INTERNATIONAL SCHOOL OF PHOTONICS
(ISP)

CURRICULUM AND SYLLABUS OF
MSc (Five Year Integrated) Degree Course in Photonics
COCHIN UNIVERSITY OF
SCIENCE AND TECHNOLOGY
COCHIN 682 022
2018

INTERNATIONAL SCHOOL OF PHOTONICS

Integrated MSc Degree in Photonics – The course structure:

SEMESTER I

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1101	Mechanics and Wave Phenomena	3		1	3	50	50	100
ISP1102	Electricity and Magnetism	3		1	3	50	50	100
ISP1103	Optics I- Geometrical Optics	3		1	3	50	50	100
ISP1104	Mathematics I	3		1	3	50	50	100
ISP1105	Statistical Methods	3		1	3	50	50	100
ISP1106	Lab+Course Viva		6		3	100+50		150
ISP1107	Communicative English	2		1	2	100		100
Total for Semester I		**17**	**6**	**6**	**20**	**500**	**250**	**750**

Semester II

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1201	Electronics I-Basic Electronics	3		1	3	50	50	100
ISP1202	Optics II - Physical Optics	3		1	3	50	50	100
ISP1203	Mathematics II	3		1	3	50	50	100
ISP1204	Thermodynamics and Thermal Physics	3		1	3	50	50	100
ISP1205	Nuclear and Particle Physics	3		1	3	50	50	100
ISP1206	Lab+Course Viva		6		3	100+50		150
ISP1207	History of Science and Technology	1		1	1	50		50
Total for Semester II		**16**	**6**	**6**	**19**	**450**	**250**	**700**

SEMESTER III

Course	Subject (modified)	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1301	Electronics II Analog Electronics	3		1	3	50	50	100
ISP1302	Classical Mechanics	3		1	3	50	50	100
ISP1303	Optics III- Optical Instrumentation	3		1	3	50	50	100
ISP1304	Mathematics III	3		1	3	50	50	100
ISP1305	Atomic Spectroscopy	3		1	3	50	50	100
ISP1306	Lab+ Course Viva		6		3	100+ 50		150
ISP1307	Seminar	1		0	1	50		50
Total for Semester III		**16**	**6**	**5**	**19**	**450**	**250**	**700**

SEMESTER IV

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1401	Electronics III Digital circuits and microprocessors	3		1	3	50	50	100
ISP1402	Mathematical Modeling and computational techniques	3		1	3	50	50	100
ISP1403	Quantum Mechanics I	3		1	3	50	50	100
ISP1404	Electromagnetic Theory and Relativistic Phenomena	3		1	3	50	50	100
ISP1405	Mathematics IV	3		1	3	50	50	100
ISP1406	Computer lab+ Course Viva		6		3	100 +50		150
ISP1407	Workshop		2	0	1	100		100
ISP1408	Seminar	1			1	50		50
Total for Semester IV		**16**	**8**	**5**	**20**	**550**	**250**	**800**

SEMESTER V

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1501	Optics IV - Applied Optics	3		1	3	50	50	100
ISP1502	Electronics IV- Electronic Instrumentation	3		1	3	50	50	100
ISP1503	Quantum Mechanics II	3		1	3	50	50	100
ISP1504	Materials Science	3		1	3	50	50	100
ISP1505	Molecular Spectroscopy	3		1	3	50	50	100
ISP1506	Lab+ Course Viva		6		3	100+50		150
ISP1507	Seminar	1			1	50		50
Total for Semester V		**16**	**6**	**5**	**19**	**450**	**250**	**700**

SEMESTER VI

Course	Subject	Work/week			Credit	Marks		
		Lecture	Lab	Tutorial		IE	UE	Total
ISP1601	Photonics I-Optoelectronics	3		1	3	50	50	100
ISP1602	Photonics II-Fiber Optics	3		1	3	50	50	100
ISP1603	Photonics III-Laser Physics	3		1	3	50	50	100
ISP 1604	Statistical Mechanics	3		1	3	50	50	100
*ISP1604	Project & Project Viva		9		3	150		150
ISP1605	Lab+ Course Viva		6		3	100+50		150
Total for Semester VI		**12**	**15**	**4**	**18**	**500**	**200**	**700**
Total for Semester I-VI					**115**	**2900**	**1400**	**4300**

* Project guidance of 9 hours shall be considered as equivalent to 3 lab hours (per project) for workload calculation

SEMESTER VII

(Course number of electives 2EX1- 2EX7 correspond to course numbers of electives chosen from the list of electives given separately. For example if 2E01 Network analysis and Communication Engineering and 2E03 Optical Sensor Technology are given as the Elective I and Elective II respectively in the VII semester then ISP 2EX1and ISP 2EX2 will be ISP 2E01 and 2E03 respectively)

Code	Title	Hrs/wk			Credit	Marks		
		Theory	Lab	Tutorial		IE	UE	Total
ISP2701	Advanced Solid state theory	4		1	4	50	50	100
ISP2702	Laser Systems and applications	4		1	4	50	50	100
ISP2EX1	Elective I	3		1	3	50	50	100
ISP2EX2	Elective II	3		1	3	50	50	100
ISP2703	Lab I Electronics+ Course Viva		4		2	100+50		150
ISP2704	Lab II- Photonics Lab		4		2	100		100
ISP2705	Seminar	1			1	50		50
Total for Semester VII		**15**	**8**	**4**	**19**	**500**	**200**	**700**

SEMESTER VIII

Code	Title	Hrs/wk			Credit	Marks		
		Theory	Lab	Tutorial		IE	UE	Total
ISP2801	Nonlinear Optics	4		1	4	50	50	100
ISP2802	Digital Signal Processing and Optical Signal Processing	4		1	4	50	50	100
ISP2EX3	Elective III	3		1	3	50	50	100
ISP2EX4	Elective IV	3		1	3	50	50	100
ISP2803	Lab I Electronics + Course Viva		4		2	100+50		150
ISP2804	Lab II Photonics		4		2	100		100
ISP2805	Seminar	1			1	50		50
Total for Semester VIII		**15**	**8**	**4**	**19**	**500**	**200**	**700**

SEMESTER IX

Code	Title	Hrs/wk			Credit	Marks		
		Theory	Lab	Tutorial		IE	UE	Total
ISP2901	Optical Communication	4		1	4	50	50	100
ISP2902	Lab I Fiber Optics Lab + Course Viva		4		2	100+50		150
ISP2903	Lab II Photonics Lab		4		2	100		100
ISP2904	Seminar	1			1	50		50
ISP 2EX5	Elective V	3		1	3	50	50	100
ISP 2EX6	Elective VI	3		1	3	50	50	100
ISP 2EX7	Elective VII	3		1	3	50	50	100
Total for Semester IX		**14**	**8**	**4**	**18**	**500**	**200**	**700**

SEMESTER X

Code	Title	Hrs/wk			Credit	Marks		
		Theory	Lab	Tutorial		IE	UE	Total
*ISP2X0 1	Project & project viva				16	200+ 100	200+ 100	600
	TOTAL for Semester X				**16**	**300**	**300**	**600**

* Project guidance of tenth semester shall be considered as equivalent to 6 lab hours (per project) for workload calculation

Total Credits for the Course

Semesters	Credits	Marks		
		IE	UE	Total
Total for VII-X	72 (Core 51 and Electives 21 credits)	1800	900	2700
Total for I-VI	115	2900	1400	4300
Total for I-X	187	4700	2300	7000

LIST OF ELECTIVES

ISP 2E01	Advanced Quantum Mechanics
ISP2E02	Biophotonics
ISP2E03	Nanophotonics
ISP2E04	Microwave Photonics
ISP 2E05	Network Analysis and Communication Engineering
ISP2E06	Advanced Laser Systems
ISP2E07	Quantum Optics
ISP2E08	Optomechanical Engineering
ISP2E09	Optical Sensor Technology
ISP 2E10	Solar Cells: Concepts and Theory
ISP 2E11	Discrete mathematics and Wavelets Theory
ISP2E12	Optical Computing
ISP2E13	Atom Optics
ISP2E14	Laser Spectroscopy
ISP 2E15	Advanced Electromagnetic Theory
ISP 2E16	Photonic bandgap structures and Metamaterials
ISP 2E17	Holography and speckle metrology
ISP2E18	Industrial Photonics

SEMESTER I

ISP 1101 MECHANICS AND WAVE PHENOMENA

Reading Section: Dimensional analysis, vectors and scalars, vector algebra, unit vectors, linearly independent and linearly dependent vectors, velocity, acceleration and force vectors.

Module 1

Motion along straight line velocity, acceleration, velocity-time graph. Newton's laws of motion, equations of motion, motion in two and three dimensions projectiles. Force, work and energy, energy conservation, work-energy theorem.

System of particles Newton's law for system of particles, collisions, conservation of linear momentum, impulse, elastic and inelastic collisions in one and two dimensions.

Module 2

Rigid body dynamics angular velocity and angular acceleration, angular momentum, torque. Newton's laws for rotational motion, angular momenta for systems of particles, conservation of angular momentum.

Requirements of equilibrium centre of gravity, Newton's laws of gravitation, gravitation near the surface of earth and inside the surface of earth, gravitational potential energy, central force, reduced mass, Kepler's law.

Module 3

Oscillations- simple harmonic motion, simple pendulum and its equation of motion, spring and spring constant, Hooke's law, work done by a spring, circular motion as SHM, damped and forced oscillations, resonance.

Module 4

Waves Transverse and longitudinal waves, traveling and standing waves, energy and power in traveling waves, phase and group velocities, superposition, interference and dispersion of waves. Sound waves traveling sound waves, intensity and sound levels, Doppler effect in sound and light, sound pollution.

Advanced Reading: Acoustics of music, concert hall acoustics, mechanics of sports.

References:

1. Mechanics D S Mathur, S Chand & Company (2007)(Text)
2. Fundamentals of Physics Resnik, Halliday and Jearl Walker, 10th Edition, Wiley (2013)
3. Feynman Lectures Vol I , Narosa Publishing House (2008).
4. University Physics with Modern Physics , Young Hugh D, Freedman Roger A., Pearson (2017)
5. Physics for scientists and engineers , Serway and Jewett, Brooks/Cole Publishers (2009)

ISP 1102 -ELECTRICITY AND MAGNETISM

Reading Section: Two types of charges- Coulomb's law, concept of electric field, field lines, dipoles and dipole moment

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, 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, 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. Losses in transformer. Choke coil, AC and DC generators.

Advanced Reading Section - Bio-electricity, signal propagation through nerve cells, EEG.

References:

1 Electricity and Magnetism - 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 Fundamentals of Physics - Resnik, Halliday and Walker; John Wiley & sons,4'h Edition (1994)
4 Basic Electrical Engineering - Thereja, S. Chand (2000)
5 The Feynman Lectures on Physics - Feynman, Leighton, Sands, Narosa Publishers (2003)
4 Electricity and Magnetism- R. Murugesan, S. Chand and Company, 4' h Edition (2001)
7 E M Purcell, Berkeley Physics course Vol 2, Electricity and Magnetism, McGraw Hill

ISP 1103 OPTICS I - GEOMETRICAL OPTICS

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.

Advanced Reading: Optics and Photonics in nature.

References

1. A text book of Optics N Subrahmaniam and Brij Lal, M N Avadhanulu, S Chand and Company , 23rd Edition,(2006)(Text)
2. Optics, Ajoy Ghatak, 6th Edition,Tata Mc Grow Hill, (2017)
3. Fundamentals of Physics- Resnik, Halliday, Krane, John Wiley and Sons, 5th Edition, (2002)
4. Modern Optics, A B Gupta, Books & Allied Ltd; 4th Revised edition (2013)
5. Optics, Eugune Hecht and A R Ganesan , 4th Edition, Pearson Education (2008)
6. Feynman Lectures Vol I - Narosa Publishing House (2003)
7. Optics, Sathyaprakash, Pragati Prakashan-Meerut (2011)
8. Introduction to Optics, Frank L Pedrotti, Leno M Pedrotti and Leno S Pedrotti, 3rd Edition, Pearson, (2006)
9. Berkeley Physics course, Vol 3, Frank S Crawford , Tata McGraw Hill (2011)

ISP 1104 MATHEMATICS I

Reading Section : Differentiation and integration of simple functions

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 Physics P K Chadopadhyaya, New Age International (1960)
6. Mathematical Methods for Physicists G B Arfken, H I Weber, Academic Press, (2001)
7. A text book of Mathematical Physicss P K Chakrabarti, S N Kundu Books and Allied Pub. Calcutta
8. Mathematical Methods in Classical & Quantum Physics Tulsi Das, S K Sharma, University Press (2009)
9. Textbook of differential calculus, Ahsan Akthar, Sabiha Ahsan, Prentice Hall India Pvt., Limited (2015)

ISP 1105 STATISTICAL METHODS

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. (2012) (Text)
2. Probability and Statistics for Engineering and the Sciences, Jay L Devore Cengage Learning, Inc, 8th Edition (2010)
3. Schaum's Outline of Probability and Statistics, Murray Spiegel, John Schiller, R. Alu Srinivasan McGraw Hill- Education, 4th Edition (2012)
4. Fundamentals of Mathematical Statistics, S C Gupta and V K Kapoor, S Chand & Co. (2014)
5. Time Series Analysis: Forecasting and Control, George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Wiley, 4th Edition (2008)

ISP 1106 LAB/VIVA

ISP 1107 COMMUNICATIVE ENGLISH

Elements of effective writing, methods of written exposition, art of condensation

1. Writing technical articles, proposals, research papers, reports, manuals and letters
2. Practical communicative Skills
3. Preparation and use of graphic aids
4. Technical Editing and Proof Reading

References

1. Technical Communication, J M Lannon, 11th Edition, Ashford Custom. New York: Pearson Longman (2008).
2. Sentence Skills: A workbook for writers, John Langan, McGraw-Hill, 3rd edition (1987)
3. New International Business English, Leo Jones, Richard Alexander, Cambridge University Press (2011)

SEMESTER II

ISP 1201 ELECTRONICS I BASIC ELECTRONICS

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.

