SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A' Grade

Revised Syllabus For

B. Sc.-M. Sc. Nanoscience and Technology

(5 years integrated) Program Part-II

CBCS PATTERN

Syllabus to be implemented from

June, 2019 onwards.

SHIVAJI UNIVERSITY, KOLHAPUR
School of Nanoscience and Technology
B. Sc. –M.Sc. Nanoscience and Technology Program
Part – II, Semester- III

DSC- 7C-Phys.: THERMAL PHYSICS AND STATISTICAL MECHANICS.

(Theory: 60 Lectures)

Unit-I

Laws of Thermodynamics: (22 Lectures)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit -II

Thermodynamic Potentials: (10 Lectures)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (C_P – C_V), C_P/C_V, TdS equations.

Unit-III

Kinetic Theory of Gases: (10 Lectures)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit-IV

1. Theory of Radiation: (6 Lectures)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

2. Statistical Mechanics: (12 Lectures)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
4. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill 13
5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.
8. Heat and Thermodynamics- Brijlal and N.Subramanyam, S.Chand and company LTD
9. Text book of heat- J.B. Rajam ,S.Chand and company Ltd
10. Heat and Thermodynamics (8^{th} Ed)-M.W. Zemansky and R.Dittman, McGraw Hill
11. Heat Thermodynamics and Statistical physics- J.P. Agrawal and Satya Prakash, Pragati Prakashan
12. Physics for Degree Students, B.Sc. Second Year Students by C.L. Arora, Dr P S Hemne, S. Chand Publications
13. Hornyak, G.L., Tibbals, H.F., Dutta, J. and Moore, J.J., 2008. Introduction to Nanoscience and Nanotechnology. CRC press.

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Part – II, Semester- III

DSC- 7C-Phys.-LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

(Theory: 60 Lectures)

1. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
4. To study the variation of thermo e.m.f. across two junctions of a thermocouple with temperature.
5. To record and analyze the cooling temperature of hot object as a function of time using a thermocouple.
6. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge
7. To determine the temperature coefficient of resistance using post office box.
8. To verify Stefan's fourth power law.
9. To determine specific heat of graphite.
10. To determine the ratio of specific heat of air by Kundt's tube.
11. Temperature of flame
12. To determine the coefficient of thermal conductivity of glass in the form of tube.
13. To determine the thermal conductivity of metal bar by Forbes's method.
14. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

Note: (Any 10 from the list as per available setup)

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition,2011, Kitab Mahal, New Delhi.
4. B.Sc. Practical Physics, C.L.Arora, S.Chand & Company Pvt.Ltd., New Delhi

5. B.Sc.Practical Physics (For B.Sc Students of All Indian Universities) by Harnam Singh, Dr P S Hemne, S Chand Publication.

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DSC- 8C-Chem.: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II
(Theory: 60 Lectures)

Unit I: **(16 Lectures)**

Solutions and Phase Equilibrium:

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only.

Introduction to nanothermodynamics.

Unit II: **(14 Lectures)**

Conductance and Electrochemistry:

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Introduction to conductivity measurement of nanomaterials in solution, Zeta Potential (definition and examples only)

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only). Electrochemical synthesis, deposition of nanomaterials, examples only. Working principles of battries and supercapacitor and examples of nanomaterials.

Unit III:

Carboxylic acids and Amines: (12 Lectures)

Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction. Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts. Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.

Use of carboxylic and amines containing organic compounds for nanoparticle synthesis and stabilization. (examples with schemes only)

Unit IV: **(18 Lectures)**

Amino Acids, Peptides, Proteins and carbohydrates:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Concept of biomolecules as self-assembled nanomaterials. Introduction to biologically capped nanomaterials for used in SERS (Surface Enhanced Raman Spectroscopy), examples only.

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
11. Hornyak, G.L., Tibbals, H.F., Dutta, J. and Moore, J.J., 2008. Introduction to Nanoscience and Nanotechnology. CRC press.

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DSC- 8C-Chem.-LAB: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

(Practical: 60 Lectures)

Section A: Inorganic chemistry

(A) Iodo / Iodimetric Titrations:

(i) Estimation of Cu(II) and K_2Cr_2O7 using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$

(ii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

(iii) Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$.

