Tribhuvan University
Institute of Science and Technology
Four Year B. Sc. Chemistry Course of Study
(Revised–2073)

Course Title: General Chemistry I **Full Marks**: 100
Course No.: CHE 301 (major) **Pass Marks**: 35
Nature of the Course: Theory **Year**: III

Course Objectives:

- To explain everyday applications and uses of chemistry.
- To promote studies in the acquisition of knowledge and understanding of chemical patterns and principles.
- To present chemical ideas in a clear and logical form.
- To explain properties, structure and bonding of inorganic compounds.
- To evaluate the environmental & technological implications of chemistry.
- To explain organic reaction mechanisms & basic heterocyclic chemistry.
- To explain the theories & applications of ionic electrochemistry.
- To introduce basic knowledge on principles & applications of spectroscopic techniques.
- To introduce polymer chemistry
- To provide knowledge of third law of thermodynamic and thermodynamic parameters.
- To provide mechanistic approaches of organic reactions.

Group A: Inorganic Chemistry

Hydrogen: Isotopes of hydrogen, general study of hydrides and their classification. **4 hrs**
Nobles gases and their compounds: Preparation, properties and structure of xenon fluorides and oxo-compounds (Valence bond treatment, VSEPR treatment, molecular orbital treatment for XeF_2). **6 hrs**
Detailed study of preparation, properties, bonding and structure of the followings: Boric acid, borates, boron nitride, borazines, boron hydrides, metal borohydrides, silicates, silicones, silanes, and siloxanes, interhalogen compounds, pseudohalogens, pseudohalides. **13 hrs**
Electronegativity: Review lecture, electronegativity equalization, recent advances in electronegativity theory, variation of electronegativity, choice of electronegativity system, group electronegativity.
Electron affinity and ionization energy: Anomalous ionization energies and electron affinities, alternation of electronegativites in the heavier elements. **11 hrs**
Chemical fertilizers: Nitrogen fixation and synthetic fertilizers, importance of chemical fertilizers, nitrogen cycle, main ingredients of plant fertilizers, major and minor nutrients, Haber Bosch process for the manufacture of NH_3, nitrogenase, model system for systems absorbing dinitrogen and production of NH_3, cyanamide process, manufacture of urea, phosphate fertilizers, environmental impact of chemical fertilizers. **6 hrs**
Environmental pollution: An elementary study of environmental pollution in air, water and soil.
Air pollution system: Sources, emission, anthropogenic emissions, (gases and particulate matter), acid rain, smog, depletion of ozone layer.
Water pollution: Dissolved oxygen, total alkalinity, biochemical oxygen demand and chemical oxygen demand, eutrophication, classification of water pollutants, control of water pollution.

Soil pollution: Introduction, source of soil pollution, acid rain, repeated use of same fertilizers, inadequate drainage system in agriculture field, application of pesticides and radioactive wastes. **10 hrs**

Group B: Organic Chemistry

Organic reactions and methods for determining mechanism: Types of mechanism, types of reaction, thermodynamic and kinetic requirements for reaction, the Baldwin‟s rules of ring closure, kinetic and thermodynamic control, the Hammond postulate, microscopic reversibility, methods of determining mechanism, identification of products, determination of the presence of an intermediate, study of catalysis, isotope labeling, stereochemical evidence, rate expression for first and second order reaction, isotope effect. **10 hrs**

Reactive Intermediates: Stability, structure, generation and fate of carbocation, carbanion, carbene, nitrene and benzyne, nonclassical carbonium ion, neighboring group participation by π and σ bonds. **10 hrs**

Free radicals: History, characteristics of free radicals (formation, propagation, termination, reactivity, stereochemistry), reactions (fragmentation, substitution, addition, oxidation, reduction), detection of free radicals. **7 hrs**

Spectroscopy and Structure Determination: Introduction of the electromagnetic spectrum, infrared spectrum, ultraviolet spectrum, nuclear magnetic resonance (NMR) spectrum: $_1$H-NMR spectrum, number of signals, equivalent and non-equivalent protons, chemical shift, peak area and proton coupling, spin-spin coupling, coupling constant, $_{13}$C-NMR spectroscopy: $_{13}$C-NMR chemical shift, $_1$H-NMR and $_{13}$C-NMR spectra of hydrocarbons, alcohols, aldehydes, ketones carboxylic acid, amines, phenol, ether and aromatic compounds (simple molecules only) & mass spectrum. **18 hrs**

