SEMESTER V & VI

B. SC. PHYSICAL SCIENCES

(PHYSICS)

CPL-501
Discipline Specific Course-I
Elements of Modern Physics
(Credits – 02, 30 Hrs (2 Hrs/week))

Marks for Major test (External): 80
Marks for internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory, The paper will include at least 20% of total marks as numerical problems.

Course Objective	Course Outcome
The course on Elements of Modern Physics deals with Bohr Model, Fundamentals of Wave Mechanics, Heisenberg uncertainty principle, Schrodinger Equation and LASER.	The student will be able to understand Photo-electric effect and Compton scattering, calculation of energy levels for Hydrogen like atoms, Principle and working of LASER systems.

UNIT-I

Introduction to Quantisation: Properties of Thermal Radiation, Spectral Distribution of Blackbody Radiation, Kirchhoff's Law, Stefan-Boltzmann Law and Wien's Distribution and Displacement law, Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's Quantum Postulates, Planck's Law of Blackbody Radiation: Experimental Verification.

Photo-electric effect and Compton scattering; Pair production and annihilation, Bremsstrahlung effect, Cherenkov radiation, Production of X-rays.

UNIT-II

Bohr Model: Drawbacks of Rutherford model, Bohr atomic model; Bohr's quantization rule and atomic stability; Calculation of energy levels for hydrogen like atoms and their spectra, Effect of nuclear mass on spectra, Correspondence principle.

Fundamentals of Wave Mechanics: De Broglie wavelength and matter waves; Wave-particle duality; Frank-Hertz, Davison and Germer experiment, phase velocity, group velocity and their relations.

UNIT-III

Heisenberg Uncertainty Principle; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle, Properties of wave-function, Physical Interpretation of wave-function.

Schrodinger Equation: Momentum and Energy operators, Stationary states, Physical interpretation of a wave function, probabilities and normalization, Schrodinger Equation, Particle in1-dimention infinite potential well.

UNIT – IV

LASER: Absorption and emission of radiation (qualitative only); Basic features of LASER, Population inversion; Resonance cavity; laser pumping; threshold condition for laser emission; Einstein's Co-efficient, 3 level and 4 level system, Basic principle and working of He-Ne LASER and Ruby LASER, Applications of LASER.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill.
- Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A. Dubson,2009, PHI Learning.
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
- Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning.

CPL-502

Discipline Specific Course-II
Nuclear Physics
(Credits – 02, 30 Hrs (2 Hrs/week))

Marks for Major test (External): 80
Marks for internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory, The paper will include at least 20% of total marks as numerical problems.

Course Objective	Course Outcome
The course on Nuclear Physics deals with Basic Properties of Nuclei Radioactivity, Nuclear Models and nuclear forces, Radiation Interaction, Nuclear Reactions, Nuclear Radiation Detector and Nuclear Reactors.	The student will be able to understand Nuclear composition and nuclear properties, Nuclear models, Nuclear detectors and reactors.

UNIT-1

Basic Properties of Nuclei: Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear mass, size, spin, parity, magnetic dipole moment, quadruple moment (shape concept) and binding energy, nuclear binding energy curve.

Radioactivity: Law of Radioactive Decay, Half-life, Radioactive Series, α-decay: Range of α-particles, Geiger-Nuttal law and α-particle Spectra, β-decay, Energy Spectra and Neutrino Hypothesis, γ-decay : Origin of γ-rays.

UNIT-II

Nuclear Models and Nuclear Forces: Similarity between nuclear matter and liquid drop, Liquid Drop Model, Semi-classical Mass formula, Limitations of liquid drop model, Magic number, Experimental signature of shell structure in nuclei, Nuclear Shell Model (qualitative only) and its application, Meson Theory of Nuclear Forces.

UNIT -III

Radiation Interaction: Interaction of heavy charged particles (proton, Alpha particles etc.); Energy loss of heavy charged particle (Discussion of Bethe formula), Range of alpha particles. Interaction of light charged particle (Beta-particle), Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect), Absorption of Gamma rays (Mass attenuation coefficient),

Nuclear Reactions: Types of nuclear reactions, Concept of reaction cross-section, Concept of Compound and Direct Reactions.

UNIT- IV

Nuclear Radiation Detectors: Gas filled counters; Ionization chamber, proportional counter, G.M. Counter (detailed study), Basic principle of scintillation counter and semiconductor detectors.

Nuclear Reactors: General aspects of reactor design, Nuclear fission reactor (Principle, construction, working and use) **Particle Accelerators:** Particle Accelerator facilities in India, Linear Accelerator, Cyclotron, Synchrotron

References:

- Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
- Nuclear Physics, S. B. Patel, New Age publication
- Introduction to the physics of nuclei and particles by R.A. Dunlap.(Singapore: Thomson Asia, 2004).
- Nuclear physics by Irving Kaplan. (Oxford & IBH, 1962).
- Introductory nuclear physics by Kenneth S. Krane.(John Wiley & Sons, 1988).

CPP- 508

Practical -V; Physics Lab--V
(Credits: 02, 60 Hours (4hrs. per week))

Max marks: 100
Examination Time: 3 Hours

Note:

1. *Each student should perform any seven experiments.*
2. *The students are required to calculate the error involved in a particular experiment.*
3. *For giving marks under Lab. Record each college will maintain practical assessment record by using the following procedure:-*
   i. *Each student has to perform a minimum number of experiments prescribed in the syllabus.*
   ii. *After completion of experiment, the teacher will check the note book and conduct Viva – voce of each student to find out how much theoretical and experimental concept the student has understood. Lab. record will be maintained by giving marks on his practical note-book.*
4. *To compute total marks for lab. performance, a separate register will be maintained. Each student will be assigned separate page on this register. Marks obtained by the student in different experiements will be entered. This record will be signed by the concerned teacher.*
5. *The laboratory 'record register' will be presented to each external examiner for Lab. Record marks. External examiners may verify the record randomly.*

List of Experiments

1. Determine e/m by Thomson's method
2. Study the frequency response of C B transistor amplifier
3. To determine Hall coefficient of a semiconductor sample.
4. Measurement of energy band gap of Ge/Si by four probe method
5. (a) Draw the plateau using G M counter (b) Determine the mass attenuation coefficient by G M counter
6. Determine the wavelength of Na by Fresnel Byprism
7. Diameter of a Lycopodium powder using corona rings
8. Study double slit interference by He-Ne laser
9. Determine the diameter of a thin wire using (He-Ne Laser) diffraction method

Extended list of experiments that may be added in above list (Experiments based on Computer programming in FORTRAN language.)

1. Compute the product of two matrices of different dimension using DO loop
2. Numerical integration by Simpson 1/3 rule
3. Fitting of a straight line using Least-Square method

References:

1 Worsnop and Flint, Advanced Practical Physics
2 Nelkon M and Ogborn, Advanced Level Practical Physics, Heinemann Education Bookd Ltd, New Delhi
3 Srivastava S S and Gupta M K, Experiments in Electronics, Atma Ran & Sons, Delhi 4 Gupta S L and Kumar V, Practical Physics, Pragati Prakashan, Meerut.

CPL- 601
Discipline Specific Course-III
Solid State Physics
(Credits – 02, 30 Hrs (2 Hrs/week))

Marks for Major test (External): 80
Marks for internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory, The paper will include at least 20% of total marks as numerical problems.

Course Objective	Course Outcome
The course on Solid State Physics deals with some important concepts of crystal structure, lattice vibrations, band theory, magnetic properties of matter and superconductivity.	The student will be able to understand the concept of crystal planes and Miller indices, Phonon, Curie law, Applications of Superconductivity.

UNIT-I

Crystal Structure I: Crystalline and glassy forms, liquid crystals, crystal structure, periodicity, lattice and basis, crystal translational vectors and axes. Unit cell and Primitive Cell, Winger Seitz primitive Cell, symmetry operations for a two dimensional crystal, Bravais lattices in two and three dimensions. Crystal planes and Miller indices, Inter-planer spacing, Crystal structures of Zinc Sulphide, Silicon, Sodium Chloride and Diamond.

UNIT- II

Crystal Structure II: X-ray diffraction, Bragg's Law and experimental X-ray diffraction methods. K-space and reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, b.c.c. and f.c.c.

Lattice vibrations: Phonon concept, Vibration of monoatomic and diatomic lattice, Acoustical and optical modes, Dispersion relation for phonons, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids, Debye T^3 law.

UNIT- III

Band Theory: Free electron gas models, Nearly free electron model, Bloch function, Kronig Penny model, Velocity and Effective mass of electron, Distinction between metals, semiconductors and insulators, Hall Effect

Magnetic Properties of Matter: Dia-, Para-, Ferromagnetic Materials, Classical Langevin Theory of dia - and Paramagnetic Domains, Curie's law.

UNIT- IV

Super Conductivity: Historical introduction, Survey of superconductivity, Super conducting systems, High T_c Super conductors, Isotopic Effect, Critical Magnetic Field, Meissner Effect, London Theory and Penetration Depth, Classification of Superconductors (type I and Type II), BCS Theory of Superconductivity, Flux quantization, Josephson Effect (AC and DC), Practical Applications of superconductivity and their limitations.

Reference Books:

- Solid State Physics, M.A. Wahab, Narosa Publication
- Solid state physics, S.O. Pillai, New Age Publication
- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India

CPL-602
Discipline Specific Course-IV
Quantum Mechanics
(Credits – 02, 30 Hrs (2 Hrs/week))

Marks for Major test (External): 80
Marks for internal Exam : 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory, The paper will include at least 20% of total marks as numerical problems.