(iv) Potassium tris(oxalate)ferrate(III)

Section B: Organic chemistry

(i) Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.

S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

Organic preparations:

i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidines
   a. and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:

ii) Nitration of any one of the following:
   a. Acetanilide/nitrobenzene by conventional method
   b. Salicylic acid by green approach (using ceric ammonium nitrate).

iii) Hydrolysis of amides and esters:

Section C: Physical Chemistry

Chemical Kinetics

1 Distribution of acetic/ benzoic acid between water and cyclohexane.

2 Study the kinetics of the following reactions.

3 Integrated rate methods:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

4 Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

Adsorption

5. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal

Reference Books:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012).
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
5. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
6. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
7. Hornyak, G.L., Tibbals, H.F., Dutta, J. and Moore, J.J., 2008. Introduction to Nanoscience and Nanotechnology. CRC press.

SHIVAJI UNIVERSITY, KOLHAPUR
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Part – II, Semester- III

DSC- 9C-Biotech.: GENERAL MICROBIOLOGY, BIOCHEMISTRY AND NANOBIOTECHNOLOGY

Theory: 60 Lectures

UNIT I **(15 Lectures)**

Understanding Microbiology

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Microbial world **(15 Lectures)**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth, Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

UNIT III **(15 Lectures)**

Study of Biomolecules:

Carbohydrates: Monosaccharides, Disaccharides, Polysaccharides, Classification. Introduction to: Structural Polysaccharides, Storage Polysaccharides, Complex Polysaccharides

Lipids: Lipid Classification, Fatty Acids, Triacylglycerols, Glycerophospholipids, Sphingolipids Cholesterol. Storage Lipids, Lipids as Signals, Cofactors, and Pigments.

Nucleic acids: Deoxyribose nucleic acid (DNA) Ribonucleic acid (RNA) Components of Nucleic acids, Nucleotides, Purines and Pyrimidines, Structure and types of nucleic acids

Proteins: Overview of amino acids and protein, Peptide bond, Primary, Secondary, Tertiary and Quaternary Structures. Fibrous protein, globular proteins. Protein Stability, Protein folding and denaturation.

Enzymes: Classification, Overview of structure, function and mechanism of actions of enzymes

Vitamins and Minerals: Importance and role of vitamins, Types of vitamins, water soluble and fat soluble vitamins. Minerals, micro nutrients, macronutrients, roles and functions, disorders of mineral deficiency.

UNIT IV **(15 Lectures)**

Role of Microbes in Nanotechnology

Microbial synthesis of nanomaterials- Concepts and introduction

Bacteria mediated nanomaterials synthesis - Methodology, Mechanism and applications, Fungi mediated nanomaterials synthesis - Methodology, Mechanism and applications, Yeast mediated nanomaterials synthesis - Methodology, Mechanism and applications,

Advantages of microbial/biogenic nanomaterials synthesis methods

Antimicrobial activity of nanomaterials- concept of MIC, MBC, possible mechanisms of the antimicrobial activities, Isolation and enrichment of metal tolerant microorganisms

SUGGESTED READING FOR CELL BIOLOGY

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by Lubert Stryer, 4th Edition
3. General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong
4. Practical Biochemistry: An Introductory Course by Fiona Frais.
5. Textbook of Practical Biochemistry by David Plummer.
6. Laboratory Mannual in Biochemistry by S. Jayaraman.

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DSC-9C-Biotech.-LAB: GENERAL MICROBIOLOGY, BIOCHEMISTRY AND NANOBIOTECHNOLOGY

(Theory: 60 Lectures)

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins.
9. Principles of Colorimetry:
   (i) Verification of Beer's law, estimation of protein.
   (ii) To study relation between absorbance and % transmission.
10. Determination of total amino acid concentration by ninhydrin method.
11. Estimation of protein concentration by i) Biuret method ii) Lowry method
12. Estimation of reducing sugar concentration by DNSA method
13. Estimation total sugar concentration by i) Phenol-H2SO4 method ii) Anthrone method
14. Enrichment and isolation of metal tolerance microorganisms
15. Test of microbial metal tolerance
16. Demonstration of microbial synthesis of metal nanomaterials.

