INTERNATIONAL SCHOOL OF PHOTONICS (ISP)

COURSE STRUCTURE AND SYLLABI OF FIRST TWO SEMESTERS OF

Master of Science

(Five Year Integrated)

in

Photonics

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

KOCHI - 682 022

2020

COURSE STRUCTURE

SEMESTER I

Course Code	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
20-351-0101	Mechanics	3		1	3	50	50	100
20-351-0102	Electricity and Magnetism	3		1	3	50	50	100
20-351-0103	Optics I Geometrical Optics	3		1	3	50	50	100
20-351-0104	Mathematics I	3		1	3	50	50	100
20-351-0105	Statistical Methods	3		1	3	50	50	100
20-351-0106	Lab + Viva		6		3	100+ 50		150
20-351-0107	Communicative English	2		1	2	50	50	100
Total for Semester I		**17**	**6**	**6**	**20**	**450**	**300**	**750**

SEMESTER II

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
20-351-0201	Electronics -I Basic Electronics	3		1	3	50	50	100
20-351-0202	Optics II - Physical Optics	3		1	3	50	50	100
20-351-0203	Mathematics II	3		1	3	50	50	100
20-351-0204	Thermodynamics and Thermal Physics	3		1	3	50	50	100
20-351-0205	Nuclear and Particle Physics	3		1	3	50	50	100
20-351-0206	Lab+Viva		6		3	100+50		150
20-351-0207	History of Science and Technology	2		1	2	50	50	100
Total for Semester II		**17**	**6**	**6**	**20**	**450**	**300**	**750**

20-351-0101 MECHANICS

Course Outcomes

On successful completion of the course, the student will be able to

1. Describe inertial and non-inertial frames of references (Understand)
2. Explain kinetic and potential energies under conservative and non-conservative forces (Understand)
3: Explain the conservation of linear and angular momentum(Understand)
4. Outline various fluid properties like viscosity and surface tension (Understand)
5. Relate special theory of relativity and Lorentz transformation(Understand)
6. Build energy-momentum relation under relativistic condition (Apply)

Module 1

Frames of reference, Laws of Mechanics, Inertial frames of reference, Galilean transformation, Galilean invariance, Conservation of momentum, Non-inertial frames and fictitious force, Centripetal force, Centrifugal force, Rotating frame of reference, Foucault's pendulum.

Module 2

Work and Power, Work-Energy theorem, Conservative forces, Potential Energy, Conservation of energy for a particle, Motion of a body near the surface of the Earth, Linear restoring force, Potential energy curve, Harmonic oscillator, Non-conservative forces, Motion under friction.

Module 3

Conservation of linear momentum, Centre of mass, Collision of two particles, Impact, Angular momentum and torque, Areal velocity, Examples of conservation of angular momentum.

Viscosity, Critical velocity, Flow of liquid through a capillary tube; Molecular forces, Surface tension, Shape of drops.

Module 4

Michelson-Morley experiment, Ether hypothesis, Special theory of relativity, Lorentz transformations, Length contraction, Time dilation, Simultaneity, addition of velocities, Relativistic Doppler's effect, Conservation of momentum and variation of mass, Relativistic energy, Relation between momentum and energy and conservation laws, Transformation of momentum and energy, Particle with zero rest mass,

References:

1. Mechanics, J C Upadhyaya, Ram Prasad and Sons (2001) (Text)
2. Mechanics D S Mathur, S Chand & Company (2007) (Tex)
3. Mechanics: Berkeley Physics Course, McGraw Hill Education; 2 edition (2017)
4. Feynman Lectures Vol I, Narosa Publishing House (2008).
5. Principles of Physics, Robert Resnick, David Halliday, 11th Edn. John Wiley & Sons (2018)

20-351-0102 ELECTRICITY AND MAGNETISM

Course Outcomes

On successful completion of this course, students will be able to:

1. Discuss the fundamental laws governing static electric fields and its implementation for to practical uses.(Understand)
2. Explain the elementary concepts of magnetism, effect of magnetic field on moving charges, laws related to current induced magnetic fields and properties of various magnetic materials. (Understand)
3. Explain the fundamentals of alternating currents.(Understand)
4. Employ the basic circuit laws and DC network theorems in the analysis of electrical circuits. (Apply)
5. Identify the behaviour of combination of circuit elements across single phase AC supply. (Analysis)
6. Examine the phenomenon of series and parallel resonance in single phase AC circuits.(Analysis)
7. Describe operating principle of practical electrical devices.(Understand)

Module 1

Quantization and conservation of charge, Millikan's oil drop experiment. Concept of electric flux- Gauss's law- Gauss's law in cylindrical, planar and spherical symmetry-applications. - Electric potential: equipotential surfaces, potential due to point charge, group of point charges and due to electric dipole. Capacitance: capacitors in series and parallel connections, storing energy in an electric field, Spherical capacitor, cylindrical capacitor, capacitor with dielectric. Electric current, current density, Ohm’s law and its limitations, resistance and resistivity, comparison between EMF and potential difference.

Module 2

Magnetic field (B), Magnetization vector (M); Magnetic Intensity (H);Magnetic Susceptibility and permeability; Relation between B, H, M, Hall Effect, Biot-Savart’s Law and its simple applications: straight wire and circular loop; Current Loop as a Magnetic Dipole and its Dipole Moment, torque on a current loop, Ampere’s Circuital Law and its application to Solenoid and Toroid, Electromagnetic induction: Faraday's Law of induction, Lenz's law, induced electric field, inductance, self and mutual induction, energy stored in a magnetic field, introduction to dia, para and ferro-magnetic materials, motion of charged particle in magnetic field, Lorentz force. Cyclotron and synchrotron.

Module 3

Alternating currents- peak, rms and average values. AC through inductance, capacitance, resistance and their combinations. LC oscillations, damped oscillations, concept of phase difference between voltage and current, phasor diagram, concept of impedance, AC power, power factor. Kirchhoff’s laws, source transformations, voltage and current division rule, practical and ideal voltage /current sources, Maxwell’s mesh or loop method, Network theorems (for DC): Thevenin’s, Norton's, super position and maximum power transfer theorems.

Module 4

Analysis of LC and RC circuits, series and parallel LCR circuits. Resonance, Acceptor and Rejecter circuits, Q-factor, relation of Q-factor to band width. Transformer- theory and construction. EMF equation,circuit parameters and equivalent circuit, distinction between ideal and practical transformer, Losses in transformer. Choke coil, Fuses, circuit breakers ,relays, AC and DC generators.

References:

1 Fundamentals of Electricity and Magnetism -9th edition, D. N. Vasudeva, S. Chand and company (2002) (Text)

2 Network theory and filter design - Aatre, New Age International Publication 2nd edition (2003) (Text)

3 Brijlal & Subramaniam, Electricity and Magnetism-6Th edition, Ratna Prakashan Mandir, Educational & University Publication, Barya ganj, New Delhi(2006).

4 Basic Electrical Engineering - volume 18Th edition,Thereja, S. Chand limited (2005).

5 K.K.Tewari, Electricity & Magnetism with electronics -7th edition, S.Chand& Co. Pvt. Ltd., Ram Nagar, New Delhi(2007).

6 Electricity and Magnetism- R. Murugesan, S. Chand and Company, 4th Edition (2001)

7.Electricity and Magnetism Berkeley Physics Course Vol.2, EdwardPurcell, 2nd Revised Edition, NewYork, Mc Graw Hill Science 2017

20-351-0103 OPTICS I - GEOMETRICAL OPTICS

Course Outcomes

After completing the course the students will be able to

1. Describe the different methods for measuring the velocity of light. (*understand*)
2. Explain laws of reflection and refraction using Fermat's principle. (*understand*)
3. Distinguish normal and anomalous dispersion.(*understand*)
4. Explain different type of aberrations in lenses. (*understand*)
5. Apply matrix method to derive thick lens and thin lens formula.(*Apply*)
6. Discuss the construction and working of compound microscope and optical telescope.*(understand*)

Module 1

Nature of light, Light as waves, rays and photons, Refractive index, velocity of light. Foucault's, Anderson's, Houston's and Kerr cell methods to measure velocity of light. Photometry- Radiometric and Photometric units, inverse square law, Lambert's Law, Lummer, Flicker and photovoltaic photometers.