Course Objective	Course Outcome
The course on Quantum Mechanics deals with applications of Schrodinger equation, spectroscopic terms and Rotational and vibrational spectra of diatomic molecules	The student will be able to understand basic concepts of Quantum Mechanics, one dimentional Harmonic Oscillator problem,Coupling Schemes, Rotational and vibrational spectra of diatomic molecules.

UNIT -1

Basics of Quantum Mechanics: Wave function and its physical significance, Properties of wave-function, Orthogonality and Normalization of wave function**,** Time dependent Schrodinger wave equation, Time Independent Schrodinger Equation, Momentum and Energy operators; Hermitian Operators- Eigenvalue and Eigen functions, Commutator relations of various operators, Stationary states; Probabilities and normalization, Probability current densities and its relation to wavefunction, Expectation Values of Dynamical quantities, Particle in 1-dimention Infinite Square Well (Energy levels and general Wavefunction)

UNIT-2

Application of Schrodinger Wave Equation: Solution of Schrodinger Equation for the Finite Potential Well, 1-Dimention Harmonic Oscillator problem - Algebraic and Analytical solutions, Free particle and concept of group velocity, Tunneling through finite potential barrier - Examples of alpha decay and tunnel diodes (qualitative only), Generalized uncertainty principles for Position-Momentum and Energ

UNIT-3

Larmor's precession, Spectroscopic terms and their notation, Selection rule, Orbital magnetic dipole moment (Bohr magneton), Coupling scheme; LS or Russel-Saunders Coupling scheme and JJ coupling scheme, Pauli principal, Hyperfine structure of spectral lines and its origin, isotopic effect, Atom in external magnetic field; Normal Zeeman effect

UNIT-4

Rotational spectra of diatomic molecules as rigid rotator, energy levels, Rotational spectra of diatomic molecules as non-rigid rotator, Intensity of rotational lines, Vibrational spectra, Vibrational-Rotational, Raman and electronic spectra of molecules: Vibrational energy of diatomic molecules, Molecules as Harmonic Oscillator

Reference:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Quantum Mechanics, D.J. Griffith, Pearson Ltd.
- Quantum Mechanics, V. K. Jain
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.

CPP- 608

Practical -VI; Physics Lab--VI
(Credits: 02, 60 Hours (4hrs. per week))

Max. Marks: 100
Examination Time: 3 Hours

Note:

1. *Each student should perform any seven experiments.*
2. *The students are required to calculate the error involved in a particular experiment.*
3. *For giving marks under Lab. Record each college will maintain practical assessment record by using the following procedure:-*
   iii. *Each student has to perform a minimum number of experiments prescribed in the syllabus.*
   iv. *After completion of experiment, the teacher will check the note book and conduct Viva – voce of each student to find out how much theoretical and experimental concept the student has understood. Lab. record will be maintained by giving marks on his practical note-book.*
4. *To compute total marks for lab. performance, a separate register will be maintained. Each student will be assigned separate page on this register. Marks obtained by the student in different experiements will be entered. This record will be signed by the concerned teacher.*
5. *The laboratory 'record register' will be presented to each external examiner for Lab. Record marks. External examiners may verify the record randomly.*

List of Experiments

1. Study the frequency response of C E transistor amplifier
2. Study the B H curve using oscilloscope
3. Experiments based on application of OPAMP
4. Determine the velocity of ultrasonic in the Kerosene oil
5. Photo electric effect:
   I. Photo current *vs* Intensity.
   II. Energy of photo electron *vs* frequency of light photon.
6. Determine the resolving power of a prism
7. Thickness of a thin paper using interference fringes in an air wedge
8. Determine the resolving power of a transmission grating

Extended list of experiments that may be added in above list (Experiments based on Computer programming in FORTRAN language.)

1. Using array variable, find out the average and standard deviation
2. Compute the sum of a finite series up to correct three decimal place
3. With the help of a program arrange the marks in ascending of descending order

References:

1 Worshnop and Flint, Advanced Practical Physics
2 Nelkon M and Ogborn, Advanced Level Practical Physics, Heinemann Education Bookd Ltd, New Delhi
3 Srivastava S S and Gupta M K, Experiments in Electronics, Atma Ran & Sons, Delhi 4 Gupta S L and Kumar V, Practical Physics, Pragati Prakashan, Meerut.

SEMESTER V & VI

B. SC. PHYSICAL SCIENCES

(GEOGRAPHY)

YET TO BE FINALISED

SEMESTER V&VI

B. SC. PHYSICAL SCIENCES

(CHEMISTRY)

Semester V

CCL-503(i)
Discipline Specific Course-I(i)
POLYMER CHEMISTRY-I
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: ***The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.***

UNIT-I

Introduction and history of polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of polymers.
Nature and structure of polymers-Structure Property relationships.

(7 Hours)

UNIT-II

Functionality and its importance:
Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization.Bi-functional systems, Poly-functional systems.
Properties of Polymers (Physical, thermal, flow & mechanical properties).

(8 Hours)

UNIT-III

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers.

(8 Hours)

UNIT-IV

Polycarbonates,Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(7 Hours)

Reference Books:

- Seymour, R.B.&Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

CCL-504(i)
Discipline Specific Course-I(i)
POLYMER CHEMISTRY-II
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

(8 Hours)

UNIT-II

Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.
Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

(7 Hours)

UNIT-III

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods.Molecular weight distribution and its significance.Polydispersity index.

(7 Hours)

UNIT-IV

Polymer Solution: Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

(8 Hours)

Reference Books:

- Seymour, R.B.&Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

CCP-509(i)
PRACTICAL-V(i)
CHEMISTRY DSC LAB V(i)
POLYMER CHEMISTRY
Credits: 02; 60Hrs (4 Hrs /week)

Marks (External): 100
Time: 6Hrs

I. Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
   a. Purification of monomer
   b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bisisobutylonitrile (AIBN)
2. Preparation of nylon 66/6
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
   a. Preparation of IPC
   b. Purification of IPC
   c. Interfacial polymerization
4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparation of novalac resin/resold resin
8. Microscale emulsion polymerization of poly(methylacrylate).

II. Polymer characterization

1. Determination of molecular weight by viscometry:
   a. Polyacrylamide-aq. $NaNO_2$ solution
   b. (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

III. Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Reference Books:

- M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
- H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
- F.W. Billmeyer, *Textbook of Polymer Science*, 3rded.Wiley-Interscience (1984)
- J.R. Fried, *Polymer Science and Technology*, 2nded.Prentice-Hall (2003)
- P. Munk& T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nded.John Wiley & Sons (2002)
- L. H. Sperling, *Introduction to Physical Polymer Science*, 4thed.John Wiley & Sons (2005)
- M.P. Stevens, *Polymer Chemistry: An Introduction*3rded.Oxford University Press (2005).
- Seymour**/** Carraher's Polymer Chemistry, 9th ed.by Charles E. Carraher, Jr. (2013).

CCL-503(ii)
Discipline Specific Course-I(ii)
Chemistry of Main Group Elements, Theories of Acids and Bases-I
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: ***The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.***

UNIT-I

Acids and Bases: Bronsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept.Hard and soft acids and bases (HSAB concept), applications of HSAB process.

(7 Hours)

UNIT-II

General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents.
Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll Process.

(8 Hours)

UNIT-III

***s*- and *p*-Block Elements**
Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale).
General characteristics of *s*-block metals like density, melting and boiling points, flame colour and reducing nature.
Oxidation states of *s*- and *p*-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S.

(7 Hours)

UNIT-IV

Complex forming tendency of *s* block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals.
Solutions of alkali metals in liquid ammonia and their properties.
Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of *s*-block metals.

(8 Hours)

Recommended texts:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Greenwood, N.N. &Earnshaw. *Chemistry of the Elements*, ButterworthHeinemann. 1997.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4thEd.,Pearson, 2010.

Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

CCL-504(ii)
Discipline Specific Course-II(ii)
Chemistry of Main Group Elements-II
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: *The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.*

UNIT-I

Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever applicable:
Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH_3), 14, 15, 16 and 17.
Oxides of N and P, Oxoacids of P, S and Cl.

(8 Hours)

UNIT-II

Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2) Interhalogen compounds.
A brief idea of pseudohalides

(7 Hours)

UNIT-III

Noble gases: Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory

(7 Hours)

UNIT-IV

Inorganic Polymers: Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones.Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.

(8 Hours)

Recommended texts:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Greenwood, N.N. &Earnshaw. *Chemistry of the Elements*, ButterworthHeinemann. 1997.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4thEd.,Pearson, 2010.
- Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

CCP-509(ii)
PRACTICAL-V(ii)
CHEMISTRY DSC LAB V
Chemistry of Main Group Elements, Theories of Acids and Bases
Credits: 02; 60 Hrs (4 Hrs /week)

Marks (External): 100
Time: 6Hrs

1. Iodometric estimation of potassium dichromate and copper sulphate
2. Iodimetric estimation of antimony in tartaremetic
3. Estimation of amount of available chlorine in bleaching powder and household bleaches
4. Estimation of iodine in iodized salts.
5. Iodimetric estimation of ascorbic acid in fruit juices.
6. Estimation of dissolved oxygen in water samples.
7. Gravimetric estimation of sulphate as barium sulphate.
8. Gravimetric estimation of aluminium as oximato complex
9. Preparation of the following: potash alum, chrome alum, tetraamminecopper(II) sulphate monohydrate, potassium trioxalatoferrate(III) (any two, including one double salt and one complex).

Recommended Texts:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.