SUGGESTED READING FOR BIOTECHNOLOGY LAB 9C

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by Lubert Stryer, 4th Edition
3. General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong
4. Practical Biochemistry: An Introductory Course by Fiona Frais.
5. Textbook of Practical Biochemistry by David Plummer.
6. Laboratory Mannual in Biochemistry by S. Jayaraman.

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Part – II, Semester- III

DSC-10C-Stats.: Statistical Methods for Physical Sciences I

Theory: 60 Lectures

Unit- I: Nature and Graphical Representation of Data (15 Lectures)

Meaning and scope of statistics in industry and physical sciences. Population and sample, census method, sampling method. Primary and secondary data, ungrouped and grouped data, qualitative data (attributes) and quantitative data (variables). Scales of measurement - nominal, ordinal, interval and ratio scale. Frequency distribution, Histogram, frequency curve, ogive curve, Boxplot.

Unit- II: **Measures of Central Tendency (15 Lectures)**

Concept of central tendency, criteria for good measures of central tendency. Arithmetic mean (A.M.), A.M., Mean of pooled data, Weighted A.M. Geometric mean (G.M.), Harmonic mean (H.M.), median, mode and their properties. Computations of A.M., G.M., H.M., median and mode for ungrouped and grouped data. Comparison between averages in accordance with requirements of good average.

Unit- III: Measures of Dispersion (15 Lectures)

Concept of dispersion, requirements of a good measure of dispersion, measures of dispersion, absolute and relative measures of dispersion. Range, mean deviation, standard deviation and their relative measures. Variance, coefficient of variation and its use. Concepts and measures of skewness and kurtosis.

Unit – IV: Correlation and Regression (15 Lectures)

Correlation and regression (for ungrouped data): Bivariate data, concept of correlation, scatter diagram, Karl Pearson's coefficient of correlation, Spearman's Rank Correlation

coefficient. Regression: concept, lines of regression, least square method, regression coefficients, relation between correlation and regression coefficients.

Concept of multiple linear regression, Plane of regression, Yule's notation, fitting of regression plane by method of least squares. Definition of partial regression coefficients and their interpretation. Residual: definition, order, properties. Concept of multiple and partial correlation. Definition, derivation and properties of multiple and partial correlation coefficients.

Reference:

1. Bhat B. R., Srivenkatramana T. and Madhava Rao K. S. (1996): Statistics: A Beginner's Text, Vol. 1, New Age International (P) Ltd.
2. Goon A.M., Gupta M.K., and Dasgupta B.: Fundamentals of Statistics Vol. I and II, World Press, Calcutta.
3. Hogg R. V. and Crag R. G.: Introduction to Mathematical Statistics Ed.4.
4. Hoel P. G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
5. Mood A. m., Graybill F. A. and Boes D. C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Rohatgi V. K. and Saleh A. K. Md. E. (2002): An Introduction to probability and statistics. John wiley & Sons (Asia)
7. Snedecor G.W. and Cochran W. G. (1967): Statistical Methods, Lowa State University Press.
8. Waiker and Lev.: Elementary Statistical Methods.
9. Gupta S. C. and Kapoor V. K.: Fundamentals of Mathematical Statistics.
10. Martin B. R. (2012): Statistics for Physical Sciences-An Introduction
11. Stanford J. L. and Vardeman S. B. (1994): Statistical Methods for Physical Science (Volume 28)

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Part – II, Semester- III

DSC-11C- Elect.: Electronic Instrumentation

(Theory: 60 Lectures)

Unit I: **(12 Lectures)**

Principle of Measurements

Measurement and error: Static and dynamic characteristics of an instrument, error in the measurements and types of static error, dynamic response of an instrument, significant figure and rounding off the numbers, statistical analysis.

System of units of measurement: fundamental and derived units, international system of units, other system of units.

Standard of measurements: classification of standard, standard for mass, length and volume, electrical standard, international standards.