Module 2

Fermat's principle, Laws of reflection and refraction form Fermat's Principle, Total internal Reflection, Prism, Minimum deviation, achromatism in prisms, dispersion without deviation, normal and anomalous dispersion, Wood's experiment.

Module 3

Refraction and Reflection by spherical surfaces, Thin lens, converging, diverging and cylindrical lenses, Lens equations, aplanatic points, Combination of lenses, F number of a lens, Power of a lens. Aberrations-Spherical aberration, coma, astigmatism, distortion, chromatic aberration.

Module 4

Matrix methods in Optics- Paraxial rays, Matrix representation of translation, refraction, reflection of light rays, ABCD law, lens wave guide.
Spectrometer, Prism, Spectrograph, Telescopes-Resolving power, Types of telescopes, optical telescope, radio telescopes, Microscopes-Resolving power and magnifying power.

References

1. A text book of Optics N Subrahmaniam and BrijLal, M N Avadhanulu, S Chand and Company , 23rd Edition,(2006)(Text)
2. Optics, AjoyGhatak, 6thEdition,TataMc Grow Hill, (2017)
3. Modern Optics, A B Gupta, Books & Allied Ltd; 4th Revised edition (2013)
4. Optics, Eugune Hecht and A R Ganesan , 4th Edition, Pearson Education (2008)
5. Feynman Lectures Vol I - Narosa Publishing House (2003)
6. Optics, Sathyaprakash, PragatiPrakashan-Meerut (2011)

20-351-0104 MATHEMATICS I

Course outcomes

After taking this course, the student will be able to

1) Understand differentiation of hyperbolic and inverse hyperbolic functions (Understand)
2) Understand integral calculus (Understand)
3) Examine Laplace, Helmholtz and Poisson equations (Analysis)
4) Analyze Bernoullis equations (Analysis)
5) Understand applications of differentiation and integration (Understand)

Module 1

Differential calculus: Differentiation of hyperbolic and inverse hyperbolic functions. Statement and applications of Leibnitz theorem, LMV theorem, Taylor's and Mclaurin's theorems (no proof). Application to expansion functions- L'Hospital's Rule and its applications. Partial differentiation Partial derivatives and total differential coefficients. Euler's theorem on homogenous function (no proof) chain rule for partial derivatives, errors and approximations.

Module 2

Integral calculus Integration by parts, definite integral, multiple integrals. Applications of differentiation and integration Equations of lengths of tangents, normal, radius of curvature, envelopes, rectification of curves. Volume of a solid of revolution, areas of surface of revolution.

Module 3

Ordinary Differential equations First order equation, variables separable, homogeneous and no homogeneous equations, integrating factor, Bernoulli's equations, enact equations, second order linear differential equations with constant coefficients. Complimentary function and particular integral, solution using auxiliary equation.

Module 4

Partial differential equations Derivation of PDE by elimination of arbitrary constants and arbitrary coefficients. Concept of Jacobian. Solution of Lagrange's Differential equations, Partial differential equation of the second degree, Laplace, Helmholtz and Poisson equations.

