical ensemble, Postulate of Equal a-priori Probabilities. Boltzmann hypothesis: Entropy and Thermodynamic Probability.

Books/references:

1. An Introduction to Thermal Physics: D.V. Schroeder.
2. Heat and Thermodynamics: M.W. Zemansky and R.H. Dittman.
3. Equilibrium Thermodynamics: C.J. Adkins

Subject name: Electromagnetic Theory and Applications
Subject code: EP2L004
L-T-P: 3-0-0
Credits: 3

Objective: The objective of this this course is to provide students with a fundamental understanding of the principles governing electric and magnetic fields. Students will learn about static and time-varying fields, Maxwell's equations, and their applications. The course aims to equip students with the knowledge and skills necessary to analyze and solve problems related to electromagnetism, laying a strong foundation for further studies and practical applications in fields such as electrical engineering, physics, and related disciplines.

Syllabus: Overview of Electrostatics, Multipole Expansion, Method of images, Continuity Equation, Time Varying Electromagnetic Fields, Poisson’s and Laplace’s Equations, Boundary Conditions, magnetostatics, magnetic field in matter, Steady Electric Current, Maxwell's Equations, Plane Electromagnetic Waves, Poynting Theorem, Propagation in Free Space and in Matter, Reflection and Refraction of Waves at Conducting and Dielectric Boundary, Wave guides, Conservation of Linear and

Angular Momentum, Potential formulation of ED, radiation and radiating systems, Bremsstrahlung, Synchrotron, Cerenkov radiation.

Books/references:

1. D. J. Griffiths, Introduction to Electrodynamics, PHI Learning 2012
2. J. D. Jackson, Classical Electrodynamics, John Wiley and Sons 1998

Subject name: Elements of Quantum Mechanics
Subject code: EP2L005
L-T-P: 3-0-0
Credits: 3

Objective: The goal of this course is to introduce basic understanding and fundamental elements of quantum mechanics. It is a fundamental subject that describes the behavior of matter and energy at the smallest scales and provides a deeper understanding of the physical world and the fundamental principles that govern at these scales. This course may serve as a fundamental framework that underpins many areas of physics and has far-reaching applications in various fields of science and technology.

Syllabus: Experimental Motivation, Future of Quantum Mechanics. Mathematical Preliminaries: Linear Algebra (esp. trace, partial trace, tensor products) - Hilbert Space - Orthogonal Polynomials – Rotations and Unitaries. Linear vector spaces, Dirac notations, Inner products, and Operator formalism. Quantum States and Density Matrices. Schrodinger's equation - Schrodinger's equation for Unitaries – Schrodinger - Heisenberg and Interaction Pictures. Simple Problems in One Dimension - Preview of Selection Rules. Harmonic Oscillators - Uncertainty Principle - Ladder Operators. Spin-1/2: Qubit states - Bloch Sphere Representation – Transitions - Rabi Oscillations. Coupled Quantum Systems. Central Force Problems, Rigid Rotor. Hydrogen Atom - Angular Momentum Operators - Addition of Angular Momentum.

Books/references:

1. Introduction to Quantum Mechanics: D. Griffiths
2. Principles of Quantum Mechanics: R. Shankar

Subject name: Statistical Physics
Subject code: EP2L006
L-T-P: 3-0-0
Credits: 3

Objective: The main objective of this course is to introduce basic understanding and fundamental elements of the collective behavior of many particles. It makes a bridge between macroscopic thermodynamic behavior and their microscopic origin. It is a fundamental subject that describes the behavior of matter and energy at the macro scales and provides a deeper understanding of the physical world and the fundamental principles that govern at these scales. This course may serve as a fundamental framework that underpins many areas of physics and has far-reaching applications in various fields of science and technology.

Syllabus: Background of Statistical physics, Microcanonical Ensemble, Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, harmonic oscillator, and paramagnetism, Classical Entropy Expression, Gibbs Paradox. Law of Equipartition of Energy, Applications to Specific Heat and its Limitations. Thermodynamic Functions of a Two-Energy Level System. Grand canonical ensemble. Application of ideal gas using grand canonical ensemble. Chemical potential. Interacting Systems: Virial and cluster expansions; van der Waals theory; liquid-vapor condensation. Quantum Statistical Mechanics, Bosons and Fermions, Symmetric and Antisymmetric wave functions, Quantization effects in molecular gases; phonons, photons; density matrix formulation. Bose Einstein condensation and properties of liquid He IV. Fermi-Dirac Distribution Law. Thermodynamic functions of strongly Degenerate Fermi Gas, Fermi Energy.

Books/references:

1. Statistical Physics of Particles: Mehran Kardar
2. Statistical Mechanics: K. Huang
3. Statistical Mechanics: R. K. Pathria

Subject name: Numerical Techniques and Computational Physics
Subject code: EP2L007
L-T-P: 2-0-2
Credits: 3

Objective: The primary objective of this course is to introduce basic understanding of numerical methods and scientific programming languages. It will contain various advanced numerical methods e.g., Monte Carlo to solve complex scientific problems. This course will also enhance computational thinking and skills, and will help students to learn analytical and methodical approaches to solve scientific and non-scientific problems by using computers.

Syllabus: Introduction to scientific programming, Modular programming and code organization. Number representation: Floating-point representation; Round off error; truncation error; stability. Random numbers: Pseudorandom numbers; Testing randomness. Numerical differentiation: Finite difference schemes to approximate derivatives; Error assessment. Numerical Integration methods; Monte Carlo integration. Root finding: Bracketing and bisection method; Newton-Raphson method; Roots of polynomials; Data fitting: Extrapolation; Linear interpolations; Lagrange interpolation; Cubic-spline interpolations; Least-Squares fitting; Linear quadratic fit; Nonlinear fit. Ordinary and partial differential equations: numerical methods. Eigenvalue problems using ODE solver and bisection. Two point boundary value problems: Shooting method. Elementary ideas of numerical solution of partial differential equations. Fourier transform of discretely sampled data, Convolution, correlation and autocorrelation using FFT, Power spectrum.

Books/references:

1. S. E. Koonin and D. C. Meredith. Computational Physics (Fortran Version)
2. W.H. Press, B.P. Flannery, S.A. Teukolsky and W.T. Vetterling, Numerical Recipes: The Art of Scientific Computing, Cambridge University Press.

Subject name: Applied Optics
Subject code: EP3L001
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to provide students with a fundamental understanding of the theoretical principles and mathematical frameworks governing the behavior of light and its applications in various optical systems.

Syllabus: Wave Propagation: Review of Maxwell's equations and propagation of waves, Plane polarized light. Reflection and refraction of EM wave, Brewster's angle, Introduction to polarization, linear, circular and elliptical polarizations, Malus's law, Anisotropic Media: Plane waves in anisotropic media, Birefringence, Uniaxial crystals; Analysis of polarized light. Quarter and half wave plates, analysis of polarized light. Interference: Michelson interferometer; Fabry-Perot interferometer and etalon, Antireflection coatings. Diffraction: Fresnel and Fraunhofer diffraction. Single slit, circular aperture; limit of resolution. Diffraction of a Gaussian beam. Fourier Optics: Fourier transform operation spatial frequency and transmittance function, spatial-frequency filtering, Phase contrast microscope. Basics concepts of holography, basics concepts and ray optics considerations of optical fiber, introduction to lasers.

Books/references:

1. A. K. Ghatak, “Optics”, 7th Edition, McGraw Hill
2. F. A. Jenkins and H. E. White, “Fundamentals of Optics”, 4th edition, McGraw Hill Education

Subject name: Solid State Physics

Subject code: EP3L002

L-T-P: 4-0-0

Credits: 4

Objective: The objective of this course is to provide a comprehensive understanding of condensed matter physics. Topics include crystallographic structures, electron conduction theories, and transport properties. Additionally, the course covers energy band theory, Bloch's theorem, and models like nearly free electron and tight binding. Furthermore, the course delves into phonons, lattice vibrations, and heat capacity models including Einstein and Debye models.

