Indian Institute of Space Science and Technology

Department of Space, Govt. of India
Thiruvananthapuram

Bachelor of Technology in
Engineering Physics

Curriculum and Syllabus

July 2024 Batch onwards

BTech in Engineering Physics

Category	Category Code	Credit
Major Core	MC	78
Major Elective	ME	6-12
MajorCore+Major Elective	MC/ME	84-90
Holistic Enrichment Courses	HEC	33-36
HEC Electives	HECE	3-6
Extra-Curricular Activities	HEC	5
Co-Curricular Activities	HEC	4
Vocational Courses	VC	6
Summer Intership	Internship	3
Minor Stream	MS	12-18
Research Project	RP	15
Total		156-159

BTech Engineering Physics

Curriculum

Semester – I

Course Code	Title	L	T	P	C
PH111C	Mechanics and Relativity	2	1	0	3
MA111C	Calculus	3	0	0	3
AV111C	Basic Electrical Engineering	3	0	0	3
CH111C	Engineering Chemistry	2	1	0	3
HS111H	Communication Skills 1	1	0	2	2
PH131C	General Physics Lab 1	0	0	2	1
AA131V	Basic Engineering Lab	1	0	2	2
CH131C	Chemistry Lab	0	0	2	1
EC11*#	Extracurricular activities	0	0	0	1
	Total	12	3	8	19

Semester II

Course Code	Title	L	T	P	C
PH121C	Electricity and Magnetism	3	0	0	3
PH141V	C++ Programming	1	0	4	3
MA121C	Vector Calculus and Differential Equations	3	0	0	3
HS121H	Communication Skills 2	1	0	0	1
AV121C	Basic Electronics	3	0	0	3
AE122H	Fluid Dynamics	3	0	0	3
CH121H	Material Science and Engineering	3	0	0	3
AV141C	Basic Electrical and Electronics Lab	0	0	2	1
EC12*#	Extracurricular activities	0	0	0	1
	Total	17	0	3	21

Semester – III (Course Codes will be finalized later)

Category	Title	Credit
MC	Linear Algebra, Complex Analysis, and Fourier Series	3
MC	Electrodynamics	3
MC	Mathematical Physics	3
MC	Classical Mechanics	3
MC	Signals and Systems	3
HEC	Introduction to Economics	2
MC	EM Waves Lab	1
HEC	Extracurricular activities	1
HEC	Cocurricular activities	(1)
		19+(1)

Semester – IV

Category	Title	Credit
MC	Quantum Mechanics 1	3
MC	Optics	3
MC	Thermal and Statistical Physics	3
MC	Instrumentation and Sensor Electronics	3
HEC	Introduction to Social Science and Ethics	2
MC	Optics Lab	1
MC	Applied Quantum Physics Lab 1	1
MC	General Physics Lab 2	1
VC	Instrumentation and Sensor Electronics Lab	1
HEC	Extracurricular activities	1
HEC	Cocurricular activities	(1)
	Total	19+(1)

Semester – V

Category	Title	Credit
MC	Solid State Physics	3
HEC	Principles of Management Systems	3
MC	Probability, Statistics and Numerical Methods	3
MC	Astrophysical Concepts	3
HEC	Environmental Science and Engineering	2
MC	Solid State Physics Lab	2
MS	Minor Stream Slot 1	3
HEC	Extracurricular activities	(1)
HEC	Cocurricular activities	(1)
	Total	19+(2)

Semester – VI

Category	Title	Credit
MC	Quantum Mechanics 2	3
ME	Major Elective Slot 1	3
MS	Minor Stream Slot 2	3
MS	Minor Stream Slot 3	3
MC	Earth, Atmospheric and Ocean Scienes	3
MC	Modern Physics Lab	1
MC	Applied Quantum Physics Lab 2	2
HEC	Computational Physics	3
HEC	Extracurricular activities	(1)
HEC	Cocurricular Activities	(1)
	Total	21+(2)

Semester – VII

Category	Title	Credit
ME	Major Elective Slot 2	3
MC	Semiconductor Physics	3
MS	Minor Stream Slot 4	3
HECE	HEC Elective Slot 1	3
MS/ME	Minor Stream Slot 5/Major Elective Slot 3	3
MS/ME/HECE	Minor Stream Slot 6/Major Elective Slot 4/HEC Elective Slot 2 (optional)	3
Internship	Summer Internship and Training	3
HEC	Extracurricular activities	(1)
HEC	Cocurricular activities	(1)
	Total	18-21+(2)

Semester – VIII

Category	Title	Credit
RP	Research Project	15
HEC	Cocurricular activities	4
	Total	19

Syllabus

Semester – I

PH111C	Mechanics and Relativity (2-1-0)	3 Credits

Introduction to vectors: linear independence – completeness – basis – dimensionality – inner product – orthogonality – displacement – derivatives of a vector – velocity – acceleration – plane polar coordinates.

Angular momentum: angular momentum and torque on a single particle – angular momentum and torque on a system of particles – moment of inertia – angular momentum of a rigid body

Oscillations: Simple pendulum – 1-D harmonic oscillator – damped and forced harmonic oscillators – resonance – coupled oscillators – normal modes

Special Relativity: Einstein's correction – Space-time interval – length contraction – time dilation - four vectors – displacement – velocity – acceleration – Lorentz transformation – conservation of 4-momentum – Mass energy relation

Text Books

1. Kleppner, D. and Kolenkow, R. J., An Introduction to Mechanics, 2nd ed., Cambridge Univ. Press (2013).
2. John R. Taylor, Classical Mechanics, University Science Books, 2005

MA111C	Calculus (3-0-0)	3 Credits

Sequence and Series of Real Numbers (7L): sequence – convergence – limit of sequence – non decreasing sequence theorem – sandwich theorem (applications) – L'Hopital's rule – infinite series – convergence –geometric series – tests of convergence (nth term test, integral test, comparison test, ratio and root test) –alternating series and conditional convergence – power series.

Differential Calculus (19L): functions of one variable – limits, continuity and derivatives – Taylor's theorem– applications of derivatives– curvature and asymptotes– functions of two variables– limits and continuity–partial derivatives– differentiability, linearization and differentials–extremum of functions – Lagrange multipliers.

Integral Calculus (19L): lower and upper integral – Riemann integral and its properties – the fundamental theorem of integral calculus – mean value theorems – differentiation under integral sign - double and triple integrals – change of variable in double integrals – polar and spherical transforms – Jacobian of transformations.

Text Books

1. **Stewart, J., Calculus: Early Transcendentals, 5th ed., Brooks/ Cole (2007).**
2. **Jain, R.K. and Iyengar, S.R.K., Advanced Engineering Mathematics, 4th ed., Alpha science international Ltd (2014).**

References

1. Greenberg, M.D., Advanced Engineering Mathematics, Pearson Education (2007).
2. James, G., Advanced Modern Engineering Mathematics, Pearson Education (2004).
3. Kreyszig, E., Advanced Engineering Mathematics, 9th ed., John Wiley (2005).
4. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, 9th ed., Pearson Education (2003).

AV111C	Basic Electrical Engineering (3-0-0)	3 Credits

INTRODUCTION: Introduction to Electrical Engineering –Basic elements in electrical circuits – Passive elements: Behavior of resistor, inductor, and capacitor. Active elements: Characteristics of voltage source and current source – independent and dependent sources.

AC FUNDAMENTALS: Introduction to Alternating Current – Basic concepts of AC circuits – RMS value and average value – Behavior of resistor, capacitor and inductor in AC circuits – concepts of reactance and impedance - Sinusoidal steady state analysis of AC circuits – Phasor analysis - Power in AC circuits – Power factor - Resonance in AC circuits- Three-phase systems – Basic concepts of balanced three-phase systems-Star and Delta connections – Power in three-phase systems.

AC CIRCUIT ANALYSIS & NETWORK THEOREMS: AC circuit analysis – mesh current method – node voltage method. Network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem, superposition theorem.

ELECTRICAL MACHINES: Basic concepts of magnetic circuits – coupled circuits. Transformers: Principle of operation – Phasor diagram - Equivalent circuit of Transformer –Regulation and efficiency – Autotransformer. Rotating electrical machines: Classification - principle of operation - constructional features and characteristics of different types of DC machines and AC machines.

Text Books/References:

1. Vincent Del Toro : ‘Electrical Engineering Fundamentals’, Pearson Education

2. A.E.Fitzgerald, David E Higginbothom, Arvin Grabel: ‘Basic Electrical Engineering’, Tata McGraw-Hill

3. Hughes, E. : ‘Electrical and Electronic Technology’, Pearson Education .

4. Charles K Alexander, Mathew N O Sadiku: ‘Electric Circuits’

5. Fitzgerald, Kingsley, Umans, ‘Electric Machinery’, TMH

6. M.G.Say, ‘ Performance and Design of AC Machines’.

7. Mittle, V. N. and Mittal, A., Basic Electrical Engineering, 2nd ed., Tata Mcgraw-Hill

8. Cotton, H., Principles of Electrical Engineering, Sir Isaac Pitman & Sons

CH111C Engineering Chemistry (2-1-0) 3 Credits

Course Description:

This course intends to provide understanding regarding, how molecules interact leading to chemical reactions and the factors affecting the reaction rates. Further, the course introduces spectroscopy as a useful characterisation techniques to identify compounds. Students also get introduced to two important class of materials, namely polymers and propellants.