References

1. Calculus Vol I & Vol II Manicavachgom Pillai, Vishwanathan Publishing Co.,(2000) (Text)
2. Differential Calculus Shanti Narayan, Vishwanathan Publishing Co.,(2000) (Text)
3. Differential Calculus Joseph Edwards, AIIBS Publishers,(2001)
4. Integral Calculus for beginners, Joseph Edwards ,MacMillan and Co (2008)
5. Mathematical Methods for Physicists G B Arfken, H I Weber, Academic Press, (2001)
6. Mathematical Methods in Classical & Quantum Physics Tulsi Das, S K Sharma, University Press (2009)

20-351-0105 STATISTICAL METHODS

Course Outcomes

After completion of this course the student should be able to

1. Explain probability space, random variables and its various properties (Understand)
2. Apply the principle of least squares in curve fitting problem (Apply)
3. Differentiate various types of statistical distributions (Analyze)
4. Differentiate chi-squre, t and F distributions (Analyze)
5. Recognize the time series.(Remember)
6. Compute the most powerful test for testing simple null hypothesis against simple alternative. (Apply)

Module 1

Probability spaces : conditional and independence, random variables and random distributions, marginal and conditional distributions
Curve fitting and principle of least squares, linear and quadratic curves, simple linear regression and correlation.

Module 2

Independent random variables, mathematical expectation, mean and variance, binomial, Poissons and normal distributions, law of large numbers.

Module 3

Central limit theorem (no proof), sampling distribution and test for mean using T-distribution, c^2 and F distributions.

Module 4

Time series analysis, Stationarity and nonstationarity, autocorrelation function
Testing statistical hypothesis significance level, Neyman-Pearson theorem (no proof) and some of its simple applications, large sample test, standard error, tests based on T, c^2 and F.

REFERENCES

1 Statistical Methods S P Gupta, S Chand & Co. (Text)
2. Probability and Statistics for Engineering and Sciences J LDevore, Brooks, California(1987) (Text)
3 Probability and Statistics, Schaum Series, McGraw Hill (2004)
4. Fundamentals of Mathematical Statistics S C Gupta and V K Kapoor, S Chand & Co.
5. Time series analysis G E P Bor, G M Jenkins

20-351-0107 COMMUNICATIVE ENGLISH

Course Outcomes

On successful completion of the Course Modules the student should be able to

1. communicate with clarity, correctness and coherence
2. take part effectively in group discussions and present their views in a logical and convincing way.
3. comprehend, analyze and interpret technical articles and research papers.
4. acquire proficiency in writing technical articles, reports, research papers and proposals
5. make effective presentation using supporting facts, evidences and graphic aids

Module 1

Practical Communicative Skills- Focus on various methodologies and practicessuch as listening, speaking, reading and writing to improve primary communicative skills. In the process basic English grammar compatibility is ensured to enable use of vivid, lucid and mistake- free language.

Module 2

Vocabulary Building- Word power is integral to effective and meaningful communication. Students are exposed to various techniques involving etymology, word power building exercises, Synonyms, Antonyms, Usages & Style, Idioms and Phrases, Adages, Proverbs, Professional and Scientific Vocabulary building.

Module 3

Writing Technical articles, proposals, research papers, reports, manuals etc;- Module focuses on scientific aspects involving Experiments, Observations, Comprehension, Analysis , Inferences, Outputs and related presentations as a part of Professional Communication for Readers, Researchers, Fellow Students, Scientific Community and world at large. Technical write-ups involve a lot of team effort, SWOT Analysis, brain storming sessions, proven facts and findings and acknowledgements.

Module 4

Technical Editing and Proof reading – The objective is to finalize the core presentation to be made before the Scientific Group / community, through further refinement involving editing, language precision, reconfirmation of supporting facts and evidences, proper use of graphic aidsfor easy and total comprehension.

References

1. Technical Writing J M Lannon
2. Sentence Skills A workbook for writers John Langon
3. New International Business English Leo Jones, Richard Alexander

20-351-0201 ELECTRONICS I BASIC ELECTRONICS

Course Outcomes

On completion of the course, the student should be able to:

1. define operation of semiconductor devices(Remember level)
2. explain DC and AC models of semiconductor devices(Evaluate level)
3. describe the working of a voltage amplifier(Understand level)
4. apply concepts for the design of Amplifiers (Apply level)
5. design and analyze of electronic oscillators (Analysis level)
6. relate frequency response to understand behaviour of Electronics circuits(Create level)
7. explain the concept of negative feedback in amplifiers (Understand)

Module 1

Diodes and their applications:
Conductors, insulators and semiconductors, Elements of semiconductor physics, p-type and n-type semiconductors, pn junction diode, diode equation, operation and characteristics of diode, breakdown mechanisms in diodes,Introduction to Zener diode, photodiode, solar cell,LED,High frequency switching diodes -tunnel,Gunn, Schottky and varactor diode
Rectification, ripple factor, Rectifiers-Half wave, Full wave and Bridge, Zener shunt regulator, Filters-Different types, Voltage multipliers, clippers, clampers.