Syllabus: Crystal structures, reciprocal lattice, X-ray and electron diffraction, Free electron theory; heat capacity; transport properties; Hall effect; elementary concepts of quantum Hall effect, quantization of conductance in a metallic nano wire. Structure and scattering; crystalline solids, liquids and liquid crystals; nano structures; bucky balls, Energy band theory; Bloch's theorem; nearly free electron model; tight binding model; application to grapheme and nano tubes, semi classical dynamics; notion of an electron in a DC electric field; effective mass, holes, crystal binding; types of solids; van der Waals solids, ionic and covalent solids, metals, Phonons and heat capacity; lattice vibrations; adiabatic & harmonic approximations, vibrations of mono and diatomic lattices, lattice heat capacity, Einstein and Debye models.

Books/references:

1. C. Kittel, Introduction to solid state physics, 7th ed., John Wiley 1997
2. N. Ashcroft and N.D. Mermin, Solid state physics 1976
3. J.R. Christman, Fundamentals of Solid State Physics. John Wiley 1988

Subject name: Physics of Atoms and Molecules

Subject code: EP3L003

L-T-P: 3-0-0

Credits: 3

Objective: This course aims to offer a profound insight into the intricate electronic structures of atoms and molecules and a sound understanding of the interactions between electromagnetic radiation and matter and their wide-ranging practical applications.

Syllabus: Hydrogen atom, the quantization of energy, Alkali atom, Energy level diagram, Effective quantum number and quantum defect, Lamb shift, Two electron atom, LS and JJ coupling, X-ray spectra: energy levels, Emission and absorption Spectra, selection rules, Magnetic effects, spectroscopy notations, Spin-orbit interaction, fine structure, Influence of external magnetic field: Zeeman and Paschen-back, effects in one and two electron atom, g-factor, Molecular energy levels, molecular bonds, harmonic and anharmonic Vibrational-rotational spectroscopy, Raman spectra, Beer-Lambert’s law.

Books/references:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill, 2019
2. Svanberg Sune, Basic Atomic and Molecular Spectroscopy, Springer, 2004

Subject name: Advanced Quantum Mechanics (Prerequisite: Elements of Quantum Mechanics)
Subject code: EP3L004
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to build upon the foundational concepts introduced in Elements of Quantum Mechanics. It delves deeper into the advanced principles and mathematical formalism of quantum physics, aiming to provide a comprehensive understanding of quantum phenomena and their applications. In this course the students are going to learn approximation methods like perturbation theory, variational methods, and their examples. Further, relativistic quantum mechanics will be covered which are essential to understand modern topic of condensed matter physics and quantum technologies.

Syllabus: Electron in a magnetic field, Landau levels, Quantum Hall effect, Aharonov-Bohm effect. Non-degenerate and Degenerate Time-independent perturbation theory, Examples: Stark effect, Atomic fine-structure. Variational method, WKB Approximation. Time-dependent Perturbation theory, Fermi Golden Rule. Formal Scattering theory, interaction picture; S-matrix. Revision of Lorentz transformations, relativistic notations, Lorentz group. The Klein-Gordon equation, negative and positive energy solutions. Charged spin-zero particle, Difficulties with K-G theory. The Dirac equation, Relativistic invariance, spin and energy operators, and Gamma matrices identities. Nonrelativistic limit, Pauli equation, Solutions and their properties. Dirac sea, Anti-particle, Klein paradox. Hydrogen atom, Dirac electron in an electromagnetic field, Charge conjugation.

Books/references:

1. Griffiths David J., Introduction to Quantum Mechanics, Pearson Education Inc.
2. Sakurai J. J., Modern Quantum Mechanics, Addison Wesley.
3. Schiff L. I., Quantum Mechanics, McGraw-Hill.
4. Merzbacher E., Quantum Mechanics, John Wiley (Asia).
5. Mathews P. W. and Venkatesan K., A Textbook of Quantum Mechanics, Tata McGraw Hill
6. Schwabl F., Quantum Mechanics Narosa.

Subject name: Experimental Techniques in Physics
Subject code: EP3L005
L-T-P: 3-0-0
Credits: 3

Objective: The objective of this course is to provide students with a sound understanding of the fundamental principles and concepts underlying experimental techniques used in physics research. The primary focus is to impart theoretical knowledge related to experimental techniques and scientific methods. By the end of the course, students will be well-prepared to comprehend and critically evaluate the potential use of various instruments used in physical sciences.

Syllabus: Scientific methods, scattering and spectroscopic principles, X-ray, light, electron, and neutron scattering methods to characterize materials, Diffraction methods, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Electrical and magnetic characterization, Raman spectroscopy, Scanning Probe Microscopy (STM and AFM), Thermometric techniques, and nuclear method in physics, NMR.

Books/references:

1. Experiments in Modern Physics, Second Edition by Adrian C. Melissinos and Jim Napolitano 2003
2. The art of Measurement, by Bernhard Kramer (V. C. H. Publication) 1988

Subject name: Introduction to Nuclear and Particle Physics
Subject code: EP3L006
L-T-P: 3-0-0
Credits: 3

Objective: The objective of this course is to provide students with a fundamental understanding of the principles that underlie nuclear and subatomic physics. Through theoretical instruction, and problem-solving exercises, this course aims to equip students with the analytical tools necessary to comprehend nuclear and particle physics.

Syllabus: Rutherford scattering, a quick review of masses, radii, spins and magnetic momenta of the nucleons and nuclei, stable and unstable nuclei, the deuteron and its properties, non-central nature of nuclear force, Isospin, consequences of isospin symmetry, realistic potentials, Thomas Fermi; nuclear shell model, magnetic moments and spin parity of nuclei, the magic numbers; The collective model and application to even-even nuclei their spectrum and selection rules for radiation, Fermi's theory of Beta decay, the Curie plot, mass of the neutrino, Fermi and Gamow Teller transitions, allowed and forbidden transitions. parity violation in beta decay and its experimental evidence, Fundamental interactions and their properties, strengths and ranges, leptons and baryon generations, the particle zoo, particle detectors and accelerators, simple applications to material science and medicine.

Books/references:

1. A.Das and T.Ferbel, Introduction to nuclear and particle physics, World Scientific. 2023
2. M.G.Bowler, Femto Physics: A short course on particle physics, Pergermon Press 1990
3. Brian R. Martin, Nuclear and Particle Physics: An Introduction 2009

Subject name: Engineering Physics Lab-I
Subject code: EP2P001
L-T-P: 0-0-6
Credits: 4

The course will consists of experiments related to Electron diffraction; Polarisation by reflection - Brewster's angle; Ferromagnetism, paramagnetism and diamagnetism; Compton effect/Photoelectric effect; Frank-Hertz experiment; Stern Gerlach’s experiment; Single photon interferometer; Electron Spin resonance; Faraday’s effect.

Subject name: Engineering Physics Lab-II
Subject code: EP2P002
L-T-P: 0-0-6
Credits: 4

The course will consists of experiments related to identification of p- and n- type semiconductor; Estimation of bandgap of semiconductor; Quantum eraser with the Mach-Zehnder interferometer; Quantum Cryptography; Fine structure: one and two electron spectra; Thermal equation of state and critical point; Equation of state for ideal gases; Powder X-ray diffraction crystals of sc, bcc, fcc types; Stark effect.

Subject name: Engineering Physics Lab-III
Subject code: EP3P001
L-T-P: 0-0-6
Credits: 4

The course will consists of experiments related to Vacuum pumps, thin film deposition and characterization; Synthesis of high temperature superconductor sample and its characterization; Synthesis of semiconductor nanoparticles and characterization of size and bandgap; SPM characterization of surfaces; X-ray fluorescence spectroscopy; Fabry-Perot interferometer He-Ne laser construction; Kerr effect; Numerical aperture of single and multimode fiber Optical fiber communication; Counting statistics using G. M. Counter; cosmic ray muon -lifetime measurement; spin-lattice relaxation time using NMR spectrometer; Rutherford scattering of alpha particles in gold. The students will perform only 5 experiments out of these.

Subject name: Product Development Lab
Subject code: EP3P002
L-T-P: 0-0-9
Credits: 6

The lab course will provide an exposure to the students to the practical aspects of design and development of a product. The importance will be given to conceptualization of the idea, design, mapping of components to functions and development of the product. The course will consists of some specific tasks relevant to the mentioned specializations. Students will be divided in the groups of 3 to 5 students for this laboratory course. Each group will be assigned with 3 to 4 activities in accordance with their interests and they will be asked to perform the assigned tasks.