CCS-505(i)
Skill Enhancement Course-I
PESTICIDE CHEMISTRY (Theory)
Credits: 02; 30 Hrs (2Hrs /week)

Total Marks: 100

Marks (External): 50

Examination Time: 2Hrs

Note: The examiner is requested to set five questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of ten short answer type questions each of two marks). The candidate is required to attempt three questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides.

UNIT-II

Structure activity relationship, synthesis and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene, Aldrin, Dialdrin); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Marks (Internal): 50

Skill Enhancement Course-I
PESTICIDE CHEMISTRY (Practicals)

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book

- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.

CCS-505(ii)
Skill Enhancement Course-III
FUEL CHEMISTRY (Theory)
Credits: 02; 30 Hrs (2Hrs /week)

Total Marks: 100

Marks (External): 50

Time: 2 Hrs

Note: The examiner is requested to set five questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of ten short answer type questions each of two marks). The candidate is required to attempt three questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

UNIT-II

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and nonconducting) Solid and semisolid lubricants, synthetic lubricants.
Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Marks (Internal): 50

Skill Enhancement Course-III
FUEL CHEMISTRY (Practicals)

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
- Jain, P.C. & Jain, M. *Engineering Chemistry*DhanpatRai& Sons, Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

Semester VI
CCL-603(i)
Discipline Specific Course-III(i)
ORGANOMETALLICS AND BIOINORGANIC CHEMISTRY
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.
A study of the following compounds (including preparation and important properties);
Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

(8 Hours)

UNIT-II

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metalcarbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls.

(7 Hours)

UNIT-III

Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals.p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)-(MO diagram of CO can be referred to for synergic effect to IR frequencies).

(7 Hours)

UNIT-IV

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

(8 Hours)

Reference Books:

- James E. Huheey, Ellen Keiter& Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
- G.L. Miessler& Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
- J.D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.

CCL-604(i)
Discipline Specific Course-IV(i)
POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Polynuclear and heteronuclear aromatic compounds:
Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine.

(8 Hours)

UNIT-II

Active methylene compounds:
Preparation: Claisen ester condensation. Keto-enoltautomerism.
Reactions: Synthetic uses of ethyl acetoacetate (preparation of non-hetero molecules having upto 6 carbon).

(7 Hours)

UNIT-III

Application of Spectroscopy to Simple Organic Molecules
Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max}&ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α,β-unsaturated compounds.

(7 Hours)

UNIT-IV

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

(8 Hours)

Reference Books:

- I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
- John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds,* Prentice Hall.
- R.M. Silverstein, G.C. Bassler& T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
- R.T. Morrison & R.N. Boyd: *Organic Chemistry,* Prentice Hall.
- Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

CCP-609(i)
PRACTICAL-VI(i)
CHEMISTRY DSC LAB VI
Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy
Credits: 02; 60 Hrs (4Hrs /week)

Marks (External): 100
Time: 6Hrs

Section A: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
a. Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or
b. Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
a. tetraamminecarbonatocobalt (III) nitrate
b. tetraamminecopper (II) sulphate
c. potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Reference Books:

- A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

CCL-603(ii)
Discipline Specific Course-III(ii)
QUANTUM CHEMISTRY
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

(8 Hours)

UNIT-II

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.
Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.
Rigid rotator model of rotation of diatomic molecule.Schrödinger equation.

(7 Hours)

UNIT-III

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.
Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

(7 Hours)

UNIT-IV

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals.Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).

(8 Hours)

Reference Books:

- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

CCL-604(ii)
Discipline Specific Course-IV(ii)
SPECTROSCOPY & PHOTOCHEMISTRY
Credits: 02; 30 Hrs (2Hrs /week)

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3Hrs

Note: The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of eight short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

UNIT-I

Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

(8 Hours)

UNIT-II

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

(7 Hours)

UNIT-III

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spinspin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

(8 Hours)

UNIT-IV

Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

(7 Hours)

Reference Books:

- Banwell, C. N. &McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).

CCP-609(ii)
Practical-VI(ii)
CHEMISTRY DSE LAB 6B: QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY
Credits: 02; 60 Hrs (4Hrs /week)

Marks (External): 100
Time: 6Hrs

UV/Visible spectroscopy

1. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colorimetry

1. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$ / $KMnO_4$ / $K_2Cr_2O_7$ in a solution of unknown concentration
2. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenathroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Analyse the given vibration-rotation spectrum of HCl(g)

Reference Books

- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. &Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.;* McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SEMESTER V & VI

B. SC. PHYSICAL SCIENCES

(ELECTRONICS)

Semester V
CEL 503 (i)
Discipline Specific Course I (Electronics)
Electronic Instrumentation - I
(Credits: 02; 30 Hrs (2Hrs /week))
Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Measurements:
Accuracy and precision. Significant figures. Error and uncertainty analysis. Shielding and grounding. Electromagnetic Interference.

Basic Measurement Instruments:
DC measurement-ammeter, voltmeter, ohm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating). Digital Multimeter - Block diagram principle of measurement of I, V, C. Accuracy and resolution of measurement.

UNIT-II (7 Hours)

Basic Measurement Instruments:
Measurement of Impedance (A.C. bridges), Measurement of Self Inductance (Anderson's bridge), Measurement of Capacitance (De Sauty's bridge), Measurement of frequency (Wien's bridge).

UNIT-III (7 Hours)

Oscilloscope:
Block Diagram, CRT, Vertical Deflection, Horizontal Deflection. Screens for CRT, Oscilloscope probes, measurement of voltage, frequency and phase by Oscilloscope. Digital Storage Oscilloscopes. LCD display for instruments.

Signal Generators:
Function generator, Pulse Generator, (Qualitative only).

UNIT-IV (8 Hours)

Power supply:
Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators (78XX and 79XX), Line and load regulation, Short circuit protection. Idea of switched mode power supply (SMPS) and uninterrupted power supply (UPS).

Reference Books:

- David A. Bell, Electronic Devices and Circuits, Oxford University Press (2015).
- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
- E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill Book -fifth Edition (2003).
- A Course in Electrical and Electronic Measurement and instrumentation, A K Sawhney, Dhanpat Rai
- Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Butterworth Heinmann-2008).
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).
- Introduction to measurements and instrumentation, 4th Edn., Ghosh, PHI Learning

CEL 503 (ii)
Discipline Specific Course I (Electronics)
Signal and System
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20

Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Introduction to Signal

Classification of Signals, Basic operations**:** Time Shifting, Time Reversal, Time Scaling, Signal representation in terms of singular functions, Correlation of Signals and its Properties, Representation of a Continuous-Time Signal by its Samples: The Sampling Theorem, Reconstruction , Aliasing.

UNIT-II (7 Hours)

System & its Properties

classification of Systems: Linear & Nonlinear ; Static & Dynamic , Causal & Non-causal , Stable & Unstable System, Time variant & Time Invariant Systems with examples,
Linear Time-Invariant Systems: Definition and Properties, Impulse Response, Representation of LTI systems using Differential and Difference equations.

UNIT-III (7 Hours)

Fourier Series:

Introduction to Frequency domain Representation, Fourier Series Representation of Periodic Signals, Convergence of Fourier Series, Properties of Fourier Series

UNIT-IV (8 Hours)

Fourier Transform:

Need for Fourier Transform, Fourier Transform for periodic and Aperiodic signals, Convergence of Fourier Transform, Properties of Fourier Transform, Applications of Fourier Transform.

Reference Books:

- Signals and systems, A. V. Oppenheim, A. S. Willsky, PHI
- Signals and systems, Tarun K. Rawat, Oxford University Press.
- Signals & Systems, Farooq Husain, Umesh Publications.
- Digital Signal Processing, S. Salivahanan, A. Vallavraj, Tata McGraw Hill.
- Principles of Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press.
- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
- Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
- Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edition, Prentice Hall.
- K.A. Navas and R Jayadevan, Lab Primer Through MATLAB, PHI

CEL 503 (iii)
Discipline Specific Course I (Electronics)
Semiconductor Devices Fabrication
(Credits: 02; 30 Hrs (2Hrs /week)))

Marks for Major Test (External): 80
Marks for Internal Exam: 20

Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (7 Hours)

Introduction of Semiconductor Process Technology: Semiconductor materials, Crystal growth techniques- Czochralski technique, Float Zone Process, Wafer preparation, Clean room.

Oxidation: Thermal oxidation process- Kinetics of growth for thick and thin oxide, Dry and Wet oxidation. Effects of high pressure and impurities, Impurity redistribution during oxidation, Masking property of silicon oxide, Chemical vapour deposition of silicon oxide, Properties of silicon oxide, Step coverage, P-glass flow.

UNIT-II (7 Hours)

Etching: Wet chemical etching- Basic process and few examples of etchants for semiconductors, insulators and conductors, Dry etching using plasma etching technique.

Epitaxy Deposition: Epitaxial growth by vapor phase epitaxy (VPE) and molecular beam epitaxy (MBE). **Diffusion:** Basic diffusion process- Diffusion equation, Diffusion profiles, Extrinsic diffusion concentration dependent diffusivity, Lateral diffusion, Doping through Ion implantation and its comparison with diffusion.

UNIT-III (8 Hours)

Lithographic Processes: Optical lithography, Exposure tools, Masks, Photoresist, Pattern Transfer, Resolution Enhancement Techniques- Electron beam lithography, X-ray lithography and Ion beam lithography, Comparison between various lithographic techniques.

Metallization: Uses of Physical Vapor Deposition and Chemical Vapor Deposition technique for Aluminum and Copper metallization.