Course objectives

- To provide the students understanding of the basics of rates of reactions of molecules
- To provide basic knowledge of spectroscopy
- To introduce the students to the properties and applications of polymers and propellants

Course Outcome:

- Students will be able to optimize the conditions for chemical reactions and analyse the mechanisms
- Students will identify compounds using UV Visible and IR spectroscopy
- Students will choose and design polymers for specific applications

- Students will compare and analyze the properties of different classes of propellants

Syllabus

Kinetic theory of gases; Chemical Kinetics: basic concepts, complex reactions, effects of temperature, catalysis; Spectroscopy: fundamentals, electronic and vibrational spectroscopy; Polymers: Polymerization mechanisms, techniques, kinetics, properties; Propellants: classification and properties

Syllabus-detailed

Kinetic theory of gases: Introduction, collision theory, estimation of gas properties

Chemical Kinetics: Introduction, elementary and complex reactions, rate law expressions, effect of temperature on reaction rates, catalysis

UV-Visible Spectroscopy-fundamentals, Beer Lambert's law, electronic transitions, empirical rules for prediction of λmax. IR Spectroscopy-Fundamentals, identification of functional groups.

Polymers: Introduction, molecular weights of polymers, polymerization mechanisms-radical, ionic and condensation, structure property relations and applications.

Propellants: classification of propellants, performance of propellants and thermochemistry, liquid propellants, oxidizers and fuels ,solid propellants , composite solid propellants, Burning ignition, and rate of burning, factors affecting rate of burning

Text Books & Reference

1. Atkins P, Paula J and Keeler J, Atkins' Physical Chemistry, 11 th ed., Oxford Univ. Press (2018).
2. Young R J and Lovell P A, Introduction to Polymers, CRC Press, (2011)
3. Kemp, W., Organic Spectroscopy, Palgrave Foundations (1991).
4. Laidler, K. J., Chemical Kinetics, 3rd ed., Pearson Education (2005).
5. Sutton G.P and Biblarz O, Rocket Propulsion Elements, 8th Ed. John Wiley and Sons (2010)

HS111H	Communication Skills 1 (1-0-2)	2 Credits

Course Objective:

This course is specially designed for the first semester students to enhance their and communication skills. Firstly, it aims to expose students to a broad spectrum of exercises and worksheets that enable the students to use their creativity and imagination, with special emphasis on improving their competence in listening, speaking, reading and writing. Along with this they will be exposed to other facets of the genre like, report writing, note taking, writing technical letters etc. As there is a lab content, they will learn the basics of presentation skills, interview skills, and will participate in Group discussions as well.

Course Outcome:

1. Understand and learn the significance of Effective Communication Skills through learning life skills which are not hinged on traditional pedagogy.

2. Develop improved listening, speaking, reading and writing skills and confidence to become successful English speakers.

3. Understand significance of verbal and non-verbal communication in their personal and professional life

4. Enhance the students' body language, social etiquette, presentation skills, interview skills, assertive communication skills, active listening and technical writing skills.

Thrust Areas

1. Listening drills
2. Pronunciation drills
3. Practice special communication situations
4. Vocabulary exercises
5. Functional grammar exercises
6. Technical writing tips (engineering and scientific papers)
7. Neuro-linguistic programming
8. Passage comprehension
9. Metronome practice with the help of mnemonics
10. Group discussions and debates
11. Technical guide lines for seminar presentation

Note: Audio Visual Lab and Language Lab employs multimedia teaching materials to enhance speaking, listening, reading, and writing skills. This course also includes neuro-linguistic programming to develop language competency.

Module 1- Functional English

Conversation Skills: Asking questions, requests, doubts, engage in conversation, Different types

of Communication-verbal and non-verbal, body language

Module 2: Teaching Grammar

Grammar Games, Exercise

Module 3: Teaching Vocabulary

Language Games, Exercise

Module 4: Presentation Skills

Module 5: Role Plays, debates, extempores, group presentations

References:

I . Alan Garner. Conversationally Speaking: Tested New Ways to Increase Your Personal and
Social Effectiveness.

2. Mike Bechtle. Confident Conversation: How to Communicate Successfully in Any Situation

3. Ronald carter, Rebecca Hughes. Exploring Grammar in Context

4. Baker, Ann and S. Goldstein, Pronunciation Pairs, Cambridge Univ Press, Cmbridge.2002.

5. S. Brown and D. Smith, Active Listening. Cambridge, CUP. 2004.

PH131C	General Physics Lab 1 (0-0-2)	1 Credit

Students will be required to complete a minimum of EIGHT experiments

1. WAVES – hollow pipes and string
2. Laws of Gyroscope
3. Pohl's Pendulum
4. Centripetal Force and Moment of Inertia
5. Earth's Magnetic Field
6. Absolute Zero Temperature
7. Ratio of Specific Heats
8. Electric field and Equipotential lines
9. e/m ratio
10. Forced oscillations and Resonance

AA131V	Basic Engineering Lab (1-0-2)	2 Credits

Part A: Introduction to sketching- Introduction to Computer-Aided Drawing - Orthographic/ Isometric / sectional views- Development of surfaces.
Part B: Electrical wiring practice, Soldering practice**,** Identification and testing of electronic components, Circuit simulation using LT SPICE, PCB Design, PCB Fabrication, Soldering of components on PCB and testing.

Text Books / References:

1. Bhatt, N. D., Engineering Drawing: Plane and Solid Geometry, 50th ed., Charotar Publishing House (2010).
2. Varghese, P. I., Engineering Graphics with AutoCAD, 26th ed., VIP Publishers (2012).
3. Bethune, J. D., Engineering Graphics with AutoCAD 2014, Pearson Education (2014).
4. Lab Manual.

CH131C	Chemistry Lab (0-0-2)	1 Credit

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Sl. No.	**Experiments**
1	Determination of total hardness of water
2	Determination of Metal ion concentration using Potentiometry
3	Determination of strength of acid by Conductometry
4	Spectrophotometric estimation of compounds
5	Kinetics of acid hydrolysis of ester
6	Determination of viscosity average molecular weight of a polymer
7	Characterization of materials using microscopy
8	Identification of functional groups of organic compounds using IR spectroscopy

Semester – II

MA121C Vector Calculus and Differential Equations (3 – 0 – 0) 3 credits

Vector Calculus: scalar and vector fields – level surfaces – directional derivatives, gradient, curl, divergence
– Laplacian – line and surface integrals – theorems of Green, Gauss, and Stokes.

Sequences and Series of Functions: complex sequences – sequences of functions – uniform convergence of series – test for convergence – uniform convergence for series of functions.

Differential Equations: first order ordinary differential equations – classification of differential equations – existence and uniqueness of solutions of initial value problem – higher order linear differential equations with constant coefficients – method of variation of parameters and method of undetermined coefficients – power series solutions – regular singular point – Frobenius method to solve variable coefficient differential equations.

Special Functions: Legendre polynomials, Bessel's function, gamma function and their properties – Sturm-Liouville problems.

Text Books

1. Ross, S. L., Differential Equations, Blaisedell (1995).
2. Kreyszig, E., Advanced Engineering Mathematics, 9th ed., John Wiley (2005).
3. Stewart, J., Calculus: Early Transcendentals, 5th ed., Brooks/Cole (2007).

References

1. Greenberg, M. D., Advanced Engineering Mathematics, Pearson Education (2007).
2. Jain, R. K. and Iyengar, S. R. K., Advanced Engineering Mathematics, Narosa (2005).

AE122H Fluid Mechanics (3 – 0 – 0) 3 credits

Course Objectives:

AE213 Fluid Mechanics

This course will introduce the students to the basic concepts of fluid mechanics. Concepts in fluid statics, fluid kinematics, and fluid dynamics will be discussed. The physical conservation laws applied to fluid flows and the conservation equations governing the incompressible flow will be discussed in detail. Solution techniques for simple fluid flow systems will be introduced. After the completion of the course, students will be able to apply their knowledge and skills to understand practical fluid flow problems and suggest solutions if possible.

Syllabus:

Fluid properties -- fluid statics -- integral control volume formulation -- applications of Bernoulli equation -- fluid kinematics -- differential formulation, continuity and momentum equations -- exact solutions of Navier-Stokes equation-- dimensional analysis -- pipe flow -- potential flow -- boundary layer theory.

Textbook:
? Cengel, Y. A. and Cimbala, J. M., Fluid Mechanics: Fundamentals and Applications, 4th ed., McGraw-Hill (2019).

Reference Books:

Fox, R. W., McDonald, A. T., Pritchard, P. J., and Mitchell, J. W., Fluid Mechanics, John Wiley (2018).

Munson, B. R., Okiishi, T. H., Huebsch, W. W., and Rothmayer, A. P., Fundamentals of Fluid Mechanics, 7th ed., Wiley (2017).

White, F. M. and Xue, H., Fluid Mechanics, 9th ed., McGraw-Hill (2022).

Kundu, P. K., Cohen, I. M., and Dowling, D. R., Fluid Mechanics, 6th ed., Academic Press (2015).

Massey, B. S. and J. Ward-Smith, Mechanics of Fluids, 7th ed., Nelson Thornes (1998).

Potter, M. C., Wiggert, D. C., and Ramadan, B. H., Mechanics of Fluids, 5th ed., Cengage (2017).

Wilcox, D. C., Basic Fluid Mechanics, 5th ed., DCW Industries (2013).

Course Outcomes (CO): (As defined by the course instructor)

Know the fundamental concepts of fluid mechanics such as continuum, fluid properties, velocity field; classification of fluid flows.

Apply the hydrostatic equation to determine forces on submerged surfaces; to manometers for pressure measurements; to the determination of buoyancy and stability; and to fluids undergoing rigid-body motion.