Subject name: Seminar
Subject Code: EP3S001
L-T-P: 0-0-3
Credits: 2

Subject name: Industrial Training Defence
Subject Code: EP4T001
L-T-P: 0-0-0
Credits: 2

Subject name: Project I
Subject Code: EP4D001
L-T-P: 0-0-6
Credits: 4

Subject name: Project II
Subject Code: EP4D002
L-T-P: 0-0-9
Credits: 6

Syllabi of the Elective courses

Subject name: Vacuum Science and Thin Films Technology
Subject code: EP4L010
L-T-P: 3-0-0
Credits: 3
Objective: The objective of this course is to provide students with a comprehensive understanding of vacuum science and the technology associated with thin film deposition at the undergraduate level. The students doing this course will have a solid understanding of principles of vacuum science and the importance of vacuum technology in various industries, various thin film deposition techniques, thin film growth mechanisms, crystallography, diverse applications of thin films in various modern technologies and research areas.
Syllabus: Need of Vacuum and basic concepts; Gas Flow regimes; Gas release from Solids: Vaporization, Thermal Desorption, Permeation, Surface diffusion, Physi-sorption and Chemisorption; Measurement of Pressure; Production of Vacuum (HV & UHV): Pumping systems; Physics of thin film deposition: adsorption, surface deposition, surface diffusion, nucleation, growth and structure development, role of surfaces, epitaxial growth, lattice mismatch, strain, self-organization, self-aligned structures, heterostructures, multilayer superlattice structures. Thin film deposition techniques: Physical Vapor Deposition, Sputtering- dc and RF sputtering; Chemical Vapor Deposition - reaction chemistry and thermodynamics; plasma enhanced CVD, metal-organic CVD, Atomic layer deposition, E-beam evaporation, Pulsed Laser Deposition, Molecular beam epitaxy (MBE).
Books/references:
1. K. L. Chopra, Thin films phenomena, Mc Graw Hill 1968
2. M. Ohring, Materials science of thin films, Academic press 1992
3. D. L. Smith, Thin films deposition: Principles and practices, Mc. Graw Hill 1995
4. J. E. Mahan, Physical vapour deposition, John Wiley 2000
5. J. H. Fendler, Nanoparticles and nanostructured films, Springer 2000

Subject name: Semiconductor Device Physics (prerequisite: Solid State Physics)
Subject code: EP4L011
L-T-P: 3-0-0
Credits: 3
Objective: The objective of the course is to provide students with a fundamental understanding of the principles governing the behaviour and operation of semiconductor devices. This course is essential for students pursuing careers electronics and semiconductor technology. The course will provide students with understanding of properties and characteristics of semiconductor materials, theory and operation of PN Junctions, comprehensive understanding of bipolar junction transistors (BJTs) and field-effect transistors (FETs), optoelectronic devices including light-emitting diodes (LEDs), photodetectors, and lasers. This course will equip students with the knowledge and skills necessary to understand, design, and work with a wide range of semiconductor devices, which are integral to many aspects of modern technology and engineering.

Syllabus: Semiconductors review: Band structure of Si, Ge, GaAs, direct and indirect band gap; Doping: Hydrogenic impurity model, shallow and deep donors, Saha ionization equation (Ionization of dopant), Intrinsic, extrinsic, and compensated semiconductors, carrier statistics, carrier density product, Boltzmann transport equation. Band-bending and band discontinuity at the interface: Poisson-Boltzmann formulation, Metal-semiconductor junctions: Schottky and Ohmic contacts, p-n junction, derivation of forward and reverse bias I-V equation, tunnel diodes: NDR region, Gunn effect, Junction breakdown mechanisms, Semiconductor heterostructures. BJTs: Static characteristics of Bipolar transistor; Frequency response and switching behavior, Non-ideal effects: Early effect, current crowding and high injection effect; Triac/SCR, MOS capacitors, JFET, MOSFET: structure and operation, basic characteristics and analysis; linear, quadratic model; equivalent circuit; Threshold voltage calculation; Substrate biasing effect; Optoelectronic devices: Carrier statistics under illumination condition, Quasi-Fermi levels, photovoltaic Effect, working of Solar Cells, Current-Voltage characteristics. Shockley-Queisser limit. Light emitting diodes (LED), Internal Quantum Efficiency, External Quantum Efficiency, Laser-diodes.

Books/references:

1. Solid State Electronic Devices - B. G. Streetman and S. K. Banerjee, Boston : Pearson, 7thedition,

2. Physics of Semiconductor Devices -S.M. Sze and K. K. Ng,Wiley- Interscience, 3rd edition, 2006.

3. Semiconductor Physics: An Introduction -K. Seeger, Springer-Verlag, Berlin, 9th edition,2004.

4. Physics of semiconductor devices 302226 M.Shur, Prentice/Hall International, 1990

5. The Physics of Low-dimensional Semiconductors: An Introduction- J. M. Davies,Cambridge University Press, 1997

Subject name: Device Fabrication Technology (Prerequisite: Solid State Physics)
Subject code: EP4L012
L-T-P: 3-0-0
Credits: 3

Objective: This course will focus on teaching students the fundamental principles and practical skills needed to manufacture various electronic, microelectronic, and nanoelectronic devices. The course aims to provide students with the knowledge about the importance of cleanroom protocols, cleanroom equipment and processes including photolithography tools, material growth techniques such as chemical vapor deposition (CVD) systems, physical vapor deposition, device fabrication processes including ion implantation, oxidation, diffusion, epitaxy, and metallization. This course equips students with the knowledge and practical skills needed to work in the semiconductor and microelectronics industries, where the creation of electronic devices plays a crucial role in modern technology.

Syllabus: Cleanroom basics–environment and protocol. Crystal growth and silicon wafer fabrication and oxidation techniques: Growth kinetics and thickness measurement techniques, defects in silicon and silicon dioxide, interface defects, polysilicon, SiC, ion-implantation, modelling and measurement of dopant profile. Microfabrication processes: Lithography and etching techniques: ion etching and chemical etching, oxide growth, diffusion, metallization. Next generation lithography. Introduction to nano-fabrication, x-ray lithography, e-beam lithography, nanoimprint lithography, stamping techniques for micro/nano fabrication. Thin film deposition, metallization characterization of the thin films; Processes involved in mask making and packaging. 3D nanofabrication using focused ion beam (FIB). MEMS and NEMS, nano and micro-structured semiconductor materials for microelectronics. Advanced device fabrication concepts: SOI, FDSOI, Self-assembly etc. Semiconductor packaging techniques. Basic process flows: Optoelectronics Devices (e.g. LED, Laser), Power Electronics Devices (e.g. Power Diodes, Power Thyristor), electronic devices (e.g. Op-amps, microcontrollers).

Books/references:

1. P. V. Zant, Microchip Fabrication, McGraw-Hill Education; 5 edition 2014 ISBN: 978-0071432412
2. H. Baltes et al, Enanabling technology for MEMS and Nanodevices, Wiley-VCH, 2008
3. Stephen A. Campbell: Fabrication Engineering at the Micro- and Nanoscale, 4th Edition. Oxford University Press 2012
4. Sam Zhang, Nanostructured thin films and coatings: Mechanical Properties, CRC Press 2010.
5. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World

Subject name: Nanoscale Transport Phenomena (Prerequisite: Elements of Quantum Mechanics and Solid State Physics)
Subject code: EP4L013
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to provide a comprehensive understanding of the principles, theories, and applications of nanoscale physics and quantum phenomena in engineering contexts. The course will be focussing on various electronic transport regimes in bulk and mesoscopic limits, band structure and density of states in 0D, 1D, and 2D systems, semi-classical transport through the Boltzmann transport equation, quantum transport models. Further, behavior of quantum heterostructures in the presence of a magnetic field, quantum dots and single electron transistors, 2D materials and topological insulators will be covered. Overall, the course aims to equip students with an in-depth understanding of nanoscale physics, quantum phenomena, and their applications in various technological fields.