UNIT-IV (7 Hours)

Process Integration: Passive components- Integrated circuit resistor, Integrated circuit inductor, Integrated circuit capacitor, MOSFET technology-Basic fabrication process of NMOS, PMOS and CMOS technology.

Characterization: introduction to Various characterization methods for structural, electrical and optical properties, Basic idea of X-ray diffractometer (XRD), Scanning electron microscope, (SEM) Transmission electron microscope(TEM) and UV-VIS-NIR spectrophotometer (Atomic force microscopy).

Reference Books:

- Physics of Semiconductor Devices, S. M. Sze. Wiley-Interscience.
- VLSI Fabrication Principles (Si and GaAs), S.K. Gandhi, John Wiley & Sons, Inc.
- Basic VLSI Design, D A Pucknell, PHI.
- Silicon VLSI Technology, James Plummer, Pearson
- Handbook of Thin Film Technology, Leon I. Maissel and Reinhard Glang.
- Fundamentals of Semiconductor Fabrication, S.M. Device and G. S. May, John-Wiley
- The science and Engineering of Microelectronics Fabrication, Stephen A. Champbell, 2010, Oxford University Press.
- Introduction to Semiconductor materials and Devices, M. S. Tyagi, John Wiley & Sons

CEL 504 (i)
Discipline Specific Course II (Electronics)
Electronic Instrumentation - II
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I **(8 Hours)**

Lock-in-amplifier:
Basic Principles of phase locked loop (PLL), Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor), lock and capture. Basic idea of PLL IC (565 or 4046). Lock-in-amplifier, Idea of techniques for sum and averaging of signals.

UNIT-II **(7 Hours)**

Virtual Instrumentation:
Introduction, Interfacing techniques (RS 232, GPIB, USB), Idea about Arduino microcontroller and interfacing software like LABVIEW.

UNIT-III **(8 Hours)**

Transducers:
Classification of transducers, Basic requirement/characteristics of transducers, Active and Passive transducers, Resistive (Potentiometer- Theory, temperature compensation & applications) and Capacitive (variable air gap type) transducers

UNIT-IV **(7 Hours)**

Transducers:
Inductive (LVDT) & piezoelectric transducers. Measurement of temperature (RTD, semiconductor IC sensors), Light transducers (photo resistors & photovoltaic cells).

Reference Books:

- David A. Bell, Electronic Devices and Circuits, Oxford University Press (2015).
- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
- E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill Book -fifth Edition (2003).
- A Course in Electrical and Electronic Measurement and instrumentation, A K Sawhney, Dhanpat Rai
- Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Butterworth Heinmann-2008).
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).
- Introduction to measurements and instrumentation, 4th Edn., Ghosh, PHI Learning

CEL 504 (ii)
Discipline Specific Course II (Electronics)
Programming with Scilab/Matlab
(Credits: 02; 30 Hrs (2Hrs /week)))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Basics:
environment, Basic computer programming, Variables and constants, operators and simple calculations, Formulas and functions, toolboxes.

Matrices and Vectors:
Matrix and linear algebra review, Vectors and matrices,Matrix operations and functions

UNIT-II (7 Hours)

Programming:
script file and function file (m-files), If-else statement, For loop, while loop, 2d Plotting, 3d plotting

UNIT-III (7 Hours)

Statistics programming
Mean and median of a vector, standard deviation and variance of a vector, largest element of a vector, percentiles

UNIT-IV (8 Hours)

image processing: Basic idea of digital images, Basic image processing, image arithmetic, adding noise to images, filtering
Numerical Analysis : Numerical integration, differentiation, ordinary differential equation

Reference Books:

- Hema Ramachandran, Achuthsankar S. Nair, SciLab : A free software to Matlab, S Chand
- Tejas Seth, SciLab : A practical introduction to programming and problem solving
- Rachna Verma, Arvind Verma, Introduction to Scilab
- Rudra Pratap, Getting started with MATLAB, Oxford
- Amos Gilat, MATLAB: An Introduction with applications, Wiley
- Raj Kumar Bansal, Ashok Kumar Goyal, MATLAB and its application in engineering, Pearson

CEL 504 (iii)
Discipline Specific Course II (Electronics);
Antenna Theory
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (7 Hours)

Introduction:
Antenna as an element of wireless communication system, Antenna radiation mechanism, Types of Antennas, Fundamentals of EMFT: Maxwell's equations and their applications to antennas.

UNIT-II (8 Hours)

Antenna Parameters:
Antenna parameters: Radiation pattern (polarization patterns, Field and Phase patterns), Field regions around antenna, Radiation intensity, Beamwidth, Gain, Directivity, Polarization, Bandwidth, Efficiency and Antenna temperature.

UNIT-III (8 Hours)

Antenna as a Transmitter/Receiver:
Effective Height and Aperture, Power delivered to antenna, Input impedance. Radiation from an infinitesimal small current element, Radiation from an elementary dipole (Hertzian dipole), Reactive, Induction and Radiation fields, Power density and radiation resistance for small current element and half wave dipole antenna.

UNIT-IV (7 Hours)

Radiating wire Structures :
Monopole, Dipole, Folded dipole, Loop antenna and Biconical broadband Antenna. Basics of Patch Antenna and its design. Examples of Patch antenna like bowtie, sectoral, fractal, etc.

Reference Books:

- Constantine A. Ballanis, Antenna Theory, John Wiley & Sons
- John Kraus, Ronald Marhefka, Antenna and Wave Propagation, McGraw Hill
- Warren Stutzman and Gary Thiele, Antenna Theory and Design, Wiley
- R.L.Yadava Antenna and Wave Propagation, PHI Learning.
- Edward Jordan and Keith Balmain, Electromagnetic Waves and Radiating Systems, Pearson

---

Semester V

CEL 505 (i)
Skill Enhancement Course II(Electronics)
Design and Fabrication of Printed Circuit Boards
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 50
Marks for Internal Exam: 50
Time: 2 Hours

Paper setter is required to set 5 questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of ten short answer type questions each of 2 marks. The remaining four questions is to be set uniformly having two questions from each unit. The student is required to attempt three questions in all selecting one question from each unit and Question no. 1 is Compulsory.

UNIT-I **(15 Hours)**

PCB Fundamentals:

PCB Advantages, components of PCB, Electronic components, Microprocessors and Microcontrollers, IC's, Surface Mount Devices (SMD), Data sheets, Classification of PCB-single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.

Schematic and Layout Design:
Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.

UNIT-II **(15 Hours)**

Technology OF PCB:
Design automation, Design Rule Checking, Exporting Drill and Gerber Files, Drills, Footprints and Libraries, Adding and Editing Pins, copper clad laminates, materials of copper clad laminates, properties of laminates (electrical and physical), types of laminates, Film master preparation, Image transfer, photo printing, Screen Printing.
Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.

Reference Books:

- R.S Khandpur, Printed Circuit Board: Design, Fabrication, Assembly and Testing, Tata McGraw Hill.
- Walter Bosshart, Printed Circuit Boards: Design and Technology, Tata McGraw Hill.

CEL 505 (ii)
Skill Enhancement Course II(Electronics)
Robotics
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 50
Marks for Internal Exam: 50
Time: 2 Hours

Paper setter is required to set 5 questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of ten short answer type questions each of 2 marks. The remaining four questions is to be set uniformly having two questions from each unit. The student is required to attempt three questions in all selecting one question from each unit and Question no. 1 is Compulsory.

UNIT-I (15 Hours)

Robot defining Criteria , basic components of a robot - sensor, actuator, controller, end effector Arduino control Board for robots, installing arduino software on windows, interfacing arduino with computer, installing arduino IDE on android devices.

Sensors:

Analog and digital sensors, active and passive sensors, attributes of sensors, sensor calibration Ultrasonic sensor (modes, accuracy, limitations, calibration), light sensor, Position encoders, Gyroscope and Accelerometer, Temperature and humidity sensor (DHT 11)

UNIT-II (15 Hours)

Actuators:

Motor characteristics (voltage, current, speed, torque, resistance), DC Motors, speed and torque, Gearing and Efficiency, Servo Motors, Stepper motors, Motor Control and its implementations.

Interfacing and other operations of robotics:

programming Arduino for DC motor control, programming Arduino for servo motor, sensor interfacing to arduino.

Reference Books:

- Cameron Hughes, Tracy Hughes, Robot Programming : A guide to controlling autonomous robots, Pearson
- Vinesh Kumar, Make your first robot, Notion press.
- K S Fu, R C Gonzalez, Robotics : control, sensing, vision and intelligence, McGraw Hill
- Ashitava Ghosal, Robotics : fundamental concepts and analysis, Oxford
- Richard Blum, Arduino Programming, Pearson

CEL 505 (iii)
Skill Enhancement Course II(Electronics)
Mobile Application Programming
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 50
Marks for Internal Exam: 50
Time: 2 Hours

Paper setter is required to set 5 questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of ten short answer type questions each of 2 marks. The remaining four questions is to be set uniformly having two questions from each unit. The student is required to attempt three questions in all selecting one question from each unit and Question no. 1 is Compulsory.