Use of finite control volume formulation of conservation laws and apply them to determine gross parameters in a fluid flow system. Understand the concepts of static, dynamic, and stagnation pressures. Use of Bernoulli equation in flow problems.

Use differential forms of conservation laws and apply them to determine velocities, pressures and acceleration in a moving fluid. Understand the kinematics of fluid particles, including the concepts of substantial acceleration, deformation, rotation, vorticity, and circulation.

Use of analytical solutions of simple incompressible laminar flow systems. Use of Dimensional analysis. Determine flow rates, pressure changes, minor and major head losses for incompressible viscous flows through pipes.

Use of concepts in potential flows to analyse elementary flow patterns (source, sink, vortex flows, and superposition of these flows) in an ideal fluid flow.

Understand the concepts of incompressible boundary layers and use the momentum integral equation to determine boundary layer thicknesses, wall shear stresses, and skin friction coefficients.

PH121C Electricity and Magnetism (3 – 0 – 0) 3 credits

Electricity: Vector calculus — gradient, curl, divergence, curvilinear coordinates, Dirac-delta function, Gauss' theorem, Stokes' theorem, electrostatic potential and field due to discrete and continuous charge distributions, energy density in an electric field, dipole and quadrupole moments, dielectric polarization – conductors and capacitors – electric displacement vector – dielectric susceptibility.

Magnetism: Currents, Biot-Savert law, magnetic induction due to configurations of current-carrying conductors – magnetization, energy density in a magnetic field, magnetic permeability and susceptibility, force on a charged particle in electric and magnetic fields, electromotive force, Faraday's law of electromagnetic induction – self and mutual inductance, displacement current.

Maxwell's equations – charge and energy – Poynting's theorem.

Text Book(s)

1. Griffith, D. J., Introduction to Electrodynamics, 3rd ed., Prentice Hall (1999).

References

1. Feynman, R. P., Leighton, R. B., and Sands, M., The Feynman Lectures on Physics, Narosa (2005).

2. Reitz, J. R., Milford, F. J., and Christy, R. W., Foundations of Electromagnetic Theory, 3 rd ed., Narosa (1998).

3. Sadiku, M. N. O., Elements of Electromagnetics, 8th ed., Oxford Univ. Press (2007).

HS121H Communication Skills 2 (1 – 0 – 0) 1 credit

Course Objective:

This is a single theory course specially structured to implement the NEP 2020. It aims to develop a diverse set of skills in students that are essential for success in the 21st century global economy. These skills include communication, critical thinking, problem-solving, collaboration, and creativity. This course stresses Written communication, Oral communication, Non-verbal and visual communication, Active listening, and Contextual communication.

Course Outcome:

1. Understand the significance of professional communication and technical writing

2. Create an awareness regarding body language, facial expressions, and gestures to enhance communication and convey messages effectively.

3. Learn Interpersonal Communication skills to develop and maintain relationships, to resolve conflicts, and to be empathetic to others.

4. Keeping the NEP goals in mind, the course endeavours to be holistic, educational, integrated, enjoyable and engaging.

Module 1: Audience analysis and adaptation

Module 2: Technical writing formats and styles (e.g., reports, minutes, posters, proposals, manuals, instructions), Writing style and tone, Clarity, conciseness, and coherence, Introduction to Technical Writing: Document planning and organization

Module 3: Reading and appreciating stories, poems, essays, Comprehensive questions and answers, Listening and note taking video lectures

Module 4: short plays, individual presentations, group discussions, debates

References:

1. Buzan, Tony. Use Your Head, Guild Publishing, 1974.

2. G. Maugur, The English Language Laboratory Drills for Students of Science and Technology, Oxford, OUP. 2005.

3. Mc Carthy, Carter. Cambridge Grammar of English. Cambridge, CUP.2006

4. Yule, George. Oxford Practice Grammar. Oxford, OUP. 2006.

5. Anderson, Kenneth. Et al. Study Speaking. CUP, Cambridge.2004.

6. Freeman, Sarah. Written Communication in English. Orient Longman, Chennai. 2005.

7. Hancock, Mark. English Pronunciation in Use. CUP, UK. 2003.

8. Swales, J. M., & Feak, C. B. Academic writing for graduate students: Essential tasks and skills (Vol. 1). Ann Arbor, MI: University of Michigan Press. 2004.

9. Belcher, W. L.Writing your journal article in twelve weeks: A guide to academic publishing success. University of Chicago Press.2019

CH121H Materials Science and Metallurgy (3 – 0 – 0) 3 credits

Course description

This course focuses on the fundamentals of structure, energetics, and bonding that form the basis of materials science. The course deals with important classes of materials: metals, ceramics and polymers and provides a basic understanding of these materials, their structure-property relations and how to characterize them. It provides an understanding of materials science and engineering with an emphasis on rapidly growing areas such as energy and the environment.

Course objectives

· To provide the students a strong understanding of the basics of materials science, structure-property relations

· To provide knowledge about important material characterizations

Course outcome

· Students will have the ability to design and choose the right materials for specific applications

Course Syllabus

Atomic bonding, particle in a finite and infinite potential well, particle in a one-dimensional lattice; Crystal structure, crystal planes, lattice constant and matching, miller indices, defects in crystals; Crystal growth, Czochralski method; Metals and alloys; Ceramics; Semiconductors; Dielectric materials; Semiconducting polymers; Tools for material characterization, X-ray diffraction, electron microscopies.

Syllabus -detailed

Atomic bonding: attractive and repulsive forces, Chemical bonding in solids, free electron model, the quantum-mechanical free electron theory; zone or band model, Kronig Penney model,

Crystal structure: lattice, basis, unit cell, crystal structures, miller indices of directions and planes, interstitial sites, ionic and covalent crystal structures, Defects; point and lattice defects, Crystal growth: Czochralski method, Bridgman and Stockbarger Methods

Metals and alloys, structure-property relations, strain hardening; Semiconductor materials; Ceramics, synthesis and processing; Semiconducting polymers, classification, mechanism of formation, structure-property relations, Material characterization, Braggs law, X-ray diffraction, electron microscopies; scanning electron microscopy, principles, applications,

Textbooks

1. Donald R. Askeland, Wendelin J. Wright, The Science and Engineering of Materials, 7th ed., Cengage Learning India Pvt Ltd (2016).

2. Prathap Haridoss, Physics of Materials: Essential Concepts of Solid-State Physics, Wiley India (2015)

3. Billmeyer, F. W., Textbook of Polymer Science, 3rd ed., Wiley India (1984).

4. W.D. Kingery, Introduction to Ceramics, 2nd ed., John Wiley & Sons, (1999).

5. Y. Leng, Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), (2008).

AV121C Basic Electrical and Electronics Engineering (3 – 0 – 0) 3 credits

DC Circuit Analysis: Network Theorems - Thevenin’s theorem, Norton’s theorem, Superposition theorem, Maximum power transfer theorem.
AC Circuit Analysis: Basic concepts of AC circuits – RMS value and average value – Behavior of resistor, capacitor and inductor in AC circuits – Sinusoidal steady state analysis of AC circuits – Power – Power factor - Resonance in AC circuits.

Introduction To Magnetic Theory

Diode – clipping, clamping circuits, applications in rectifiers and power supplies.
Amplifiers: BJT-Characteristics- DC analysis and AC analysis of BJT. Application of BJT as

amplifiers/switch.
Introduction to operational amplifiers – characteristics/specifications and application circuits.
Digital circuits – Boolean logic – basic gates – truth tables – logic minimization using K maps – combinatorial and sequential circuits.

Text Books:

1. Boylestad, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education (2003).

3. Mano, M. M., Digital Design, Prentice Hall (2002).
4. Same as Reference (Electrical Part)

References:

1. Vincent Del Toro : 'Electrical Engineering Fundamentals', Pearson Education, 1989
2. A.E.Fitzgerald, David E Higginbothom, Arvin Grabel: 'Basic Electrical Engineering',Tata

   McGraw-Hill, 2010.
3. Hughes, E. : 'Electrical and Electronic Technology', Pearson Education, 2008.
4. Charles K Alexander, Mathew N O Sadiku: 'Electric Circuits' McGraw-Hill; 4th edition, 2008.
5. Fitzgerald, Kingsley, Umans, 'Electric Machinery', Tata Mcgraw-Hill, 2017.
6. M.G.Say, ' Performance and Design of AC Machines', CBS; 3rd edition, 2002
7. Mittle, V. N. and Mittal, A., Basic Electrical Engineering, 2nd ed., Tata Mcgraw-Hill, 2005
8. Cotton, H., Principles of Electrical Engineering, Sir Isaac Pitman & Sons, 1967.
9. Mottershed, A., Electronic Devices and Circuits: An Introduction, EEE Publication, 12^{th} Indian

   ed. (1989).
10. Bapat, Y. N., Electronic Devices and Circuits, Tata McGraw-Hill, 9th ed. (1989).
11. Malvino, A. P., Electronic Principles, 12th ed., 3rd TMH ed., Tata McGraw-Hill (1989).
12. Jain, R. P., Modern Digital Electronics, McGraw-Hill (2004).
13. Floyd, T. L., Electronic Devices, Pearson Education, 8th ed. (2007).

PH141V C++ Programming (1 – 0 – 4) 3 credits

Introduction to Linux – introduction to programming – basic elements of a program, variables, values, types, assignment – expressions and control flow – iteration and loop design, arrays, for loop, functions, parameters, recursion – object-oriented paradigm, objects, classes, inheritance, reusability, polymorphism, overloading, libraries, classes for file handling

Text Books

1. Lippman, S. B., Lajoie, J., and Moo, B. E., C++ Primer, 5th ed., Addison-Wesley

(2012).