Heterocyclic systems: Structure of pyrrole, furan and thiophene, source of pyrrole, furan and thiophene, electrophilic substitutions in pyrrole, furan and thiophene (reactivity and orientation), saturated five member hetero cycles, structure of pyridine, source of pyridine compounds, reactions of pyridine, electrophilic substitution in pyridine, nucleophilic substitution in pyridine, basicity of pyridine, reduction of pyridine. **5 hrs**

Group C: Physical Chemistry

Electrochemistry:

Electrolytic conductance: Failure of Arrhenius theory in case of strong electrolytes, Debye-Hückel theory of interionic attraction for electrolytic conduction (elementary treatment only), activity and activity coefficients, ionic strength, Debye-Hückel limiting law (elementary treatment only).

Electrochemical cells: Reversible and irreversible cells, types of reversible electrodes, thermodynamics of reversible electrode and cell, thermodynamic quantities of cell reaction from emf ($\triangle$G, $\triangle$H, $\triangle$S and K_{eq}), chemical cells with and without transference, concentration cells with and without transference, liquid junction potential, applications of emf measurement: determination of activities & activity coefficients, formal & standard electrode potentials, solubility products. **15 hrs**

Spectroscopy:

Introduction: Electromagnetic radiation, atomic and molecular spectra, origin of molecular spectra, classification of molecular spectra.

Rotational spectrum: Microwave spectrum, concepts of rigid & non-rigid rotors, energy levels of rigid rotor, selection rules, application of rotational spectra.

Vibrational spectrum: Infrared spectrum, energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, effect of anharmonic motion, idea of vibrational frequency of different functional groups.
Raman spectrum: Concept of polarizibility, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.
Electronic spectrum: Introduction, Franck-Condon principle, selection rules, application of electronic spectroscopy. **10 hrs**

Polymer Chemistry:
Introduction and classification of polymers and copolymers, properties of polymers (crystalline, amorphous, thermoplastic, thermosetting), addition and condensation polymerization, degree of polymerization, average molecular weight of polymers, determination of average molecular weight of polymers by osmometry, light scattering and viscosity measurement methods, solution of macromolecules. **7 hrs**

Thermodynamics:
Entropy, entropy change in isolated system, dependence of entropy on temperature, volume and pressure, entropy change in ideal gas, entropy of mixing, entropy change in physical and chemical transformation, third law of thermodynamics and its significance, free energy change for a reaction, Gibbs free energy change, properties of Gibbs free energy: variation with temperature (Gibbs-Helmholtz equation) and pressure, calculation of free energy change, reaction isotherm, thermodynamic criterion of equilibrium, Clapeyron equation, Clausius-Clapeyron equation, thermodynamics equilibrium constant, K_p & K_c for gaseous reactions, variation of K_p and K_c with temperature, thermodynamics of Le-Chatelier's principle (quantitative treatment), related numericals. **18 hrs**

Course Title: General Practical Chemistry I **Full Mark**: 50
Course No.: CHE 302 (major) **Pass Mark**: 20
Nature of the Course: Practical **Year**: III

Course Objectives:
- To handle and manipulate chemical apparatus and material safely.
- To make accurate observation and measurements, being aware of possible sources of error.
- To plan and organize simple experimental investigations to test hypotheses.
- To perform numerical calculations in which guidance on the methods of solution is provided.

Experiments on Inorganic Chemistry
Qualitative analysis of salt mixture containing not more than 6 ionic species (excluding salts insoluble in acids) out of the following: Pb^{++}, Hg^{++}, Ag^{+}, Hg^{+}, Bi^{+++}, Cu^{++}, Cd^{++}, As^{+++}, Sb^{+++}, Sn^{++}, Fe^{++}, Fe^{+++}, Cr^{+++}, Al^{+++}, Co^{++}, Ni^{++}, Mn^{++}, Zn^{++}, Ba^{++}, Ca^{++}, Sr^{++}, Mg^{++}, K^{+}, NH_4^{+}, CO_3^{-}, S^{-}, SO_3^{--}, $S_2O_3^{--}$, NO_2^{-}, CH_3COO^{-}, F^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, SO_4^{--}, $C_2O_4^{--}$, PO_4^{---} BO_3^{---}. **33 hrs**

Complexometric Titration:
Determination of Zn^{++}, Mg^{++}, Ca^{++} and total hardness of water using EDTA.
Determination of Ca Hardness of water.
Spectrophotometric Analysis: Determination of total iron in ground water.
Determination of dissolved oxygen in a sample of water. **18 hrs**

Experiments on Organic Chemistry

Qualitative analysis of organic compounds: Systematic qualitative analysis of simple mono functional organic compounds and preparation of their at least one derivative (aldehyde, ketone, carboxylic acid, carbohydrate, phenol, hydrocarbon, amine, nitro, amide and ammonium salt).