UNIT-I (15 Hours)

Introduction to Mobile Application Programming :
What is mobile Application Programming, Different Platforms, Architecture and working of Android, iOS and Windows phone 8 operating system, Comparison of Android, iOS and Windows phone 8 functions

Android Development Environment:
What is Android, Advantages and Future of Android, Tools and about Android SDK, Installing Java, Eclipse, and Android, Android Software Development Kit for Eclipse, Android Development Tool: Android Tools for Eclipse, AVDs: Smartphone Emulators, Image Editing

UNIT-II (15 Hours)

Android Software Development Platform:
Understanding Java SE and the Dalvik Virtual Machine, Directory Structure of an Android Project, Common Default Resources Folders, The Values Folder, Leveraging Android XML, Screen Sizes, Launching Your Application: The Android Manifest.xml File, Creating Your First Android Application

Android Framework Overview:
The Foundation of OOP, The APK File, Android Application Components, Android Activities: Defining the User Interface, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications, Content Providers: Data Management, Android Intent Objects: Messaging for Components, Android Manifest XML: Declaring Your Components.

Reference Books:

- Barry Burd, Andriod Application Development, John Wiley & sons
- Joseph Annuzzi, Lauren Darcy, Introduction to Android Application Development, Addison Wesley
- Mathew Gimson, Android Programming

CEP 509 (i)
Practical -V (Electronics)
Electronic Instrumentation Lab
(Credits: 02; 60 Hrs (4Hrs /week)

Marks: 100
Time: 4 Hours

At least 8 experiments are to be performed including at least 6 experiments from following:

1. To analyze analog and digital multi meter for various measurements.
2. To study the front panel controls of storage CRO.
3. To measure resistance by Wheatstone bridge and measurement of bridge sensitivity.
4. To measure Capacitance by De Sauty's bridge
5. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
6. To determine the Characteristics of LVDT.
7. To determine the Characteristics of Thermistors and RTD.
8. To measure temperature using Thermocouples.
9. To design regulated power supply of given rating (5 V or 9V).
10. To design and study the Sample and Hold Circuit.
11. To plot the frequency response of a microphone.
12. To measure pressure using Piezo-Electric Pick up.
13. To measure distance using LDR.
14. To study Arduino microcontroller.
15. To study RS 232 interface.

CEP 509 (ii)
Practical -V (Electronics)
Signal and System Lab
(Credits: 02; 60 Hrs (4Hrs /week)

Marks:100
Time: 4 Hours

At least 08 experiments are to be performed including at least 06 experiments from following using numerical computation software SciLab/MatLab

1. To generate continuous and discrete unit step signal.
2. To generate ramp and exponential signal in continuous and discrete domain.
3. To perform addition and subtraction of two signal in continuous and discrete domain.
4. To find and plot even and odd components of a signal.
5. To perform time shifting and time scaling operation on signals.
6. To perform folding and multiplication operation on signals.
7. To generate a random binary signal.
8. To determine and analyze energy of a continuous and discrete signal.
9. To determine and analyze power spectrum of a signal.
10. To determine autocorrelation and cross correlation of discrete data sequences.
11. To obtain and plot convolution of a discrete signal.
12. To obtain pole-zero plot of a given transfer function.
13. To determine and plot Fourier series representation of a given function.
14. To determine and plot Fourier transform of a discrete signal.
15. To write a program for time invariant system.
16. To write a program for linear system.

CEP 509 (iii)
Practical -V (Electronics)
Electronics Skill Lab
(Credits: 02; 60 Hrs (4Hrs /week)

Marks: 100
Time: 4 Hours

At least 08 experiments are to be performed including at least 06 experiments from following:

1. To familiarize about electronic components and their values
2. To study data sheets of diode and transistor.
3. Introduction of circuit schematic and layout tool.
4. To design schematic and layout of full wave rectifier.
5. To design schematic and layout of regulated DC power supply.
6. To design schematic and layout of clipper circuit.
7. Introduction of Design rule check (DRC) and Netlist.
8. Introduction of PCB types and standards.
9. Introduction of image transfer techniques.
10. Introduction of etching techniques.
11. Introduction of Soldering tools, materials and process.
12. To build and test full wave rectifier circuit on PCB.
13. To build and test power supply circuit on PCB.
14. To build and test clipper circuit on PCB.

Semester VI
CEL 603 (i)
Discipline Specific Course III (Electronics)
Digital System Design
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (7 Hours)

Introduction to digital design and VERILOG:
Digital logic design flow, Benefits of CAD, Introduction to HDLs, Verilog and its capabilities, Design Methodologies, Modules, Instances, Components of Simulation and Test Bench.Basic Concepts: Data Types, System Tasks and Compiler Directives. Modules and Ports.

UNIT-II (7 Hours)

Combinational circuit design using Verilog:
multiplexers, demultiplexers, decoders, encoders and adder circuits.

UNIT-III (8 Hours)

Sequential circuit design using Verilog:
flip-flop, latch and register. Finite state machines: Mealy and Moore. shift registers and counters.

UNIT-IV (8 Hours)

Programmable logic devices:
Evolution of Programmable logic devices. PAL, PLA, FPGA architectures. Placement and routing. Logic cell structure, Programmable interconnects, Logic blocks and I/O Ports. Clock distribution in FPGA. Timing issues in FPGA design. Boundary scan

Reference Books:

- Samir Palnitkar, Verilog HDL, Pearson Education; Second edition (2003).
- Zainalabedin Navabi, Verilog Digital System Design. TMH; 2nd edition.
- J. Bhaskar, A Verilog HDl Primer, Pearson
- D.J. Laja and S. Sapatnekar, Designing Digital Computer Systems with Verilog, Cambridge University Press, 2015.
- VLSI design, Debaprasad Das, 2nd Edition, 2015, Oxford University Press.
- Lizy Kurien and Charles Roth, Principles of Digital Systems Design and VHDL. Cengage Publishing.
- Ming-Bo Lin, Digital System Designs and Practices: Using Verilog HDL and FPGAs. Wiley India Pvt Ltd.
- Wayne Wolf, FPGA Based System Design. Pearson Education.

CEL 603 (ii)
Discipline Specific Course III (Electronics);
Digital Signal Processing
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20

Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Discrete-Time Fourier Transform:
Fourier Transform representation for Discrete –Time Aperiodic & Periodic Signals, Properties of Discrete –Time Fourier Transform, Basic Fourier Transform Pairs.

UNIT-II (7 Hours)

Z-Transform
Introduction to Z-Transform, Region of Convergence (ROC) for Z-Transform, Z-Transform Properties, Inverse Z-Transform, Analysis of LTI Systems Using Z-Transform, Application of z transform,

UNIT-III (7 Hours)

Discrete Fourier Transform:
Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT Properties: Periodicity, Linearity, Circular Time Shifting, Circular Frequency Shifting; Linear Convolution Using the DFT

Filter Concepts:
Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Advantages and Disadvantages of Digital Filters, Simple FIR Digital Filters, Simple IIR Digital Filters

UNIT-IV (8 Hours)

Finite Impulse Response Digital Filter:
Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters Rectangular Windowing Method

Infinite Impulse Response Digital Filter:
Design of IIR Filters from Analog Filters, IIR Filter Design by Impulse Invariance Method.

Reference Books:

- Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India.
- Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- Principles of Signal Processing and Linear Systems, B.P. Lathi, 2009, 1st Edition, Oxford University Press.
- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
- Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

- Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edition, Prentice Hall.
- K.A. Navas and R Jayadevan, Lab Primer Through MATLAB, PHI

CEL 603 (iii)
Discipline Specific Course III (Electronics);
Photonic Devices
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Classification of photonic devices. Interaction of radiation and matter, Radiative transition and optical absorption.

Light Emitting Diodes- Construction, materials and operation. Semiconductor Laser- Condition for amplification, laser cavity, heterostructure and quantum well devices. Charge carrier and photon confinement, line shape function. Threshold current. Laser diode.

UNIT-II (7 Hours)

Photodetectors: Photoconductor. Photodiodes (p-i-n, avalanche) and Photo transistors, quantum efficiency and responsivity. Photomultiplier tube.

UNIT-III (7 Hours)

Solar Cell: Construction, working and characteristics

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

UNIT-IV (8 Hours)

Introduction to Fiber Optics: Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations -Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes - Single Mode Fibers-Graded Index fiber structure.

Reference Books:

- Gerd Keiser, Optical communications essentials, McGraw Hill.
- Djafar K. Mynbaev, Fiber-Optic communications technology, Pearson.
- John M Senior, Optical Fiber Communications, PHI.
- J. Wilson & J.F.B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996).
- S.O. Kasap, Optoelectronics & Photonics, Pearson Education (2009).
- AK Ghatak & K Thyagarajan, Introduction to fiber optics, Cambridge Univ. Press (1998).
- Optoelectronic Devices and Systems, Gupta, 2nd edition, PHI learning.

CEL 604 (i)
Discipline Specific Course IV (Electronics);
VLSI Design
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

CMOS Logic:
Inverter, NAND gate, combinational logic, NOR gate, compound gates, pass transistors and transmission gates, Tristates, Multiplexers, latches and flip flops. VLSI Design flow

UNIT-II (7 Hours)

MOS Transistor Theory:
Introduction, I-V characteristics, C-V characteristics, Non Ideal I-V effects - Velocity saturation, Channel length modulation, Body Effect, Subthreshold conduction. Noise Margin.

UNIT-III (7 Hours)

Circuit characterization and Performance Estimation:
Delay Estimation, RC Delay Models, Delay in multistage logic networks, choosing the best number of stages, static and dynamic power dissipation, Low power design, Interconnect, Design Margin

UNIT-IV (8 Hours)

Circuit Design:
Combinational Circuit Design: Static CMOS, Ratioed Circuits
Sequential Circuit Design: Sequencing static circuits, Conventional CMOS latches and flip-flops.