Module 2

Transistors -BJTs, pnp and npn transistors, CE, CB, CC configuration, transistor characteristics, small signal BJT model using h-parameters
Unipolar transistors: FET classifications, construction and working of n-channel and p-channel JFET,JFET parameters, MOSFET-enhancement and depletion type operations and their characteristics

Module 3

Transistor biasing: -Need for biasing, faithful amplification, DC load line analysis, operating point, Stability factor (definition only), Biasing Techniques-Base resistor, collector feedback, bias circuit with emitter resistor and voltage divider biasing. Transistor amplifier- Classification of amplifiers, Transistor as an amplifier, CE, CC and CB amplifiers, multistage amplifiers, DC, RC, and transformer coupled amplifiers, Frequency response of RC coupled amplifier
Power amplifiers-Class A, class B, and Class C operations, Push Pull amplifiers

Module 4

Feedback amplifiers: Positive and negative feedback, Advantages of using negative feedback, voltage series feedback, current series feedback, emitter follower
Oscillators: classification, Barkhausen criteria, different types, RC oscillators: RC phase shift oscillator, Wien bridge oscillator,LC oscillators: Hartley, Colpitts and clapp oscillators, crystal oscillator. Multivibrators: Astable, Monostable and Bistable multivibrators

References

1. A textbook of Applied Electronics-R. S. Sedha, S.Chand (2009) (Text)
2. Electronics devices and circuits- Allen Mottershed, Prentice Hall India, (1973) (Text)
3. Electronics Fundamentals: Circuits, Devices & Applications - Thomas L. Floyd, Pearson/Prentice Hall, (2007)
4. Electronics devices and circuit theory- Robert Boylestead and Nasheleski, Prentice Hall, (2004)
5. Integrated Electronics- Millman and Halkias, Tata Mc Grow Hill, (1972)
6. Basic Electronics and Linear circuits- N. N. Bhargava, Tata Mc Grow Hill (1984)

20-351-0202 OPTICS II - PHYSICAL OPTICS

Course Outcomes

On completing this course, the students should be able to :

1. Illustrate the concept of superposition of waves (Apply level)
2. Explain the concept of coherence (Understand level)
3. Classify interference phenomenon based on division of amplitude and division of wavefront (Apply level)
4. Examine Fresnel's theory to describe diffraction of light (Analyze level)
5. Differentiate between Fresnel and Fraunhofer diffraction (Understand level)
6. Summarize the idea of polarized light, its generation and detection (Understand level)

Module 1

Superposition of two sinusoidal waves, path difference and phase difference, Analytical and graphical methods. Coherent sources, spatial and temporal coherence, complex representation of light waves, Interference of two monochromatic waves, optical beats.
Theory of interference and bandwidth, Interference by division of wave front, Young's double slit experiment, Fresnel's bi-prism, Lloyd's mirrors.

Module 2

Interference by division of amplitude, two beam interference, parallel sided plates, colour of thin films, wedge shaped film, Newton's rings - reflected and transmitted systems, Radius of rings and expression for wavelength, Michelson interferometer, Determination of wavelength separation and standardization of meter. Types of fringes- localized and non-localised fringes in white light

Module 3

Diffraction-Fresnel`s assumptions, Rectilinear propagation of light and Fresnel's theory, Fresnel's zones, theory of zone plate and its comparison with convex lens, Fresnel and Fraunhofer diffractions-Fresnel`s diffraction at straight edge, Cornu's spiral application to diffraction phenomena. Fraunhofer diffraction at single slit, Double slit and multiple slits, missing orders in double slit diffraction pattern, theory of plain transmission grating- oblique and normal incidence, absence spectra, determination of wavelength of light using grating, dispersion and resolving power, Blazed gratings.