References

1. Fundamentals of Electronics- J. D. Ryder, Prentice Hall India, 5 th edition, (2009) (Text)
2. Electronics devices and circuits Allen Mottershed, Prentice Hall India, (1973) (Text)
3. Electronics devices and circuit theory- Robert Boylestead and Nasheleski, Prentice Hall, (2004)
4. Integrated Electronics- Millman and Halkias, Tata Mc Grow Hill, (1972)
5. Principles of Electronics V. K. Metha, S. Chand & Co (2003)
6. Basic Electronics and Linear circuits N. N. Bhargava, Tata Mc Grow Hill (1984)

ISP 1202 OPTICS II - PHYSICAL OPTICS

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. Feynman Lectures Vol I - Narosa Publishing House (2003)
6. Optics, Sathyaprakash, Pragati Prakashan-Meerut (2011)
7. Fundamentals of Optics, Jenkins and White, McGraw Hill Education, 4th edition (2017)
8. Fundamentals of Physics Resnik, Halliday, Krane , John Wiley and Sons, 5th Edition, (2002).
9. Wave optics and applications - R.S Sirohi ,Orient Longman, (2001)
10. Fundamentals of Physics- Resnik, Halliday, Krane, John Wiley and Sons, 5th Edition, (2002)

11. Introduction to Optics, Frank L Pedrotti, Leno M Pedrotti and Leno S Pedrotti, 3rd Edition, Pearson, (2006)

ISP 1203 MATHEMATICS II

Reading Section :Vector Algebra, Matrix Algebra

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) (Text)
4. Trigonometry S L Loney, S Chand & Co, (2002)
5. Matrices - Shanti Narayanan, S Chand & Co.,(2002)
6. A text book of Mathematical Physics P K Chakrabarti, S N Kundu Books and Allied Pub. Calcutta
7. Mathematical Methods in Classical & Quantum Physics Tulsi Das, S K Sharma, University Press (2009)
8. Calculus Vol I & Vol II Manicavachgom Pillai, Vishwanathan Publishing Co.(2000)

ISP 1204 THERMODYNAMICS AND THERMAL PHYSICS

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 Books:

1. Thermal Physics by Kittel and Kroemer
2. Introduction to Thermal Physics by D. Schroeder
3. Heat and thermodynamics-Brijlal and Subramanium
4. Heat and Thermodynamics by D S Mathur- Revised fifth edition.
5. Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics by S.C. Garg , R.M. Bansal, C.K. Ghosh

6. Thermal Physics: An Introduction to Thermodynamics, Statistical Mechanics and Kinetic Theory by P.C. Riedi
7. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
8. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
9. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
10. Thermal Physics by Satya Prakash, J. P. Agarwal
11. Heat and Thermodynamics – Zeemansky and R. H. Dittman, Tata McGraw Hill (1997)
12. Thermodynamics Zeemansky, Tata McGraw Hill, 5th Edition (1968).

ISP 1205 NUCLEAR AND PARTICLE PHYSICS

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) -Gellman-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 for module III)
3. Modern Physics-Murugesan, S. Chand and Co, (2008) (Text)
4. Introduction to Nuclear Physics- Herald A. Enge, Addison Wesley Pub, (1972)
5. Nuclear Physics Kaplan, Narosa publishing House, (1962)
6. Nuclear Radiation detectors - Price, Tata McGraw Hill (1968)
7. Particle hunters- Neeman, Y. Kirch, Cambridge Univ. Press
8. Quantum Physics Eisberg and Resnik, John Wiley and Sons, 2nd Ed, (2002)
9. The cosmic onion-Quarks and nature of Universe - Frank Close, AIP (1983)
10. Elements of Nuclear Physics - W.E. Burcham, Longmans (1981).
11. University Physics with Modern Physics H. D. Young and R. A. Freedman, 11th Edition, (2004).
12. Elements of Nuclear Physics M. L. Pandya & R. P. S. Yadav, 7thEdition, (2002)
13. Nuclear Physics D. C. Tayal (2003)

ISP 1206 LAB/ VIVA

ISP 1207 HISTORY OF SCIENCE & TECHNOLOGY

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 (Vol. I-IV), The MIT Press (1971)
2. Science in India (Vol 2) - Indian National Science Academy
3. Golden Age of Indian Mathematics, S Parameswaran, Swadeshi Science Movement (1998)
4. Mathematics in Ancient and Medieval India, A K Bag , Chaukhambha Orientalia (1979)
5. The History of Science from the Ancient Greeks to the Scientific Revolution, Ray Spangenburg, Diane Moser, Facts on File; 1st Edition (1993)
6. Astronomy before the telescope - C. B. F. Walker, St Martin's Press; 1st American Edition (1997)
7. Aryabhatiya of Aryabhata - K S Shukla and K V Sharma, Indian National Science Academy (1976)
8. The sulbasutras of Baudhayana, Apastamba, Katyayana and Manava, S N Sen and A K Bag, Indian National Science Academy (1983)
9. The Birth of a New Physics (Revised and Updated Edition) Bernard Cohen, W. W. Norton & Company (1985)
10. Lilavati's daughters: The women scientists of India, Edited by Rohini Godbole and Ram Ramaswamy, Indian Academy of Sciences (2007)

SEMESTER III

ISP 1301 ELECTRONICS-II ANALOG ELECTRONICS

Module 1

The differential amplifier- Emitter coupled logic, Common mode and Differential mode gain, CMRR, Single ended AC voltage gain, double ended AC voltage gain Complementary output stage, Improves differential amplifier with constant current source. DC level shifter, Integrated circuits, semiconductor processes, Monolithic ICs, Resistor and capacitor design on ICs.

Module 2

Op-amps: Block diagram representation, Ideal Op-amp characteristics, Equivalent circuit ,Electrical parameters, open loop configurations, Transfer characteristics ,inverting and non-inverting amplifiers, stabilization of gain by negative feedback, voltage follower, current to voltage converter, Inverter and other configurations.

Module 3

Applications of Op-amp-Analog circuits, Adding circuits, Integration and Differentiating circuits, Comparators, detector, Schmitt trigger, Logarithmic amplifier, voltage regulator using Op amps, Analog computations, Basic ideas, active filters op-amp based oscillators: Phase shift and Wein bridge oscillators, introduction to PLL (block diagram),VCO

Functional block of IC 555 Timer, Astable and Monostable Multivibrator.

Module 4

Silicon Controlled Rectifier (SCR) -construction, operation and characteristics, turn on and turn off methods, DIode AC switch(DIAC) and TRIode for Alternating Current(TRIAC), Light Activated Silicon Controlled Rectifier (LASCR), Gate Turn-off Thyristor (GTO), Silicon controlled Switch (SCS), Programmable Unijunction Transistor (PUT), Silicon Unilateral Switch (SUS)

Unijunction Transistor (UJT)-construction, equivalent circuit, operation and characteristics, application-relaxation oscillator.

References:

1. Electronics Fundamental and Applications- J. D. Ryder, Prentice Hall, India, 5 th edition (2009) (Text)
2. Integrated Electronics- Milman&Halkias, Mc Graw Hill- Kogakusha (2003) (Text)
3. Integrated Electronics- K. R. Botkar, Khana Publishers, 9 th Ed (1996)
4. Electronic Principles Malvino, McGraw Hill 4 th Ed (1989)
5. Op- Amps and Linear Integrated circuits- Ramakant A. Gaykward PHI, (1999)
6. Electronic Devices and Circuits - Milman and Halkias,Tata Mc Graw Hill Ed (1991)
7. Power electronics - Soumitra Kumar. Mandal , McGraw Hill Ed(2014)
8. Power Electronics- Daniel W. Hart,McGraw-Hill Ed(2011)

ISP 1302 CLASSICAL MECHANICS

Module 1

Constraints: types of constraints, difficulties associated with constraints, generalized coordinates. Principle of virtual work, D'Alembert's principle, Lagrange's equations, velocity dependent potentials, Kinetic energy of a system in terms of generalized velocities. Applications of Lagrangian formulation: motion of a particle in space, Atwood's machine, bead sliding on rotating wire, simple pendulum, harmonic oscillator.

Module 2

Calculus of Variation: Hamilton's Principle, techniques of the calculus of variations, Lagrange's equation from Hamilton's principle. Generalized momenta, cyclic coordinates. Conservation theorems and symmetry properties: Conservation of linear momentum, Conservation of angular momentum, Conservation of energy, Noether's theorem (no proof).

Module 3

Central force problem: reduction to equivalent one body problem, equations of motion and first integrals, classification of orbits and stability condition for orbits. Kepler's laws.

Theory of small oscillations: equilibrium and potential energy, Normal modes, Normal modes of CO_2 type molecules.

Module 4

Hamiltonian mechanics: Hamiltonian of a system, Hamilton's equations of motions, Canonical transformations, Generating functions. Poisson Brackets: fundamental properties of PB, Equations of motion in Poisson Bracket form, PB and integrals of motion, Canonical invariance of PB, Lagrange brackets. Hamilton-Jacobi equation for Hamilton's principal function, Action angle variables in system of one degree of freedom.

Advanced Reading: Action -angle variables. Hamilton Jacobi equation. Rigid body dynamics- Euler's angles - equations of motion, symmetric top, Corioli's force.

References

1. Classical Mechanics, H Goldstein, C Poole and J Safko, 3rd edition, Addison Wesley (2005) (Text)
2. Classical Mechanics – G Aruldhas, PHI learning, (2014) (Text)
3. Classical Mechanics- Rana and Joag, Tata McGrawHill (1992)
4. Classical Mechanics - V B Bhatia, Narosa Pub.(1997)
5. Classical Mechanics of particles and rigid bodies Kiran C Gupta, Wiley Eastern Ltd.(1998)
6. Mechanics L. D Landau and E. N Lifshitz., Butterworth Heinemann,3rd Ed (2002)
7. Classical Mechanics C R Mondal, Prentice Hall India, (2002)

ISP1303 OPTICAL INSTRUMENTATION

Module 1

Double beam Interferometry—Interference in a plane parallel plate and in a plate of varying thickness, Fizeau fringes, Mach-Zehnder Interferometer, Sagnac Interferometer, Interferometric measurements of rotation ,Channeled Spectra , Achromatic fringes, Fringes of equal thickness, Fringes of equal inclination, Fringes of equal chromatic order, Phol Interferometer. Speed of light and Michelson Morley experiment. Detection of Gravitational waves using interferometric techniques, Recent Experimentations and Results (LIGO)

Module 2

Multiple beam Interferometry-multiple beam fringes of equal inclination , visibility and Intensity distribution. Fabry Perot Interferometer and Fabry Perot etalon, resolving power and expression for finesse. Nonreflecting films, Highly reflecting films and Interference filters, Broad band reflectors, band pass filters, dichroic beam splitters and cold mirrors.

Wavefront shearing interferometers, Twyman- Green interferometer, Scanning Fabry- Perot Interferometer-central spot scanning, Spherical Fabry-Perot Interferometers, dynamic and static wavelength meters.

Module 3

Theory of concave grating, Mountings for gratings-various mounting techniques, Grating spectrographs, resolution and dispersive power of spectrographs, single beam and double beam monochromators. Spectrometers and flourimeters

Adaptive optics-Wavefront sensor, Guided star systems, MEMS and Deformable mirror and wavefront corrections, actuators, Adaptive optics and vision optics

Module 4

Light sources and Standardization of light sources Incandescent lamps and Fluorescent lamps,- Tungsten and halogen lamps, High pressure and low pressure discharge lamps- Sodium , Hydrogen, Mercury, Metal Halide lamps, Electrode less discharge lamps-magnetic induction lamps, plasma lamps, sulfur lamps, Broad band LED sources, supercontinuum sources.

Imaging systems-Different types of projectors, LCD projectors, Endoscopes, Head up displays, 3D projection systems

Camera, High speed camera, video camera- remote sensing and its applications- Radars and Lidars, Confocal microscopes, Phase contrast microscopes- Introduction to optical imaging

References:

1. Optical interferometry- P Hariharan, Academic press, 3rd Edition (2003) (Text)
2. Optics, Eugene Hecht and A R Ganesan , 4th Edition, Pearson Education (2008) (Text)
3. Basics of Interferometry - P Hariharan, Academic Press(2006)(Text)
4. Optical measurement techniques and applications - P.K Rastogi, Artech House(1997)
5. Principles of Adaptive optics: -R.K Tyson, CRC Press, 3rd Edition (2010)
6. Wave optics and applications - R.S Sirohi ,Orient Longman, (2001)
7. Geometrical and physical optics- R S Longhrust, Orient Longman, 3rd Edition, (1991)
8. Introduction to optics and optical imaging - C.Scott, Wiley-IEEE Press (1998)

9. Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light, Max Born and Emil Wolf, 7th Edition, Cambridge University Press (1999)
10. Light, R W Ditchburn, Dover Publications (2011)
11. Handbook of Optics - Vol I and Vol II - Michael Bass, Mc Graw Hills (2001)
12. Fundamentals of Optics, Jenkins and White, McGraw Hill Education, 4th edition (2017)
11. Handbook of Applied Photometry- C De Cusatis, AIP Press (1997)
12. Introduction to Soild State Lighting, rtūras Žukauskas, Michael S. Shur, Remis Gaska, Wiley (2002)

ISP 1304 MATHEMATICS II

Module I - Curvilinear coordinates: description of curvilinear coordinate system expression for square of distance element, metric-scale factors, differential distance vector, line integral, area element and area vector, volume element and volume integral, expression for the above in rectangular, spherical and cylindrical coordinate system, conversion of unit vectors in spherical and cylindrical coordinated into rectangular coordinates and vice versa.
Expression for gradient, divergence, curl and Laplacian operator in curvilinear coordinate system- corresponding expression in rectangular, spherical and cylindrical coordinate system- physical significance of gradient, divergence and curl, non linear term in Navier-Stoke's equation in hydrodynamics- removal of non linear term

Module II - Vector space: field, definition of vector space, inner product, norm, Schwart'z inequality, dual vectors and dual space, Bra and Ket notations, linearly independent and dependent vectors, orthonormal vectors, Schmidt's othogonalisation, basis, dimension, change of basis, linear operator, adjoint and Hermitian operators, matrix representation of operators, similarity and unitary transformations, eigen value and eigen vectors, projection operator, function space, Hilbert space
Module III - Partial Differential equations: separation of variables technique, Laplace's equation in rectangular, cylindrical and spherical polar coordinates and their solutions, spherical harmonics. Differential equations: series solution, ordinary and singular points, Frobenius method, Dirac Delta function Green's function technique to solve differential equations

Module IV - Sturm-Liouville Problem, Hermitian differential equations, Beta and Gamma function, orthogonal functions, Legendre, Bessel and Hermite differential equations and their solutions, Legendre, Bessel and Hermite functions and their properties.