51hrs

Experiments on Physical Chemistry

1. To determine the transition temperature of hydrated sodium sulfate decahydrate by thermometric method.
2. To determine the critical micelle concentration (CMC) of a soap or detergent by surface tension method using a stalagmometer.
3. To determine the molecular weight of a polymer by viscosity measurement.
4. To determine the cell constant of the given conductivity cell.
5. To verify Ostwald dilution law and determine the dissociation constant of the weak acid.
6. To determine the equivalent conductivity of strong electrolyte at infinite dilution by conductance measurement.
7. To verify Nernst equation.
8. To determine the true thermodynamic solubility product of calcium sulfate at room temperature. **51 hrs**

Text Books: for theoretical course CHE 301

1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and Sons. Inc, 2007.
2. F. A. Cotton, G. Wilkinson & C. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, John Wiley & Sons (Asia), Pvt., Ltd., 2007.
3. R. T. Morrison & R. N. Boyd, *Organic Chemistry*, 6th & 7th Edition, Prentice- Hall of India Pvt., Ltd., 2008.
4. I. L. Finar, *Organic Chemistry*, Vol. I and Vol. II, Prentice Hall, London, 1955, (Available recent edition).
5. Streitweiser & Heathcock, *Introductory Organic Chemistry*, Wiley and Sons, New York, 1981.
6. J. March, *Advanced Organic Chemistry*, 4th Edition, Wiley Eastern Ltd., India, 2005.
7. Francis A. Corey & Rechard J. Sundberg, *Advanced Organic Chemistry*, 5th Edition, University of Verginia, Verginia.
8. N. D. Cheronis & J. B. Entrikin, *Identification of Organic Compounds, A Student's Text using Semi-micro Techniques*, John Wiley& Sons, Inc (Latest Edition).
9. R. L. Shriner, R. C Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds*, A Hand Manual, John Wiley and Sons, Inc. New York (Latest edition).
10. M. R. Pokhrel & B. R. Poudel, *A Text Book of Inorganic Chemistry*, National Book Centre, Bhotahity, Kathmandu, Nepal, 2013.
11. D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, 2010.
12. Stanley H. Pine, *Organic Chemistry*, Special Indian Edition, The McGraw-Hill Companies, New Delhi, India (Latest Edition). 13. G. T. Miller Jr, *Living in the Environment: An Introduction to Environmental Science*, Wardsworth Publication, California, USA, 1994.
14. A. K. De, *Environmental Chemistry*, New Age International Publishers, New Delhi, India, 2008.

15. S. H. Maron & C. Prutton, *Principles of Physical Chemistry*, 4th Edition, Oxford & IBH Pub. Co., 1992.
16. S. Negi & S. C. Anand, *A Textbook of Physical Chemistry*, New Age International (P) Ltd., New Delhi, 1999.
17. R. P. Rostagi & R. R. Mishra, *An Introduction to Chemical Thermodynamics*, 6th Edition, Vikash Publ. House, India, 1996.
18. P. Atkins & J. de Paula, *Elements of Physical Chemistry*, 5th Edition, Oxford University Press Inc., Printed in India by Saurabh Printers Pvt. Ltd., New Delhi, 2009.