Syllabus: Preliminary concepts: Mean Free Path, Coherence Length, Thermal Diffusion Length; Classification of transport regimes, Resistance (in d-dimension) in the bulk and mesoscopic limits. Brief overview of band structure and density of states for 0D, 1D and 2D systems, band gap engineering and semiconductor heterostructures. Two-dimensional electron gas, quantum wires, and quantum dots in real world: properties and applications; qualitative description of gated 2DEG based devices. Semi-classical transport and scattering mechanisms: Brief review of semi-classical transport (Boltzmann Transport Equation). Carrier mobilities in 2DEGs. Ballistic Transport: Landauer and Landauer-Buttiker formalisms, Current in resonant tunneling diodes. Conductance quantization in Quantum Point Contacts, adiabatic transport model, bias spectroscopy of QPCs. Quantum heterostructures in magnetic field: Quantum Hall effects, QPC in magnetic field. Quantum dots, Coulomb blockade, and Single Electron Transistors, Stability diagrams of double quantum dots. 2D materials: Graphene, WS_2/$MoS_2$and their properties. Topological insulators.

Books/references:

1. Transport in Nanostructures - David K. Ferry, Stephen Goodnick, Jonathan Bird, Cambridge University Press, 2009
2. Quantum Heterostructures: Microelectronics and Optoelectronics - Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, Cambridge University Press 1999
3. Electronic Transport in Mesoscopic Systems - Supriyo Dutta, Cambridge University Press 1995
4. Quantum Transport - Introduction to Nanoscience, Y. V. Nazarov, Y. M. Blanter, Cambridge University Press 2009
5.The Physics of Low-dimensional Semiconductors: An Introduction - John M. Davies, Cambridge University Press, 1997

Subject name: Magnetism and Spintronic Devices (Prerequisite: Elements of Quantum Mechanics and Solid State Physics)
Subject code: EP4L014
L-T-P: 3-0-0
Credits: 3

Objective: Objectives: The course aims at providing the fundamentals understanding of Magnetism, magnetic materials and spintronic devices. The Physics of magnetic systems is proposed as prototypical for understanding: a) long range order; b) phenomena at the nanoscale, c) quantum states and interactions. The basic principles on different length scales that underlie the variety of magnetic materials and devices will be illustrated. Fundamentals on Magnetism is finalized to understand the functioning of spintronic devices such as magnetic memories, and spintronic devices. At the end of the course the student will be able to recognize on their own description of magnetic phenomena, magnetic memories and spintronic devices.

Syllabus: Magnetism Fundamentals: Electron spin, exchange interaction, magnetic ordering phenomena, magnetic anisotropy, Heisenberg and Ising models, Spin wave excitations, damping, Domains, Domain walls and exotic spin structures. Device structure and materials: Magnetic nanostructures, surfaces and interfaces. Spin dependent transport phenomena: Anisotropic magnetoresistance, Giant magnetoresistance, tunnelling magnetoresistance, and related phenomena. Spin dependent transport phenomena: Spin-transfer torque, spin-orbit interaction, spin injection, spin diffusion and voltage control of magnetism, Anomalous Hall Effect, Spin Hall Effect. Spintronic devices: Spin valve, magnetic tunnel junction, spin transistors, spin torque oscillators, spin LED. Introduction to topological Hall Effect and Skyrmions.

Books/references:

1. Magnetism and Magnetic Materials, by J. M. D. Coey (Cambridge 2012 University Press)
2. Introduction to Spintronics by Supriyo Bandyopadhyay, and Marc Cahay (CRC Press) 2015
3. Nanomagnetism and Spintronics by Teruya Shinjo (Elsevier Science Ltd.) 2013
4. Fundamentals of Magnetism and Spintronics by Atowar Rahman (Zorba books) 2022

Subject name: Selected Topics in Devices and Technology (Prerequisite: Elements of Quantum Mechanics and Solid State Physics)
Subject code: EP4L015

L-T-P: 3-0-0

Credits: 3

Objective: The objective of the course is to provide introduction to concepts related to advanced device technologies in areas involving superconducting devices, neuromorphic devices, microfluidic devices, optical devices and sensors, biosensors and energy storage devices. The aim is to equip students with knowledge and skills that can be applied in industry, research, or further academic pursuits within these areas.

Syllabus: The course will cover the topics related to spintronics devices; Superconducting devices: Josephson Junction; Neuromorphic devices; Nano and Microfluidic devices; Nanotechnology for gas sensors, actuators, plasmonic; Biosensors; Biomaterial based devices; Energy storage devices.

Books/references:

(i) Introduction to Biosensors: From Electric Circuits to immunosensors, Yoon, Jeong-Yeol (Springer 2016). (ii) Biosensors: A Practical Approach, A. E. G. Cass IRL Press at Oxford University Press, 1990. Nanotechnology and Biosensors, Dimitrios P Nikolelis, Georgia Paraskevi Nikoleli (Elsevier 2018) (iii) Modern Battery Engineering: A Comprehensive Introduction by Kai Peter Birke, World Scientific; Illustrated edition (2019) (iv) Modern Batteries, 2nd Edition, by C. Vincent and Bruno Scrosati- Paperback ISBN: 9780340662786 (v) Nanomaterials-Based Charge Trapping Memory Devices By Ammar Nayfeh, Nazek El-Atab (Elsevier 2020) (vi) Advances in Memristors, Memristive Devices and Systems, Vaidyanathan, Sundarapandian, Volos, Christos (Eds.), Springer 2017 (vii) Micro- and Nanoscale Fluid Mechanics for Engineers: Transport in Microfluidic Devices By Brian J. Kirby. 2009, (viii) Tabeling, P. Introduction to Microfluidics, Oxford, 2005. (ix) Bruss, H. Theoretical Microfluidics, Oxford, 2008.

Subject name: Fiber and Integrated Optics (Prerequisites: Applied Optics)

Subject code: EP4L020

L-T-P: 3-0-0

Credits: 3

Objective: The objective the course includes providing students with a comprehensive understanding of the principles, design, and applications of optical fibers and integrated optics. With this course the students will understand the fundamental principles of optics and the behavior of light in optical fibers, gain knowledge about the fabrication, types, and characteristics of optical fibers. Further, they will learn the design and operation of key components used in optical waveguides, such as couplers, splitters, and connectors; study the design and fabrication of integrated optics devices, such as waveguide-based modulators, switches, and sensors; and learn about the integration of various optical components on a single substrate for compact and efficient optical systems.

Syllabus: Modes in planar optical waveguides: TE and TM modes, Modes in channel waveguides: Effective index and Perturbation method. Directional coupler: coupled mode theory, Integrated Optical devices: Prism Coupling, optical switching and wavelength filtering etc. Step Index and graded index fibers, Attenuation in optical fibers, LP Guided Modes of a step-index fiber, Single-mode fibers, Gaussian approximation and splice loss. Pulse dispersion, Dispersion compensation, Basics of Optical Communication Systems, and recent trends. Fiber fabrication technology and fiber characterization. Periodic interaction in waveguides:

Coupled Mode Theory, Fiber Bragg Gratings, Long period Gratings and applications, Optical fiber sensors: basic principles and applications.

Books/references:

1. Fiber-Optic Communication Systems by Govind P. Agrawal
2. Optical Fiber Communications: Principles and Practice by John M. Senior
3. Integrated Optics: Theory and Technology by Robert G. Hunsperger
4. Integrated Optics: Devices, Materials, and Technologies by Giancarlo C. Righini
5. Silicon Photonics: Fundamentals and Devices by Bahram Jalali and Sasan Fathpour

Subject name: Optoelectronics Devices and Systems (pre-requisite: Applied Optics and Solid State Physics)
Subject code: EP4L021
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to equip students with a comprehensive understanding of the principles, applications, and practical aspects of optoelectronic devices and technologies to prepare them for careers in industries related to photonics and optoelectronics. The course aims to provide fundamental understanding of the topics semiconductor optoelectronic materials, Lasers, guided waves and optical modes, semiconductor heterostructures and quantum-well lasers, semiconductor amplifiers, modulators, photodetectors. Further, the course will also include some topics on emerging trends in optoelectronics.