References:

1. Vector Analysis with an Introduction to Tensor Analysis - Murray R Speigel, Tata McGraw Hill (1975) Schaum series (Text)
2. Matrices and Tensors for Physicists - A W Joshi, New Age International (19950
3. Linear Vector Space - Hamos (Text)
4. Mathematics for Physicists and Engineers – G B Arfken, Academic Press (2001), (Text)
5. Mathematics for Physicists - Dennery and Kerzywiki
6. Mathematical Methods for Physicists - G B Arfken, H J Weber Academic Press (2001)
7. A textbook of Mathematical Physics - P K Chakrabarti, S N Kundu Books and Allied Pub, Calcutta (1996)
8. Mathematical Methods in Classical and Quantum Physics - Tulsi Dass, S K Sharma; University

Press (1986)
9. Mathematical Physics: Differential equations and Transform Theory - A K Ghatak, I C Goyal, S J Chua; Mc Millan India Ltd.(2002)
10. Mathematical Physics (Parts 1,2 and 3) - J D Anand, P K Mittal, A Wadhwa Har, Anand Publications(2003)

ISP 1305 ATOMIC SPECTROSCOPY

Module 1

Structure of atom: Rutherford model, alpha particle scattering, Bohr atom model, Bohr's interpretation of H atom, Hydrogen spectral series, Ritz combination principle, Combination and intercombination series, Bohr's correspondence principle, Sommerfield relativistic atom model, Wilson Somerfield modification, Vector atom model, Quantum numbers, Larmor theorem. Atomic orbitals and their shapes (no derivation)

Module 2

Symmetry of atomic states, equivalent and nonequivalent electrons, normal and inverted atoms.

Coupling schemes: Spectral terms and term symbols based on electronic configuration.

LS coupling, jj coupling, Pauli's exclusion principle, Hund's rule of multiplicity, selection rules, intensity rules

Spectra of one electron systems: Expression for spin orbit interaction, fine structure of Hydrogen atom, ionized Helium, alkali atoms, fine structure of doublet states- Sodium D1, D2 lines, Lande interval rule, Lamb shift, Intensity of spectral lines.

Hydrogen spectra- Hyperfine structure, Lande Interval rule..

Module 3

Spectra of two electron systems: Alkaline-earth atoms, Mercury spectrum

Zeeman effect: Normal and anomalous Zeeman effect, classical interpretation of normal Zeeman effect, explanation based on vector atom model, Lande's g factor, Evaluation of Zeeman shift, Zeeman effect in Sodium atom, experimental arrangement.

Intensity distribution of Zeeman lines: BDO rule, Keiss and Megger's rule.

Paschen- Back effect: Splitting of Sodium lines, selection rules, Zeeman and Paschen –Back effect in Hydrogen.

Module 4

Stark effect : Experiment, Stark effect in Hydrogen, weak field and strong field effect: First order and second order stark effect in Hydrogen (Qualitative ideas only). Hyperfine structure

X-ray spectra: Origin, Continuous and characteristic emission spectra, absorption spectra, explanation, Comparison of optical and X- ray spectra, Mosely's law, importance of Mosely's law, practical applications of singlet oxygen.

References

1. Atomic spectra- H E White, Tata Mc Graw Hill NY (1983) (Text)
2. Elements of Spectroscopy – Gupta, Kumar and Sharma, Pragathi Prakashan Meerat, 6th edition (2011) (Text)
3. Physics of Atoms and Molecules, B.H. Bransden and C.J. Joachain, Prentice Hall, 2nd edition (2003)
4. Concepts of Modern Physics, Arthur Beiser and Shobhit Mahajan ,Tata Mc Graw Hill (2009)
5. Spectroscopy, B. P. Straughan, S. Walker Chapman and Hall (1976).
6. Quantum physics of atoms, molecules, solids, nuclei and particles, Robert Eisberg and Robert Resnick , John Wiley, 2nd Edition (2006)

ISP 1306 Lab /Viva

ISP 1307 Seminar

SEMESTER IV

ISP 1401 ELECTRONICS III
DIGITAL CIRCUITS AND MICROPROCESSORS

Module 1
Digital fundamentals: the binary number system, octal and other codes, 1's and 2's complements, Binary arithmetic, Boolean algebra, Boolean theorems, Synthesis of Boolean functions, Karnaugh diagram, Logic gates, Fundamental logic operations, Universal gate (NAND & NOR)

Combinational logic circuits, Half adder, Full adder, Half subtractor and Full subtractor, Multiplexer, Encoder and decoder, Demultiplexer
Logic families: DCTL, RTL, DTL NAND gate, TTL NAND gate, ECL circuits, PMOS, NMOS and CMOS logics

Module 2
Flip-flop, RS latches, level clocking, D latcher, edge triggered D flip fops, JK flip flop, JK Master slave flip-flops. Registers and counters: Shift register, controlled shift registers, Ripple counters, decoding gates, synchronous counters, Ring counters, changing the counter modulus, decade counters.

Module 3
Basic D/A converter, variable, resister networks, binary ladders, A/D converters, counter method, successive approximation, dual slope A/D conversion, A/D accuracy and resolution, VCO, sample and hold circuits, Static RAMs, Dynamic RAMs.

Module 4
Microprocessors 8085: Block diagram, pin out diagram, instruction format, Addressing modes, Instruction types- Data transfer instruction, Arithmetic instructions, Logical instructions, Program control instructions, input output instructions, stack instructions, instruction timing and execution, timing diagrams, Programming Microprocessors. Peripheral operations- Interrupt system, Serial input and Serial output, Programmed I/O ports, Memory interfacing, Direct Memory Access, DMA controller. Introduction to 16 bit microprocessor.

References :

1. Digital Computer electronics- Malvino and Brown, Tata McGraw Hill education Pvt. Ltd, 3 rd Ed (1995) (Text)
2. Microprocessor Architecture Programming and applications using 8085 - R. S. Goanker, Prentice Hall India, 5'h Ed (2006) (Text)
   Electronic Devices- Applications and Integrated circuits-Mathur Kulashreshta and Chandha, Umesh publications
3. Digital principles and applications Malvino&Leach, Tata Mc Grow Hill, 5' h Ed (2002)
4. Fundamentals of Micro processers and Microcomputers B. Ram, Bhantat Rai Publishers, 6'h Ed (2006)
5. Microprocesser (8085) and its Applications-A. Nagoorkani, RBA Publications (2004)

6. Digital Logic and Computer Design-M Morris Manno, PHI (1995)
7. Fundamentals of digital circuits-A.Anadan, PHI (2006)
8. Digital circuits and design- S. Salivahanan& S. Arivazhavan, Vikas Pub. (2003)

CEL 1402 MATHEMATICAL MODELING AND COMPUTATIONAL TECHNIQUES

Module 1

Solution of algebraic and transcendental equations: Iterative, bisection and Newton-Raphson methods, Solution of simultaneous linear equations: Matrix inversion method, Interpolation: Newton and Lagrange formulas

Module 2

Numerical differentiation, Numerical Integration, Trapezoidal, Simpson and Gaussian quadrature methods, Least-square curve fitting, Straight line and polynomial fits, Numerical solution of ordinary differential equations: Euler and Runge Kutta methods. (Ref. 1)

Module 3

Models and reality, properties of models, basic steps in building a model, models using dimensional analysis-,Newton's law of gravitation, period of perfect pendulum, Mathematical modeling through ordinary differential equation- planetary motion, motion of satellite, models through difference equations, Maximum entropy principle – Maxwell- Boltzmann equation, Bose- Einstein and F-D statistics (Ref 2 and 3)

Module 3

Principle of Object Oriented Programming, Software evaluation, OOP paradigm, Basic concept of OOP, Benefits of OOP, Application of OOP, Introduction to C++,Tokens, Keywords, Identifiers, Constants, Operators, Manipulators, Expressions and control structure, Pointers, Functions, Function prototyping, Parameters passing in functions, Values Return by functions, Inline functions – friend and virtual functions, Classes, objects, constructors and destructors, Operator overloading, Type conversions , Type of constructors , Function over loading (Ref 5 and 6)

References:

1. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice Hall India, 5th Edition (2012) (Text)
2. An introduction to mathematical modeling- E A Bender- John Wiley and sons (1978) (Text)
3. Mathematical modeling – J N Kapur New Age publishers (2008) (Text)
4. Object Oriented Programming with C++, Balagurusamy, Mcgraw Hill Education, 6th Edition (2013) (Text)
5. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia Publications (1997) (Text)
6. Engineering and Scientific Computations Using Matlab, Sergey E. Lyshevski, Wiley (2003) (Text)
7. Numerical methods in Science and Engineering, M.K. Venkataraman, National Publishing Co. Madras, 5th Edition (1999)
8. Schaum's Outline of Programming with C++, John R. Hubbard, McGraw-Hill (2000)

ISP 1403 QUANTUM MECHANICS I

Module 1

Origin of quantum theory:

Blackbody radiation: Spectral distribution, concept of energy density, Ultraviolet catastrophe, Planks formulation of black body radiation, Deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzmann Law and Wien's displacement law from Planck's law.

Photoelectric effect, Einstein's quantum theory of photoelectric effect, Compton effect; Wavelike properties of particles: Matter waves, de Broglie hypothesis, Davisson and Germer experiment, the wave-particle duality.

Wave packets: localized wave packets, the uncertainty principle, consequences of uncertainty principle, uncertainty relations, motion of wave packets, propagation of wave packet without distortion, group and phase velocities.

Module 2

Schrodinger wave function, Born's interpretation of wave functions, particle in a box, Schrödinger's equation for a particle subjected to forces, wave function and its interpretations, probability, probability current density and continuity equation, expectation values, Ehrenfest's theorem, admissibility conditions of wave functions, normalizations of wave functions, box normalization, time dependent and time independent Schrödinger equations, stationary states and super position principle.

Module 3

Postulates of Wave Mechanics, Dynamical variables as operators, Linear operators, Commutator brackets, Eigen functions and Eigen values, Hermitian operators and their properties, Orthogonality conditions, Schimidt'sorthogonalization procedure, Physical significance of Eigen functions and Eigen values, Degeneracy, Simultaneous measurability of observables, general uncertainty relations.

Module 4

Applications of Schrödinger equation: Particle in a box , Square well potential with rigid walls, square well potential with finite walls, square potential barrier and quantum tunnelling, Alpha decay, Linear harmonic oscillator,

Particle in a spherically symmetric potential, separation of R, Θ and Φ equations, Hamiltonian of two interacting particles, rigid rotator, Hydrogen atom, Energy Eigen values, Hydrogen wave function, Radial probability density functions and Hydrogen atom orbitals.

References:

1. Quantum Physics-Eisberg and Resnik ,John Wiley Sons(2002) (Text)
2. Concepts of Modern Physics-Beiser, Tata McGraw Hill (2002) (Text)
3. Quantum Mechanics- G Aruldhas, Printice Hall India (2004)(Text)
4. Quantum Mechanics: Concepts and Applications, NouredineZettili, John Wiley & Sons, 2001
5. Quantum mechanics- Mathews and Venketesan, Tata McGraw Hill (2006)
6. Quantum Mechanics-Thankappan V K, New Age International, 2nd edition (2003)
7. Introduction to Quantum Mechanics – David J Griffiths, Pearson, 2ndedn

ISP 1404 ELECTROMAGNETIC THEORY AND RELATIVISTIC PHENOMENA

Reading section: Vector algebra and vector calculus

Module 1

Electrostatics: Electric field, Gauss's Law in integral and differential forms, applications of Guass's law, Scalar potential, Energy of continuous charge distribution, Poisson and Laplace equations, Boundary conditions and uniqueness theorem, Dielectrics, induces dipoles, polarization and field of a polarized object, Guass's law for dielectric media, Displacement field, linear dielectric and dielectric constant, energy and forces in dielectric systems.

Module 2

Magnetostatics : Magnetic fields & magnetic forces, Bio-Savart law, Amper's law, Applications of Amperes law, Magnetic vector potential, Magnetization, Torque and forces on magnetic dipoles, The field of a magnetized object, Ampere's law in magnetized material, Boundary conditions, Magnetic susceptibility and permeability.

Module 3

Faraday's law of electromagnetic induction, energy and magnetic field, Maxwell's equation in vacuum and dielectric media, Vector and Scalar potentials, gauge transformations- Lorentz and Coulomb gauges, Solutions of Maxwell's equation in vacuum and dielectric media, Poynting's theorem, conservation of energy and momentum, Reflection and refraction of EMW at dielectric boundaries, Snell's law, TIR, Brewster's angle.

Module 4

Michelson- Morley experiment, Postulates of special theory of relativity, Lorentz transformations, velocity addition, velocity dependent mass, structure of space-time and Minkowski diagram, Relativistic Mechanics- proper time, proper velocity, Relativistic momentum and energy, Compton scattering, Magnetism as relativistic phenomenon.
Transformation of fields, the field tensor, four vectors, Maxwell's equation in tensor form.

Reference:

1. Introduction to electrodynamics,David J Griffiths, Pearson Education India Learning Private Limited, 4th edition (2015) (Text)
2. Electrodynamics J.D Jackson, Wiley, 3rd Edition (2007) (Text)
3. The Feynman Lectures on Physics, Richard P Feyman, Vol 1&2 , Narosa Publishing house(2008)
4. Concepts of Modern Physics, Arthur Beiser and Shobhit Mahajan ,Tata Mc Graw Hill (2009)
5. Electricity and Magnetism K K Tewari, S Chand & Company, 3rd Edition (2007).
6. Electricity and Magnetism D.N Vasudeva , S Chand & Company (2002)
7. Classical Electrodynamics- P S Sengupta, New Age International, 2nd Edition (2015)
8. Electromagnetic Theory and wave propagation- S N Ghosh , Narosa Publishers 2nd Ed(2002)
9. Electromagnetic waves and radiating systems- Jordan E C and K G Balmian, Prentice Hall India Learning Private Limited, 2nd edition (1998)
10. Introduction to special theory of relativity, R Resnick, Wiley India edition (2010)

ISP 1405 MATHEMATICS IV

Module 1

Tensor Analysis: definition, law of transformations, rank of tensor, covariant and contravariant tensors, algebra of tensors, lowering and raising of indices, contraction of tensors, fundamental tensors, metrics, covariant derivatives, Christoffel symbols, curvature tensor, Cartesian tensors, stress, strain and Hooke's law, moduli of elasticity, piezo electricity and dielectric susceptibility

Module 2

Fourier series, Laplace Transform, Laplace Transform of some simple functions, solving Differential equations using Laplace Transform. Fourier Transform, Properties of FT, Convolution Theorem, Solving Differential equations using FT.