2. Lafore, R., Object-Oriented Programming in C++, 4th ed., Sams Publishing (2001).

References

1. Cohoon, J. P. and Davidson, J.W., Programming in C++, 3rd ed., Tata McGraw-Hill, (2006).
2. Bronson, G., A First Book of C++, 4th ed., Cengage (2012).
3. Stroustrup, B., The C++ Programming Language, 3rd ed., Pearson (2005).

Semester – III

MA211 Linear Algebra, Complex Analysis and Fourier Series (2 – 1 – 0) 3

Course codes will be finalized later.

Linear Algebra: matrices; solution space of a system of equations Ax = b, eigenvalues and eigenvectors, Cayley-Hamilton theorem – Definition of Group, ring field – Vector spaces over real field, sub-spaces, linear dependence, independence, basis, dimension – inner product –Gram–Schmidt orthogonalization process – linear transformation; null space and nullity, rangeand rank of a linear transformation.

Complex Analysis: complex numbers and their geometrical representation – functions of complex variable
– limit, continuity and derivative of functions of complex variable – analytical functions and applications – harmonic functions – transformations and conformal mappings – bilinear transformation – contour integration and Cauchy's theorem – convergent series of analytic functions – Laurent and Taylor series – zeroes and singularities – calculation of residues – residue theorem and applications.

Fourier Series and Integrals: Expansion of periodic functions with period 2π – Fourier series of even and odd functions – half-range series – Fourier series of functions with arbitrary period– conditions of convergence of Fourier series. Fourier integrals.

Text Books

1. Kreyszig, E., Advanced Engineering Mathematics, 10th ed., John Wiley (2011).
2. Mathews, J. H. and Howell, R., Complex Analysis for Mathematics and Engineering, Narosa (2005).

References

1. Brown, J. W. and Churchill, R. V., Complex Variables and Applications, 9th ed., McGraw-Hill (2013).
2. Greenberg, M. D., Advanced Engineering Mathematics, Pearson Education (2007).
3. Jain, R. K. and Iyengar, S. R. K., Advanced Engineering Mathematics, Narosa (2005).
4. Churchill, R. V. and Brown, J. W., Complex Variables and Applications, 6th ed., McGraw- Hill (2004).

PH211 Electrodynamics (3 – 0 – 0) 3 credits

Electromagnetic Waves: Waves in one-dimension – Wave eqaution – Sinusoidal waves – Reflection and transmission – Polarization – Electromagnetic waves in vacuum – wave equations for E and B – Monochromatic plane waves – Energy and momentum in electromagnetic waves – Electromagnetic Waves in Matter – Propagation in linear media – Reflection and transmission at normal and oblique incidence – Absorption and Dispersion – Electromagnetic waves in conductors – Reflection at a conducting surface – Frequency dependence of permittivity – Guided Waves – Wave guides – TE waves in a rectangular

wave guide – Waves in coaxial transmission
line.

Potentials and Fields: Scalar and vector potentials, Guage transformations – Coulomb gauge.

Radiation: Dipole radiation – Electric and magnetic dipole radiation – Radiation from an arbitrary source – Power radiated from point charges – Radiation
reaction.

Electrodynamics and Relativity: Relativitistic electrodynamics – Magnetism as a relativistic phenomenon – field tensor – transformation of fields – Relativistic
potentials.

Suggested Text: Introduction to Electrodynamics, D. J. Griffiths, Prentice Hall of India.

PH212 Mathematical Physics (3 – 0 – 0) 3 credits

Sketching functions, Gaussian integrals, Generalized functions: Step function, Dirac delta function.

Vectors and Tensors: Cartesian tensors, rotations and index notation, Isotropic tensors: Kronecker delta, Levi-Civita symbol, Gram determinant. Rotations in three dimensions, Proper and improper rotations, scalars and pseudoscalars; polar and axial vectors.

Linear vector spaces: Definitions and basic properties, the dual of a linear space, the inner production of two vectors, basis sets and dimensionality, Gram-Schmidt orthonormalisation, Expansion of an arbitrary vector, Basis-independence of the inner product, The Cauchy-Schwarz inequality

Matrices: Pauli matrices, Expansion of a (2x2) matrix, the exponential of a matrix, Rotation matrices in three dimensions: generators of infinitesimal rotations and their algebra, matrices as operators in a linear space, projection operators, Hermitian, unitary and positive definite matrices.

Infinite-dimensional vector spaces: square-summable sequences, square-integrable functions, continuous basis, the wave function of a particle, Hilbert space.

Linear operators on a vector space: linear operators, norm and bounded operators, adjoint of an operator, derivative operator in square-integrable space, adjoint of the derivative operator, matrix representations of unbounded operators.

Orthogonal polynomials: Orthogonality and completeness, recursion relation, the classical orthogonal polynomials, hypergeometric differential equation, Rodrigues formula and generating function, Hermite polynomials, linear harmonic oscillator eigenfunctions, generalized Laguerre polynomials, Jacobi polynomials:Chebyshev polynomials and Legendre polynomials, associated Legendre functions, Spherical
Harmonics.

Discrete probability distributions mean and variance, Bernoulli trials and the binomial distribution, the geometric distribution, photon number distribution in blackbody radiation, The Poisson distribution.

Continuous probability distributions: Probability density and cumulative distribution, The moment-generating function, The Gaussian distribution, The Gaussian as a limit law, The central limit theorem.

Text Books

1. Mathematical Physics with Applications, Problems, & Solutions, V. Balakrishnan, Ane Books Pvt. Ltd, 2018

References

2. Mathematics for physicists, P. Dennery and A. Krzywicki, Dover Publications, 2012
3. Vector and Tensor Analysis with Applications, A. I. Borisenko, Dover Publications, 1979
4. Group Theory and its application to physical problems, M. Hamermesh, Dover Publications
5. Introduction to Mathematical physics, Charlie Harper, Prentice Hall India Learning Private Limited, 1978
6. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber and F. E. Harris, Elsevier, 2012

AV211 Analog Electronic Circuits (3 – 0 – 0) 3 credits

Basic stability and device stabilization techniques (BJT). Small signal low & high frequency models for (BJT, FET, MOSFET), Large signal amplifiers, Differential Amplifier, Instrumental amplifiers, Integrated circuits, Tuned amplifiers, Feedback amplifiers, Oscillators, Multivibrators, Wave shaping circuits, Filter design.

Basic stability and device stabilization techniques (BJT). Small signal low & high frequency models for (BJT, FET, MOSFET). Large signal amplifiers - Multistage amplifiers - Differential amplifier - Tuned amplifiers - Feedback amplifiers – Power amplifiers - Instrumental amplifiers. Oscillators – Multivibrator - Wave shaping circuits - Active Filter design- Integrated circuits (PLL, Timers, A/D converters)

.

Textbooks:

1. J. Millman and C.C. Halkias, Integrated Electronics - Analog and Digital circuit system, McGraw Hill, 1996.

References:

1. David A.Bell, Electronic Devices and Circuits, Prentice Hall of India, 2006.
2. Donal L. Schilling and Charles Beloue, Electronic Circuits , Third Edition, McGraw Hill, 2005.
3. David A. Bell, Solid State Pulse Circuits , Prentice Hall of India, 1992.
4. John D. Ryder, Electronic Fundamental and Applications - Integrated and Discrete system , Prentice Hall of India, 1999.
5. J. Millman and H. Taub, Pulse Digital and Switching waveform-Devices and circuits , McGraw

PH213 Classical Mechanics (3 – 0 – 0) 3 credits

Brief survey of the Newtonian mechanics of a particle and systems of particles; Constraints , generalised coordinates, D'Alembert's principle and Lagrange's equation, velocity dependent potential and dissipation function.

Variational principles and Lagrange's equations, Lagrange multipliers,conservation theorems and symmetry properties.

Central force motion, Kepler's laws,orbital dynamics, stability of circular orbits, precession of equinoxes and of satellite orbits.

Rigid body motion, Euler angles, inertia tensor and moment of inertia.

Euler's equations of motion, free motion of rigid bodies, motion of symmetric top.

Hamiltonian's canonical equations of motion,Routh's procedure; Principle of least action; Small oscillations, normal coordinates and normal mode frequencies.

Canonical transformations, equations of canonical transformations, symplectic approach.

Poisson Brackets (PB) and canonical invariants , infinitesimal canonical transformations, Noether's theorem conservation laws in the PB formulation, angular momentum PB relations.

Hamiltonian-Jacobi theory of linear oscillatory systems, Hamiltonian's principal and characteristic functions, separation of variables, action-angle variables;

Text Books

1. Goldstein, H - Classical Mechanics, Addison Wesley, 2nd ed., 1980.
2. Biswas, S. N - Classical Mechanics, Books and Allied, 1998.

References

1. Rana, N. C and P. S. Jog - Classical Mechanics, Tata McGraw Hill, 1991.
2. Hand, L. N and J. D. Finch - Analytical Mechanics, Cambridge University Press, 1998.
3. L. Breklhovskikh, L and V. Gancharov - Mechanics of Continua and Wave dynamics, Springer Verlag, 1985.
4. Lai, W. M, D. Rubin and E. Krempl - Introduction to Continuum Mechanics, Pergamon Press, 1978.
5. Landau, L. D and E. M. Lifshitz - Mechanics, Pergamon Press, 1960.