Reference Books:

- Neil H.E. Weste, David Harris, CMOS VLSI Design : A circuits and systems perspective, Pearson
- Jan M Rabaey, Anantha Chandrakasan & Nikolic, Introduction to Digital Integrated Circuits: A design perspective, Pearson

CEL 604 (ii)
Discipline Specific Course IV (Electronics)
Internet of Things
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20
Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I **(8 Hours)**

Introduction:
Definition and characteristics of IOT, Physical Design of IoT, Logical Design of IoT, Basic steps of IoT Design methodology, IoT enabling technologies, M2M basics, Difference between IoT and M2M. Software defined networking. network function virtualization.

UNIT-II **(7 Hours)**

IoT Physical Devices:
Basic building blocks of an IoT device, Exemplary Devices - Raspberry Pi, Arduino,
Arduino board details, Analog, digital and PWM pins, Arduino IDE software, SPI and I2C communications,

UNIT-III **(7 Hours)**

Interfacing:
Interfacing LED, LCD with Arduino, Programs to interface sensors to Arduino, Interfacing motors.

UNIT-IV **(8 Hours)**

Case Studies:
Smart lighting, Home intrusion detection, smart parking system, Air pollution monitoring, Smart irrigation

Reference Books:

- Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-on approach, Universities press
- K.G.Srinivasa, G.M.Siddesh, Internet of Things, Cengage
- Adrian Mcewen, Hakin Cassimally, Designing the internet of Things, Wiley
- David Hanes, Gonzalo Salagueiro, IoT Fundamentals, CISCO

CEL 604 (iii)
Discipline Specific Course IV (Electronics);
Consumer Electronics
(Credits: 02; 30 Hrs (2Hrs /week))

Marks for Major Test (External): 80
Marks for Internal Exam: 20

Time: 3 Hours

Paper setter is required to set nine questions in all. Question no. 1 is Compulsory and is based on the entire syllabus consisting of eight to ten short answer type questions each of 2 marks. The remaining eight questions is to be set uniformly having two questions from each unit. The student is required to attempt five questions in all selecting one question from each unit and Question no. 1 is Compulsory wherein student is required to attempt 8 parts.

UNIT-I (8 Hours)

Audio and Video Systems

Microphones: Construction, working principles and applications of microphones, their types viz: a) Carbon b) moving coil, c) velocity, d) crystal, e) condenser, e) cordless etc; Loud Speaker: Direct radiating, horn loaded woofer, tweeter, mid range, multi-speaker system, baffles and enclosures; Sound recording on magnetic tape, its principles, block diagram and tape transport mechanism; Digital sound recording on tape and disc CD system: Hi-Fi system, pre-amplifier, amplifier and equalizer system, stereo amplifiers

UNIT-II (7 Hours)

Video Systems:

Different types of screens: LCD, LED, Plasma, CRT, 3d display, Digital cameras (still and video), Basic idea of principles of Black and White and colour TV and their difference, Standards Remote Control, VCD and DVD Players

UNIT-III (7 Hours)

Office and Home Gadgets

Basic block diagram, working of the followings: Desktop computer, Laptop, Micro SD card, Pen drive, Hard disk, Printer (inkjet and laser), Scanner, FAX machine, Photostat and Xerox machines, EPABX, Micro wave ovens, washing machine, RO, UPS/inverters, Air conditioners,Refrigerators

UNIT-IV (8 Hours)

Advance Gadgets:

Basic block diagram and working of the followings: Drones, Bar coding, Automated Teller Machines (ATM), Dish washer, cable TV and DTH, cable TV using internet, Electronic Ignition Systems for automobiles, Home security and CCTV, 3D Printers, LCD projector

Reference Books:

- S.P Bali, Consumer Electronics, Pearson Education
- Philip Hoff, Consumer Electronics for Engineers, Cambridge University Press
- B.Grob, Basic Electronics,Tata Mc Graw Hill
- Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, Prentice Hall

CEP 609 (i)

Practical -VI (Electronics)

Digital System Design Lab

(Credits: 02; 60 Hrs (4Hrs /week)

Marks: 100

Time: 4 Hours

At least 08 experiments are to be performed including at least 06 experiments from following using Verilog:

1. Write code to realize basic and derived logic gates.
2. To design Half adder, Full Adder using basic and derived gates.
3. To design Half subtractor and Full Subtractor using basic and derived gates.
4. Design and simulation of a 4 bit Adder.
5. Multiplexer (4x1) using logic gates.
6. To design Demultiplexer using logic gates.
7. To design Encoder using logic gates.
8. To design Decoder using logic gates.
9. Design and simulation of Comparator.
10. Design and simulation of Clocked D, JK and T Flip flops (with Reset inputs)
11. Design and simulation 3-bit Ripple counter
12. Design and simulation of ALU
13. To design and study switching circuits (LED blink shift)
14. To design traffic light controller.
15. To interface a keyboard.
16. To interface multiplexed seven segment display.
17. To interface a LCD using FPGA
18. To interface a stepper motor and DC motor.
19. To interface ADC 0804.

CEP 609 (ii)

Practical -VI (Electronics)

Digital Signal Processing Lab

(Credits: 02; 60 Hrs (4Hrs /week)

Marks: 100

Time: 4 Hours

At least 08 experiments are to be performed including at least 06 experiments from following using numerical computation software SciLab/MatLab

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \leq n \leq 50$.

2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for N = 5

$$x(n) = rect\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \leq n \leq N \\ 0 & otherwise \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H(e^{jw})$

(b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n)u(n)$$

4. Given a casual system

$$y(n) = 0.9y(n-1) + x(n)$$

(a) Find $H(z)$ and sketch its pole-zero plot

(b) Plot the frequency response $|H(e^{jw})|$ and $\angle H(e^{jw})$

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is $f_s = 500\,Hz$. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4-point sequence:

$$x(n) = \underset{\uparrow}{\{1,1,1,1\}} = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & otherwise \end{cases}$$

Compute the DTFT $X(e^{jw})$ and plot its magnitude

(a) Compute and plot the 4 point DFT of $x(n)$

(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)

(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)

7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$x(n) = \underset{\uparrow}{\{1,2,2,1\}}$$

$$h(n) = \underset{\uparrow}{\{1,-1,-1,1\}}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.

9. Design an FIR filter to meet the following specifications:
passband edge $F_p = 2\ KHz$
stopband edge $F_s = 5\ KHz$
Passband attenuation $A_p = 2\ dB$
Stopband attenuation $A_s = 42\ dB$
Sampling frequency $F_s = 20\ KHz$

10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{jw}) = jwe^{-j\tau w} \qquad |w| \le \pi$$

Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response.

CEP 609 (iii)

Practical -VI (Electronics)

Advance Communication Lab

(Credits: 02; 60 Hrs (4Hrs /week)

Marks: 100

Time: 4 Hours

At least 08 experiments are to be performed including at least 06 experiments from following:

1. To study FSK modulator.
2. To study PSK modulator.
3. To study ASK modulator.
4. To study Time Division Multiplexing of two band limited signals.
5. To study Frequency Division Multiplexing of two band limited signals.
6. To study various line coding techniques
7. To study Pre-emphasis and de-emphasis
8. To study DPSK generation and detection
9. To study QPSK generation and detection
10. To measure Numerical Aperture of a given optical fiber
11. To study Analog and Digital communication link using optical fiber.
12. To study BER in optical transmitter fiber link.
13. To measure losses in a given optical fiber (propagation loss, bending loss)
14. To measure directivity and gain of Standard dipole antenna.
15. To measure directivity and gain of microstrip patch antenna
16. To measure directivity and gain of Yagi antenna

SEMESTER V & VI

B. SC. PHYSICAL SCIENCES

(MATHEMATICS)

CML-506 (i): Groups and Rings

Marks (Theory): 80 **Marks (Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Definition of a group. Examples of abelian and nonabelian groups. The group Z_n of integers under addition modulo n and the group of $U(n)$ of units under multiplication modulo n. Generator of a group. Cyclic groups. Permutations groups. Alternating groups, Cayley's theorem. Subgroups and Subgroup criteria. Cosets, Left and right cosets, properties of cosets.

Section – II

Index of a sub-group. Coset decomposition, Lagrange's theorem on groups and its consequences, Normal subgroups, Quotient groups, Homomorphisms, isomorphisms, automorphisms on group. Center of a group and class equation of a group and derived group of a group.

Section – III

Introduction to Rings, Subrings, Integral domains and Fields, Characteristics of a ring. Ring homomorphisms, Theorems on Ring homomorphisms. Ideals (Principle, Prime and Maximal) and Quotient rings, Field of quotients of an integral domain.

Section – IV

Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion of irreducibility of polynomials over the field of rational numbers. Polynomial rings over commutative rings. Principal ideal domain, Unique factorization domain.

Books Recommended:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2^{nd} edition).
3. VivekSahai and VikasBist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

CML-506(ii): Sampling Techniques

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Sample Surveys: Concepts of population, sample, sampling unit, parameter, statistic, sample frame and standard error. Principal steps in sample surveys - need for sampling, census versus sample surveys, sampling and non- sampling errors, sources and treatment of non-sampling errors, advantages and limitations of sampling. Sampling Methods: Types of sampling: Subjective, probability and mixed sampling methods. Methods of drawing random samples with and without replacement.

Section-II

Estimates of population mean, total, and proportion, their variances and the estimates of variances in Simple Random Sampling With and Without Replacement. Estimates of population mean, total, and proportion, their variances and the estimates of variances with (i) Stratified Random Sampling with Proportional and Neyman allocation, and (ii) Systematic Sampling when N= nk. Comparison of relative efficiencies. Advantages and disadvantages of SRS, Stratified and Systematic sampling methods.