Module 3

Functions of Complex Variables: Analytic functions, power series, Taylor and Laurent series, Contour integration, Cauchy's theorem, Cauchy's Integral formula, Integration involving branch cuts and branch points.

Module 4

Group Theory: Definition, Examples, properties of a group, Sub Group, Group multiplication table, Cyclic Group, Permutation group, Isomorphism and homomorphism of Groups, Cayley's theorem, Conjugate elements and classes, Representation of group, Reducible and Irreducible representations, Character table, Group of symmetry of an equilateral triangle and a square.

References:

1. Mathematics for Physicists and Engineers – G B Arfken, Academic Press (2001), (Text)
2. Chemical Applications of Group Theory- F A Cotton, Wiley Eastern (1971)(Text for module III)
3. Mathematical methods in Classical and Quantum Physics- T Dass & S K Sharma
4. Complex Variables- Schaum Series
5. Elements of Group Theory for Physicits- A W Joshi, Wiley Eastern Ltd, 3rd Edition (1988)
6. Introductory methods of Numerical Analysis- C S Sastry Prentice Hall India (2001) (Text)
7. Numerical Methods- Balagurusamy, Tata Mc Grow Hill (2001)
8. Elements of group theory for Physicists, A W Joshi, Wiley Eastern Ltd, 3rd edition, (1988)
9. Churchill-Complex variable theory

ISP 1406 COMPUTER LAB

Mathematical modeling and simulation

Object Oriented Programming with C++ - Beginning with C++- Tokens, Expressions and Control Structures- Functions in C++- Manipulating Strings- Operator Overloading and Type Conversions- Inheritance: Extending Classes- Polymorphism

Simulation and modeling using C++ - basic simulation programs

Awareness on Mat Lab, Mat CAD and Lab VIEW

References:

1. System simulation with digital computer — Narsingh Deo, Prentice Hall India (2003)(Text)
2. Object Oriented Programming With C++,fifth edition by E Balagurusamy(Text)
3. Graph Theory with Applicaations to Engneering and computer science- Narsingh Deo, Prentice Hall India (2003) (Text).

ISP 1407 WORK SHOP
(Engineering drawing Practice to be given)
ISP 1408 SEMINAR/VIVA

SEMESTER V

CEL 1501 - OPTICS IV APPLIED OPTICS

Module 1

Photometry and Radiometry- quantities and units, Colourimetry- chromaticity coordinates, UCS chromaticity coordinates, UCS diagrams, RGB colour mixing and colour purity , colour temperature, CCT, Visual basis of colourimetry, Human eye and colour deficiency ,colour vision model (Ref 1,9)

Module 2

Diffraction – Fraunhofer and Fresnel diffractions, Fresnel-Kirchoff integral, Fourier transform in Fraunhofer diffraction, diffraction by a single slit, diffraction by a rectangular aperture, two slit fraunhoffer diffraction pattern, N-slit fraunhoffer diffraction pattern, fourier transforming property of lens, spatial frequency filtering (Ref 3,10)

Module 3

Birefringence-Birefringent crystals, polarisers, polarization beam splitters, Wave plates (half-wave, Full-wave and quarter-wave), Compensators and Variable retarders, Circular polarizers Optical activity - Dextro and lavo rotatory substances, optical activity in liquids, Half-shadeplate, Laurrents half-shade polarimeter

Optical anisotropy-Index ellipsoid, Stress birefringence – Photoelasticity (Ref 3,6,7,5)

Module 4

Analysis of Polarization- Mathematical description of polarization, states of polarization, polarization ellipse, special forms, Elliptical parameters, Stokes polarization parameters, Stokes vectors, Stokes parameters for polarized and unpolarized light, Stokes Intensity formula Jones and Muller matrix calculus- Matrices for polarizer, retarder, and rotator in both representations, Neutral density filter, Muller matrix for Depolarizer

Poincare sphere, Representation of polarization states (Ref 4,8,3)

References :

1. Handbook of Applied Photometry - C De Cusatis, AIP. (1997)
2. Introduction to Soild State Lighting - Zukauskas, Shur, Caska, Wiley (2001)
3. Optics - Eugene Hecht (3rd Edition), Addison Weseli Long inc (1998)
4. Polarized light – Edward Collet, Marcel Decker (1992)
5. Introduction to Optoelectronics- Wilson and Hawkes, PHI, (1996)
6. Wave optics and Applications - R. S. Sirohi, Orient Longmann (2001)
7. Optical Electronics - Thyagarajan and Ghatak, Cambridge University Press (1997)
8. Polarization of light - S. Huard, John Wileyand Sons (1997)
9. Light emitting diodes- E Fred Scheubert, Cambridge University Press (2003)
10. Optics- Ajoy Ghatak, McGraw Hill (2010)

ISP 1502 - ELECTRONICS IV - ELECTRONIC INSTRUMENTATION

Module 1

DC deflection instruments-D'Arsonval movement in DC meters- suspension mechanisms, Principle of operation of galvanometers -PMMC-as voltmeter, ammeter & ohmmeters, AC Deflection measurements-electro dynamometer instruments-electro thermic typeinstruments -hotwire ammeters & thermo couple ammeters- rectifier type instruments-fullwave & half wave, digital instruments-resolution and sensitivity in digital meters –digitalvoltmeter (DVM) - ramp & integrating type, Digital Multimeters (DMM), comparison measurements —Basic AC and DC potentiometers- self balancing potentiometers, Display devices- Classification of displays- LED, LCD, Nixie tube etc.

Module 2

Cathode Ray Oscilloscope: — Basic Principle — CRT features — Block diagram of Conventional CRO and, general CRO types-dual beam &dual trace, front panel controls of CRO-triggered modes & time base generation circuits, General performance parameters bandwidth, rise time and sensitivity, Special types of CRO — Sampling oscilloscope — Storage oscilloscope-Digital storage Oscilloscope (DSO), CRO measurements-lissajous figures measurement of phase difference and frequency, Graphic recorders —strip chart recorders & X-Y recorders.

Module 3

Tuned amplifiers Chopper stabilized amplifiers, Harmonic distortion in amplifiers .Signal analysers -Wave analyser —heterodyne & frequency selective, voltage and gain output measurements. Lock in Amplifiers, Spectrum analyser, BOXCAR averagers

Module 4

Definition of transducers- classification of transducers - passive transducers: principle of operation construction details- characteristics and applications of passive electrical transducers-strain gauge parameters and types, temperature transducers –resistance thermometers, thermistors, inductive transducers -variable reluctance transducers- LVDT, capacitive transducers- variable air gap type-variable area type — variable permittivity type, Active transducers-Thermo electric transducers, Piezo electric transducers. Photoelectric transducers Data converters, DAC and ADC transfer characteristics, conversion techniques, performance parameters, Voltage to frequency converters.
serial interfacing standards RS232C,RS422A, IEEE 488 (GPIB).
Introduction to microcontrollers, Basic ideas of 8051 micro controller, architecture,

References :

1. Electrical and electronic instruments, G. K. Banerjee, PHI learning Pvt. Ltd. (2012) (Text)
2. Elements of electronic instrumentation and measurement - J J Car, Prentice HallIndia (1986)
3. Electronic Instrumentation- H. S. Kalsi, Tata Mc Graw Hill (2006)
4. Industrial and Solid State Electronics: Devices and Systems - T. J. Maloney, PrenticeHall India (1986)

5. A course in electrical and electronic measurement and instrumentation A. K. Sawhney,DanapathRai and Co (2005)
6. Transducers and Instrumentation P. V. S. Murthy, Prentice Hall India (2003)

ISP1503 QUANTUM MECHANICS II

Reading Section: Linear vector space, The Hilbert space, dimension and basis of a vector space, square-integrable functions, Bra and ket notations, Dirac delta function,Matrix representation of Kets, Bras and operators.

Module 1

Representation in continuous bases: Position and Momentum representations in Q.M., connecting position and momentum representations, parity operator, Matrix and wave mechanics. Solution of linear harmonic oscillator: Operator method, coherent states, matrix representation of creation, annihilation, number, position and momentum operators of harmonic oscillator.

Module 2

Orbital angular momentum, General formalism of angular momentum, eigen functions and eigen values of J_z and J^2, matrix representation of angular momentum, geometrical representation of angular momentum, eigen functions and eigen values of L_z and L^2. Spin angular momentum: general theory of spin, Pauli spin matrices.

Module 3

Time independent perturbation-first order and second order correction, the stark effect, Degenerate perturbation theory; Variational method, hydrogen and helium atoms; WKB approximation, tunnelling through potential barrier.
Pictures of quantum mechanics, Schrödinger picture, Heisenberg picture and interaction picture.
Time dependent perturbation theory: first order approximation, transition probability for constant and harmonic perturbations, Fermi-Golden rule.

Module 4

Scattering theory: scattering amplitude and differential cross section of spinless particles, partial wave analysis, Optical theorem, partial wave analysis for inelastic scattering, Born approximation, scattering by hard sphere, square well and coulomb scattering, scattering of identical particles.

References

1. Quantum Mechanics: Concepts and Applications, 2nd Edition,NouredineZettili, John Wiley & Sons, 2009 (Text)
2. Quantum Mechanics G Aruldhas, Printice Hall India,(2004)
3. Quantum mechanics Mathews and Venketesan ,Tata McGraw Hill (2006)
4. Modern Quantum Mechanics- J J Sakurai,Pearson Education ,Revised Ed (2003)
5. Quantum Mechanics-Thankappan VK , New Age International (P)Ltd, 2nd edition (2003)

ISP 1504 Materials Science

Module 1

Crystal symmetry and crystal systems: translational vectors and lattices, unit ISPl, Miller indices, symmetry operations, reciprocal lattices, hexagonal close packed structure, NaCl, CsCl, diamond and ZnS structures, X-ray diffraction and Bragg's law, Powder diffraction, different types of bonding in crystals, Vandervaal's, ionic, covalent and hydrogen bonds.

Module 2

Lattice vibrations: phonons, phonon spectra of monatomic and diatomic linear lattices, scattering of phonons by neutrons, experimental techniques to get phonon spectra, lattice heat capacity, Einstein's Model, Debye's Model.

Module 3

Band theory of solids: density of states, Fermi level, origin of bands, Bloch theorem, Kronig- Penny model, classification of materials based on band gap, electrical conduction in metals and semiconductors, effect of doping on Fermi level in semiconductors, Material characterisation using SEM, TEM and AFM.

Module 4

Dielectric properties of solids: polarisability, local electric field of an atom,ferroelectric crystals, Clausius Mosotti relation, Lorentz – Lorenz formula, Curie-Weiss Law,magnetic properties of solids, dia, para and ferro magnetism, Langevin's theory of diamagnetism and paramagnetism,ferromagnetic domains, hysterisis, BH curve, adiabatic demagnetization.

References:

1. Solid State Physics – C Kittel, 7th edition, John Wiley (2004)(Text)
2. Introduction to Solids – Azaroff, Tata McGraw Hill (1977)
3. Text Book of Solid State Physics - S O Pillai, New age International (2002)
4. Problems in Solid State Physics - S O Pillai,New age International (2003)
5. Solid State Physics- A J Dekker, MacMillian India Ltd (2005)
6. Solid State Physics- M A Wahab,2nd edition,Narosa Publishing House Pvt. Ltd(2005)
7. Solid State Physics, N W Ashcroft, N David Mermin, Harcourt, (1976)

ISP 1505 MOLECULAR SPECTROSCOPY

Module 1

Microwave spectra of molecules: Rotational energy levels of rigid and non rigid diatomic molecules, Rotational term values, Pure rotational spectra of diatomic molecules, Effect of isotopic substitution on spectra.

Polyatomic molecules: Linear and symmetric top, Microwave spectrometer, Evaluation of molecular constants, Diatomic vibrating rotator, Vibrational term values, Evaluation of vibrational constants of diatomic molecules.

IR spectroscopy : Pure vibration spectrum of diatomic molecules, SHO and anharmonic oscillator, Interaction of rotation and vibration, Breakdown of Born- Oppenheimer approximation.

Module 2

Vibration of polyatomic molecules: Modes of vibration of linear tri atomic and non-linear tri atomic molecules with special reference to CO_2 and H_2O. Linear and symmetric top—Analysis by IR spectroscopy. Experimental techniques of IR spectroscopy.

Group theoretical applications in molecular spectroscopy with special reference to molecules like water

Raman spectroscopy: Classical and quantum theory of Raman effect, Stokes and anti-stokes Raman lines, Pure rotational Raman spectra, Linear , symmetric top and spherical topmolecules, Vibrational Raman Spectra, Complemetary nature of IR and Raman Spectra, Structure determination from Raman and IR spectra, Experimental techniques and instrumentation.

Module 3

Electronic spectroscopy: Electronic spectra of diatomic molecules, Vibrational coarse structure, progressions and sequences, Deslander's table, isotope effect, Frank-Condon principle, Intensity distribution in absorption and emission spectra, Dissociation and predissociation, Evaluation of dissociation energy, Rotational fine structure of electronic spectra—P, Q, R branches, Band head formation, Band shading, Fortrat parabola, Basic ideas of experimental techniques.

Module 4

Spin resonance spectroscopy: Spin and applied field- Nuclear Magnetic Resonance – Theory, Experimental techniques , Relaxation, Chemical shift, Medical applications. ESR: Theory and experimental echniques, g – factor, Hyperfine structure. **Mossbauer's spectroscopy:** Mossbauer's effect, theory and experimental techniques, Isomer shift.