Unit II: **(18 Lectures)**

Sensors and Actuators

Classification of transducer, selecting of transducer, Electrical Transducers and their parameters; Types of Transducers: Electro acoustic transducers (microphone and speaker), Force/Pressure transducers (resistance pressure transducer, strain gauge, and load cell), Temperature Transducers (Thermistor, Thermocouple and RTD), Fiber Optical sensors, Smart sensors, signal conditioner: Introduction to Instrumentation Amplifier and active filters..

Unit III: **(18 Lectures)**

Measurement techniques

Impendence measurement: Introduction, resistance measurement- Voltmeter-Ammeter method and Whetstone Bridge method, measurement of low resistance: Kelvin's bridge method, Inductance measurement: Maxwell's bridge, capacitance measurement: Schering bridge, frequency measurement: Wien bridge, Q-meter, complex impendence measurement meters and digital LCR Q-meter.

Voltage and Current measurement: Introduction, basic DC ammeter, basic DC voltmeter.

Unit IV: **(12 Lectures)**

Data Converter and Data Acquisition System

Data converter: D/A converter: Weighted resistor network and R-2R network, A/D Converter: A/D Converter circuit: parallel comparator, successive approximation, and dual slope ADC.

Data Acquisition System: Block diagram of DAS, objective of DAS, single channel and multi channel Data Acquisition System, computer based data acquisition system and data loggers.

Suggested Books:

1. H. S. Kalsi, Electronic Instrumentaion, TMH(2006)
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice- Hall (2005).
3. Instrumentation Measurement and analysis: Nakra B C, Chaudry K, TMH
4. E.O.Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
5. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education (2005)
6. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall (2013).
7. Oliver and Cage, “Electronic Measurements and Instrumentation”, TMH (2009).
8. Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Buterworth Heinmann- 2008).
9. A. K Sawhney, Electrical and Electronics Measurements and Instrumentation, DhanpatRai and Sons (2007).
10. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).

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Part – II, Semester- III

DSC-10C- & DSC-11C-Lab.: Statistics and Electronic Instrumentation

(60 Lectures)

Statistics Lab (any 5 experiments)

1. Graphical presentation of the frequency distribution
2. Measures of central tendency
3. Measures of dispersion
4. Measures of skewness & kurtosis
5. Correlation and regression
6. Multiple Regression
7. Partial and multiple correlation

Instrumentation Lab (any 5 experiments)

1. Study of Uncertainty & Errors
2. Study of Load Cell
3. Study of LVDT
4. Study of Thermistors
5. Study of LDR
6. Study of Photodiode
7. Study of Phototransistor
8. Study of Analog to Digital Converter
9. Study of Digital to Analog Converter
10. Study of Fiber optic sensor

SHIVAJI UNIVERSITY, KOLHAPUR
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Part – II, Semester- IV

DSC-7D-Phys.: WAVES AND OPTICS

(Theory: 60 Lectures)

Unit-I

1. Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(4 Lectures)**

2. Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(2 Lectures)**

3. Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity**.** **(7 Lectures)**

Unit-II

1. Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage, Introduction to superfluidity **(6 Lectures)**

2. Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

(6 Lectures)

Unit III

1. Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(3 Lectures)**

2. Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. **(10 Lectures**)

3. Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes. **(3 Lectures)**

Unit IV

1. Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(14 Lectures)**

2. Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

Reference Books:

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
4. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison-Wesley
5. Text book of optics for B.Sc.Classes- BrijLal and N.Subrahmanyam, S.Chand & Company Ltd. New Delhi, 2006
6. Wave Optics- R. K. Verma, Discovery Publishing House New Delhi, 2006
7. A text book of light- 8th Edition,D. N. Vasudeva, Atma Ram & Sons, Delhi (1976)

8. Optics- 2nd Edition, Ajay Ghatak, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi,
9. Principles of Physics-10th Edition, Halliday and Resnick, Wiley University Physics-14th Edition, H.D. Young and R. A. Freedman, Pearson
10. Hornyak, G.L., Tibbals, H.F., Dutta, J. and Moore, J.J., 2008. Introduction to Nanoscience and Nanotechnology. CRC press.