Section-III

Time series: Time series and its components with illustrations, additive, multiplicative and mixed models. Determination of trend by least squares and moving average methods. Growth curves and their fitting with reference to Modified exponential, Gompertz and Logistic curves. Determination of seasonal indices by Ratio to moving average, ratio to trend and link relative methods.

Section-IV

Demand Analysis: Introduction. Demand and supply, price elasticity of supply and demand. Methods of determining demand and supply curves, Leontief's ,Pigous's methods of determining demand curve from time series data, limitations of these methods Pigou's method from time series data. Pareto law of income distribution curves of concentration. Index Numbers: Concept, construction, uses and limitations of simple and weighted index numbers. Laspeyer's, Paasche's and Fisher's index numbers, criterion of a good index numbers.

Recommended Books:

1. A.M.Goon, M.K.Gupta, B. Dasgupta: Fundamentals of Statistics Vol II World Press Private Ltd.,Calcutta
2. A.M.Goon,M.K.Gupta,B.Dasgupta An outline of Statistical Theory Vol II World Press Private Ltd.,Calcutta.
3. Cochran W.G., Sampling Techniques, Wiley Publishers
4. Daroga Singh and Chowdhary: Theory and Analysis of Sample survey designs. Wiley Eastern.
5. S.P.Gupta : Statistical Methods. Sultan Chand and Sons.
6. Sukhatmeet. al., Sample Theory of Surveys with Applications, Lowa State Uni. Press & IARS
7. V.K. Kapoor and S.C. Gupta: Fundamentals of Applied Statistics. Sultan Chand.

CML-507 (i): Sequence and Series

Marks (Theory): 80 **Marks (Total): 100**
Marks: Internal Assessment (20) **Time: 3 Hours**

Note:Attempt five questions in all. The question paper will consist of four sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. Each of the four sections **(I-IV)** will contain two questions and the students are required to attempt one question from each section. All questions carry equal marks.

SECTION-I

Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighborhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties.

Sequence: Real sequences and their convergence, theorem on limits of sequence, bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, subsequences, subsequential limits.

SECTION-II

Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series. D-Alembert's ratio test, Raabe's test, Logarithmic test, De Morgan and Bertrand's test, Cauchy's nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Alternating series: Leibnitz's test, absolute and conditional convergence. Arbitrary series: Abel's lemma, Abel's test, Dirichlet's test.

SECTION-III

Fourier's series: Fourier expansion of piecewise monotonic functions, Properties of Fourier Co-efficients, Dirichlet's conditions, Parseval's identity for Fourier series, Fourier series for even and odd functions, Half range series, Change of Intervals.

SECTION-IV

Riemann integral: Definition and examples. Darboux's Theorem and condition of existence of Riemann's integral. Integrabililty of continuous, monotonic functions and discontinuous functions. Properties of integrable functions. Continuity and differentiability of integrable functions. Primitive. The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Books Recommended

1. T.M.Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi,1985.
2. R.R. Goldberg, Methods of Real Analysis, John Wiley and Sons, Inc., New York, 1976.
3. SC Malik and Savita Arora, Mathematical New Age International (P) Limited Published, New Delhi, 2012 (Fourth Edition).
4. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
5. R.G. Bartle and D.R. Shernert: Introduction to Real Analysis, Wiley, 2011.
6. Shanti Narayan : A Course of Mathematical Analysis, S. Chand & Co., New Delhi

CML-507(ii): Sample Surveys and Design of Experiments

Marks (Theory): 80 **Marks (Total): 100**

Marks (Internal Assessment): 20 **Time : 3 Hrs**

Note:Attempt five questions in all. The question paper will consist of four sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. Each of the four sections **(I-IV)** will contain two questions and the students are required to attempt one question from each section. **All questions carry equal marks.**

Section-I

Sample Surveys: Concepts of population and sample. Complete enumeration vs. sampling. Need for sampling. Principal and organizational aspects in the conduct of a sample survey. Properties of a good estimator, Sampling and non-sampling errors.

Section-II

SRSWR & SRSWOR, determination of sample size. Stratified random sampling and different allocations. Systematic sampling, comparison of known sampling strategies under linear trend. Ratio and Regression estimators and their comparison with SRSWOR estimator.

Section-III

Indian official Statistics: Present official Statistical system in India relatinig to census of population, agriculture, industrial production, and prices; methods of collection of official Statistics, Their reliability and limitation and the principal publications containing such Statistics. Also the various agencies responsible for the data collection- C.S.O., N.S.S.o., office of the Registrar General, Their historical development, main functions and important publications.

Analysis of variance and covariance: analysis of variance and covariance (with one concomitant variable) in one way and two way classified data with equal number of observations per cell.

Section-IV

Design of experiments: Principles of experimentation, uniformity trails, completely randomized, Randomized block and Latin square designs. Missing plot technique, 2^2 and 2^3 Factorial experiments: construction and analysis.

Regression Analysis: Two variable linear model- estimation, testing and problems of predication. Predication of the estimated regression equation, interval estimation, variance estimation.

Books Recommemded

1. W.G. Cochran, *Sampling Techniques,* John Wiley and Sons, New York, 1997.
2. A.M. Goon, M. K. Gupta and B. Dasgupta, *fundamentals of Statistics* (Vol.II), 8th Ed. World Press, Kolkata, 2005.
3. A.M. Goon, M. K. Gupta and B. Dasgupta, *An Outline of Statistical Theory* (Vol. II), 3rd Ed. World Press, Kolkata, 2005.
4. S.C. Gupta and V.K. Kapoor, *Fundamentals of Applied Statistics,* 4th Ed., Sultan Chand and Sons, 2008.
5. A. M. Kshirsagar, *A Course in Linear Models,* Marcel Dekker, Inc., N.Y., 1983.

CML-508(i): Number Theory & Trigonometry

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Section-II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, the Möbius inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Section-III

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

Section-IV

Exponential, Logarithmic, Circular functions; sin(nx), cos(nx), tan(nx), $\sin^n x$, $\cos^n x$, $\tan^n x$, hyperbolic and inverse hyperbolic functions - simple problems. Gregory's series, Summation of Trigonometric series, Trigonometric expansions of sine and cosine as infinite products (without proof).

Recommended Books:

1. David M. Burton, Elementary Number Theory (6th Edition), Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Neville Robinns, Beginning Number Theory (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.
3. Trigonometry : P. Duraipandian
4. Plane Trigonometry part 2 : S. L. Loney, (Macmillan and Co. London)

CML-508(ii): Integer Programming and Theory of Games

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Scope and applicability. Formulations. Combinatorial optimization. Relaxations. Linear programs with integer solutions. Integer Programming Problem (IPP): Pure and Mixed IPP, Methods for solving IPP: Branch and Bound Method, implicit enumeration,Gomory's Cutting Plane Method.

Section-II

Applications of IPP, 0-1 Programming: applications, enumeration algorithm. Gomory-Chvátal theory. The mixed integer Gomory cut. The problem of convergence and stalling. Disjunctive programming: optimization over unions of polyhedra.

Section-III

Introduction to Game theory, Fundamental theorem of game theory, min-max and max-min principle, Formulation of two person zero sum rectangular games, Solution of rectangular games with saddle, points.

Section-IV

Dominance principle, rectangular games without saddle point- mixed strategy, games, Bayesian Games, Extensive Form Games with Perfect Information. Graphical, algebraic and linear programming solution of m x n games.

Recommended Books:

1. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, -2010.
2. Frederick Hillier and Gerald Lieberman, Introduction to Operations Research. 9th Edition, McGraw-Hill Professional, 2010.
3. P. R. Thei, G. E. Keough: An introduction to Linear Programming and Game Theory. Wiley, New Jersey, 3rd Ed., 2008.
4. S. Chandra, Jayadeva, AparnaMehra: Numerical Optimization with Application, Narosa Publishing House, 2009

CML-605 (i): Linear Algebra

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Vector spaces, subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vactor space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension.

Section – II

Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vactor spaces, Vactor space of all the linear transformations, Null Space, Range space of a linear transformation, Rank and Nullity Theorem,

Section – III

Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations.

Section – IV

Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt, Orthogonalization process, Adjoint of a linear transformation and its properties, Unitary linear transformations.

Books Recommended:

1. I.N. Herstein,: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2^{nd} edition).
3. VivekSahai and VikasBist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

CML 605(ii): Bio-Mathematics

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Population growth, Administration of drugs, Cell division. Modelling Biological Phenomena: Heart beat, Blood Flow, Nerve Impulse transmission, Chemical Reactions, Predator-prey models. Stability and oscillations: Epidemics, the phase plane, Local Stability, Stability, Limit Cycles, Forced oscillations, Computing trajectories.

Section-II

Mathematics of Heart Physiology: The local model, The Threshold effect, The phase plane analysis and the heart beat model, Physiological considerations of the heart beat model, A model of the cardiac pace-maker. Bifurcation and chaos: Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation, Chaos, Stability, The Poincare plane.

Section-III

Mathematics of imaging of the Brain: Modelling of computerized tomography (CT, Magnetic resonance Imaging (MRI), Discrete analogues and Numerical Implementation. Networks in Biological Sciences: Dynamics of Small world networks, scale-free networks, complex networks, cellular automata.

Section-IV

Modelling Molecular Evolution: Matrix models of base substitutions for DNA sequences, The Jukes-Cantor Model, the Kimura Models, Phylogenetic distances. Constructing Phylogenetic trees: Unweighted pair-group method with arithmetic means (UPGMA), Neighbour- Joining Method, Maximum Likelihood approaches.