Module 4

Polarization , Experimental observation, Polarization by reflection and refraction, Brewster angle, Pile of plates, Biot's polariscope., Malus laws, Double refraction - Optic axis, Uniaxial and biaxial crystals, Geometry of calcite crystals, Nicol prism, Nicol as analyzer and polarizer. Huygen's explanation of double refraction, Quarter wave and Half wave plates, Production and detection of plane, elliptical and circular polarization of light.

Reference

1. Optics, Ajoy Ghatak, 6th Edition,Tata Mc Grow Hill, (2017) (Text)
2. A text book of Optics N Subrahmaniam and Brij Lal, M N Avadhanulu, S Chand and Company , 23rd Edition,(2006)(Text)
3. Modern Optics, A B Gupta, Books & Allied Ltd; 4th Revised edition (2013)
4. Optics, Eugune Hecht and A R Ganesan , 4th Edition, Pearson Education (2008)
5. Fundamentals of Optics, Jenkins and White, McGraw Hill Education, 4th edition (2017)
6. Wave optics and applications - R.S Sirohi ,Orient Longman, (2001)

20-351-0203 MATHEMATICS II

Course outcomes

After completing this course, the student will be able to

1) Understand the concept of gradient, divergence and curl (Understand)
2) Understand elementary transformations of a matrix (Understand)
3) Analyze hyperbolic functions (Analysis)
4) Examine eigen values and eigen vectors of a matrix (Analysis)
5) Understand Greens theorem, Gauss theorem and Stokes theorem (Understand)

Module 1

Vector Calculus Vector differentiation, Gradient, divergence and curl, Solenoidal and irrotational vector point functions.
Vector integration, Line, surface and volume integration, Greens theorem, Gauss theorem and Stokes theorem (statements) Physical interpretations.

Module 2

Matrices inverse of matrices, adjoint matrices (complex conjugate transpose) orthogonal, symmetric, skew symmetric, Hermitian and skew Hermitian matrices, elementary transformations of a matrix.

Module 3

Similarity and unitary transformation of matrices, diagonalisation of matrices, Eigen values and eigen vectors, Cayley-Hamilton Theorem, solution of algebraic equations using matrices consistent and inconsistent equations.

Module 4

Complex numbers Eulers formula, De Moivre's theorem (no proof), nth root of complex number. Trigonometry Expansion of $\sin^n x$, $\cos^n x$ and $\tan^n x$, hyperbolic functions, separation into real and imaginary parts of sine, cosine, tangent, logarithmic and inverse tangent functions, summation of function using C+iS method.

References

1. Mathematical methods of Physics G B Arfken, H J Weber, Academic Press(2001)(Text
2. Differential Calculus Shanti Narayanan, Vishwanathan Publishing Co.(,2000)(Text)
3. Vector Analysis with introduction to Tensor analysis Schaum Series, (1974)
4. Trigonometry S L Loney, S Chand & Co, (2002)
5. Matrices - Shanti Narayanan, S Chand & Co.,(2002)
6. Calculus Vol I & Vol II Manicavachgom Pillai, Vishwanathan Publishing Co.(2000)

20-351-0204 THERMODYNAMICS AND THERMAL PHYSICS

Course Outcomes

After completing this course, the students will be able to

1. Describe thermodynamic systems and processes based on Pressure, Volume, Temperature, and Entropy. (Understand)
2. Employ laws of thermodynamics in relevant thermodynamic processes (Apply)
3. Predict the efficiency of heat engines based on Carnot's cycle (Apply)
4. Discuss Entropy, Thermodynamic functions, and TdS relations (Understand)
5. Apply Maxwell's thermodynamical relations and Gibbs Helmholtz equations (Apply)
6. Classify phase transitions and critical phenomena (Understand)
7. Relate thermal and electrical conductivity to Transport processes (Analyze)