AV223 Signals and Systems (3 – 0 – 0) 3 credits

Classification of signals and systems, Types of signals, Transformation of independent variable, Periodic
signals and Periodicity, Types of systems, Analysis of Continuous Time Signals and LTI systems:
Convolution, Impulse response, Trigonometric and exponential Fourier series, Eigen functions of LTI
systems, Fourier Transform, Magnitude and Phase Spectra, Properties of Fourier Transform, Laplace

Transform, Region of Convergence, Properties, Linear Constant coefficient Differential Equations, State
Space Matrix for continuous time systems.
Anlaysis of Discrete Time Signals and LTI DT systems: Periodicity, Discrete Convolution, DFT,
Properties, Z Transform, ROC, Properties, Difference Equations, State variable equation and matrix,
some applications – signal processing, communication, control systems etc.

Textbooks:

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems - Continuous and Discrete,
Prentice Hall, 2006.
2. B.P. Lathi, Linear Systems and signals, 2nd edition, Oxford University Press, 1998.
3. Simon Haykin, Barry Van Veen, Signals and Systems, John Wiley and Sons (Asia) Private
Limited, 2005.
4. A.V. Oppenheim, A.S. Willsky and I.T. Young, Signals and Systems, Prentice Hall, 2006.

References:

1. Douglas K. Lindner, Introduction to Signals and Systems, Mc-Graw Hill International,1999.
2. Robert A. Gabel, Richard A. Roberts, Signals and Linear Systems, John Wiley and Sons (SEA)
Private Limited, 1995.
3. M. J. Roberts, Signals and Systems - Analysis using Transform methods and MATLAB, Tata
McGraw Hill, 2003.
4. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, Signals and Systems, Tata McGraw Hill, New
Delhi, 2001.
5. Ashok Ambardar, Analog and Digital Signal Processing, 2nd Ed., Brooks/ Cole Publishing
Company, 2006.
6. A. Papoulis, Circuits and Systems: A Modern Approach, HRW, 1980.
7. . B.P. Lathi, Signal Processing and Linear Systems, Oxford University Press, 1998

HS211 Introduction to Economics (2 – 0 – 0) 2 credits

Module 1: ***Exploring the subject matter of Economics***

What is Economics? Definitions – Importance of Economics for Engineers – Schools of thought The Economic Problem – Scarcity and Choice – Resource allocation – the question of What to produce, How to Produce and How to Distribute Output – its nature and Importance in developing countries – Economic Systems – Basics of Capitalism, Socialism, Mixed Economy, Market Economy and Third World Economies.

Is Economics a Science? Distinction between Micro and Macro Economics.

Module 2: ***Principles and Concepts of Micro Economics***

Determinants of individual demand/supply, Demand/Supply schedule and demand/supply curve, Market versus individual demand/supply, Shifts in the demand/supply curve, Demand and Supply together, How Prices allocate resources - Equilibrium - Elasticity - Consumer equilibrium – Marginal utility – Consumer surplus - Production – factors of production, production function – Laws – TR, AR, MR- Costs – TC, AC, MC, OC – Variable Vs Fixed costs – Short Run Vs Long Run costs - Markets – Perfect competition, Monopoly, Monopsony, Oligopoly.

Module 3: ***Basics of Macro Economics***

The roots of macroeconomics, macroeconomic concerns, the role of government in the Macro economy, the components of the macro economy, the methodology of macroeconomics. Concepts of GNP, GDP, NNP, NDP and National Income – Personal Income and Disposable Income – Nominal and Real GDP – Limitations – Black Economy Concept of Inflation, Deflation, Methods of calculation – Classical Vs Keynesian Economics – Full employment Vs Under employment equilibrium – Globalization – Global Financial Crisis.

Module 4: ***Economic Problems and Policies***

Developing Countries Vs Developed Countries, differences, characteristics, LDC's. Meaning of Development

– Development Vs Growth, Measuring development - Problems of Growth – lessons and controversies, Indian situation - Poverty and Inequality – vicious circle of poverty – Recent BPL controversy - Population and Development – Demographic transition theory – optimum population - Agriculture, Industry and development - Balance of Payments – Closed and Open Economy – LPG- Planning and Growth – Global Financial Crisis.

A Research

Report. Text

Books

1. Samuelson, Paul A and William D Nordhaus "Economics" (17th Edition), Mc Graw Hill.
2. Dewett K K "Modern Economic Theory" S Chand
3. Thirlwall, A P "Growth and Development with Special Reference to Developing Economies" Palgrave.

References

1. Ackley, Gardner "Macroeconomic Theory" Surjeet PublicationsKoutsoyiannis, A "Modern Micro Economics" Palgrave Macmillan
2. Black, John "Dictionary of Economics" Oxford University Press.
3. Meir, Jerald M and James E Rauch, "Leading Issues in Economic Development" (7 th Edition) Oxford University Press.
4. Todaro, Michael P and Steven C Smith "Economic Development" Pearson Education Ltd.
5. Govt. of India, "Economic Survey" (latest survey) Ministry of Finance.
6. The Hindu, News paper, Daily.
7. Connor, David E "The Basics of Economics" Greenwood Press.

PH231 EM Waves Lab (0 – 0 – 2) 1 credit

- Liquid lens
- Diffraction –single slit and circular aperture
- Michelson interferometer
- Faraday optic effect
- Beam profile of a laser diode
- Fabry-Perot etalon
- Rayleigh scattering
- Diffraction – wavelength of a He-Ne laser
- Birefringence

Text Books

Lab Manual

Semester – IV

PH221 Optics (3 – 0 – 0) 3 credits

Ray methods in optics, Fermats principle,ray transfer matrices(ABCD),unit planes, nodal planes, system of lens and mirrors. Ray methods in media with spatially varying refractive index. Aberrations, coma, astigmatism,
curvature, distortion and chromatic aberration. (8 lectures)

Interference of light waves Two wave interference : By division of wavefront, division of amplitude, testing flatness of surfaces,interference with extended sources, Haidinger fringes, Fizeau fringes, Newton'sRings,Straightfringes, Two wave interferometers : Michelson Interferometer-temporal coherence. Twyman-Green Interferometer, Mach-Zehnder Interferometer, Sagnac Interferometer, Multiple beam interferometer :Fabry-Perot Interferometer. (10 lectures)

Diffraction Huygens Principle. Fresnel and Fraunhoffer diffraction, diffraction by single slit, graphical treatment of amplitudes, rectangular aperture, resolving power with rectangular aperture and resolving power of a prism, circular aperture and resolving powers of telescope and microscope, Double slit : qualitative aspects, derivation of equation of intensity, comparison of single and double slit patterns, position of maxima and minima, effect of finite width of slit, spatial coherence. Diffraction grating : principle, intensity distribution, maxima, minima, secondary maxima, spectra formation etc. Action of thin lens. Ultrasonic diffraction. Michelsons stellar interferometer, correlation interferometer. (12 lectures)

Polarization by reflection, polarization angle and Brewster's law, Malu's law, polarization by double refraction, Nicol Prizm, parallel and crossed polarizers, Wave plates, refraction by calcite prisms, Rochon and Wollaston prism, Polarization by scattering, Poincare sphere. Kerr, Pockels, and Faraday effects. (10 lectures)

Light quanta and their origin, thermal equilibrium of radiation, Einstein's coefficients, metastable states, population inversion, spontaneous and stimulated emission, Lasers, threshold for lasing, resonant cavities, two and three-level lasers - examples. (6 lectures)

References:

1. Optics, by K K Sharma, Academic Press, 2006

2. Fundamentals of optics (4th Edition) Jenkins and White, McGraw Hill

3. Optics, by Ajoy Ghatak.

4. Born. M and E. Wolf, Principles of Optics, Seventh edition, Cambridge University Press, 2006.

5. Baha E. A., Saleh and M. C. Teich - Fundamentals of Photonics, John Wiley and Sons, 1991.

6. Goodman, J. W - Introduction to Fourier Optics, Third Edition, Viva Books Private Limited, 2007.

7. Basics of Laser Physics, K. F. Renk, Springer.

PH222 Quantum Mechanics 1 (3 – 0 – 0) 3 credits

Mathematical Introduction: Linear vector spaces, inner products, linear operators, eigenvalue problems, generalization to infinite dimensions.

Towards quantum mechanics: relevant experiments, wav- particle duality, uncertainty principle, postulates of quantum mechanics, Schrodinger equation, probability current and conservation.

Simple one-dimensional potential problems: Free particle, particle in a box; scattering in step-potentials, transmission and reflection coefficients.

Harmonic oscillator: Obtaining eigenvalues and eigenfunctions using

ladder operators. Angular momentum: Rotations in three dimensions,

eigenvalue problem of L^2 and L_z.

Hydrogen atom: Eigenvalue problem, degeneracy of the spectrum, numerical estimates and comparison with experiments.

Text Books

1. R. Shankar, Principles of Quantum Mechanics, 2nd edition, Springer.
2. N. Zettili, Quantum Mechanics: Concepts and Applications, Wiley.

PH312 Thermal and Statistical Mechanics (3 – 0 – 0) 3 credits

Preliminary concepts, probability theory, introduction to central limit theorem, random walk problem, quasi-static process,thermal and mechanical interactions, laws of thermodynamics, thermodynamic potentials.

Statistical description of a system of particles,microstates, concept of ensembles, basic postulates, phase space, Liouville's theorem, microcanonical, canonical and grand canonical ensembles. Partition functions. Chemical potential,free energy and connection with thermodynamic variables. Equivalence of ensembles. Ideal gas,Gibbs paradox, M-B gas velocity distribution. Equipartition theorem,

Formulation of quantum statistics,density matrix, ensembles in quantum statistical mechanics. Identical particles, Maxwell-Boltzmann,Bose-Einstein and Fermi-Dirac statistics. Black body radiation,Stefan-Boltzmann law, Wien's displacement law, Einstein and Debye’s theories of specific heat of solids. Ideal Bose gas, Bose-Einstein condensation, Ideal Fermi gas.Ideal gases in the classical limit.