References:

1. Funamental of Molecular spectroscopy- C N Banwell and Elaine M McCash, Tata Mc Graw Hill, 4 th edition 2016 (Text)
2. Molecular structure and spectroscopy- G. Aruldhas, Prentice Hall of India Learning Pvt. Ltd. (2007) (Text).
3. Physics of Atoms and Molecules, B.H. Bransden and C.J. Joachain, Prentice Hall, 2nd edition (2003)
4. Quantum physics of atoms, molecules, solids, nuclei and particles, Robert Eisberg and Robert Resnick , John Wiley, 2nd Edition (2006)
5. Molecular Spectra and Molecular Strucuture: Spectra of diatomic molecules- G Herzberg, Krieger Pub Co; 2nd edition (1989)
6. Chemical Applications of Group Theory- F A Cotton, 3rd Edition, Wiley (2008)

ISP 1506 LAB/ VIVA
ISP 1507 SEMINAR

SEMESTER VI

ISP 1601 PHOTONICS II - OPTOELECTRONICS

Module 1

Optical properties of semiconductors- Radiative and non-radiative recombination, band to band recombination , exciton absorption, donor- acceptor and impurity band absorption, long wavelength absorption, Relation between absorption and emission –stokes shift in optical transitions, near band gap transitions, Deep level transitions, Auger recombination

Module 2

Junction Theory-PN junction- current density across junctions, injection efficiency, Quasi-fermi level and high level injection, graded junctions- heterojunction, double heterojunction quantum well and quantum dots, superlattices

Basics of all solid state lamps- LED materials and device configurations, efficiency, high brightness LEDs , light extraction from LEDs, DBR, LED structures- SH, DH, SQW,MQW- device performance characteristics

White solid state lamps-generation of white light and applications

Module 3

Opto-electronic detectors-Thermal detectors, Photoconductive detectors - junction photodoides, P-I-N photodetector- quantum efficiency and frequency response, Silicon photodiodes- performance characteristics

APD- design issues and band width, Phototransistors, Modulated barrier photodiodes, Schottky barrier PD, Metal Semiconductor photodetectors, MSM PD, Detectors for long wavelength operation, Microcavity PD

Solar cells- I-V characteristics and spectral response, Materials and design considerations of solar cells

Module 4

Display devices- PL, EL, CL displays, displays based on LED , Plasma panel and LCD

Optoelectronics modulation –Analog and Digital modulation, Optical hetrodyning and electro-optic measurements, fibre coupling, EO,AO, and MO based switching devices and modulators, SEED

References:

1. Semiconductor optoelectronic devices- Pallab Bhattachraya, PHI, ISBN-978-81203-2047-5 (2009) (Text)
2. Semi conductor optoelectronics- Jasprit singh, Tata Mc Graw Hill (1995) (Text)
3. Semiconductor physics and optoelectronics- V Rajendren,J Hemaletha, M Stalin Maccolin, Vikas Publishers Delhi(2004), ISBN,81-259-1448-X
4. An introduction to Optoelectronics- Wilson and Hawkes , PHI, (1996)
5. Light Emitting Diodes- E Fred Scheubert, Cambridge University Press , (2003)
6. Sold State Lighting- Zukaszukasu, John Wiley Sons , NY (2002)

7. Optoelectronic devices and systems – S C Gupta , PHI, (2005)
8. Solid state Electronic devices- Ben G Streetmann and Sanjay Banerjee,PHI(2003)5th Edition, ISBN-81-203-1840-4
9. Introduction to Semi conductor Materials and Devices- M S Thyagi, John Wiley Sons, NY, (2003)
10. Physics of semiconductor devices- S M Sze John Wiley Eastern 2nd Edition, (2002)ISBN-9971-51-266-1

ISP1602 PHOTONICS II - FIBRE OPTICS

Module 1

Optical waveguides, numerical aperture, Modes in planar waveguides, Goos-Hanchen effect, evanescent field. Cylindrical fibres. Step index and graded index fibres, single mode and multimode fibres, cut of wavelengths, Integrated Optics, channel waveguides, electro optic waveguides, i/p and o/p couplers, e-o and m -o modulators applications of integrated optics - lenses, grating, spectrum analysers.

Module 2

Transmission characteristics of optical fibre, attenuation, absorption and scattering losses, nonlinear losses, wavelengths for communication, bend losses, dispersion effects in optical fibres- material , waveguide dispersions, modal birefringence and polarization maintaining fibres. Nonlinear effects in optical fibres - Self phase modulation, cross phase modulation, stimulated Raman scattering, stimulated Brillouin scattering.

Module 3

Optical fibre measurements – Attenuation, loss dispersion band width, refractive index profile. OTDR. Testing of optical fibre systems, eye pattern techniques. Fabrication and characterization of silica, polymer fibres and photonic crystal fibres. Erbium doped fibres. Fibre components – couplers, connectors, Packaging, Splicers, Cable, Fiber joints, fiber polishing, Industrial, medical and technological applications of optical fibre.

Module 4

Fibre optic sensors – advantages of fibre optic sensors. Intensity modulation and interference type sensors, intrinsic: and extrinsic fibre sensors. Wavelength modulated sensors. Fibre Bragg grating and fibre long period grating sensors. Distributed fibre optic sensors. Polarisation modulation type sensors. Sagnac and fibre gyro, temperature, pressure, force and chemical sensors.

References:

1. Optical Fibre communication - J. M. Senior. Prentice Hall India (1994) (Text)
2. Optical Fibre communication systems - J. Gowar, Prentice Hall India (1995)
3. Fibre optic communication - J. Palais, Prentice Hall India (1988)
4. Fundamentals of Fibre Optic Telecommunication -B. P. Pal., Wiley Eastern (1994)
5. Integrated Optics - R. G. Huspcrger. Springer Verlag, (1998)
6. Fundamentals of Fibre Optics-B. P. Pal, Wiley Eastern, (1994)
7. Understanding Fiber optics- J. Hecht, Pearson Edu. Inc (2006)
8. An introduction to Fiber Optics, Ghatak and Thyagarajan, Cambridge University Press 1998.
9. Fibre optic sensors - principles and applications - B.D.Gupta, New India Publishing, (2006).
10. Fibre Optic Communication Systems, 3rd Edition - G.P. Agrawal, John Wiley and Sons, (2002)

ISP 1603 PHOTONICS III - LASER PHYSICS

Module 1

Radiative transitions and emission linewidths Radiative decay of excited states, Spontaneous emission, decay rate, transition probability, spectral linewidths, spectral line shapes and various line broadening mechanisms, homogeneous and inhomogeneous broadening.

Radiation and thermal equilibrium: Radiation in a cavity, Modes of oscillation, Rayleigh- Jeans and Planck's radiation formula, field quantization, relationship between cavity radiation and blackbody radiation, Absorption and Stimulated emission, Einstein's A and B coefficients.

Module 2

Conditions for producing a Laser : Absorption and gain of homogeneously broadened radiative transition, gain coefficient and stimulated emission cross section for homogeneous and inhomogeneous broadening.

Necessary and sufficient conditions for laser action: Population inversion (necessary condition), saturation intensity (sufficient condition), Development and growth of a laser beam, shape or geometry of amplifying medium, exponential growth factor (gain), threshold requirements for a laser with and without cavity.

Laser Oscillation above threshold: Laser gain saturation, Laser beam growth beyond the saturation intensity, Optimization of laser output power, laser output fluctuations- laser spiking, relaxation oscillations. Laser amplifiers (Elementary ideas only).

Module 3

Requirements for obtaining population inversions: Inversions and two level systems, rate equations for three and four level systems, pumping mechanisms.

Laser cavity modes: Longitudinal laser cavity modes, FP resonator, transverse laser cavity modes, Properties of laser modes, spectral and spatial hole burning, properties of Gaussian beams

Stable laser resonators: Stable curved mirror cavities, ABCD Matrices, cavity stability criteria, unstable and ring resonators.

Module 4

Q-switching: Theory, giant pulses, methods of producing Q-switching within a laser cavity, gain switching.

Mode locking : Theory,pico second optical pulses, techniques for producing mode-locking,

Pulse shortening techniques: Generation of ultra short optical pulses, Self phase modulation, pulse compression (shortening) with gratings or prisms, femto second optical pulses and techniques to characterize femto second pulses.

Properties of laser beams and techniques to characterize laser beam, Semi classical theory of lasers, polarization in the medium, first order theory

References:

1. Laser fundamentals- W. T .Silfvast, 2 nd edition, Cambridge University Press (2008) (Text).
2. Lasers: Fundamentals and Applications, K. Thyagarajan and Ajoy Ghatak, Springer, 2nd edition (2011)
3. Principles of Lasers, Orazio Svelto and David C. Hanna, Springer, Fifth Edition (2010)
4. Lasers, A. E. Siegman, Univ Science Books; Revised ed. edition (1986)
5. Laser Physics, Peter W. Milonni, Joseph H. Eberly , Wiley (2010)

ISP 1604 STATISTICAL MECHANICS

Module 1

Connection between statistics and thermodynamics - macroscopic and microscopic systems- its general descriptions, Quantum states and phase space, density distribution in phase space, Liouville theorem, statistical distribution function, Determination of the number of microstates, statistical origin of thermodynamics, Entropy from the statistical mechanics point, Nernst theorem.

Module 2

Ensemble: microcanonical, canonical and grand canonical ensembles, Canonical Ensemble Theory: distribution function for canonical ensemble, Ideal gases in canonical ensemble, equipartition theorem, Distribution function of grand canonical ensemble.

Module 3

Classical statistics: Distribution laws - Maxwell-Boltzmann distribution. Velocity distribution, relationship between entropy and probability. Partition functions, Partition function of monoatomic gas, Brownian motion, Einstein theory of Brownian motion. Langevin equation for Brownian motion.

Module 4

Quantum Statistics: Bose-Einstein and Fermi-Dirac distributions. Thermodynamic behavior of ideal Bose gas, thermodynamics of black body radiation- Specific heats of solids, Bose-Einstein condensation, Bosons and Fermions, F-D statistics, Thermodynamic behavior of an ideal Fermi gas - Electron gas in metals.

.

References:

1. Statistical Mechanics - K Huang, John Wiley & sons, 2nd edition (2008)
2. Modern Thermo Dynamics-D. Kondepadi. Ilya Prigogene, John Wiley sons (1998)
3. Statistical Mechanics Kamal Singh, S. Chand and Co, New Delhi, 1st edition (1988)
4. Statistical Mechanics R. K. Pathria, Butternorth-Heinemann, (1972)
5. Modern Physics- Beiser, Tata Mc Graw Hill, (2002)

6. Statistical Mechanics, A survival Guide- A. M. Glazer and J. S. Wask, Oxford University Press (2001)
7. Introductory Stastistical physics-Roger Bowle, Academic press
8. Statistical Physics, Berkeley Physics Course Vol 5, F Reif, Tata McGraw Hill, 2011
9. Statistical Mechanics, R. K. Pathria, 2nd edition, Elsevier (2002)
10. Landau and Lifshitz , Statistical Physics

ISP 1605 PROJECT/VIVA

ISP 1606 -LAB/VIVA

SEMESTER VII

ISP 2701 ADVANCED SOLID STATE THEORY

Reading Section - Crystal structures, X-ray crystallography, Band theory, Bloch function

Module 1

Free electron Fermi Gas: energy levels in one dimension, effect of temperature on Fermi-Dirac distribution, free electron gas in three dimensions, heat capacity of electron gas, experimental heat capacity of metals, Electrical conductivity and Ohm's law, experimental electrical resistivity of metals, motion in magnetic fields, Hall effect, thermal conductivity of metals, Wiedemall-Franz law.

Band gap in semiconductor crystals, equations of motion, Holes, Effective mass, physical interpretation of effective mass, effective masses in semiconductors, intrinsic carrier concentration, impurity conductivity.

Module 2

Magnetism (Quantum View): para, dia, ferro and ferri magnetism, Weiss molecular field, Neel model of anti-ferromagnetism, spin wave.

Dielectric function of the electron gas, dispersion relation for electromagnetic waves, transverse optical modes in a plasma, longitudinal plasma oscillations, Plasmons, electrostatic screening, Mott metal-insulator transition, screening and phonons in metals, Polaritons, Electron-electron interaction, Electron-phonon interaction: Polarons,

Module 3

Superconductivity: experimental survey, type I and type II superconductors, Meissner effect, Heat capacity, Energy gap, isotope effect, Thermodynamics of the superconducting transitions, London equation, Coherence length, BCS theory of superconductivity, BCS ground state,Flux quantization in a superconducting ring, Single particle tunneling, Josephson effects, SQUID, high temperature super conductors,applications.

Module 4

Optical processes in semiconductors: electron hole pair formation and recombination,absorption in semi-conductors, donor and acceptor impurity bands, oscillator strength of band-to-band transition, Franz-Keldysh and Stark effects, luminescence emission from semiconductors.

Quantum confined systems: quantum confinements and its consequences in idealized quantum wells, quantum wires and cubic quantum dots. Artificial atoms, electronic structure form bulk to quantum dots. Electron states in direct gap semiconductors, electronic states in indirect gap semiconductors, hole states.