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Part – II, Semester- IV

DSC-7D-Phys.-LAB.: WAVES AND OPTICS

Practical: 60 Lectures

1. To investigate the motion of coupled oscillators.
2. To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify λ^2– T Law.
3. To study Lissajous figures by using CRO.
4. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method).
5. To determine velocity of sound in air by Kundt's tube and audio oscillatoror Phase shift method (CRO and microphone).
6. To determine viscosity of liquid by Searle's viscometer.
7. To determine velocity of sound in air by resonating bottle.
8. To determine frequency of a crystal oscillator.
9. To determine the Resolving Power of a Prism.
10. To determine the Resolving Power of a Plane Diffraction Grating.
11. To determine wavelength of sodium light using diffraction due to straight edge.
12. To determine wavelength of sodium light using Newton's Rings.
13. Determine thickness of thin film using interference in wedge shaped thin film.
14. Goniometer I-To study cardinal points of optical system.
15. Goniometer II- To study the equivalent focal length of optical system.
16. To study angle of specific rotation of sugar using Polarimeter.

Note: (Any 10 from the list as per available setup)

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition,2011, Kitab Mahal, New Delhi.
4. B.Sc. Practical Physics, C.L.Arora, S.Chand & Company Pvt.Ltd., New Delhi
5. Practical Physics – Gupta and Kumar (Pragati Prakation Meerat)
6. Advanced Level Practical Physics – J.M. Nelcon, J.M. Ogloom (EIBS).
7. A Text Book of Practical Physics - Shrinivasan and Balasubramanyam.
8. Engineering Practical Physics- S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.

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Part – II, Semester- IV

DSC-8D-Chem.: TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

Theory: 60 Lectures

Unit I **(30 Lectures)**

Transition Elements, Coordination Chemistry and Crystal Field Theory:

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, and ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only)

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Important oxide nanomaterials of transition metal ions: Ti, Zn, V, Mn, Fe,

Unit II

Kinetic Theory of Gases: **(08 Lectures)**

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation.

Andrews isotherms of CO2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).
Importance of collision theory in nanocatalysis (examples only).

Unit III

Liquids and Solids: (14 Lectures)

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).
Definition of Ostwald ripening, Relationship between surface tension and spherical nature of liquids.

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Aromatic hydrocarbons (8 Lectures)

Preparation(Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid.
Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation andsulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides (8 Lectures)

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni)reactions.
*Preparation:*from alkenesandalcohols.

*Reactions:*hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson'sether synthesis: Elimination vs substitution.

Aryl Halides

Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer& Gattermann reactions.

Reactions (Chlorobenzene):Aromatic nucleophilic substitution (replacement by –OH group)and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3(or $NaNH_2/NH_3$).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and arylhalides.

Unit IV

Chemical Kinetics: **(08 Lectures)**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.
7. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
8. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
9. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008
10. Hornyak, G.L., Tibbals, H.F., Dutta, J. and Moore, J.J., 2008. Introduction to Nanoscience and Nanotechnology. CRC press.

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Part – II, Semester- IV

DSC-8D-Chem.-LAB: TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

(Practical: 60 Lectures)

Section A: Analytical chemistry

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).

ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$

ii. Cis and trans $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)

iii. Tetraamminecarbonatocobalt (III) ion

iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)

ii. Fe (III) and Al (III)

Section B: Organic chemistry

1. Detection of extra elements.

2. Functional group test for nitro, amine and amide groups.

3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Section C: Physical Chemistry

Conductometry:

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Mixture of strong acid and weak acid vs. strong base

iv. Strong acid vs. weak base

Potentiometry:

I Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Dibasic acid vs. strong base

iv. Potassium dichromate vs. Mohr's salt

Reference Books

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

6. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

7. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

8. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

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B. Sc. –M.Sc. Nanoscience and Technology Program
Part – II, Semester- IV

DSC-9D-Biotech.: IMMUNOLOGY AND MEDICAL NANOTECHNOLOGY
(Theory: 60 Lectures)

UNIT I **(15 Lectures)**

Immunology:

Introduction, History, Phylogeny, Overview of immune system, innate and adaptive immunity, cells and organs of immune system, haematopoiesis, cells of the immune system, organs of the immune system, systematic evolution of immune system.