Reference Books: for theoretical course CHE 301

1. A. Sharpe, *Inorganic Chemistry*, 2nd Edition, ELBS & Longman, Singapore, 1986, (Preferably available recent edition).
2. R. D. Madan & Satya Prakash, *Modern Inorganic Chemistry,* S. Chand & Company Ltd., 1994.
3. K. N. Upadhyaya, *A Textbook of Inorganic Chemistry*, 2nd Edition, Vikash Publishing House Pvt., Ltd., 1995.
4. G. Marc Loudon, *Organic Chemistry*, 4th Edition, Oxford University.
5. Lawry & Richardson, *Mechanism and Theory in Organic Chemistry*, Haper and Row, New York, 1981.
6. C. Norman, *Principles of Organic Synthesis*, 2nd Edition, Chapman and Hill. London, 1978. (Preferably available recent edition).
7. Warren, *Organic Synthesis, the Disconnection Approach*, Wiley, New York, 1982. (Preferably available recent edition).
8. House, *Modern Synthesis Reactions*, 2nd Edition, W. A. Benjamin. New York, 1972.
9. R. M. Silverstein, F. X. Webster, D. J. Kiemle & D. L. Bryce, *Spectrometric Identification of Organic Compounds,* 8th Edition, Wiley Student Edition, Wiley India Pvt. Lt., 2015.
10. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern, New Delhi, 1981, (Preferably available recent edition).
11. T. W. Graham Solomons, *Organic Chemistry*, John Wiley and Sons, New York. (Available recent edition).
12. R. A. Bansal, *A Textbook of Organic Chemistry*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1993 (Available recent edition). 13. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry* (Vol. I & II), 2nd
Edition, Ekta Books Nepal, 2007.
14. A. K. Bhagi and G. R. Chatwal, *Bioinorganic and Supramolecular Chemistry,* Himalaya Publishing House, Mumbai (Available recent edition).
15. A. K. Bhagi & G. R. Chatwal, *Environmental Chemistry*, Himalaya Publishing House, Mumbai, (Available recent edition).
16. James, E. Huheey, Ellen A. Keiter, Richard L. Keiter & Okhil K. Medhi, *Inorganic Chemistry: Principles of Structure and Reactivity*, Fourth Edition, Dorling Kindersley (India) Pvt. Ltd., 2008.
17. S. Glasstone & D. Lewis, *Elements of Physical Chemistry*, Mcmillan & Co., Ltd.
18. P. Atkins & J. D. Paula, *Atkin's Physical Chemistry*, 10th Edition, Oxford University Press, 2014 (reprinted).
19. A. Bahal, B. S. Bahal & G. D. Tuli, *Essential of Physical Chemistry,* Revised Multicolor Edition, S. Chand & Co. Ltd., New Delhi, 2009.

20. K. L. Kapoor, *Textbook of Physical Chemistry*, Macmillan India Ltd., Vol. I to Vol.V, 3rd Edition, 2001.
21. D. Alberty, *Physical Chemistry*, 6th Edition, Wiley Eastern Ltd., New Delhi, 1992.
22. G. M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Edition D. N. Bajpai, *Advanced Physical Chemistry,* S. Chand & Co., New Delhi.
23. V. K. Jha, *Theoretical Principles of Molecular Spectroscopy*, Kathmandu, Nepal, 2011.

Text Books: for practical course CHE 302

1. A. I. Vogel, *A Textbook of Quantitative Inorganic Analysis, Including Elementary Instrumental Analysis*, ELBS & Longman, 1969, (Preferably available recent edition).
2. A. I. Vogel, *A Text Book of Qualitative Inorganic Analysis,* ELBS & Longman, 1969, (Preferably available recent edition).
3. R. L. Shriner, R. C. Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds, A Laboratory Manual*, John Wiley and Sons, Inc. New York, 1986. (Preferably available recent edition).
4. B. P. Levitt, ed. Findlay‟s *Practical Physical Chemistry*, Longman, London, 1973.
5. Moti Kaji Sthapit & R. R. Pradhananga, *Experimental Physical Chemistry*, Taleju Prakasan, Kathmandu, 1998.
6. N. M. Khadka, S. D. Gautam & P. N. Yadav, *A Core Experimental Chemistry for B.Sc.* Heritage Publication, Kathmandu, 2016.

Reference Books: for practical course CHE 302

1. Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, 10th Edition, Goel Publishing House, Meerut, 1994.
2. A. I. Vogel, *A Textbook of Practical Organic Chemistry, Including Qualitative Organic Analysis,* Longmans, (Latest Edition). 3. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman, 1986,
(Preferably recent edition).
4. D. P. Shoemaker & C. W. Garland, *Experiments in Physical Chemistry,* McGraw Hill, Kogakusha Ltd, Tokya, 1967.
5. B. D. Khosla, A. Guali & V. C. Garg, *Senior Practical Physical Chemistry*, 5th Edition, R. Chand & Co., New Delhi, 1987.
6. J. N. Gurtu and R. Kapoor, *Advanced Experimental Chemistry* (Vol I-III), S. Chand & Co. New Delhi, 1984.
7. J. N. Gurtu and A. Gurtu, *Advanced Physical Chemistry Experiments*, 4th Edition, Pragati Prakashan, 2008.
8. S. K. Agrawal and Keemti Lal, *Advanced Inorganic Chemistry*, Pragati Prakasan, Meerut (Latest Edition).