References:

1. Introduction to Solid State Physics - C. Kittel, 7th edition, John Wiley (2004) (Text)
2. Solid state Physics - J. R. Hook and H. E. Hall, John Wiley and Sons, second ed. (1993)(Text)
3. Semiconductor Optoelectronics - PallabBhatacharya, Prentice Hall, second ed.(2002) (Text for module IV)

4. Nanostructures: Theory and Modelling, C Delerue and M Lannoo, Springer Verlag (2004) (Text formodule IV)
5. Solid State Physics- A. J. Dekker, MacMillan India Ltd. (2005)
6. Solid State Physics- M. A. Wahab,2nd edition,Narosa Publishing House Pvt. Ltd (2005).
7. Solid state Physics-N. W. Ashcroft and N. David Mermin, Harcourt (1976)

ISP 2702 LASER SYSTEMS AND APPLICATIONS

Module 1

Classification of lasers- two level, three level and four level laser systems

Laser systems involving low density media- He-Ne laser, Ar -ion laser, Kr- ion laser, He-Cd laser, Copper vapour laser, , CO_2 laser, N_2 laser, , Excimer laser, X-ray laser, FEL laser

Laser systems involving high gain media – Dye lasers, Solid state lasers- Ruby laser, Nd-YAG laser, Nd-glass laser, Pico and Femto second lasers- Alexandrite laser. Ti-Sapphire laser and fiber laser

Laser diode- Thresold current and power output, Semiconductor lasers- hetrojunction lasers, Quantum well lasers, DFB laser, Surface emitting lasers, Rare-earth doped lasers (Ref 1)

Module 2

Industrial applications of lasers- laser absorption in metals, semi-conductors, insulators
Laser welding, laser surface treatments, laser-induced material removal- cutting, scribing, marking etc.
Laser generated plasma, optical fibre splicing, laser deposition of thin films (Ref 2)

Module 3

Lasers in chemistry- laser isotope separation, laser induced chemical reactions- IR photochemistry
Ulrafast processes in Bio-molecules-monitouring fast chemical reactions, study of photochemical processes and stimulation photochemical reactions
Lasers in medicine - Photo dynamic therapy , laser angioplasty, lasers in surgery,
Laser Displays
Fluorescence spectroscopy, energy transfer, sensitization and quenching phenomena. Fluorescence of dyes and rare earth ions(Ref 2,3,14,15)

Module 4

Holography and Speckle Interferometry- Hologram recording and reconstruction, thin and thick holograms, applications of holography in NDT and pattern recognition, Principles of Speckle interferometry and its application to Non Destructive Testing
Other applications of lasers- pollution monitoring, LIDAR, laser gyros, laser induced fusion, CD ROM,
Laser cooling and trapping of atoms- magnetic and optical traps, optical molasses
Lasers in computing- optical logic gates (Ref 4,8,9,10,11,13)

References:

1. Laser Fundamentals - William T Silfvast, Cambridge University Press, Second Edition(2008) (Text)
2. Laser Processing and Analysis of Materials- W WDuley , Plenum Press (1983)(Text)
3. Industrial applications of lasers- John F Ready, Accademic Press, USA (second Edition), ISBN 0-12-583961-8 (1997)(Text)
4. Lasers, Principles , Types and Applications- K R Nambiar, New Age International Delhi(2004), (Text)
5. Laser picosecond Spectroscopy and photochemistry of Biomolecules, V S Letokhov(Ed.), Adam Hilger, Bristal and Philadelphia (1987)
6. Lasers and Non-linear optics – B B Laud , Third Edition, New Age International Private Limited, 2011
7. Fundamentals of Photonics- B E Saleh , M Teich, John Wiley Sons 2nd Edition (2007)
8. Optical Holography- P Hariharan, Cambridge University Press, 2nd Edition(1996)
9. Lasers in Medicine – H K KCobener, Wiley Sons
10. Laser Cooling and Trapping - H J Metcalf and P Van der Straten, Springer Verlag, 1999
11. Optical computing – D G Beitelson , MIT Press, (2000)
12. Laser Processing and Chemistry- Dieter Bauerle, Springer Verlag, 3rd Edition (2000)
13. Wave Optics and its applications, R S Sirohi, Orient Longmann (2001)
14. Spectroscopy, Luminescence and radiation centre in minerals-A S Marfunin, Springer Verlag, NY (1997)
15. Luminescence in solids-DRVij, Plenum Press, New York (1998)

ISP 2703 LAB I-ELECTRONICS
ISP 2704 LAB II – PHOTONICS LAB

ISP 2705 SEMINAR / VIVA

SEMESTER VIII

ISP 2801 NON LINEAR OPTICS

Reading section :Maxwells equations, Poynting Vector, propagation of EMW in conducting and non conducting media, boundary conditions and snell s law

Module 1

Non-linear polarization, non-linear wave mixing, physical origin of non-linear optical coefficients, susceptibility tensors, propagation of EMW through 2^{nd} order nonlinear media, OSHG, second order non-linear materials, phase matching conditions

OPA and OPO frequency conversion- basic equations, backward wave parametric amplification and oscillation in three wave mixing

Module 2

Third order non-linearity- third order susceptibility tensor, Degenerate four wave mixing , Phase conjugate optics- properties of phase conjugate light, Distortion correction theorem, Generation of phase conjugate light, FWM in optical Kerr media, coupled mode formulation, Experiments involving OPC- resonators with OPC mirror, Imaging through distorting medium, Image processing through FWM

Module 3

Two photon Absorption, Experimental set up to detect TPA, SRS-Quantum mechanical description of Raman scattering, Raman cross section and gain, SRS described by non-linear polarization, Antistokes Raman Scattering, CARS- FWM

Self action effects- intensity dependent refractive index

Self-induced transparency- pulse area theorem, self focusing- Threshold condition conditions for self focusing

Module 4

Non-linear absorption- single beam TPA, TPA assisted ESA, Multiphoton absorption, Applications of N L absorption-, Multiphoton spectroscopy, saturable and reverse saturable absorbers, optical limiting- Z-scan- theory of closed aperture and open aperture Z- scan . Non-linear Fabry perot-etalon, NLF as a computing element, Optical Bistability- Absorptive and dispersive bistability, Optical logic gates,

References:

1. Hand book of Non-linear optics-Richard L Sutherland,(Second Edition), MarISP Dekker Inc, (2003) (Text)
2. Non-linear optics- Robert W Boyd, Academic Press, Elsevier, Inc (Third Edition)(2008), (Text)
3. Photonics, Elementals and Devices- V V Rampal, Wheeler Publishing (1992)

4. Lasers and Non –linear optics- B B Laud, Wiley Eastern 3rd Edition, (2004)
5. Optical Electronics in modern Communications (5th Edition), A Yariv, Oxford University Press, (1997)
6. Non-Linear Optics- Shen, John Wiley Sons(1991)
7. Non-linear Fibre Optics- Govind P Agarwal,Accademic Press, 3rd Edition(1989)
8. Quantum Electronics- A Yariv, John Wiley Sons(1975)
9. Fundamentals of Photonics, B E A Salch, M C Teich, John Wiley Sons, 2nd edition (2007)
10. Physics of nonlinear optics-Guang S He and Song H Lie, world scientific , London (1999)

ISP 2802 DIGITAL SIGNAL PROCESSING AND OPTICAL SIGNAL PROCESSING

Module 1

Characteristics of signals: unit step function, impulse, ramp functions, frequency spectum of periodic wave functions.

Discrete time signals, LTI systems, transfer functions and impulse response function, convolution theorem- stability consideration, properties of discrete time systems, difference and differential equation representation, concept of causality and stability, recursive & non- recursive systems- realization structures.

Module 2

sampling and digitization, Nyquist theorem, Reconstruction of signal, Aliasing, Quantisation

Z transform and its properties, inverse Z transform Discrete FT and its properties, FFT, decimation in time and frequency.

Two dimensional Z-transform, Digital fillers, IIR and FIR filters, design considerations- Realisation of FIR & IIR filters- comparison of FIR & IIR filters.

Module 3

Fresnel Transform, Hilbert transform, Mellin transform, Two dimensional Fourier Transform, convolution and correlation. Effect of lens on wavefront. FT properly of lens, OTF. Time and space integrating architecture, spectrum analysis, Vanderlugt filter.

Module 4

Image spatial filtering. SLMs AO. MO, EO and LC based SLMs, Optical numerical processing. Simple .- arithmatic evaluation of polynomials. Optical implementation of matrix vector multiplication, double integration, partial differential equations.

References:

1. Signal processing using optics- B G Boone,Oxford Univ Press, (2000)(Text).
2. Optical computing-D G Feitelson.,MIT Press, (2001) (Text)
3. The Fourier Transform And its Applications to Optics-P M Duffieux, John Wiley Sons 2nd Ed, (1983)
4. Contemperory optics- Thygarajan & Ghatak, Mac Millian India, (1981)

5. Digital signal processing-Proakis JG Manolakis,Prentice Hall of India, 3rd edition(2002)(Text)
6. Digital signal processing –P Ramesh Babu, 4th edition, Scitech publications (2008)
7. Digital signal processing-A Nagoor Kani, RBA publications
8. Modern digital and analog communication systems Lathi B P, CULT OXFORD, (1998).
9. Digital image processing- B Jahane, Springer verlag, (1997).

ISP 2EX3- Elective III, 2EX4 - Elective IV

ISP 2803 LAB -1 ELECTRONICS
ISP 2804 LAB- II PHOTONICS
ISP 2805 SEMINAR /VIVA

SEMESTER IX

ISP 2901 OPTICAL COMMUNICATION

Module 1

Evolution of Optical Communication, Evolution of fiber types, guiding properties of fibers, crosstalk between fibers, dispersion properties of fibers, nonlinear properties of optical fibers, SRS, SBS, Intensity dependent refractive index. Characterization of materials for fibers, fiber perform preparation, fiber drawing, Optical cable design, cable structures, connectors, splicing

Module 2

Optical sources- LED, structures, materials, quantum efficiency, power, modulation-Laser Diode, Modes and threshold conditions, laser diode rate equations, external quantum efficiency, resonant frequencies, laser diode structures and radiation patterns, single mode lasers, modulation of laser diodes, temperature effects

Module 3

Photodetectors, photodetector noise, signal to noise ratio, optical receiver operation, error sources, receiver configuration, digital receiver performance calculations, pre amplifier types, High impedance and Trans impedance amplifiers, analog receivers

Module 4

Digital transmission systems, Point to point links, link power budget, rise time budget, line coding, coherent systems, heterodyne and homodyne detection, WDM concepts and components, operational principle of WDM, Optical Amplifiers, semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Gain and Power Conversion Efficiency, Soliton communication, basic principle, Optical Network, Network topologies, Basic ideas of SONET and SDH networks, RF over fiber

References:

1. Optical Fiber Communications Principles and Practices- J M Senior, Prentice Hall India (1994) (Text)
2. Optical Fiber Communications – Gerd Keiser, 4th Ed (2006) (Text)
3. Optical Networks: A Practical Perspective- Kumar.N.Sivarajan, Rajeev Ramaswami
4. Optical Fiber Communication- J Palais, Prentice Hall International, (1988)

ISP 2902 LAB I FIBRE OPTICS LAB
ISP 2903LAB - II PHOTONICS LAB
ISP 2904 SEMINAR / VIVA
ISP 2EX5 Elective V
ISP 2EX6 - Elective VI
ISP 2EX7- Elective VII

LIST OF ELECTIVES

ISP 2E01 ADVANCED QUANTUM MECHANICS

Module 1

Rotations in classical physics, rotations in quantum mechanics, infinitesimal rotations, finite rotations, properties of rotation operator, Euler rotations, representation of the rotation operator, rotation matrices and the spherical harmonics.
Addition of angular momenta, Clebsch-Gordan coefficients, eigenvalues of J^2 and J_z, calculation of Clebsch-Gordan Coefficients. Coupling of orbital and spin angular momenta, spin orbit functions, addition of more than two angular momenta.

Module 2

Many particle systems: Schrodinger equation, interchange symmetry, system of distinguishable non-interacting particles, system of identical particles, exchange degeneracy, symmetrization postulate, constructing symmetric and anti-symmetric functions, systems of identical non-interacting particles, wave functions of two, three and many particle systems, the Pauli exclusion principle, The exclusion principle and periodic table.

Module 3

Effect of magnetic fields on central potentials: effect of magnetic field on charged particle, the normal Zeeman Effect. Perturbation theory: spin-orbit coupling, anomalous Zeeman effect.
Interaction of atoms with radiation: classical treatment of incident radiation, quantization of electromagnetic field, Transition rate for absorption and emission of radiation, transition rates within dipole approximation, electric dipole selection rule, spontaneous emission.

Module 4

Relativistic quantum mechanics- Klein-Gordon equation, plane wave solutions, interpretation of K-G equation, Dirac equation, Dirac matrices, plane wave solution, positron theory, spin of Dirac particles. Spin magnetic moment, the spin-orbit energy
Introductory ideas inQuantum FieldTheory. Necessity of a Field View, Klein- Gordon Field as Harmonicoscillators.

References

1. Quantum Mechanics: Concepts and Applications, NouredineZettili, John Wiley & Sons, 2001 (Text)
2. Quantum Mechanics G Aruldhas, Printice Hall India,(2004)(Text for module 4)
3. An Introduction To Quantum Field Theory, Michael E. Peskin and Daniel V. Schroeder, Westview Press; (1995) (Test for field theory part)
4. Quantum mechanics Mathews and Venketesan ,Tata McGraw Hill (2006)
5. Advanced Quantum Mechanics- J J Sakurai, Pearson Education, (2006)
6. Quantum Mechanics-Thankappan VK , New Age International (P)Ltd, 2nd edition (2003)

ISP 2E 02 BIO-PHOTONICS

Topics for reading: Fundamentals of light as matter, basics of biology, fundamentals of light matter interactions, lasers, laser technology, nonlinear optics (introduction to bio-photonics by PN Prasad , Chapter 1 6).

Module 1
Photobiology; interaction of light with ISPls with ISPls and tissues, Photo-process in Biopolymers-human eve and vision, Photosynthesis; Photo-excitation free space propagation, optical fibre delivery system, articulated arm delivery, hollow tube wave-guides.
Optical coherence Tomogaphy, Fluorescence, resonance energy transfer imaging.

Module 2
Bio-imaging: Transmission microscopy, Kohler illumination, microscopy based on phase contrast, dark-field and differential interference contrast microscopy, Florescence, confocal and multi-photon microscopy.
Optical Biosensors: Florescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Biosensors based on fibre optics, planer waveguides, Flow Cytometry: basis, flurochromes for flow cytometry, DNA analysis.

Module 3
Laser activated therapy; Photodynamic therapy, photo-sensitizers for photodynamic therapy, applications of photodynamic therapy, two photon photodynamic therapy. Tissue engineering using light; contouring and restructuring of tissues using laser, laser tissue regeneration, femto-second laser surgery.

Module 4
Laser tweezers and laser scissors: design of Laser tweezers and laser scissors, optical trapping using non Gaussian optical beam, manipulation of single DNA molecules, molecular motors, laser for Genomics and Proteomics, semi conductor Quantum dots for bio imaging, Metallic nano-particles and nano-rods for bio-sensing, Photonics and biomaterials: bacteria as bio-synthezers for photonics polymers.
References:

1. Introduction to bio-photonics P.N. Prasad Wiley Interscience (2003) (Text)
2. Biomedical Photonics A handbook T.Vo Dinh (CRC Press) (2002)
3. Optical Imaging Techniques in ISPl Biology Guy Fox, Taylor & Francis Group, C.R.C(2007).
4. An Introduction to Biomedical Optics- R. Splinter & B.A. Hooper, Taylor & Francis Group, C.R.C(2007).

ISP 2E 03 NANOPHOTONICS

Module 1

Foundations for Nanophotonics. Confinement of Photons and Electrons, Propagation Through a Classically Forbidden Zone: Tunneling, Localization Under a Periodic Potential: Bandgap, Cooperative Effects for Photons and Electrons, Nanoscale Optical Interactions, Nanoscale Confinement of Electronic Interactions, Quantum Confinement Effects, Nanoscale Electronic Energy Transfer.Near-Field Interaction and Microscopy : Near-Field Optics, Modeling of Near-Field Nanoscopic Interactions, Nanoscale Enhancement of Optical Interactions, Time- and Space-Resolved Studies of Nanoscale Dynamics.