Syllabus: Semiconductor optoelectronic materials, bandgap modification. Light absorption and emission, photoluminescence. Electro-luminescence, radioactive and non-radiative recombination, Rates of emission and absorption, condition for amplification by stimulated emission, the laser amplifier. Semiconductor LED, guided waves and optical modes, optical gain, confinement factor, internal and external efficiency, semiconductor heterojunctions, double heterostructure, Semiconductor Laser, Single-frequency lasers; DFB and DBR lasers, VCSEL; heterostructures and quantum-wells lasers and quantum cascade lasers. Semiconductor optical amplifiers (SOA), Semiconductor modulators: direct modulation of laser diodes, electro-optic modulation, acousto-optic modulation. Semiconductor Photodetectors. Photonic integrated circuits (PICs). Emerging trends and advancements in optoelectronics.

Books/references:

1. S. O. Kasap, "Optoelectronics and Photonics: Principles and Practices," Prentice-Hall, 2001
2. Photonics: Optical Electronics in Modern Communications, Amnon Yariv & Pochi Yeh
3. Fundamentals of Photonics, B.E.A. Saleh & M.C. Teich
4. Building Electro-optical systems and making it all work, P.C.D. Hobbs
5. Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh, McGraw Hill Companies
6. Semiconductor Optoelectronic Devices 2nd Edition", P. Bhattacharya, Prentice Hall, ISBN 0134956567.
7. Physics of Semiconductor Devices, by S. M. Size (2nd Edition, Wiley, New York, 1981)
8. Optical Electronics by Ajoy Ghatak and K Thyagarajan

Subject name: Introduction to Nonlinear optics (Prerequisites: Applied Optics)
Subject code: EP4L022
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to equip students with a comprehensive understanding of the principles and applications in the field of nonlinear optics. The course will cover topics related to wave propagation in anisotropic media, nonlinear optical processes including second and third harmonic generation, nonlinear wave propagation, non-linear Schrodinger equation, and impact of nonlinear effects in communication systems. Further, the course will cover emerging topics in the same field.

Syllabus: Wave propagation in anisotropic media. Origin of optical nonlinearity, Nonlinear optical polarization; Second order and third order processes; Nonlinear optical wave equation; Second order nonlinear processes; Second harmonic generation, difference and sum frequency generation, spontaneous parametric down conversion; Birefringence and quasi phase matching; Conversion efficiency of a nonlinear optical process; Optical parametric oscillators (OPOs) and amplifiers (OPAs). Nonlinear Schrödinger equation. Third order nonlinear processes; Third harmonic generation, Intensity-dependent refractive index. Self-focusing, Self-phase modulation, Cross phase modulation and four wave mixing; Impact of nonlinear effects in light wave communication systems; supercontinuum generation; Stimulated Raman and Brillouin scattering; Ultrafast and intense field nonlinear optics. Special topics in nonlinear optics.

Books/references:

1. G. P. Agrawal, Nonlinear Fiber Optics, Academic Press (1995)
2. Robert W. Boyd, Nonlinear Optics (3rd edition), Elsevier Academic Press (2007)
3. Y. R. Shen, The Principals of Nonlinear Optics, Wiley-Interscience (1984)
4. E. G. Sauter, Nonlinear Optics, (Wiley, New York, 1996).

Subject name: Introduction to Quantum Optics (Prerequisites: Applied Optics, Elements of Quantum Mechanics)
Subject code: EP4L023
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to familiarize students with the fundamental principles and applications of quantum optics. The students will gain understanding of topics related to quantum interferometry, quantum cryptography, quantum teleportation, quantization of EM fields, generation and detection of quantum light, and application of technologies pertaining to quantum optics.

Syllabus: Review of quantum mechanics and basic tools; Electro-magnetic field quantization - photons; classical and non-classical statistics of optical radiation; Entanglement – mathematical and physical concept; Principles of quantum interferometry; Different key distributions: secure random key distribution (quantum cryptography), entanglement swapping, and quantum teleportation; Hanbury Brown and Twiss (HBT) effect, Quantization of the EM field, Quantum states of light, Correlation functions, Generation of quantum light, Detection of quantum light, coincidence-counting, Phase-sensitive detection, Quantum state engineering by linear and nonlinear optical processes, Squeezed states and applications.

Other applications of quantum technology: quantum imaging, quantum metrology, quantum communications.

Books/references:

1. Elements of Quantum optics by P. Meystre and M. Sargent III
2. Quantum Optics by M. Scully and M. Suhail Zubairy
3. Quantum optics by Mark Fox
4. D. S. Simon, G. Jaeger, and A. V. Sergienko Quantum Metrology, Imaging, and Communication
5. R. Loudon, Quantum Theory of Light, 3rd Edition (Oxford University Press, 2000)
6. Girish S. Agarwal, Quantum Optics, 1st Edition (Cambridge University Press, 2012)

Subject name: Selected Topics in Optics and Photonics
Subject code: EP4L024
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to provide introduction to the selected topics in the area of optics and photonics to equip the students for career in these areas.

Syllabus: The course will cover topics related to Advanced Light Sources, Advanced detectors, THz spectroscopy, Green Photonics Plasmonic, Holography, Biomedical optics and Photonic integrated circuits.

Subject name: Concepts of Quantum Computing & Quantum Algorithms (Prerequisites: Elements of Quantum Mechanics)
Subject code: EP4L030
L-T-P: 3-0-0
Credits: 3

Objective: Upon completion of this course, students should be able to (a) distinguish between classical and quantum measurements, (b) distinguish between classical and quantum noise, (c) appreciate quantum entanglement as a distinct feature of quantum mechanics, (d) design and implement simple quantum algorithms, and (e) analyze the performance of classical and quantum algorithms.

Syllabus: Introduction to Quantum Computation: Overview of quantum mechanics, pure and mixed states, density matrices, unitary operations, quantum evolution, and superoperators. Measurements, decoherence and quantum noise. Spin-half systems and photon polarizations, quantum correlations, entanglement and Bell Test. Computational complexity and Turing machines, universal quantum logic gates, reversible computation and quantum circuits. **Quantum Algorithms:** Grover's search algorithm, Quantum fast Fourier transform and Shor's prime factor algorithm. Quantum neural networks and machine learning. Quantum programming languages and circuit simulators.

Books/references:

1. M.A. Nielsen and I.L. Chuang, “Quantum Computation and Information”, Cambridge University Press.
2. N.D. Mermin, "Quantum Computer Science", Cambridge University Press.
3. R.J. Lipton and K.W. Regan, “Introduction to Quantum Algorithms via Linear Algebra”, The MIT Press

4. E.F. Combarro, S.G. Castillo and A.D. Meglio, "A Practical Guide to Quantum Machine Learning and Quantum Optimization: Hands-on Approach to Modern Quantum Algorithms", Packt Publishing
5. J. Weaver and F. Harkins, "Qiskit Pocket Guide: Quantum Development with Qiskit", O'Reilly Media

Subject name: Quantum Communications, Cryptography, and Error Correction (Prerequisites: Concepts of Quantum Computing & Quantum Algorithms or similar courses)
Subject code: EP4L031
L-T-P: 3-0-0
Credits: 3

Objective: This course discusses quantum entanglement as a resource for safe and secure communications. Limitations of classical cryptography are discussed along with several protocols for quantum secure communications. Information loss in classical and quantum communication is discussed. Limitations of classical error correction are highlighted and several quantum error-correcting schemes are introduced along with their implementation in algorithms and quantum communications. Upon completion of this course, students should be able to (a) apply concepts of information theory to quantum communications, (b) analytically analyze various quantum communication protocols in terms of entropy, channel capacity etc, (c) detect and correct errors in leaky classical and quantum channels, (e) discuss quantum error-correcting models and fault-tolerant quantum computing, and (f) apply classical and quantum cryptography protocols to eliminate eavesdropping.

Syllabus: Communication: Digital communication and communication channels. Shannon's theorems, information and entropy. Quantum communication, dense coding and teleportation. Von Neumann entropy and quantum channel capacity. **Error correction:** Overview of error correction in classical and quantum systems. Limitation of classical error correction in quantum systems. Quantum error models and error correction codes. Single and multi-qubit error, quantum parity check and stabilizer codes. Fault-tolerant quantum computation, surface codes, threshold theorems and quantum error rates. Implementation in terms of hardware, software and algorithms. **Cryptography**: Cryptography and OTP. Public and private key cryptography. Quantum key distribution and quantum cryptography. Protocols for quantum secure communications. Experimental implementation of quantum cryptography protocols. Error correction in quantum communication and cryptography.