Module 1

Thermodynamic systems, thermodynamic equilibrium- thermodynamic process and cycles, concept of thermodynamic state, extensive and intensive variables; heat and work, internal energy function and the first law of thermodynamics, Equations of states, Laws of thermodynamics, Thermodynamic processes – Indicator diagram (P-V diagram, P-T diagram, T-V diagram, T-S diagram) - Work done in Quasi static process-Work done in Isothermal, Adiabatic, Isochoric, Isobaric processes, First law of thermodynamics-Application of first law to heat capacities-(relation between C_p and C_v) and latent heat– adiabatic and isothermal elasticity of a gas- Theory of specific heat

Module 2

Reversible and irreversible processes, Conditions for reversibility-second law of thermodynamics-heat engine, Carnot's engine and Carnot's cycle, derivation for expression for efficiency, efficiency, Carnot's theorem, Claussius theorem and inequality.
Entropy - Change in entropy in reversible and irreversible processes, principle of increase of entropy-Entropy and available energy- entropy and disorder, Entropy of ideal gas. Temperature - entropy diagram, entropy and second law of thermo dynamics. Nernst Heat Theorem,
Elementary kinetic theory of gases: equilibrium properties — pressure and equation of state, Ideal and real gas, Van der Waal's equation of State.

Module 3

Thermodynamic functions-Enthalpy, Helmhlotz function, Gibbs function-Maxwell's thermodynamic relations-TdS relations-application of Maxwell's thermodynamical relations-variation of intrinsic energy with volume, Joule-Kelvin coefficient, Claussius-Clapeyron equation from Maxwell's thermodynamic relations, Thermodynamic Potential, Gibbs Helmholtz equations

Module 4

Phase transitions and critical phenomena - Phase diagram, first order phase transition. Clausius-Clapeyron equation in the context of first order phase transition, Kirchhoff's equation, second order phase transition. Ehrenfest's equations, liquid helium and superfluidity.

Transport processes – momentum transport and viscosity, energy transport and thermal conductivity, charge transport & electrical conductivity

Reference:

1. Thermal Physics, Kittel and Kroemer, W. H. Freeman; Second edition (1980) (Text).
2. Heat and Thermodynamics, D S Mathur- Sultan Chand and Sons, RevisedFifth edition (2004) (Text).
3. Heat and thermodynamics, Brijlal and Subramanium, S Chand (2008)
4. Introduction to Thermal Physics, D. Schroeder, Pearson (1999).
5. Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, S.C. Garg , R.M. Bansal, C.K. Ghosh, TataMcGraw Hill Education Private Limited; 2e edition (2013).
6. Thermal Physics: An Introduction to Thermodynamics, Statistical Mechanics and Kinetic Theory, P.C. Riedi, Macmillan (1976).
7. Heat and Thermodynamics, Zeemansky and R. H. Dittman, Tata McGraw Hill (1997)

20-351-0205 NUCLEAR AND PARTICLE PHYSICS

Course Outcomes

On completion of the course, the students will be able to;

1. recognize constituents of an atom and factors affecting nuclear stability. (Understand)
2. describe nuclear forces using liquid drop and shell model. (Understand)
3: classify nuclear decays and particles involved in it.(Understand)
4. explain various particle detectors and their function (Understand)
5. evaluate radiation hazards and suggest precautions to avoid exposure.(Evaluate)
6. compare different nuclear particles and their properties (Analyze)

Module 1

Atomic nucleus, Nuclear radius – shape – spin – parity – Magnetic and electric Moments, relationship between nuclear radius and mass number, Nuclear forces, nucleons, isotropic spin, isotopes and isobars, isomers, mirror nuclei, stability of nuclei, binding energy, fission and fusion. Nuclear models-semi empirical mass formula, liquid drop model, shell model, magic numbers, Parity of nuclear states, Meson theory of nuclear forces.