Module 2

Quantum-Confined Materials : Quantum Wells, Quantum Wires, Quantum Dots Quantum Rings, Manifes,tations of Quantum Confinement, Optical Properties, Quantum-Confined Stark Effect, Dielectric Confinement Effect, Single-Molecule Spectroscopy, Quantum-Confined Structures as Lasing Media, Metallic nanostructures and their applications. Growth Methods for Nanomaterials, Epitaxial Growth, Laser-Assisted Vapor Deposition
(LAVD).

Module 3

Characterization of Nanomaterials, X-Ray Characterization, Transmission Electron Microscopy (TEM) Scanning Electron Microscopy (SEM). Nanostructured Molecular Architectures : Noncovalent Interactions, Nanostructured Polymeric Media, Molecular Machines, Dendrimers, Supramolecular Structures. Photonic Crystals : Basics Concepts, Bandgap and band structures in two and three dimensional lattices. Periodic structures in nature, Experimental methods of fabrication, Photonic Crystal Optical Circuitry, Photonic Crystal Fibers (PCF).

Module 4

Nanocomposites: Nanocomposite Waveguides, Random Lasers, Nanocomposites for Optoelectronics. Nanolithography - Two photon lithography, Near filed phase mask soft lithography, Nanoimprint lithography. Bio Nanophotonics and nanomedicine : Photonic materials of biological origin, Nanoparticles for Optical Diagnostics. Upconverting nanophosphors for bioimaging Biosensing, Nanoclinics for Optical Diagnostics and Targeted Therapy.

References :

1. Nanophotonics: P. N. Prasad, Wiley India (2005) (Text).
2. Introduction to Nanophotonics - Sergey V. Gaponenko, Cambridge University Press (2010)
3. Biophotonics: P. N. Prasad, Wiley India (2005).
4. Nanophotonics, Heve Rigneault and Jean–Michel Lourtioz, ISTE (2006).
5. Nanophotonic Fabrication: Self-Assembly and Deposition Techniques , Takashi Yatsui, Springer, (2012)

ISP 2E 04 MICROWAVE PHOTONICS

Module 1
General performance consideration of transmission lines-coaxial cables, wave guides. microstrip, stripline, optical fibre, comparison of losses. Radio frequency beam forming. scanning techniques, circuit beam formers, imaging reflector antennas, RF electronic beam steering techniques for optical fibres.

Module 2
Phased array antennas. AO lime delays for phased array antennas, delay line, lime delays arrangements for phased array antennas, experimental results, two dimensional array antennas, beam steering.

Module 3
Optically controlled beam scanning, phase shifters, injection locking, beam Steering using subharmonic injection locking, inter junction locking method, unilateral injection locking.

Module 4
Binary optical delay lines, fibre optical delay lines, square root cascade delay lines, hack ground binary fibre optical delay line, architecture and design of BIFODEL.
Optical beam steering of antennas using lasers, Optically controlled array, image mask, fibre optic shulter switch, signal lo noise ratio and laser out put. radiation pattern and reduction in side lobe level, photonic crystals (or microwave application).
Tea Antenna design with fibre optics- A Kumar, Artech House (1996).

References:

1. Coplanar waveguides, circuit, components and systems- E J Simons, Wiley(2001)(Text)
2. Integrated optics,circuits-EJ Murphy., MarISP Dekker Inc.(1999)
3. Photonics crystals - S G Johnson, J D Joannopoulos; Kluver Pub(2002)

ISP 2E 05 NETWORK ANALYSIS AND COMMUNICATION ENGINEERING

Module I
Basic circuit concepts-Kirchoff's law, Classification of circuits, T and Đ networks ,Network theorems and applications in circuit analysis , Loop variable and node variable analysis – Laplace transform analysis of impulse and sinusoidal waveforms for RL, LC and RLC circuits Reciprocity and Substitution theorems .Transients in linear circuits- R L & R C.

Module 2
Two port networks, open circuit impedance and short circuit admittance parameters, Transmission parameters, Hybrid parameters and their inter relations
Laplace transform analyses of simple network, partial fraction expansion, initial and final value theorems, convolution integral. Network functions, complex frequency, impedance and admittance between transfer function and impulse response and their use in network analysis, zero plot.

Module 3

Introduction to positive real functions, network functions, network synthesis - synthesis of passive one port network, LC, RC, RL network, Foster and Causer methods

Modulation techniques- amplitude modulation and demodulation, frequency division multiplexing, frequency modulation and demodulation. FM Radio, stereophonic FM broadcasting, Television, B/Wand color Transmission and reception.

Module 4

Principles of AM- SSB, DSB,VSB. FM and PM – Direct and indirect modulation. Digital modulation-sampling, quantization, coding, aliasing parameter PCM, DPCM, DM, ADM. Carrier modulation-Ask, FSK, PSK, QPSK, BPSK Multiplexing-TDM, FDM, WDM

References:

1 Principle of network synthesis - Van Vakenberg,Wiley (1960)
2. Basic circuit theory - Desor and Kuo. Me. Gtaw Hill (1969)
3. Network analysis - Van Valkenberg,Prentice Hall India, 3rd Ed(2004)
4. Network lines and fields Ryder, Prentice Hall India,2nd Ed(2003)
5. An introduction to digital and analog communication - Simon Haykin, John Wiley, (1994)
6. Principles of communication systems - Taub. H and Schilling, Tata McGraw Hill, 2nd edition, (1991)
7. Modern digital and analog communication systems- CULT OXFORD(1998)
8. Network Analysis-G. K Mithal, Khana Publishers4th Ed (1997)
9. Electronic Communication Systems- Kennely $&Davis,TataGraw Hill 4th Ed(1999)
10. Monochrome & Colour Television- R R Gulati, New Age International (2004)

ISP 2E06 ADVANCED LASER SYSTEMS

Module 1

Gas lasers: General principle of population inversion in gas laser excitation and depopulation mechanisms-pulsed and continuous wave lasers-collision lasers. Helium Neon gas laser-energy levels-energy transfer-excitation methods- fabrication details-operating characteristics. He-Cd lasers-laser structure-excitation mechanism.

Molocular gas lasers: Discharge in molecular CO_2 - inversion mechanisms- CO_2 laser modes-CW and pulsed CO_2 lasers-power supply of CO_2 lasers-laser amplifier-TEA CO_2 lasers-Nitrogen laser-pumping method-emission characteristics-pulsed N_2 laser design. Far IR gas lasers-laser structure and excitation mechanisms.

Module 2

Ion laser: Argon ion energy levels - excitation mechanisms-fabrication of argon ion lasers-uv emission-Excimer and metal vapour rare gas dimers-electronic structure-rare gas excimer-energy level diagram - excimer decay mechanism - xenon halide and krypton halide lasers-excitation mechanisms - efficiency physics of metal vapour laser-copper vapour laser-fabrication details.

Module 3

Solid state lasers: properties of solid state laser materials fluorescence emission in solids - Ruby Nd. YAG, Nd: Glass lasers - laser energy levels pumping sources and cavity configurations - power supply - CW and pulsed operation - General ideas of the following: Tunable solid state lasers-Ti-sapphire and Alexandrite lasers--diode pumped solid state lasers-color center lasers., high power fiber lasers

Semiconductor lasers

Tunable diode lasers- tuning methods--high power semiconductor diode lasers- frequency control of laser output- mode locking of semiconductor lasers, large wavelength semiconductor lasers.

Module 4

Dye laser: Spectroscopy of organic dyes-fluorescence and phosphorescence- optical pumping-incoherent and coherent pumping-threshold condition-rate equation-cw and pulsed dye lasers-turning mechanism-dye laser line width-ring dye laser-General ideas of the following lasers: Spin flip Raman laser-, -X-ray lasers and chemical lasers.

References:

1. Laser Fundamentals - William T. Silfvast, 2nd Edition, Cambridge University Press(2008)(Text)
2. Solid State Laser Engineering - W. Koechener, Springer Verlag, 1992
3. Dye Laser – Schaffer, 2nd edition, Springer Verlag, 2006
4. Photonics – A Yariv, P Yeh, Sixth Edition, Oxford University Press, 2007
5. Semiconductor optoelectronic Devices-Pallab Bhattacharya, Prentice Hall India, 2009
6. Lasers: Principles and Applications- J F B Hawkes, J Wilson, Prentice Hall, 1996
7. Laser Physics-Peter W Milonni, Joseph H Eberly, John Wiley and Sons, 2010

ISP 2E 07 QUANTUM OPTICS

Prerequisite: Advance level knowledge in Quantum Mechanics (ISP 2E01 Advanced Quantum Mechanics)

Module1

Quantization of EMF. Field quantisation. Fock slates, coherent slates, coherence properties of EMF - first order optical coherence, coherent field, photon correlation measurements, photon counting measurements.

Representation of EMF. Expansion in number states, coherent states, P-representation, correlation and characteristic functions, Photon statistics, photon number representation.

Module 2

Density of states and density matrix .Squeezed light-generation and application of squeezed light, coherent interaction of light with matter, Maxwell - Bloch equations. Spontaneous decay of two level atoms.

Module 3

Optical bistability- dispersive and absorptive cases, Bell's inequalities in quantum optics, EPR argument, experimental studies, nondemolition measurements, quantum coherence. Entanglement and interferometric measurements, Quantum Teleportation.

Module 4

Deflection of atoms by light. Kapitza- Dirac effect. Optical Stern -Gerlach experiment, Interaction between Atoms and quantized fields- dressed fields, Jaynes - Cummings model.

References:

1. Quantum optics-D P Walls& G H Milburn , Springer verlag.(1993) (Text).
2. Elements of quantum optics -Meysre and M Sargent , Springer verlag ,(1998) (Text)
3. Fundamentals of Quantum Optics- John R Klauder and ECG Sudarshan, Dover publication(2006)
4. Quantum Optics -D F Walls, G J Milburn Springer Verlag, 2nd edition (2008)
5. Quantum Optics- Werner Vogel, Dirk-Gunnar Welsch, Wiley VCH,3rd edition(2006)
6. Introductory Quantum Optics Chrostopher Gerry and Peter L knight, Cambridge University Press (2004)
7. Quantum Optics an Introduction - Mark Fox Oxford University press (2006)

ISP 2E08 OPTO-MECHANICAL ENGINEERING

Module 1

Drawings of optical components and systems, dimensional tolerances and error budgets Principles of opto mechanical design-structural and kinematic aspects- vibration control Materials for optical systems, properties and selection criteria, metal mirrors- fabrication methods and light weighting.

Module 2

Light weight mirror design- estimating minor weight, mirror self-weight deflection, contoured back mirrors and sandwich mirrors, Optical mounts for lenses, windows, small mirrors and prism: adjustment mechanism- lilear, tilt and rotary adjustment mechanism.

Module 3

Structural analysis of optics- finite element theory, displacement and dynamic models for optics, stress models, optical surface evaluation, modeling of optical structures, ray tracing, optimum design. MEMS design and applications

Module 4

Thermal and thermo elastic analysis of optics, heal transfer analysis, model types, interpolation of temperature fields, thermo elastic analysis.

Fabrication methods- method selection manufacturing methods, fabrication of light weight components, chemical and vacuum coating processes in optics.

References:

1. Hand book of optomechanical engineering - A Ahmad, CRC (1997)(Text)
2. Passive Micro optical Alignment Methods R.A. Boudreau & S.M. Boudreau, Taylor & Francis Group, C.R.C(2005).

ISP 2E 09 OPTICAL SENSOR TECHNOLOGY

Module 1

Light beam as a sensing tool- simple optical sensors- single and double optic sensors- measurements of small displacements- radius of curvature-lamp and scale arrangement- angle of rotation - speed of rotation - stroboscope, method of Triangulation, projected fringe technique, LIDAR for atmospheric remote sensing. LIDAR equation.

Module 2

Interferometry for precision measurements, two-beam interferometry, Michelson interferometer, fringe displacement and fringe counting, heterodyne interferometer, super heterodyne interferometry. electron speckle pattern interferometry photoelastic measurements. Moire technique.

Module 3

Optical fibre sensors - general features- types of OFS- intrinsic and extrinsic sensors, shutter based multimode OFS simple fibre based sensors for displacement, temperature and pressure measurements- reflective FOS and applications, Fibre Bragg grating based sensors.

Light transmission in microbend fibres- microbend OFS- measurements with microbend sensors- evanescent wave phenomenon- evanescent wave FOS- chemical sensors using EWFOS- distributed sensing with FOS- OTDR and applications, FO smart sensing.

Module 4

Interferometric FOS- basic principles- interferometric configurations- Mach-Zender, Michelson and Fabry-Perot configurations- component, and construction of interferometic FOS- applications of interometric FOS- Sagnac interferometer- fibre gyro, OTDR and Applications

References:

1. Optical measurement techniques and applications- P KRastogi. Artech House (1997)(Text)
2. Fibre Optics principles and applications - B D Gupta, NIPA (2006)
3 Fundamentals of Fibre Optics in Telecommunications and Sensor Systems- B.P. Pal, Wiley Eastern(1994)
4. Optics -AjoyGhatak, Tata Mc Graw Hill, 3rd Ed (2005)
5 Lasers, Theory and Applications - Ghatak & Thyagarajan, Mcmillan India Ltd (2002)
6. Optical Fibre sensors, components and subsystems Vol. 3- Brain Culshaw and John Dakin, Artech House Inc. (1996)
7. Optoelectrinic Devices and Systems- S C Gupta, PHI (2005)

ISP 2E10: SOLAR CELLS: CONCEPTS AND THEORY

Pre-requisites: Basics of electromagnetic theory, quantum mechanics and solid state physics.

Module 1

Nature of Solar Radiation: Light as electromagnetic wave, Interaction of sunlight with Earth: the solar spectrum. Interaction of radiation with matter, Interaction of sunlight with atmosphere, air mass. Other Renewable energy resources.

Semiconductors: quasi-Fermi distributions, Fermi energy and electrochemical potential, workfunction, absorption of photons, direct and indirect transitions, generation of electron hole pairs, radiative recombination of electrons and holes, Non-radiative recombination processes: Auger recombination, trap-state recombination, surface state recombination.

Module 2

Conversion of thermal radiation into chemical energy, maximum efficiency for the production of chemical energy. Conversion of chemical energy into electrical energy: transport of electrons and holes, field current, diffusion current, total charge current, separation of electrons and holes, diffusion length and life time of minority carriers, dielectric relaxation, ambipolar diffusion, Dember effect.

Pn junctions: equilibrium conditions, non-equilibrium conditions, quantitative analysis of I-V relation, pn junction under illumination.