Introduction to first and second-order phase transitions.

Textbooks:

1. Stat. Mech. by R. K. Pathria and P. D. Beale
2. Stat. Mech. by K. Huang

AV227	Instrumentation and Measurement	(3 – 0 – 0) 3 credits

Introduction to measurement and instrumentation, Static characteristics of instruments; Types of Errors, Statistical Error Analysis, Propagation of Errors; Dynamic Characteristics of Instrumentation Systems, Sensor Reliability; Basic analog measuring instruments (PMMC, electrodynamometer, rectifier) and its use as electronic voltmeter and ammeter. Wattmeter and Energy meters; High Current/ Voltage Measurement – C. T., P. T., C. V. T; Null-Based Measurement - D.C. and A.C. potentiometer, Wheatstone bridge circuits, Low and High resistance Measurement, Bridges for measurement of inductance and capacitance, Wagner-Earth connection; Typical Circuits in Measurement - Differential and Instrumentation Amplifier, Filters, Current Sources, Precision Rectifiers, V-to-f converters; Digital Measurement systems: Frequency and time-periodmeters, phase-angle measurement; Digital voltage measurement, DMM, Sample & Hold Circuits, A/D converters and comparative study, D/A circuits; General Instruments – CRO, DSO and Probes, Function Generator,Spectrum analyzers, Data Acquisition Systems; Transducers & Signal Conditioning: Resistive Sensors (Potentiometers, Strain gauges and Load Cell, Torsion Bars, RTD, Thermistor); Inductive transducers (Variable Reluctance sensors, LVDT, Tachogenerator) and Capacitive transducers; Temperature sensors (Thermocouple, Semiconductor), Light Sensing Devices, Piezoelectric sensors, Pressure Sensors

Text Books:

1. Doebelin, E.O., Measurement systems: Application and Design, 5th ed., McGraw hill, 2003.
2. Albert D. Helfrick, William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India Private Limited.

References:

1. J. G. Webster, The Measurement, Instrumentation and Sensors Handbook, Vol 1 and 2,

CRC Press,
1999
2. Golding E.W. and Widdis F.E., Electrical measurements and measuring instruments, Sir Issac
Pitman and Sons pvt ltd, 1995.
3. 3.John P. Bentley, Principle of Measurement Systems, Pearson Education; 3rd Edition, 2006.
4. L. K. Baxter,Capacitive Sensors – Design and Applications, IEEE Press Series on Electronic
Technology, NJ (1997).

1. M. B. Stout,Basic Electrical Measurements, Prentice Hall Pvt. Ltd., India, New Delhi, 1982.

HS221 Introduction to Social Science and Ethics (2 – 0 – 0) 2 credits

Social Science: introduction to sociology, anthropology – social science research design and sampling. Ethics: professional and personal ethics – values & norms and human rights.

Text Books

- Lecture Notes

References

2. Perry, J. and Perry, E., Contemporary Society: An Introduction to Social Science, 11th ed., Allyn & Bacon (2005).
3. Giddens, A., Sociology, 5th ed., Wiley (2006).
4. Flyvbjerg, B., Making Social Science Matter, Cambridge Univ. Press (2001).
5. Singer, P., A Companion to Ethics, Wiley-Blackwell (1993).

CH Material Science and Engineering (0 – 0 – 2) 1 credit

Course description

This course focuses on the fundamentals of structure, energetics, and bonding that form the basis of materials science. The course deals with important classes of materials: metals, ceramics and polymers and provides a basic understanding of these materials, their structure-property relations and how to characterize them. It provides an understanding of materials science and engineering with an emphasis on rapidly growing areas such as energy and the environment.

Course objectives

- To provide the students a strong understanding of the basics of materials science, structure-property relations

- To provide knowledge about important material characterizations

Course outcome

- Students will have the ability to design and choose the right materials for specific applications

Course Syllabus

Atomic bonding, particle in a finite and infinite potential well, particle in a one-dimensional lattice; Crystal structure, crystal planes, lattice constant and matching, miller indices, defects in crystals; Crystal growth, Czochralski method; Metals and alloys; Ceramics; Semiconductors; Dielectric materials; Semiconducting polymers; Tools for material characterization, X-ray diffraction, electron microscopies.

Syllabus -detailed

Atomic bonding: attractive and repulsive forces, Chemical bonding in solids, free electron model, the quantum-mechanical free electron theory; zone or band model, Kronig Penney model,

Crystal structure: lattice, basis, unit cell, crystal structures, miller indices of directions and planes, interstitial sites, ionic and covalent crystal structures, Defects; point and lattice defects, Crystal growth: Czochralski method, Bridgman and Stockbarger Methods

Metals and alloys, structure-property relations, strain hardening; Semiconductor materials; Ceramics, synthesis and processing; Semiconducting polymers, classification, mechanism of formation, structure-property relations, Material characterization, Braggs law, X-ray diffraction, electron microscopies; scanning electron microscopy, principles, applications,

Textbooks

1. Donald R. Askeland, Wendelin J. Wright, The Science and Engineering of Materials, 7th ed., Cengage Learning India Pvt Ltd (2016).
2. Prathap Haridoss, Physics of Materials: Essential Concepts of Solid-State Physics, Wiley India (2015)
3. Billmeyer, F. W., Textbook of Polymer Science, 3rd ed., Wiley India (1984).
4. W.D. Kingery, Introduction to Ceramics, 2nd ed., John Wiley & Sons, (1999).
5. Y. Leng, Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), (2008).

PH241 Optics Lab (0 – 0 – 2) 1 credit

- Stokes parameter
- Diffraction at an edge

- Fourier optics
- Fiber optics-numerical aperture and fiber loss
- Measurement of refractive index and absorption coefficient
- Characterization of optical sources – LED and Laser diode
- Pockel effect
- Kerr effect
- Ultrasonic diffraction
- Holography

Text Books

Lab Manual

AV337 Instrumentation and Sensor Electronics Lab (0 – 0 – 3) 1 credit

- Resistance measurement through Wheatstone bridge
  - DC excitation
  - AC excitation
- Measurement of capacitance
  - Wein bridge
  - Schering bridge
  - Small variation in capacitance
- Inductive transducers
  - Inductance measurement
  - LVDT
- Variable resistivity transducers
  - Strain guage
  - Resistance of a salt solution
  - Variable area transducer
- Measurement of temperature
  - Thermocouple
  - Thermistor
  - RTD
- Light detector
  - Photo resistor
  - Photo transistor
  - Photo diode

- Calibration of flow and level
- Calibration of Value and pressure gauges
- Dead weight tester for pressure calibration
- PC based temperature calibrator

PH Applied Quantum Physics Lab 1 (0 – 0 – 2) 1 credit

1) Spectra of gases using grating.

2) Laser beam profile (He-Ne Laser).

3) Photon Count - Dark counts

4) Photon count of an attenuated He-Ne Laser/LED.

5) Random number generation with photons

6) Malu's law with photon counts.

7) Stern-Gerlach experiment with photons.

8) Slit diffraction with photon counts.

9) G2 of a Laser beam.

10) BB84 protocol.

PH131 General Physics Lab-2 (0 – 0 – 2) 1 credit

Students will be required to complete a minimum of EIGHT experiments

1. Millikan's Oil Drop Experiment
2. Franck-Hertz experiment
3. Magnetic moment in a magnetic field
4. Gamma ray spectroscope
5. Compact ripple tank
6. Inductance of a coil
7. Electron Diffraction
8. ESR/NMR
9. Plank's Constant using a Photocell
10. Hall Effect in Metals

Semester – V

MA311 Probability, Statistics, and Numerical Methods (3 – 0 – 0) 3 credits

Probability Theory: Elementary concepts on probability – axiomatic definition of probability – conditional probability – Bayes' theorem – random variables – standard discrete and continuous distributions – moments of random variables – moment generating functions – multivariate random variables – joint distributions of random variables – conditional and marginal distributions – conditional expectation – distributions of functions of random variables – t and χ^2 distributions – Schwartz and Chebyshev inequalities – weak law of large numbers for finite variance case – central limit theorem for iid finite variance case.

Statistics: Elementary concepts on populations, samples, statistics – sampling distributions of sample mean and sample variance – point estimators and its important properties – point estimator for mean and variance and proportion – confidence interval for sample mean – tests of hypotheses – Chi-squared test of goodness of fit.

Numerical Methods: Solution of algebraic and transcendental equations – system of linear algebraic equations – interpolation – numerical integration – numerical solution of ordinary differential equations – system of nonlinear algebraic equations.

Text Books

1. Walpole, W. E., Myers, R. H., Myers, S. L., and Ye, K., Probability & Statistics for Engineers & Scientists, 9th ed., Pearson Education (2012).
2. Jain, M. K., Iyengar, S. R. K., and Jain, R. K., Numerical Methods for Scientific and Engi-neering Computation, New Age International (2003).

References

1. Johnson, R. A., Miller & Freund's Probability and Statistics for Engineers, 6th ed., Prentice Hall (2000).
2. Milton, J. S. and Arnold, J. C., Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, McGraw-Hill (2002).
3. Ross, S. M., Introduction to Probability and Statistics for Engineers and Scientists, 3 rd ed., Academic Press (2004).
4. Hogg, R. V. and Tanis, E. A., Probability and Statistical Inference, 7th ed., Prentice Hall (2005).
5. Larsen, R. J. and Marx, M. L., An Introduction to Mathematical Statistics and its Applications, 4th ed., Prentice Hall (2005).
6. Conte, S. D. and de Boor, C., Elementary Numerical Analysis, 3rd ed., Tata McGraw-Hill(2005).
7. Krishnamurthy, K. V., Numerical Algorithms, Affiliated East-West Press (1986).