Books/references:

1. M.A. Nielsen and I.L. Chuang, "Quantum Computation and Information", Cambridge University Press.
2. R. Wolf, "Quantum Key Distribution: An Introduction with Exercises", Springer.
3. I.V. Djordjevic, "Quantum Information Processing, Quantum Computing, and Quantum Error Correction: An Engineering Approach", Academic Press
4. D.A. Lidar and T.A. Brun, "Quantum Error Correction", Cambridge University Press

Subject name: Architecture and Hardware for Quantum Computer (Prerequisites: Concepts of Quantum Computing & Quantum Algorithms or similar courses)
Subject code: EP4L032

L-T-P: 3-0-0
Credits: 3

Objective: This course introduces the physical realization of quantum computers in various material platforms and discusses the underlying challenges faced by these platforms. The software architecture in terms of quantum programming languages, compilers and microcontrollers is discussed along with simulators to analyze various pros and cons of mapping the circuits to different device layouts. Upon completion of this course, students should be able to (a) understand the different layers required to build a quantum computer, (b) map quantum circuits onto specific device layouts, (c) interpret quantum circuits written in QASM and execute quantum algorithms using simulator QX, (d) identify and describe different hardware blocks in a classical controller for a quantum computer, (e) gain conceptual insight into the operation, opportunities, and challenges of various qubit realisations, and (f) obtain a good overview of the state-of-the-art.

Syllabus: Quantum Architecture: Quantum languages, compilers, QISA framework and QX simulators. Quantum circuit mapping, qubit placement and scheduling of operations on physical device layouts. Classical controller and quantum processor. Controlling qubits - frequency up/down conversion, modulation schemes and frequency generator. Amplifiers, ADC, DAC, digital preprocessing, FPGA and Cryo-CMOS. **Quantum Hardware:** Quantum materials and Hamiltonian engineering challenge in various quantum hardware platforms. Overview of the experimental state-of-the-art, assess the strengths and weaknesses of the following seven technologies: Nuclear Magnetic Resonance; Trapped Ion; Majorana fermions and Topological quantum computing; Superconducting chip; Diamond Nitrogen Vacancy-Center; Neutral atom; Photonics. Remote entanglement, modular quantum computing architecture and the quantum internet. QEC and near-term applications of noisy quantum machines.

Books/references:

1. G. Chen, D.A. Church, B.G. Englert, C. Henkel, B. Rohwedder, M.O. Scully, M.S. Zubairy, “Quantum Computing Devices”, Chapman and Hall/CRC

2. S. Haroche, J.M. Raimond, “Exploring the Quantum: Atoms, Cavities, and Photons”, Oxford University Press.

3. H.M. Wiseman and G.J. Milburn, “Quantum Measurement and Control”, Cambridge University Press.

4. M.A. Nielsen and I.L. Chuang, “Quantum Computation and Information”, Cambridge University Press.

Subject name: Open Quantum Systems and Quantum Devices (Prerequisite: Elements of Quantum Mechanics and Statistical Physics)
Subject code: EP4L033
L-T-P: 3-0-0
Credits: 3

Objective: This course aims to provide a profound insight into the fundamental understanding of the theoretical principles and mathematical frameworks governing the operation of quantum devices and their transport properties. A sound understanding of the interactions between the environment and the system of interest (subsystem) and their wide range of practical applications. This course will provide a fundamental understanding of the principles governing the behaviour and operation of quantum devices like thermal diodes, thermal transistors, thermo-electric heat engines, etc. This course will equip students with the knowledge and skills necessary to understand, design, and work with a wide range of quantum devices, integral to many modern technology and engineering aspects.

Syllabus: Motivation and general construction for Open Quantum Systems, System Reservoir Approach, Quantum Master Equation (QME): General setup, Application to damped quantum Harmonic oscillator and damped charged driven oscillator; Quantum Langevin Equation (QLE), Comparisons between QLE and QME; Transport through a system coupled to multiple reservoirs; Non-equilibrium Greens Function Techniques; Theory of thermal diodes and thermal transistors; Understanding the operation of a thermoelectric heat engine and its characterizations; Open two level/multi-level systems: Perturbative and some exact results; Jaynes - Cummings Model: Exact Solutions; Generalizations of Jaynes - Cummings Model; Hybrid quantum systems; Driven dissipative systems (Cavity-QED, Circuit-QED systems)

Books/references:

1. Heinz-Peter Breuer and Francesco Petruccione, The theory of open quantum systems. Oxford University
Press, USA (2010)
2. Howard Carmichael, An Open Systems Approach to Quantum Optics; Springer Berlin Heidelberg (2009)
3. Ulrich Weiss, Quantum Dissipative Systems, World Scientific (2012)

Subject name: Biomaterials and its Applications (Prerequisites: Statistical Physics, Solid State Physics)

Subject code: EP4L040

L-T-P: 3-0-0

Credits: 3

Objective: This course is an introduction to the field of biomaterials. Biomaterials are materials that are used to interact with biological systems. They are used in a wide range of applications, including medical implants, tissue engineering, and drug delivery. With this course, the students will (i) understand the fundamental principles of biomaterials science, (ii) describe the different types of biomaterials and their properties, (iii) explain the biocompatibility and immune response to biomaterials, and (iv) design and select biomaterials for specific applications.

Syllabus: Introduction to biomaterials, Physics of biological systems, thermodynamics of biological systems, the mechanics of cells and tissues, and the transport of molecules through biological membranes, Biocompatibility and immune response, physics of cell adhesion, and protein adsorption. Biomaterials for drug delivery, Biomaterials processing, Biomaterials for orthopaedic applications, Biomaterials for cardiovascular applications, Biomaterials for dental applications, Biomaterials for tissue engineering

Books/references:

1. Biomaterials Science: An Introduction by Joon B. Park and Park K. Sung (Academic Press, 2023)
2. Physics of Biological Systems: From Molecules to Species by Henrik Flyvbjerg, John Hertz, Mogens H. Jensen, Ole G. Mouritsen, and Kim Sneppen
3. Biomaterials: The Intersection of Biology and Materials Science by Johnna S. Temenoff and Antonios G. Mikos

Subject name: Introduction to Soft Matter (Prerequisites: Statistical Physics)
Subject code: EP4L041
L-T-P: 3-0-0
Credits: 3
Objective: This course is an introduction to the physics of soft matter. Soft matter is a broad term that encompasses a wide range of materials, including colloids, polymers, gels, and biological macromolecules. These materials are often characterized by their disordered structure and their ability to undergo large deformations. Upon completion of this course, students will be able to (i) understand the fundamental principles of soft matter physics, (ii) describe the structure and properties of colloids, polymers, and gels, (iii) explain the physical basis of phase transitions and rheological behaviour in soft matter, and (iv) apply their knowledge of soft matter to solve real-world problems.
Syllabus: Introduction to soft matter: What is soft matter? Why is it important? Structure and properties of colloids: Colloid stability, interparticle forces, phase behavior, diffusion, and rheology; Ambiphiles, liquid crystals; Polymer physics: Polymer structure, polymer solutions, polymer blends, and polymer melts; Gelation and phase transitions in soft matter: Gel formation, sol-gel transition, polymer crystallization, and glass transition.; Rheology of soft materials: Viscosity, elasticity, and viscoelasticity; Applications of soft matter: Soft matter in materials science, biology, and medicine; active matter.
Books/references:
1. Soft Condensed Matter Physics: An Introduction by Philip M. Chaikin and T. C. Lubensky (Cambridge University Press, 2017)
2. Intermolecular and Surface Forces by Jacob N. Israelachvili. 3rd Edition, 2011