Course Title: Basic Biochemistry (Elective) **Full Marks**: 50
Course No.: CHE 303 **Pass Marks**: 17.5
Nature of the course: Theory **Year**: III

Course Objectives:

- To explain the basic tenets of biochemistry
- To explain the functions of biomolecules in the living organisms

Biochemistry: Definition and short history and its application, pH scale and pH of biological fluids, Henderson-Hassel balch equation and its importance; Biologically important buffers. **3 hrs**

Nucleic acids: Nucleotides, building blocks of nucleic acids, nucleotides and nucleic acids have characteristic bases and pentoses, phosphodiester bonds link successive nucleotides in nucleic acid , nucleic acids structure, DNA store genetic information, DNA molecules have distinctive base compositionproperties, DNA is a double helix, DNA can occur in different three dimensional form, biosynthesis of DNA (replication), biosynthesis of RNA(transcription), genetic code, mutation (nucleotides and nucleic acid undergo nonezymatic transformation, and mutants, DNA repair, DNA sequencing (Frederic Sanger), recombinant DNA technology, DNA cloning, restriction endonucleases and DNA ligase yield recombinant DNA, clonong vector allow amplification of insert DNA Segments), PCR (polymerase chain reaction amplifies specific DNA biological functions of DNA and RNA, biosynthesis and repair of DNA and mRNA, codon, mutation, DNA sequencing by Frederick Sanger method, DNA cloning, the polymerase chain reaction amplifies specific DNA sequences, its application), DNA polymorphism, genetic diseases, human genome project. **22 hrs**

Amino acids, peptide and proteins: Amino acids**:** amino acids share common structural features, amino acid residues in proteins are L-stereoisomers, amino acid can be, amino acids can be classified by R group, uncommom amino acid also have important functions, amino acids not found in proteins, degradation of amino acids (oxidative deamination, transamination, decarboxylation, functions of pyridoxal phosphate (PLP), biosynthesis of glycine, methionine, serine, and tyrosine, amino acid sequencing (terminal group analysis (Edman-N-terminal sequencing), quantitative estimation of proteins (SDS-PAGE). **15 hrs**

Enzymes: Definition, properties, terminologies, coenzymes, cofactors and prosthetic group, enzyme kinetics, Michaelis-Menten equation, transformations of Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee plot, enzyme inhibition(competitive, noncompetitive and uncompetitive), effect of pH, temperature, substrate concentration and incubation time onenzyme action, mechanism of enzyme action(lock and key model and induced fit model), regulation of enzyme activity, enzymes of industrial and clinical diagnostic importance. **12 hrs**

Carbohydrates: Glycogenesis, gluconeogenesis, glycolysis, TCA cycle, relation between glycolysis, relation between glycolysis and respiration, pentose phosphate pathway, principle of bioenergetics, electron transport system and oxidative phosphorylation. **8 hrs**

Lipids: Definition, classification of lipids (natural lipids, fats, waxes, soaps, phospholipids, glycolipids, steroids), saponification number, iodine value, acid number, rancidity, autooxidation (rancidity), fatty acids: saturated and unsaturated fatty acids, metabolism (β-oxidation of fatty acids), biosynthesis of fatty acids (palmitic acid and lipid (tripalmitin, cholesterol biosynthesis,

and bile salts derived from cholestrol, theories of fat absorption, prostanoids, eicosanoids, leukotrienes, lipooxygenase and cyclooxygenase pathway. **15 hrs**

Text Books: for Biochemistry CHE 303

1. David L. Nelson & Michael M. Cox, *Lehninger's Principle of Biochemistry*, Worth Publishers, New York, USA, 2005.
2. Lubert Stryer, *Biochemistry,* W. H. Freeman and Company, New York, USA, 1975.