PH321 Solid State Physics (3 – 0 – 0) 3 credits

Bonding in Condensed matter Physics: Forces and energy of interatomic bonding, Primary bonds: Covalent bonds, Ionic bonds, Metallic bonds etc. Secondary bonds: Van der Waals bonds, Hydrogen bonds etc.

Crystal structure: Bravais lattice, primitive vectors, primitive unit cell, conventional unit cell, Wigner-Seitz cell; Symmetry operations and classification of 2- and 3-dimensional Bravais lattices; Common crystal structures; Reciprocal lattice and Brillouin zone; Bragg-Laue formulation of X-ray diffraction by a crystal.

Band theory of solids: Free electron theory, Limitations of free electron theory; Periodic potential and Bloch's theorem; Nearly free electron model; origin of Bands and band gaps; Tight binding method; Effective mass of an electron in a band: concept of holes; Energy band in one dimension, different zone schemes; E-k diagram in three dimensions, band structures and energy gap; Classification of metal, semiconductor and insulator; Fermi energy, Topology of Fermi surfaces.

Lattice dynamics and Specific heat: Classical theory of lattice vibration under harmonic approximation; Vibrations of linear monatomic and diatomic lattices, acoustical and optical modes, long wavelength limits; Normal modes and phonons; Inelastic scattering of neutron by phonon; Lattice heat capacity, models of Debye and Einstein, comparison with electronic heat capacity.

Magnetic properties of solids: Origin of magnetism; Diamagnetism: quantum theory of atomic diamagnetism; Landau diamagnetism (qualitative discussion); Paramagnetism: quantum theory of paramagnetism; Mean field theory: Ferromagnetism, Curie-Weiss law, temperature dependence of saturated magnetisation, ferromagnetic domains; Heisenberg model (introduction) Ferrimagnetism and antiferromagnetism.

Superconductivity: Overview of superconductivity - Experimental survey; Zero resistance state, Meissner effect, flux quantization, London equations, penetration depth, isotope effect, specific heat. Type I and Type II superconductors. Electron-electron interaction via lattice: Cooper pairs and BCS formalism, multiband, High Tc superconductors (qualitative discussion).

Text books:

1. Ali Omar, Elementary Solid State Physics, Pearson
2. N. Ashcroft and D. Mermin, Solid State Physics, Cengage.
3. Charles Kittel, Introduction to Solid State Physics, Wiley.
4. H. Ibach and H. Luth, Solid State Physics: An Introduction to Theory and Experiment, Springer.
5. A. C. Rose-Innes and E. H. Rhoderick, Introduction to Superconductivity, Pergamon.

ES323 Astrophysical Concepts (3 – 0 – 0) 3 credits

Sky coordinates and motions: Earth Rotation – Sky coordinates – seasons – phases of the Moon – the Moon's orbit and eclipses – timekeeping (sidereal vs synodic period).

Planetary motions – Kepler's Laws –

Gravity. Light & Energy – Telescopes –

Optics – Detectors.

Planets: Formation of Solar System – planet types – planet atmospheres – extrasolar planets.

Stars: Measuring stellar characteristics (temperature, distance, luminosity, mass, size) – HR diagram – stellar structure (equilibrium, nuclear reactions, energy transport) – stellar evolution.

Galaxies: Our Milky Way – Galactic structure – Galactic rotation – Galaxy types – Galaxy formation.

Cosmology: Expansion of the Universe – redshifts – supernovae – the Big Bang – history of the Universe – fate of the Universe.

Text Books/References:

1. B. W. Carroll & D. A. Ostlie, An Introduction to Modern Astrophysics, Latest Edition, Addison-Wesley.
2. Frank Shu, The Physical Universe, Latest Edition, University Science Books.
3. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.
4. T. Padmanabhan, Invitation to Astrophysics, Latest Edition, World Scientific Publishing Co.
5. T. Padmanabhan, Theoretical Astrophysics vols 1-3, Latest Edition, Cambridge University Press.
6. Malcolm Longair, High Energy Astrophysics, vols 1-2, Latest Edition, Cambridge University Press.
7. Sparke and Gallaghar, Galaxies in the Universe: An Introduction, Latest Edition, Cambridge University Press.
8. Dina Prialnik: An Introduction to the Theory of Stellar Structure and Evolution, Latest Edition, Cambridge University Press.

HS321 Environmental Science and Engineering (2 – 0 – 0) 2 credits

Course description

This course teaches the students the importance of awareness and knowledge of environment, major environmental issues the world is facing today, how technology can technology positively and negatively impact the environment, how each individual can contribute to reducing pollution and impact on the environment, the daily choices each can make towards a sustainable environment, and how to choose technology and engineering aspects to reduce the adverse impact on the environment and reduce carbon footprint towards a sustainable environments

Course objectives

· To create a strong awareness about the environment in students and provide them with a strong understanding and knowledge of the current environmental issues

· To provide knowledge about the technological and engineering aspects which can reduce the adverse impacts on the environment and improve the technology for creating a sustainable environment.

Course outcome

· Students will acquire the awareness, understanding, and knowledge choose the right choices, materials, and to design and technology for reducing pollutants, carbon footprint, and a sustainable environment.

Course Syllabus

Brief: Introduction to environment, Biogeochemical cycles, environmental issues, environmental and drinking water quality, and treatment processes, Pollutants-Types, Sources and consequences and technological solutions/innovations, Engineering Interventions for better environment, Wsate management-Technological aspects, Protools and norms in Environment.

Detailed syllabus:

Awareness of the impact of environment on quality of life – natural resources – biological systems – bio-geo chemical cycles – chemical processes; water treatment operations, water sampling, storage, quality measurement – oxygen demand – detection of pollutants – current environmental issues; pollutants, global warming, causes and consequences, air pollution, organic and inorganic air pollutants, smog-acid mine drainage, accumulation of salts in water– soil formation; micro and macro nutrients in soil, pollutants in soil – green chemistry: an alternative tool for reducing pollution – engineering interventions; flow sheets, waste minimization, e-waste management, ASP, reverse osmosis, trickling filter – environmental management; solid, liquid waste management, hazardous wastes, ISO standards – Kyoto protocol, Montreal protocol, Euro norms.

Text Books

1. Rao, V., Textbook of Environmental Engineering, Prentice Hall of India (2002).

References

1. Baird, C. and Cann, M., Environmental Chemistry, 3rd ed., W. H. Freeman and Company (2005).

2. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, GOI (1999).

3. Manual on Sewerage and Sewage Development, CPHEEO, Ministry of Urban Development, GOI (1993).

4. Hauser, B. A., Practical Hydraulics Hand Book, Lewis Publishers (1991).

5. Hammer, M. J., Water and Wastewater Technology, Regents/Prentice Hall (1991).

6. Sharma, J. P., Comprehensive Environmental Studies, Laxmi Publications (2004).

7. Garg, S. K., Environmental Engineering (vol. 1 and 2), Khanna Publishers (2004).

8. Kiely, G., Environmental Engineering, McGraw-Hill (1997).

9. Bharucha, E., Textbook of Environmental Studies, University Grants Commission (2004).

10. Vanloon, G. W. and Duffy, S. J., Environmental Chemistry: A Global Perspective, Oxford Univ. Press (2000).

HS311 Principles of Management Systems (3 – 0 – 0) 3 credits

Industrial Management: Development of Management thought-Management Functions – planning – organizing – power and authority-organization structures – span of control – delegation, leadership, directing and controlling-management by objectives-forecasting models.

Project Management: Characteristics of R&D projects – Development of project network – project representation – project scheduling – linear time – cost trade-offs in projects-project monitoring and control with PERT – resource leveling-break even analysis – application of linear programming in resource allocations-simplex method.

Human Resource Management: personnel management-functions of HRM – assignment of people to projects-man power planning-workers participation in management – grievance handling – performance appraisal – organizing for maximum performance: quality of work life, job rotation, job enrichment.

Text Books/References

1. Koontz H., O Donnel, C., and Weihrich, H., Essentials of Management, McGraw-Hill (1990).
2. Venkataratnam, C. S. and Srivastava, B. K., Personnel Management and Human Resources, Tata McGraw-Hill (1991).
3. Mazda F., Engineering Management, Prentice Hall (1997).
4. Gido, J. and Clements, J. P., Successful Project Management, 2nd ed., South-Western College Publishing (2003).
5. Khanna, O. P., Industrial Engineering and Management, Dhanpat Rai Publications (P) Ltd. (2003).
6. Memoria, C. B. and Gankar, S. V., Personnel Management – Text and Cases, Himalaya Publishing House (2007).

PH341 Solid State Physics Lab (0 – 0 – 2) 1 credit

- X-ray diffraction
- X-ray fluorescence
- Dielectric loss variation with frequency and temperature
- Curie temperature measurement
- Magnetic susceptibility by quink's tube
- Electrical conductivity by two probe and four probe
- NMR

Semester – VI

PH416 Quantum Mechanics II (3 – 0 – 0) 3 credits

Approximation methods: Variational methods, WKB approximation; time-indepdndent perturbation theory; time-dependent perturbation theory: Interaction picture, Fermi's golden rule, sudden and adiabatic approximations.