Module 2

Nuclear decays: Radio activity, units, radio activity, alpha and beta decay, Gamow's theory, neutrino, Fermi's theory of beta decay, gamma decay (introduction), Radiation hazards. Nuclear fusion and fission. Interaction of radiation with matters (elementary idea), Particle detectors - electroscope, scintillator, bubble chamber, cloud chamber, ionization chamber, GM counter. Cosmic rays-Discovery, latitude, EW, altitude effects, primary and secondary cosmic rays, cosmic ray showers, Bhabha's theory, Pair production and annihilation, Positron and its discovery, discovery of pi and mu mesons and strange particles, van Allen belts, origin of cosmic rays, solar neutrino problem, neutrino oscillation and mass of neutrino.

Module 3

Nuclear reactor- critical condition, design aspects, classification, breeder reactor, effect of nuclear radiation on living systems, Nuclear reactors and environment protection. Particle accelerators -Van de Graff generator, Cyclotron, Synchrotron, Linear accelerator, Colliders.

Module 4

Forces of nature and their unification (introductory ideas), Nuclear reactions, conserved qualities in nuclear reactions, Leptons, Baryons, Mesons and Gauge particles, intrinsic and relative parity of elementary particles. (Elementary ideas of the following) -Gellmann-Nakano-Nishijima relation, fundamental particles and their classifications, Standard model Parity violation and CPT conservation, CP violation and neutral Kaon decay, eightfold way, quark structure.

References

1. Modern Physics- Beiser, Tata Mc Graw Hill, (2002) (Text)
2. Elementary particles and symmetries- I H Ryder, Gordon and Breach, (1975) (Text)
3. Modern Physics- Murugesan, S. Chand and Co, (2008)
4. Elements of Nuclear Physics - W.E. Burcham, Longmans (1981).
5. University Physics with Modern Physics H. D. Young and R. A. Freedman, 11th Edition, (2004).
6. Elements of Nuclear Physics M. L. Pandya & R. P. S. Yadav, 7thEdition, (2002)

20-351-0207 HISTORY OF SCIENCE & TECHNOLOGY

Course Outcomes

After completing the course the students will be able to

1. understand the ancient discoveries in Science (Understand)
2. analyse the emergence of modern Science and the present electronic revolution (Analysis)
3. recognise the Indian contribution during ancient to medieval period (Understand))
4.analyse classical works of certain Mathematicians and Physicists that initiated the development of Optics (Analyse)

Module I

Knowledge in ancient Europe- Plato- Aristotle-Ptolemaic system of Universe-Copernican system- Emergence of true science- Galileo – Kepler- Newton – Faraday and the discovery of electrical machines- The industrial revolution

Module II

Emergence of modern science- Atomic discoveries- Relativity and quantum theory- The nuclear era- The code of life- New materials - The electronic revolution and the IT era

Module III

Astronomy in ancient India, Egypt and other civilizations, some of the astronomical instruments

Indian contribution during ancient to medieval period: sulbasutras, decimal system, number representation (various alpha numeric systems), contributions of Aryabhata, Brahmagupta, Varahamihira, Bhaskara Contribution by Kerala mathematicians during middle age e.g. Madhava, Neelakanda, Jyeshtadeva. Indian contribution to modern science during the last 200 years-contributions of C V Raman, J C Bose, S N Bose etc

Module IV

Introducing some of the classical works e.g. Aryabhatiyam, Opticks, Galileo's modern science. Principia of Newton. Topics in Philosophy of Science- facts and truth in science- Kanada- Francis Bacon- Thomas Kuhn and Karl Popper- The four percent universe and the current scenario

References:

1. Science in History - J D Bernal, All India Peoples Science Network, Vol 1-4 (1969)
2. Golden Age of Indian Mathematics - S Parameswaran ,1998
3. Mathematics in Ancient and Medieval India - A G Bag , 1979
4. Aryabhatiya of Aryabhata - K V Sharma, INSA, 2009
5. The Sulbasutras - S N Sen and A K Bag, INSA, New Delhi, 1983
6.Lilavati's daughters, Indian National Science Academy, 2007
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