Subject name: Polymer Physics (Prerequisites: Statistical Physics)
Subject code: EP4L042
L-T-P: 3-0-0
Credits: 3
Objective: This course is an introduction to the physics of polymers, with a focus on industry-oriented topics. Polymers are long-chain molecules that are used in a wide range of products, including plastics, rubber, and textiles. Upon completion of this course, students will be able to (i) apply the principles of physics to understand the structure, properties, and behavior of polymers, (ii) design and select polymers for specific applications, (iii) understand the principles of polymer processing, and (iv) apply their knowledge of polymer physics to solve industry-oriented problems.
Syllabus: Fundamental physics of polymers: Polymer structure and conformation, intermolecular forces, polymer thermodynamics, and polymer dynamics; Polymer solutions and melts: Statistical mechanics of polymer solutions, polymer diffusion, and polymer rheology; Polymer blends and composites: Phase behavior of polymer blends, morphology of polymer composites, and mechanical properties of polymer composites; Polymer recycling: Physics of polymer degradation, recycling methods, and the circular economy; Polymer applications: Polymers in packaging, electronics, and medicine; Industry-Oriented Topics: Polymer processing: Polymer extrusion, injection molding, and blow molding; Biodegradable polymers: Mechanisms of biodegradation, biodegradable polymers for sustainable packaging; Polymer-based nanomaterials: Synthesis and properties of polymer-based nanoparticles, polymer-based nanofibers, and polymer-based nanocomposites; Polymer-based sensors and

actuators: Mechanisms of polymer sensing and actuation, polymer-based sensors for environmental monitoring, and polymer-based actuators for biomedical devices; Polymer-based drug delivery systems: Controlled release of drugs from polymer matrices, targeted drug delivery using polymer-based nanoparticles, and polymer-based hydrogels for tissue engineering.

Books/references:

1. Fundamentals of Polymer Physics by M. Rubinstein and R. P. Colby (Cambridge University Press, 2003)
2. Polymer Science: A Comprehensive Reference, 10-Volume Set by B. M. Culbertson, M. Matzner, and H. F. Mark (Academic Press, 1989-1995)
3. The Theory of Polymer Dynamics by M. Doi and S. F. Edwards Clarendon Press

Subject name: Medical Physics (Prerequisites: Introduction to Nuclear and Particle Physics, Introduction to Bioscience and Technology)

Subject code: EP4L043

L-T-P: 3-0-0

Credits: 3

Objective: This course provides an overview of the principles and applications of physics in medicine and healthcare. Students will gain an understanding of the role of physics in modern healthcare and its impact on patient diagnosis and treatment.

Syllabus: Introduction to medical physics: History of medical physics, Ethical and safety considerations in medical physics, overview of medical imaging, and radiation therapy; Medical imaging: X-ray imaging, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound imaging, Nuclear Medicine and Positron Emission Tomography (PET); Radiation therapy: Principles of radiation therapy, external beam radiation therapy, and brachytherapy; Radiation safety and protection: Radiation biology, radiation dosimetry, and radiation shielding, Regulatory guidelines and safety measures; Other applications of medical physics: Nuclear medicine, laser physics, and medical robotics, Particle therapy and its advantages, Emerging technologies in cancer treatment Patient-specific treatment planning, Special Topics and Research Applications.

Books/references:

1. Introduction to Medical Imaging: Physics, Engineering, and Clinical Applications by NB Smith and A Webb
2. The Essential Physics of Medical Imaging by JT. Bushberg, JA Seibert, EM. Leidholdt Jr., and John M. Boone
3. Radiation Therapy Physics" by William R. Hendee and Geoffrey S. Ibbott
4. Radiobiology for the Radiologist" by Eric J. Hall and Amato J. Giaccia
5. Introduction to Health Physics" by Herman Cember and Thomas E. Johnson

Subject name: Advanced Statistical Mechanics (Prerequisites: Statistical Physics)

Subject code: EP4L50

L-T-P: 3-0-0

Credits: 3

Objective: Upon completion of this course, students will be able to (i) Apply the principles of statistical mechanics to solve complex problems in engineering physics, (ii) Understand the thermodynamics and statistical properties of classical and quantum systems, including at critical points, and (iii) Describe the behavior of non-equilibrium systems using statistical methods, including transport phenomena.

Syllabus: Thermodynamics from a statistical perspective; ideal gases; real gases; classical/quantum phase transitions; critical phenomena; universality; critical exponents; phase diagrams; mean-field theory; Ising model, scaling theory; renormalization group. Application of statistical mechanics in condensed matter systems Non-equilibrium statistical mechanics: Linear response theory; fluctuation-dissipation theorem; Fokker-Planck equation; Langevin equation; master equations; transport theory. Boltzmann equation.

Books/references:

1. Statistical Mechanics, 3rd Edition by R.K. Pathria and P.D. Beale (Academic Press, 2011)
2. Advanced Statistical Mechanics by K. Huang (World Scientific, 2008)

Subject name: Plasma Science and Technology (Prerequisites: Electromagnetic Theory and Applications)
Subject code: EP4L051
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to provide students with a comprehensive understanding of the principles, applications, and technologies associated with plasma. With this course the students will be able to have a solid foundation in the fundamental principles of plasma physics, including the behaviour of charged particles in electromagnetic fields, plasma instabilities, and collective phenomena. They will learn about the basic properties of plasmas, such as temperature, density, and magnetic confinement and plasma parameters. Further, they will touch upon the diverse applications of plasma science and technology in fields such as materials processing, fusion energy research, and semiconductor manufacturing.

Syllabus: Introduction to plasma, Basic plasma characteristics: Debye shielding, plasma frequency, and plasma parameter, Charged particle motion in E and B fields, Mirror confinement, Plasma oscillations, Waves in unmagnetized plasmas, Solitons, Two stream instability, Rayleigh Taylor instability, Vlasov equation and Landau damping, Waves in magnetized plasmas (fluid theory), The Magnetohydrodynamic (MHD) equations, General properties of ideal MHD plasmas, MHD equilibrium, MHD waves, MHD stability. Plasma processing of materials, Laser driven fusion, Cerenkov free electron laser.

Books/references:

1. Plasma physics, Peter Andrew Sturrock
2. Introduction to Plasma Physics, by D. A. Gurnett and A. Bhattacharjee, Cambridge, 2005
3. Plasma Dynamics, R. O. Dendy, Clarendon Press, Oxford, 1990.
4. Introduction to Plasma Physics and Controlled Fusion, second edition, F. F. Chen, Plenum Press, 1984

Subject name: Advanced Modelling Techniques (Prerequisites: Statistical Physics)
Subject code: EP4L052
L-T-P: 3-0-0
Credits: 3

Objective: This course is an introduction to the theory and practice of molecular simulation. Molecular simulation is a powerful tool for studying the behavior of complex systems, such as materials, fluids, and biomolecules. Upon completion of this course, students will be able to (i) understand the fundamental principles of molecular simulation, (ii) apply Monte Carlo and molecular dynamics methods to solve problems in engineering physics, (iii) simulate the behavior of fluids, solids, and biomolecules, and (iv) apply molecular simulation to solve real-world problems.

Syllabus: Introduction to molecular simulation, Monte Carlo methods, Molecular dynamics simulations, Force fields, MD integration algorithms for different thermodynamic ensembles (NVE, NVT, NPT), various integration schemes, periodic boundary conditions, long-range interactions, Ewald Summations, Simulation of fluids, Simulation of solids, Simulation of biomolecules, Event-driven techniques, Applications of molecular simulation, finite element method.

Books/references:

1. Computational Physics by J.M. Thijssen

2. Numerical Recipes by William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery

3. Monte Carlo Methods in Statistical Physics by M.E.J. Newman and G.T. Barkema

Subject name: Experimental High Energy Physics

Subject code: EP4L053

L-T-P: 3-0-0

Credits: 3

Objective: This course teaches the students important concepts and methods in experimental high energy physics (EHEP), with the aim to understand the detection mechanism employed in the huge detectors used in accelerator facilities, and gain exposure to the methods used to understand the intricate working of nature using a synergy of hardware and software modes.

Syllabus: Interaction of high-energy particles with matter: Specific applications; related to EHEP, Relativistic kinematics, Decay kinematics: Rapidity, pseudo-rapidity; Accelerators and its types used in EHEP: Linear, and Circular; Detectors in High Energy physics: General concept of building a HEP experiment; Types of detectors: Gaseous detectors, Semiconductor detector, Scintillator and Cerenkov detectors specific to EHEP, Calorimeters; Current HEP Detectors such as CMS, Belle II, and LHCb; Detector Simulation: Need of simulation, Monte-Carlo (MC) simulation; Data analysis in EHEP: General approach of data skimming, calibration, track reconstruction, reconstruction of events; computing and error analysis in EHEP: applications in EHEP data analysis.