Antigen: Introduction to the concept of immunogenicity, antigenicity, factors influencing immunogenicity, epitopes, haptens, pattern recognition receptors.

Antibody: Basic structure of antibody, antibody classes and biological activities, antigenic determinants and immunoglobulins

UNIT II **(15 Lectures)**

Concepts of immunology:

T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, B cell receptors, monoclonal antibodies, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

UNIT III **(15 Lectures)**

Nanodiagnostics

Nanotechnology in molecular imaging. Materials for use in diagnostic and therapeutic applications. Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging. Nanoparticles and quantum dots as molecular labels. Diagnostic Nanochips, lab on chips (microfluidic technology) and microelectromechanical systems (MEMS). Biosensor and nanobiosensor basic concepts, characterization, perception, Defferent types of nanobiosensors; Nanobiosensors for medical diagnostics. Nanoprobes for analytical applications.

UNIT IV **(15 Lectures)**

Nanomedicine

Applications of nano in biology. Concept of disease, Cause and molecular/cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approach to developing nanomedicines. Various kinds of nanosystems in use. Nanodrug administration nano-devices for drug delivery and theranostics. Introduction to the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nanobiomachines and nanorobots.

SUGGESTED READING FOR MAMMALIAN PHYSIOLOGY

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
1. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
2. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
5. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

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Part – II, Semester- IV

DSC-9D-Biotech.-LAB: IMMUNOLOGY AND MEDICAL NANOTECHNOLOGY

Practical: 60 Lectures

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Double diffusion.
5. Immunodiffusion.
6. Radial Immunodiffusion.
7. Rocket Immunodiffusion
8. Immunofluorescence
9. Haemagglutination assay
10. Haemagglutination inhibition assay
11. Separation of serum from blood
12. Double immunodiffusion test using specific antibody and antigen
13. ELISA
14. Dot Elisa
15. Preparation of nanoformulation and its evaluation.
16. Demonstration of design of nanodiagnostics device

SUGGESTED READING FOR BIOTECHNOLOGY LAB 9D

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

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B. Sc. –M.Sc. Nanoscience and Technology Program
Part – II, Semester- IV
DSC-10D Stats.: Statistical Methods for Physical Sciences –II

(Theory: 60 Lectures)

Unit I: **Probability** **(15 Lectures)**

Concept of experiment with random outcome, sample space, finite and countably infinite sample space, discrete sample space, events, types of events, power set. Classical (apriori) definition of probability of an event, Axiomatic definition of probability.

Theorems on probability: i) $P(\Phi) = 0$, ii) $P(A^c) = 1 - P(A)$, iii) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$, iv) If A is subset of B then $P(A) \leq P(B)$, v) $0 \leq P(A \cap B) \leq P(A) \leq P(A \cup B) \leq P(A) + P(B)$ simple examples. Conditional probability and independence of events: Independence of two events, properties and examples. Definition of conditional probability, Bayes theorem and applications.

Unit II: Probability Distributions **(15 Lectures)**

Univariate probability distributions: Discrete random variable, probability mass function (p.m.f.), cumulative distribution function (c.d.f.), properties of c.d.f., and examples. Definition of expectation of random variable, properties of expectation, expectation of function of random variable, definition of mean and variance of univariate distribution. Definitions of Discrete uniform distribution, Bernoulli distribution, Binomial distribution Poisson distribution, Exponential distribution and Normal distribution. Mean and variance of these distributions, Important properties of these distributions. Applications of these distributions.

Unit III: Sampling from Finite Population **(15 Lectures)**

Concept of sampling for finite population: SRS, SRSWR, SRSWOR, Stratified, systematic Sampling, Sampling error, Definitions of Chi-square distribution, Students t distribution, F – distribution, Mean and variance of these distributions, Important properties of these distributions. Applications of these distributions, examples.

Unit IV: Testing of Hypothesis **(15 Lectures)**

Notion of random sample from probability distributions, statistic, sampling distribution of statistic. Critical region, idea of one & two tailed test, type I and II errors, level of significance, p – value. Statement of Central Limit Theorem (CLT), Large sample tests for mean and proportion, Small sample tests, Small sample tests for mean and significance of correlation coefficient. Chi-square test for variance, Goodness of fit tests. Numerical Examples.