Scattering theory: Transition rates and cross sections, Lippmann-Schwinger equation, scattering amplitude, Green's functions; Born approximation; phase shifts and partial waves.

Symmetries in quantum mechanics: Continuous symmetries: space and time translations, rotations; rotation group and its irreducible representations; Irreducible spherical tensor operators, Wigner-Eckart theorem. Discrete symetries: parity and time reversal.

Identical particles: Meaning of identity and consequences; symmetric and antisymmetric wavefunctions; Slater determinant.

Relativistic Quantum Mechancis Klein-Gordon equation; Dirac equation, free particle solution, electromagnetic interaction of the Dirac particle, spin and magnetic moment of the electron.

Special topics: Path integral formalism; basics of quantum information: entanglement, Einstein-Podolsky-Rosen paradox, Bell's inequality, coherent states.

Text Books/References

1. J. J. Sakurai, Modern Quantum Mechanics, Addison-Wesley.
2. R. Shankar, Principles of Quantum Mechanics, Springer.C. Cohen-Tannoudji, et al., Quantum Mechanics, Wiley-Interscience.
3. A Peres, Quantum Theory: Concepts and Methods, Kluwer Academic Publishers.

ES322 Earth, Atmosphere and Ocean Sciences (3 – 0 – 0) 3 credits

Atmospheric Science:

General introduction – Structure of the Atmosphere, Composition of Atmosphere.

Radiative processes – Black body radiation – Scattering & Absorption – Greenhouse effect.

Hydrostatic equation – First Law of Thermodynamics – Adiabatic processes – Dry & Moist air – Virtual temperature – Convection.

Clouds – Growth of clouds droplets to rain.

Frames of references – Fundamental forces – Equations governing conservation of mass, momentum, energy – Coriolis force.

Horizontal motion in the atmosphere – Scale analysis – Geostropic wind –

Gradient wind. General circulation – Jet streams – ITCZ – Monsoons.

Ocean:

General introduction - Physical characteristics of Ocean – The Ocean basins.Density of sea water, distribution of temperature, salinity and density in space & time. Heat budget of the Ocean.

Ocean circulation – The wind driven circulation – Ekman

layer. Western boundary currents – Sverdrup theory.

Thermohaline

circulation. Air sea

interactions.

Wind-forced circulation of the Indian Ocean.

Solid Earth:

Earth's origin and composition.

Earth's interior and exploring its dynamic interaction with the surface.

Plate tectonics as the driving force for volcanism, mountain building, and

earthquakes. Minerals, ores and rocks: formation processes, general

physical and chemical properties.

Petroleum,coal and natural gas – origin, structure and composition, accumulation/ migration, source/reservoir rocks.

Text Books/References:

1. An introductory Survey, 2nd Edition by J.M. Wallace and P.V. Hobbs, Academic Press
2. Introduction to Physical Oceanography, Robert H Stewart
3. Engineering and general geology by Parbin Singh

PH331 Modern Physics Lab (0 – 0 – 6) 2 credit

- Law of distance and absorption of gama or beta rays using Geiger-Muller counter
- Zeeman effect
- Fine structure effect
- One electron and two electron spectra
- Atomic spectra of two electron systems
- Balmer series: determination of Rydberg's constant
- Magnetostriction measurement with Michelson interferometer
- Statistical analysis of data using charging and discharging of a capacitor
- X-ray fluorescence
- Moseley's law using NaI(Ti) scintillator detector
- Gamma ray spectroscopy
- Fourier series

- ESR
- Hall effect
- Band gap of LED using Newton's ring
- P-N junction characterization

Text Books

Lab Manual

PH425 Computational Physics (2 – 0 – 3) 3 credits

Errors and uncertainties in computations: Types of errors, errors in functions, errors in algorithms. Matrix computing and scientific libraries.

Zero-finding and matching: Newton's rule for finding roots. Quantum eigenvalues, particle in a box. Fields due to moving charges.

Integration: Trapezoid rule, Simpson's rule, Gaussian quadrature, multi-dimensional integrals. Monte-Carlo integrations.

Differential equations: Euler's algorithm, Runge-Kutta methods. A forced non-linear oscillator, the motion of a charged particle in an electric field, dynamics of non-linear systems. Numerical solutions of boundary value problems: solution of Laplace equation and Poisson's equation. Heat flow in a meta bar, waves on a string. Born and Eikonal approximations to quantum scattering, partial wave decomposition of the wave function. Solitons. Confined electronic wave packets: time-dependent Schrodinger equation.

Data fitting: Lagrange interpolation, cubic splines, least-square fitting. Fitting exponential decay, fitting heat flow. Non-linear least-squares fitting.

Fourier analysis. Fourier spectral methods. Harmonics in non-linear oscillations. Discrete Fourier transform. Highly non-linear oscillator, Processing noisy signals.

Random walk simulations. Decay simulation, Monte-Carlo simulations. The Ising model, Metropolis algorithm. Molecular dynamics simulations.Text Books/References

1. S. E. Koonin, Computational Physics, Westview, 1990.
2. R. H. Landau, M. J. Paez, Computational Physics: Problem Solving with Computers, Wiley-VCH, 2004.
3. H. Gould, J. Tobochnik, W. Christian, An Introduction to Computer Simulation Methods: Applications to Physical Systems, Pearson, Addison-Wesley, 2007.
4. P. L. Devries, J. E. Hasbun, A First Course in Computational Physics, Jones & Bartlett, 2011.
5. J. P. Boyd, Chebyshev and Fourier Spectral Methods, Dover, 2001.

PH Applied Quantum Physics Lab 2 (0 – 0 – 2) 1 credit

1. Saturation Absorption Spectroscopy
2. Polarization spatial entanglement
3. Shot-Noise measurement of lasers
4. Mach-Zehnder interferometer and complementarity test
5. B92 QKD protocol with weak coherent pulse
6. Quantum Bit Error Rate (QBER) measurement
7. Heralded single photon generation
8. B92 QKD protocol with heralded single photon source
9. Random number generation
10. Single photon interference and diffraction
11. Hong-Ou-Mandel (HOM) interferometer
12. Bell parameter measurement
13. Fidelity measurement of entangled state
14. Quantum Computation/Simulations

Semester – VII

PH417 Semiconductor Physics (3 – 0 – 0) 3 credits

Semiconductor in equilibrium: Equilibrium distribution of electrons and holes, qualitative description of dopant atoms and energy levels, equilibrium distribution of electrons and holes in extrinsic semiconductor, degenerate and non-degenerate semiconductors, statistics of donors and acceptors, probability function, compensated semiconductors, Fermi energy levels and its variation with doping concentration and temperature, relevance of Fermi energy.

Carrier transport phenomena: Carrier drift current density, mobile effects, conductivity, velocity saturation, carrier diffusion current density, total current density, graded impurity distribution and the Einstein's relation.

Non-equilibrium excess carriers in semiconductors: Carrier generation and recombination, characteristics of excess carriers, continuity equations, time-dependent diffusion equations, derivation of ambipolar transport equation, dielectric relaxation and its time constant, quasi-Fermi energy levels, surface effects.

The p-n junction: Basic structure of the p-n junction, zero applied bias, reverse applied bias, non-uniformly doped junctions, qualitative description of charge flow in a p-n junction, small-signal model of the p-n junction, generation-recombination currents, junction breakdown, charge storage and diode transients, tunnel diode.

Metal-semiconductor and semiconductor heterojunctions: The Schottky barrier diode, metal-semiconductor ohmic contacts, tunneling barrier, heterojunctions, heterojunction materials, equilibrium electrostatics, current-voltate characteristics.

Bipolar transistor: Basic principle of operation, minority carrier distribution, low-frequency common-base current gain, non-ideal effects, switching characteristics, the Schottky-clamped transistor, polysilicon emitter BJT, heterojunction bipolar transistors.

Special topics: Fundamentals of metal-oxide semiconductor field-effect transistor, energy band diagrams, non-ideal effects in MOSFETs, radiation and hot-electron effects, junction FETs, optical devices.

Text Books/References

1. Donald A. Neamen, Semiconductor Physics and Devices: Basic Principles, McGraw-Hill.
2. S. Wang, Fundamentals of Semiconductor Theory and Device Physics, Prentice Hall.
3. M. Shur, Physics of Semiconductor Devices, Prentice Hall.

Minor in Applied Physics

Sem V – 1 slot
Sem VI – 2 slots
Sem VII – 1- 3 slots

A student will have to take 4-6 courses from the list of courses 1-13, to earn a Minor in Applied Physics.

List of courses:

1. Fundamentals of Quantum Mechanics
2. Quantum Computation
3. Quantum Optics and Quantum Communication
4. Quantum Metrology and Quantum Sensing
5. Introductory Solid State Physics
6. Quantum Information Theory
7. Introductory Semiconductor Physics
8. Optical Engineering fundamentals
7. Opto-Mechanical Design Analysis
8. Optical Fabrication and Testing
9. Lasers and Optoelectronics
10. Fourier Optics
11. Guided Wave Optics and Optical Communication
12. Adaptive Optics
13. Optical Systems Analysis and Design

Major Electives

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1. Physics of Quantum Information
2. Optical Thin Films Science and Technology
3. Optical and Electro-optical Sensors
3. Integrated Optics
4. Introduction to Quantum Optical Technologies
5. Advanced Optoelectronics
6. Statistical and Quantum Optics
7. Non-linear Optics
8. MEMS and MOEMS
9. Laser Applications
11. Nano-Optics
12. Device Physics and Nanoelectronics
13. Cold Atoms and BEC
14. Advanced Solid State Physics
15. Advanced Statistical Mechanics
16. Atomic and Molecular Physics