Recommended Books:

1. Elizabeth S. Allman and John a. Rhodes, Mathematical Models in Biology, Cambridge University Press, 2004.
2. C. Epstein, The Mathematics of Medical Imaging, Prentice Hall, 2003 (copyright Pearson Education, 2005).
3. S. Helgason, The Radon transform, Second Edition, Birkhauser, 1997.
4. D. S. Jones and B. D. Sleeman, Differential Equations and Mathematical Biology, Cahapman& Hall, CRC Press, London, UK, 2003.
5. James Keener and James Sneyd, Mathematical Physiology, Springer Verlag, 1998, Corrected 2nd printing, 2001.

CML-606(i) Mechanics-II

Theory: 80 **Marks (Total): 100**
Marks (Internal Assessment): 20 **Time: 3 Hrs**

Note:Attempt five questions in all. The question paper will consist of four sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. Each of the four sections **(I-IV)** will contain two questions and the students are required to attempt one question from each section. All questions carry equal marks.

Section - I

Analytical conditions of equilibrium of co-planar forces: Equilibrium of three forces, conditions of equilibrium, trigonometric theorem's, conditions of equilibrium of co-planar forces (First, Second and Third form); Friction: Definition of friction and basic laws, problems based on equilibrium of rods and ladders; Centre of gravity: Basic concepts and definitions, centre of gravity of a uniform rod, a thin uniform lamina in the form of a parallelogram, a thin uniform triangular lamina, three uniform rods forming a triangle, a uniform quadrilateral lamina, lamina in the form of a trapezium, centre of gravity of a body by integration.

Section - II

Motion of a particle attached to an elastic string, Hooke's law, motion of horizontal and vertical elastic strings, Definition of work, Power and Energy, work done by a variable force, work done in stretching an elastic string, principle of work and energy, conservative system of forces, principle of conservation of energy, impulse of a constant force and a variable force.

Section - III

Motion of a particle on smooth curves, motion on the outside and inside of a smooth vertical circle, cycloidal motion, motion on a rough curve under gravity.

Section - IV

Projectile motion of a particle in a plane, velocity at any point of the trajectory, directions of projection for a particle, range and time of flight on an inclined plane, directions of projection for a given velocity and a given range; range and time of fight down an inclined plane.

Books Recommended:

1. S.L. Loney: Statics, Macmillan Company, London.
2. R.S. Verma: A Text Book on Statics, Pothishala Pvt. Ltd., Allahabad
3. S.L. Loney, An Elementary Treatise on the Dynamics of a Particle and a Rigid Bodies, Cambridge University Press, 1956.
4. F. Chorlton, Dynamics, CBS Publishers, New Delhi.
5. A.S. Ramsey, Dynamics Part-1&2, CBS Publisher & Distributors.

CML-606(ii): Queuing and Reliability Theory

Marks (Theory): 80 **Marks(Total) : 100**
Marks (Internal Assessment) : 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

General concepts of queueing system and Introduction to stochastic processes, Measures of performance, Arrival and Service processes, Kendall's notation, Single server and multi server models. channels in parallel with limited and unlimited queues --M/M/1/K, M/M/C.

Section-II

Queues with unlimited service, Finite source queues, Applications of Simple Queuing Decision Models, Design and Control Models.

Reliability concepts – Systems of components. Series and parallel systems – Coherent structures and their representation in terms of paths and cuts, Modular decomposition.

Section-III

Reliability of coherent systems – Reliability of Independent components, association of random variables, bounds on systems reliability and improved bounds on system reliability under modular decomposition.

Section-IV

Life Distribution: Survival function – Notion of aging IFR, DFR, DFRA, NBU and NBUE classes, Exponential distributions and its no-ageing property, ageing properties of other common life distribution, closures under formation of coherent structures, convolutions and mixtures of theses cases. Reliability estimation: Estimation of two and three parameter Gamma, Weibull and log normal distributions.

Recommended Books:

1. D. Gross and C. Harris, Fundamentals of Queueing Theory, 3rd Edition, Wiley, 1998. (WSE Edition, 2004).
2. J. Medhi, Stochastic Models in Queueing Theory, 2nd Edition, Academic Press, 2003. (Elsevier India Edition, 2006).
3. John G. Rau, Optimization and Probability in Systems Engineering, V. N. Reinhold Co. 1970.
4. L. Kleinrock, Queueing Systems, Vol. 1: Theory, Wiley, 1975.
5. Marvin Rausand and ArnljotHoyland, System Reliability Theory: Models, Statistical Methods and Applications, 2" Ed. John Wiley and Sons Inc. 2003.
6. U N Bhatt: An Introduction to Queueing Theory: Modeling and Analysis in Applications (Statistics for Industry and Technology), Birkhauser Boston, 2008.

CML-607 (i): Real and Complex Analysis

Marks (Theory): 80 **Marks (Total): 100**
Marks: Internal Assessment (20) **Time : 3 Hours**

Note:Attempt five questions in all. The question paper will consist of four sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. Each of the four sections **(I-IV)** will contain two questions and the students are required to attempt one question from each section. All questions carry equal marks.

SECTION-I

Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem.

SECTION-II

Baire's category theorem, Contraction Principle, continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass Property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness.

SECTION-III

Improper integrals and their convergence, comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, differentiability and integrability of an integral of a function of a parameter.

SECTION-IV

Topology of complex numbers: Trigonometric, exponential, logarithmic and hyperbolic trigonometric functions. Extended complex plane, Stereographic projection of complex numbers. Continuity and differentiability of complex functions. Analytic functions, Cauchy-Riemann equations, harmonic conjugates, harmonic functions. Construction of analytic functions: direct method and Milne-Thomson method.

Books Recommended

1. T.M.Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi,1985.
2. R.R. Goldberg, Methods of Real Analysis, John Wiley and Sons, Inc., New York, 1976.
3. D. Somasundaram and B. Choudhar: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
4. M.D. Raisinghania, Elements of Real Analysis, S.Chand Publication, 2003.
5. R.G. Bartle and D.R. Shernert: Introduction to Real Analysis, Wiley, 2011.
6. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
7. L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.

CML-607(ii): Optimization Techniques

Marks (Theory): 80 **Marks (Total): 100**

Marks (Internal Assessment): 20 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Dynamic programming: Multistage decision processes, Recursive nature of computations, Forward and Backward recursion, Bellman's principle of optimality, Selective dynamic programming applications involving additive and multiplicative separable returns for objectives as well as constraint functions, Problem of dimensionally.

Goal Programming: Weighted and pre-emptive goal programming, graphical solution.

Section-II

Decision Analysis: Decision making under risk- Decision tree analysis, Posterior (Baye's) probabilities, Decision under uncertainty- criterion of pessimism, criterion of optimism, Laplace criterion, criterion of realism, criterion of regret.

Section-III

General concepts of queueing system, Measures of performance, Arrival and service Processes, Single server and multi server models, channel in parallel with limited and unlimited queues- M/M/1/K, M/M/C. Queues with unlimited service. Finite source queues. Applications of simple queueing decision model's, Design and control models.

Section-IV

Basics of reliability. Classes of life distributions. Series, parallel configuration. Reliability models, Reliability, Mean time before failure and Hazard rate of Exponential and Weibull distributions. Concepts and definitions of preventive maintenance, corrective maintenance and age replacement.

Books Recommended

1. R.B. Cooper, *Introduction to Queueing Theory, 2nd*Ed., North Holland, 1981.
2. D. Gross, C.M. Harris, *Fundamentals of Queueing Theory,* 3rd Ed., John Wiley and Sons Inc. P. Ltd., 2002.
3. U.N. Prabhu, *Foundations of Queueing Theory,* International Series in Operations & Management Science, Kluwer Academic Publishers, 2nd Ed., 2002.
4. John G. Rau, *Optimization and Probability in Systems Engineering,* V.N. Reinhold Co., 1970.
5. Riccardo Manzini, Alberto Regattieri, Hoang Pham, Emilio Ferrai, *Maintenance for Industrial Systems,* Springer-Verlag, London Limited, 2010.
6. P.K. Kapur, R.B. Garg, S. Kumar, *contributions to Hardware and Software Reliability,* World Scientific, Singapore, 1999.

CMS-608(i): Solid Geometry

Marks (Theory): 50 **Marks(Total) : 100**
Marks (Internal Assessment) : 50 **Time : 2 Hrs**

Note: *The examiner is requested to set five questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of five short answer type questions each of two marks). The candidate is required to attempt three questions in all selecting one from each UNIT and the compulsory Question No.1. All questions carry equal marks.*

UNIT-I

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.

UNIT-II

Paraboloids: Circular section, Plane sections of conicoids. Generating lines. Confocal conicoid. Reduction of second degree equations.

Books Recommended:

1. R.J.T. Bill, Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd. 1994.
2. P.K. Jain and Khalil Ahmad: A Textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd. 1999.

CMS-608(ii)

Skill Enhancement Course

Financial Mathematics

Credits: 02; 30 Hrs (2Hrs /week)

Marks (Theory): 50 **Marks (Total) : 100**
Marks (Internal Assessment) : 50 **Time : 2 Hrs**

Note: *The examiner is requested to set five questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus will consist of five short answer type questions each of two marks). The candidate is required to attempt three questions in all selecting one from each UNIT and the compulsory Question No.1.*

UNIT-I

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR.

UNIT-II

Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

Recommended Books:

1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, Futures and Other Derivatives (6th Edition), PrenticeHall India, Indian reprint, 2006.
3. Sheldon Ross, An Elementary Introduction to Mathematical Finance (2nd Edition), Cambridge University Press, USA, 2003