References:

1. Rohatgi V.K., Saleh A. K. and Md. Ehsan: An Introduction to probability and Statistics.
2. Kale B. K.: A first course on parametric inference.
3. Cochran W. G.: Sampling techniques.
4. Murthy M. N.: Sampling Theory and Methods.
5. Gupta S. C. and Kapoor V. K.: Fundamentals of Mathematical Statistics.
6. Edward P. J., Ford J. S. and Lin (1974): Probability for Statistical Decision Making, Prentice Hall.
7. Meyer P. L. (1970): Introductory Probability and Statistical Applications, Addision Wesley.
8. Martin B. R. (2012): Statistics for Physical Sciences-An Introduction
9. Stanford J. L. and Vardeman S. B. (1994): Statistical Methods for Physical Science (Volume 28)

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Part – II, Semester- IV

DSC-11D- Elect.: Analytical Instrumentation

(Theory: 60 Lectures)

Unit I: **(18 Lectures)**

Ultraviolet and Visible Spectroscopy

Introduction, nature of electromagnetic radiation, electromagnetic spectrum, brief review of atomic and molecular theory.

Ultraviolet and Visible Spectrophotometry: Instrumentation, radiation sources, detectors, readout module, filters, monochromators and performance, grating system for single beam and double beam UV/Vis spectrophotometry.

Unit II: **(12 Lectures)**

Fluorescence, Phosphorescence Spectroscopy

Fluorescence Spectrophotometry: Introduction, Theory of Fluorescence, instrumentation for fluorescence measurement: Sources, Monochromator and Detectors.

Phosphorescence Spectrophotometry: Introduction, Theory of Phosphorescence, instrumentation for Phosphorescence measurement: Sources, Monochromator and Detectors.

Unit III: **(18 Lectures)**

Infrared, Raman, and X-Ray Diffraction

Infrared Spectrophotometry: Introduction, Theory of IR spectroscopy, Instrumentation, radiation sources, detectors, readout module.

Raman Spectroscopy: Introduction, Theory of Raman spectroscopy, Instrumentation, radiation sources, detectors, readout module.

X-Ray Diffraction (XRD): Introduction, Theory of XRD, Production of X-rays and X-ray spectra, instrumental units, detectors for measurement of X-ray radiation.

Unit IV: **(12 Lectures)**

Atomic Absorption and Flame Emission Spectroscopy and Microscopy

Atomic Absorption Spectrometry (AAS): Introduction, Theory of AAS, Instrumentation for Atomic Absorption Spectrometry, Nebulizer and atomizer.

Atomic Emission Spectroscopy (AES): Introduction, Theory of AES, Instrumentation, spectroscopic sources, atomic emission spectrometer.

Microscopy's: Introduction of Scanning Electron Microscopy (SEM), and Atomic Force Microscopy (AFM).

Suggested Books:

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York
2. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers.
3. D.C. Harris, Quantitate Chemical Analysis, W.H.Freeman
4. Christian G.D, Analytical Chemistry, John & Sons, Singapore
5. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York
6. Vogel's Textbook of Qualitative Chemical Analysis, ELBS
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
8. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication

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Part – II, Semester- IV

DSC-10D- & DSC-11D-Lab.: Statistics and Analytical Instrumentation Lab

(60 Lectures)

Statistics Lab

1. Applications of binomial and Poisson distribution
2. Applications of exponential and normal distribution
3. Sampling from finite population
4. Large sample tests
5. Small sample tests

Analytical Instrumentation Lab (any 5 experiments)

1. Data interpretation and plotting
2. Studies on UV-Visible spectrophotometer
3. Studies on X-Ray Diffractions
4. FT-IR spectra interpretation
5. FT-RAMAN spectra interpretation
6. Fluorescence spectra interpretation
7. Phosphorescence spectra interpretation
8. Scanning Electron Microscope image interpretation
9. Atomic Force Microscope image interpretation
10. Analysis of atomic absorption spectra