Module 3

Semiconductor solar cells: generation of electric power, solar cell equation, maximum power and fill factor, the Shockley - Queisser limit, ultimate efficiency, role of recombination time, Detailed-Balance treatment, Nominal efficiency, Shockley-Queisser efficiency limit. Role of electric field in solar cells.

Losses in solar cells, effect of series and shunt resistance on efficiency, effect of solar radiation on efficiency, effect of temperature on efficiency. Solar cell design: design for high short circuit current, high open circuit voltage and high fill factor. Solar simulator: I-V measurement, quantum efficiency measurement, minority carrier life time and diffusion length measurement.

Module 4

Types of solar cells: crystalline silicon solar cells, thin film solar cell technologies: general advantages, materials, common features, solar cells structures, CdTe, CIGS, a-Si and micro/poly crystalline Si solar cells. Tandem solar cell, Organic solar cells, Dye-sensitized solar cells, Perovskite solar cells.

Thin film deposition techniques: Evaporation, sputtering, CVD

References:

1. C Julian Chen, Physics of Solar Energy, John Wiley and sons, 2011
2. Peter Wurfel, Physics of solar cells: from principles to advanced concepts, Wiley-VCH, 2009
3. Chetan Singh Solanki, Solar Photovoltaics, PHI Learning, 2011
4. Paul A Lynn, Electricity from sunlight: An introduction to photovoltaics, John Wiley and

ISP 2E11 DISCRETE MATHEMATICS AND WAVELET THEORY

Module 1
Introduction to Discrete mathematics, notions and notations, functions - definition,
construction, properties, construction techniques, inductively defined sets, language construction Equivalence relations, inductive proof, optimal algorithm, solving recurrences, comparing rates of growth.

Module 2
Elementary logic- Prepositional Calculus, formal reasoning system, predictive- logic, first order predictive calculus, equivalent formulae.
Applied logic, equality, programme correctness, higher order logic, computational logic, abstract data types and algebras, computational algebra.

Module 3
Wavelet theory - one-dimensional wavelet systems, scaling equations, orthonormal wavelet systems.

Module 4
Wavelet image compression, wavelet filter design, wavelet channel coding and digital modulation techniques.

References:

1. Discrete Mathematics - Hein James L, Jones and Burlett Publishers Inc. (1998)(Text)
2. Wavelet analysis - H L Resnikoff and R O Wells, Springer verlag (1998)(Text)
3. Foundations of Discrete Mathematics - Joshi K D, Wiley Eastern. (1989)
4. Wavelets and allied topics - P K Jain Mhaskar. Krishna. Narosa (2001)

ISP 2E 12 Optical Computing

Module I
Analog optical processing. Linear Optical processing. Spatial filtering using binary filters, inverse filtering. Analog optical arithmetic- nonlinear optical processing, arithmetic operation.

Module 2
Recognition using analog optical systems, matched niter, joint transform correlation, amplitude modulated recognition Tiller. Digital optical computing, nonlinear devices, integrated optical devices. SLM

Module 3
Shadow costing and symbolic substitution, design algorithm of shadow casting system, polarization encoded optical shadow tailing { POSC). POSC processing, symbolic substitution and optical implementation.

Module 4
Optical implementation of memory, holographic and wave guide optical interconnections Optical Computing devices- Nonlinear Fabry -Perot etalon. Optical transistor, threshold logic devices, devices using threshold logic gale components, optical computer.

References:

1. Optical computing-an introduction - MA Karim. AAS Awwal, John Wiley, (1992)Text)
2. Signal processing using optics- B G Boone . Oxford Univ Press, (2000)
3. Optical computing-D G Feitelson. MIT Press , 2001 (Text)
4. Optical computing Digital and Symboles,Raymond Arathoon, MaISP Deccker N Y (1989)

ISP2E13 ATOM OPTICS

Pre requisites: Knowledge in quantum optics (ISP 2E09)

Module 1
Linear Atom Optics- Light forces on atoms. atomic cooling. Doppler and Sisyphus cooling. Evaporative cooling. Atomic beam collimation and focusing, channeling by standing Waves. Evanescent Held mirrors, focused laser beam mirrors.

Module 2
Atomic diffraction - Ramn-Nath and Bragg regime, grilling and interferometers, Atomic traps and cavities magneto optic. magnetic and optical traps. atomic waveguides.
Quantum atom optics- matter wave coherence, Bose Einstein Condensation, experiments in alkali vapours, atom lasers, matters wave Solitons.

Module 3
Nonlinear wave mixing- Atomic four wave mixing, mixing of optical and mailer waves. parametric amplification of atomic and optical fields.

Module 4
Entanglement between atomic and optical fields, matter waves super radiance, mailer wave amplification. Application of atom optics.

References:

1. Atom Optics - P Meysire . Springer Verlag. (2001)(Text)
2. Laser cooling and atom traps-Melcalfe, Springer Verlag (1998)

ISP 2E 14 LASER SPECTROSCOPY

Module I

Spectroscopy technique, Conventional spectroscope recording in UV-Vis-NIR region using dispersing spectrographs, Comparison between Spectrometers and interferometers.
OG Spectroscopy-theory and experimental techniques applications of OGS.(Ref 3)

High Resolution spectroscopy-Doppler free spectroscopy, Two photon absorption spectroscopy, Saturation absorption spectroscopy.

Module 2

Laser photoionization spectroscopy-photoionization of excited atoms-Rydberg atomic states OODR Technique. Photoionization detection of single atoms-Different methods of single atom detection. (Ref 3,5,8)
Pump-probe technique, ultrafast spectroscopy

Module 3

Correlation spectroscopy of scattered light, photon assisted collisional energy transfer, single molecule detection, spectroscopic characterization of BE condensates.
Thermal lens spectroscopy- Focal length of thermal lens single and double beam techniques - applications of TLS. (Ref 2,3,9,10)

Module IV

Photoacoustic Spectroscopy- Theory of PAS of gases,-Resonance conditions RG Theory (analytical treatment) PA effect in gases, liquids, and solids- Design of PA spectrometer Application of PAS Evaluation of optical and thermal parameters-Thermal diffusivity- Depth profiling.(Ref 9,10)

References:

1 Laser Spectroscopy : W Demtroder , Springer Verlag 3rd ed, 2003 (Text)
2. Photoacoustic spectroscopy Rosencwaig, Wiley,(1981)
3. Thermo optic spectroscopy- J Sell, Academic press, (1992)
4. Lumincence in Solids D R Vij ,Plenum Press NY, (1998)
5. Lasers and Nonlinear optics B B Laud, New Age International 2ndEdition, (2003)
6. Laser spectroscopy and its Applications- Leon J Radzemski, MarISP Deklar Pub.IncNY (1987)
7. Laser Photoionization Spectroscopy _ Vladin S Letokhov, Accademic Press Inc (1987)
8. Introduction to laser Spectroscopy, David L Andrivi and Andry A Demodiov, Springer International Inc, 2nd edition, (2002)
9. Photothermal investigations of solids and liquids, Jeffry a Sell, Academic Press Inc, New York (1989)
10. Photo thermal Science and techniques –Darryl P Almond and Pravin M Patel, Chapmann and Hill (1996)

ISP 2E 15 ADVANCED ELECTROMAGNETIC THEORY

Module 1

Guided Waves- TE TM & TEM Waves -attenuation, Wave impedence, Rectangular wave guides, impedence and Q-factor of wave guides, power handling cavity,TE & TM in circular waveguides attenuation.

Module 2

Transmission Lines-Lossy transmission line, Lossless transmission line,characteristics, striop lines, microstrip lines, properties of substrates.

Module 3

Anntenna- Antenna structure, radition pattern, gain beam width, minor lobes, Travelling wave antenna, Directional properties of dipole antenna. Polarization, Thermal impedence Loss, SNR.

Module 4

Antenna arrays- Linear array, Binomial array, Antenna synthesis, Superdirective arrays,arrays of two isotropic point sources, pattern multiplication , horn antennas, parabolic reflectors., Planar antenna

References:

1. Electromagnetic waves and radiating systems- Jordan E C and Balmian, PHI 2nd Ed (1998)(Text)
2. Antenns- Krauss J D,Mc Graw Hill (1995)
3. Introduction to Electromagnetism- Paul C A and Nassar S A, Mc Graw Hill (1987)
4. Microstrip Antennas- Bohl and Bhatia, Artech House (1980)

ISP 2E16: PHOTONIC BANDGAP STRUCTURES AND METAMATERIALS

Pre-requisites: Basic understanding of electromagnetic theory, basics of material science including electrical, magnetic and optical properties of materials

Module 1

Electromagnetism in mixed dielectric media- macroscopic Maxwell's equations-electromagnetism as an Eigen value problem-general property of harmonic modes-scaling properties of Maxwell's equations

Discrete translational symmetry- photonic band structures-rotational symmetry and irreducible Brillouin zone-time reversal invariance- Bloch wave propagation velocity

Module 2

1D Photonic crystals- multilayer film- physical origin of photonic band gaps- the size of the band gap- evanescent modes in PBG

Two dimensional Photonic crystals-localization of light by point defects-linear defects and waveguides-surface states- preliminary concepts of 3D PBG structures-crystals wit complete PBG-localization at a point defect and linear defect

Module 3

Applications of Photonic crystals-periodic dielectric waveguide-two dimensional model-symmetry and polarization-quality factor of lossy cavities- photonic crystal slabs-rod and hole slabs-designing a mirror-designing a cavity-narrow band filter-temporal coupled mode theory-waveguide bend

Module 4

Optical Metamaterials- optical properties of metal dielectric composites-electric and magnetic metamaterials-negative index metamaterials-nonlinear optics using metamaterials and super resolution – transformation optics and electromagnetic cloaking

References:

1. Photonic Crystals: Molding the Flow of Light, John D. Joannopoulos, Steven G. Johnson, Joshua N. Winn & Robert D. Meade, Princeton University Press, Second Edition (2008) (Text)
2. Optical Metamaterials Fundamentals and Applications, Wenshan Cai, ,Vladimir Shalaev, Springer New York (2010) ISBN 978-1-4419-1151-3 (Text)
3. Photonic Crystals: The Road from Theory to Practice, Steven G. Johnson, John D Joannopoulos, Springer New York (2002)
4. Tutorials in Metamaterials (Series in Nano-Optics and Nanophotonics), Edited by Mikhail A. Noginov, Viktor A. Podolskiy, CRC Press, 1st Edition (2012) ISBN-13: 978-1420092189

ISP 2E17 HOLOGRAPHY AND SPECKLE METROLOGY

Module 1

Theoretical foundation for holography and speckle: preliminaries of wave equations and intensity, two wave interference with different frequency, and different amplitudes, between two plane and collinear waves, scalar theory of diffraction, concept of diffraction at an aperture, Frenel-Kirchhoff diffraction formula.

Module 2

Holography: photography and holography, digital holography - general principles, stability requirements, numerical reconstruction by Fresnel approximation and convolution approach, recording of digital holograms, holographic interferometery and its applications.

Module 3

Speckle metrology: Introduction, speckle statistics, speckle phenomenon, first order statistics of speckle pattern, second order statistics of speckle pattern, objective speckle and subjective speckle, superposition of speckle pattern, autocorrelation of speckle, Effect of surface characteristics on speckle pattern, Effect of coherence of light on speckle pattern,

Speckle photography, electronic speckle correlation interferometery – formation of correlation fringes and its analysis using digital image processing, in-plane and out of plane configuration, Digital speckle photography, speckle shearing interferometery, Digital speckle shearing interferometery,

Speckle applications: deformation, surface roughness and vibration measurements, nondestructive testing, phase evaluation methods – Fourier transformation and phase shifting, phase unwrapping.

Module 4

Dynamic speckle and its applications: Dynamic speckle/Biospeckle, statistics of biospeckle, first order statistics, spatial contrast and temporal contrast, second order statistics, autocorrelation function, Brier's contrast.

References:

Text books:

1. Donges A., Noll R. Speckle Metrology. In: Laser Measurement Technology. Springer Series in Optical Sciences, vol 188. Springer, Berlin, Heidelberg (2015).
2. H. John Caulfield and Chandra S. Vikram. New Directions in Holography and Speckle. Published by American Scientific Publishers (2006).
3. Jones, R., and Wykes, C., Holographic and Speckle Interferometry, Cambridge University Press, London 1983.
4. Sirohi, R. S., Speckle Metrology, Marcel Dekker, New York, 1993.

ISP 2E 18 INDUSTRIAL PHOTONICS

Module 1

Optical fiber transmission, fiber components-couplers, isolators, circulators, multiplexers, filters, fiber gratings, optical switches, wavelength converters, optical amplifiers, Transmitters, Receivers-Principle of operation, Performance parameters, Specifications, Applications

Module 2

Optical Node-design concepts, broadcast and select network, wavelength routed network, configurations, logical topologies, advantages, demonstrators, LAMBDANET, STARNET, RAINBOW-AON, MONET, DWDM networks, FTTx (x=home, curb, building, antenna)

Module 3

Control and Management Functions- Configuration, Performance and Fault Management- Access network, architecture, deployment- Photonic Packet switching

Module 4

Fiber Optic Assembly- Reliability requirements, Fiber Optic Standards, Assembly environment-clean rooms, classification- Tools for Fiber optic assembly- strippers, cleavers-Instruments for test purpose- IL Meter, BR Meter, Optical Spectrum Analyzer, Optical power meters, OTDR, Fiber optic Sources- Fiber joints-connectors, splices, Fusion splicers-Fiber polishing-Fiber cable design and structures-Photonic Packaging-Passive and active component packaging

References:

1. Optical Networks: A Practical Perspective 3rd Edition, 2010 by R Ramaswamy and Kumar N Sivarajan (Text)
2. WDM Optical Networks Concepts, Design and Algorithms, 2002 – Sivaram Murthy and Mohan Guruswamy
3. Understanding Optical Communications by Harry J.R.Dutton (pdf version available at http://cs5517.userapi.com/u133638729/docs/3745fff272ed/Dutton_HJR_Understanding_Optical_Communications.pdf)
4. Optoelectronic Packaging by Alan R. Mickelson, Nagesh R. Basavanhally, Yung-Cheng Lee
5. Wdm Technologies: Active Optical Components, Volume 1 By Niloy K. Dutta, Masahiko Fujiwara
6. Clean Assembly Practices to Prevent Contamination and Damage to Optics by J.Pryatel, W.H.Gourdin (pdf version available at https://e-reports-ext.llnl.gov/pdf/328839.pdf)