Reference Books: for Biochemistry CHE 303

1. L. Veerakumari, *Biochemistry*, MJP Publishers, Chennai, India, 2004.
2. A. Mazur & B. Harrow, *Text Book of Biochemistry,* W. B. Saunders Co., Philadelphia, USA, 1971.
3. J. L. Jain, *Biochemistry,* Sultan Chand and Co., 1999.
4. P. K. Kuchel & G. B. Ralston, *Theory and Problems of Biochemistry,* Shaum Series, McGraw Hills Book Company, New York, USA, 1988.
5. T. Devasena, *Enzymology*, Oxford University Press, New Delhi, India, 2010.
6. A. C. Deb, *Fundamentals of Biochemistry,* New central book agency (P) Ltd, India, 2012.
7. A.V. S. S. Rama Rao, *A Textbook Biochemistry*, 7th Edition, UBS Publishers‟ Distributors Ltd. 8. B. R. Pandey, *An Easy Approach to Basic Biochemistry,* Heritage Publishers & Disstributors Pvt. Ltd., Kathmandu, 2015.
9. S. K. Kalauni, *A Textbook of Basic Biochemistry,* ABC Publication, Kathmandu, 2016.

Course Title: Analytical Chemistry (Elective) **Full Marks**: 50
Course No.: CHE 305 **Pass Marks**: 17.5
Nature of the Course: Theory **Year**: III

Course Objectives:

- To explain the basic tenets of analytical chemistry
- To explain the principle and instrumentation of different analytical techniques

Basic Concept: Introduction to analytical chemistry, Qualitative and quantitative analysis, Analytical methodology: Sampling, Conversion of analyte to a measurable form, Measurement, Calculation and interpretation of the measurement, The analytical balance. Factors affecting the choice of analytical methods, destructive and non-destructive methods, Choice of analytical methods depending upon sample size: a) macro analysis, b) microanalysis, c)semi-microanalysis d) ultra micro analysis, e) trace analysis, interference, sensitivity and detection limits. **20 hrs**

General Concept of Statistical Methods in Chemical Analysis: Errors in chemical analysis, Absolute and relative errors, Accuracy and precision, Types of errors in experimental data, Determinate and indeterminate errors, Systematic errors, Proportional errors, Random errors, Sources of random errors, Distribution of experimental data, Statistical treatment of random error, Significant figures, Confidence limits and reliability of results, Student's t test, Criteria for rejection of result (Q-test), Regression analysis,. **14 hrs**

Titrimetric Methods of Analysis: General principle, Requirements for reactions used in titrimetric analysis, Concentration system, Stoichiometric calculations, Aliquots, Introduction to

redox, precipitation and complexometric titrations, Calibration of volumetric glasswares. **8hrs**

Gravimetric Methods of Analysis: General principle, Stoichiometry of gravimetric reactions, Formation and properties of precipitate, Coprecipitation and purity of precipitates, Post precipitation, Drying and ignition of precipitates, Use of common organic reagents in gravimetric analysis, Applications of gravimetric analysis. **6hrs**

Separation Methods: Solvent extraction: Nernst distribution law, Distribution coefficient, Distribution ratio, Applications of solvent extraction. **5hrs**

Chromatography: Definition and classification of chromatography, stationary and mobile phase, Paper chromatography, Ion exchange chromatography, Gas chromatography, HPLC, Affinity chromatography, Exclusion chromatography, Column chromatography and thin layer chromatography. **12hrs**

Instrumental Methods

Principle, instrumentation and applications of atomic absorption spectroscopy, flame photometry, UV-visible spectrophotometry & polarography. **10hrs**

Text Books: for Analytical Chemistry CHE 305

1. R. A. Day jr & A. L. Underwood, *Quantative Analysis*, 6th Edition, Prentice Hall of India, New Delhi,2009.
2. Douglas A. Skoog, F. James Holler & Timothy A. Nieman, *Principles of Instrumental Analysis*, 5th Edition, Thomson Brooks/Cole, 1998.
3. Willard, Merritt, Dean & Settle, *Instrumental Methods of Analysis*, 6th Edition, CBS Publishers, India, 1986.
4. *Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition*, Pearson Education 2008.

Reference Text Books: for Analytical Chemistry CHE 303

1. H. Kaur, *Instrumental Methods of Chemical Analysis*, Second Edition, Pragati Prakashan, Meerut.
2. B. Sivasankar, *Instrumental Methods of Analysis*, Oxford University Press, 2012.
3. A. K. Srivastava & P. C. Jain, *Instrumental Approach to Chemical Analysis*, S, Chand and Company, New Delhi.
4. S. K. Gautam, B. R. Poudel & H. R. Sharma, *Concise Analytical Chemistry*, Natural Book Centre, 2016.
5. B. R. Pandey, *An Easy Approach to Analytical Chemistry*, Heritage Publishers and Distributors Pvt. Ltd., Kathmandu, 2016.