Books/references:

1. Techniques for nuclear and particle physics experiments: a How to approach by W. R.Leo (Springer)

2. Experimental Techniques in High Energy Nuclear and Particle physics by T. Ferbel (World Scientific)

3. Introduction to Experimental particle physics by R. C. Fernow

4. Data Reduction and Error analysis for the physical sciences by P. Bevington and D. K. Robinson

5. Data analysis Techniques for High Energy physics by R. Frunwirth, M. Regler, R. K. Bock and H. Grote

6. Relativistic Kinematics; a guide to the kinematic problems of High Energy physics by R.Hagedorn
7. The Experimental Foundations of particle physics by R. N.Cahn and G. Goldhaber

Subject name: Physics and Applications of Accelerators
Subject code: EP4L054
L-T-P: 3-0-0
Credits: 3
Objective: The objective of this course is to provide insight into the various types of acceleration mechanism and the types of accelerators used in various scientific research including medical physics.
Syllabus: Different types of accelerators, ion sources; Concept of lab, centre of mass frames, cross sections of interactions; Materials modification using accelerated ions (stopping powers, range); Materials characterization using accelerator (Rutherford backscattering spectrometry, Particle induced X-ray emission, Nuclear reaction analysis etc.); Accelerator based atomic, nuclear and particle physics. Data analysis; Accelerators for medical applications
Books/references:
1. Ion-solid interactions: fundamentals and applications by M. Nastasi, J. Mayer and J Hirvonen, Cambridge solid state science series.
2. Knoll Glenn F., Radiation Detection and Measurements, John Wiley and Sons
3. Beyer H. F. and Shevelko V. P., Introduction to the physics of highly charged ion
4. Ferbel T. Experimental Techniques in High-Energy Nuclear and Particle Physics, World Scientific Publ.
5. Livingston M. S. and Blewet J.P., Particle Accelerators, McGraw Hill
6. Leo W. R., Techniques for Nuclear and Particle Physics Experiments, Springer Verlag

Subject name: Selected Topics in Condensed Matter Physics (Prerequisites: Solid State Physics)
Subject code: EP4L055
L-T-P: 3-0-0
Credits: 3
Objective: The objective of the course is to provide introduction to the various areas in the condensed matter physics for the students who want to pursue higher studies in the areas of emerging condensed matter physics.
Syllabus: Topics related to Superconductivity, magnetism, Spintronics, topological phases, 2D materials.

Subject name: Selected Topics in Theoretical Physics
Subject code: EP4L056
L-T-P: 3-0-0
Credits: 3

Objective: The objective of the course is to provide introduction to the various fields in the theoretical physics for the students who want to pursue higher studies in the areas of cosmology, string theory, particle physics, astrophysics.
Syllabus: Topics related to general theory of relativity, cosmology, string theory, black holes, quantum field theory, and standard model physics.

Course Name: Econophysics (Prerequisites: Advanced statistical physics, Mathematical Methods for Physics)
Subject code: EP4L057
L-T-P: 3-0-0
Credits: 3
Objective: This course introduces students to the relatively new field of econophysics which tries to build an interface between physics and economics. After introducing the basics of economics and statistical mechanics, time-dependent stochastic processes are discussed followed by modelling asset prices as Brownian motion. Modern portfolio theory is introduced with the aim of managing risk. The idea of physical economics as a contrarian view to neo-classical economics is introduced based on two-dimensional calculus and the idea of circuits. Laws of thermodynamics are discussed in economics parlance along with a discussion of non-equilibrium thermodynamics. Models of wealth distributions are discussed in terms of Boltzmann equations. Game theory and Nash equilibrium are discussed in economic settings. Upon completion of this course, students should be able to: (i) understand the basic economic ideas, (ii) apply ideas of thermodynamics and heat engines to economic processes, (iii) understand and execute portfolio management by minimising risk, (iv) apply ideas from equilibrium and non-equilibrium statistical mechanics to the price movement of various assets, (v) apply the Kinetic theory of gases to wealth distribution, and (vi) learn and apply game theory in practical situations.
Syllabus: Introduction to complex systems, probability theory, statistical mechanics and economics. Reading financial data. Markov processes and Chapman-Kolmogorov equation. Langevin equations, Brownian motion and asset prices. The Fokker-Planck equation and stock prices. Risk and portfolio analysis - Markowitz model and random matrix theory. Economic and monetary circuits, first and second law of physical economics. Production laws, slowly changing productive markets and rapidly changing financial markets. A simple model of trade - computing demand and supply, inflation. Economic growth, Carnot cycle and entropy as a utility function. Non-equilibrium economics. Wealth distribution - Gibrat's model, Lotka-Volterra model and Collision models. Games and competitions - cooperative games and Nash equilibrium. Evolutionary game theory, replicator dynamics and Lotka-Volterra equations. Quantum Games.
Books/references:
1. P. Richmond, J. Mimkes and S. Hutzler, "Econophysics & Physical Economics", Oxford University Press.
2. C.R.D. Cunha, "Introduction to Econophysics: Contemporary approaches with Python simulations", CRC Press
3. S. Sinha, A. Chatterjee, A. Chakraborti, B.K. Chakrabarti, "Econophysics: An Introduction", Wiley-VCH

Course Name: Physics of Financial Markets (Prerequisites: Econophysics, Elements of Quantum Mechanics)
Subject code: EP4L058
L-T-P: 3-0-0
Credits: 3

Objective: This course builds upon the earlier course on Econophysics and extends the application of the ideas from statistical and quantum physics to economics with particular emphasis on derivative markets. Money markets, derivatives and hedging are introduced followed by the Efficient Market Hypothesis. Stochastic processes, Martingales and fluctuation-dissipation theorem are discussed for option pricing models along with the Black-Scholes differential equation. Option Greeks are discussed. Regression models, time series and forecasting are discussed. Criticality, phase transition and power laws are introduced to describe catastrophic events like the market crash. Path integral in quantum mechanics and finance is introduced with application to Black-Scholes Hamiltonian. Optimal control theory is introduced for business cycle models. Cryptocurrencies are discussed in terms of cryptography and entropy of information channels. Graph theory is introduced to study complex networks of interacting economic agents. Upon completion of this course, students should be able to: (i) understand the workings of the derivative markets, (ii) learn the Black-Scholes model for option pricing along with its parameters (Greeks), (iii) learn forecasting from time series and regression analysis, (iv) apply phase transition ideas to the theory of market bubbles and crashes, (v) apply path integrals from quantum mechanics to Monte-Carlo integrations in finance, (vi) apply optimal control theory used in statistical mechanics to business models, (v) understand the workings of cryptocurrencies, and (vi) apply graph theory to study complex networks.

Syllabus: Financial concepts - Stocks, Hedging, Derivatives, Efficient Market Hypothesis. Stochastic Processes - Martingales and fair games, Markov chains, Ornstein-Uhlenbeck processes and Fluctuation-Dissipation theorem.Options pricing - Binomial and Wiener Process, diffusion process and Green's function, Stochastic Integrals and Fokker-Planck equations, Black-Scholes differential equation, Martingales and dynamic hedging. The Greeks - volatility smile and value at risk. Regression models and hypothesis testing. Time series - MA, AR and ARMA, autocorrelation, Box-Jenkins and forecasting. Catastrophe theory - Bubble, Crashes, Fat tails, Levy-Stable distributions, criticality, power laws and extreme-value theory. Quantum finance - Black-Scholes Hamiltonian, path integrals in quantum mechanics and finance, Monte-Carlo integration. Optimal control theory - macroeconomic models, Hamiltonians for Optimal control and Robinson-Crusoe economy. Cryptocurrencies - Entropy, information channels, cryptography and quantum computing. Bitcoins and blockchains, Ethereum and smart contracts. Complex networks - Metrics, random and scale-free networks, opinion dynamics.

Books/references:

1. V. Ziemann, "Physics and Finance", Springer
2. C.R.D. Cunha, "Introduction to Econophysics: Contemporary approaches with Python simulations", CRC Press
3. D.Orrell, "Quantum Economics and Finance: An Applied Mathematics Introduction", Panda Phana Publishing