Course Structure

MSc Chemistry
BS (5^{th} to 8^{th} Semester)
Department of Chemical Sciences,

University of Lakki Marwat, Lakki Marwat, KP.

MSc Chemistry Scheme of Studies

BS 5th to 8th Semester Breakup and Course Contents

Semester-V
CHEM-251: Inorganic Chemistry 3 1
CHEM-261: Organic Chemistry 3 1
CHEM-271: Physical Chemistry 3 1
CHEM-211: Analytical Chemistry 3 1
Total 12 4
Semester-VI
CHEM-351: Inorganic Chemistry 3 1
CHEM-361: Organic Chemistry 3 1
CHEM-371: Physical Chemistry 3 1
CHEM-*: Biochemistry/Applied
Chemistry/Fuel Chemistry etc. 3 1
Total 12 4
Semester-VII
Specialization (Inorganic/Organic/Physical/ Analytical/Biochemistry/Applied Chemistry/ Fuel Chemistry etc.)
Theory Lab.
Paper-I 3 0
Paper-II 3 0
Paper-III 3 0
Lab-I 0 1
Elective Course-I (other than the field of specialization) Environmental Chemistry 3 0
Research Thesis / Research Project /Advanced Lab. / Position Paper (literature survey) 0 3
Total 12 4
Semester VIII:
Specialization (Inorganic/ Organic/Physical/ Applied/Analytical-/Biochemistry/ Fuel Chemistry etc.)
Theory Lab
Paper-IV 3 0
Paper-V 3 0
Paper-VI 3 0
Lab-II 0 1
Elective Course - II (other than the field of specialization) Environmental Chemistry 3 0
Research Thesis / Research Project / Advanced Lab / Position Paper (write-up) 0 3
Total 12 4

BS 3rd Year
Semester-V
Course Title: INORGANIC CHEMISTRY
Code: CHEM-251
Credit Hours: 3+1
Course Objectives:
Students will acquire knowledge about the physical and chemical properties of d- & f- block elements on the basis of their electronic configurations and will be able to work out structures of coordination compounds through development of understanding of VBT, CFT and MOT.
Course Contents:
Chemistry of d-block elements and coordination complexes:
Back ground of coordination chemistry, nomenclature and structure of coordination complexes with coordination number 2-6, chelates and chelate effect, theories of coordination complexes, Werner's theory, valence bond theory (VBT), crystal field theory (CFT) and molecular orbital theory (MOT), Jahn-Teller theorem, magnetic properties, spectral properties, isomerism, ,stereochemistry, and stability constants of coordination complexes.
Chemistry of f-block elements:
i. Lanthanides: General characteristics, occurrence, extraction and general principles of separation, electronic structure and position in the periodic table, lanthanides contraction, oxidation states, spectral and magnetic properties and uses. ii. Actinides: General characteristics, electronic structure, oxidation state and position in the periodic table, half-life and decay law.
CHEM-251 Lab.
Preparations of following Inorganic Complexes;
Tetraamminecopper (II) sulphate.
Potassiumtrioxalatochromate (III).
Potassiumtrioxalatoaluminate (III).
cis-Potassium dioxalatodiaquachromate (III).
Determination of zinc and cadmium by complexometric titration
Chromatographic separations of transition metals;
Separation of Ni^{2+} & Co^{2+} ions in a mixture by paper chromatography.
Separation of Ni^{2+} & Cu^{2+} ions in a mixture by paper chromatography.
Separation of Cu^{2+} & Fe^{2+} ions in a mixture by paper chromatography.
Spectrophotometric determination of iron, manganese and nickel.
Recommended Books:
1. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, (1999).
2. Housecraft, C. and Sharpe, A. G., *Inorganic Chemistry*, 4th ed., Prentice Hall, (2012).
3. Miessler, G. L. and Tarr, D.A., *Inorganic Chemistry*, 4th ed., Pearson-Prentice Hall International, (2010).
4. Douglas, B., McDanial, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, New York, (1994).

5. Shriver, D. and Atkins, P., *Inorganic Chemistry*, 5th ed., W. H. Freeman & Company, (2010).
6. Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Blackwell Science Ltd., (1996).
7. Atkins, P. and Jones, L., *Chemicals Principles,* 5th ed., W. H. Freeman & Company, (2010).
8. Svehla, G., *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, 5th ed., Longman Group Limited, (1979).
9. Huheey, J. E., Kieter, E. A. and Kieter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity,* 4th ed., Prentice Hall, (1997).
10. Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods,* 2nd ed., Chapman and Hall (1974).
11. Müller, U., *Inorganic Structural Chemistry,* 2nd ed., John-Wiley & Sons, Ltd., (2006).
12. Marusak R. A., Doan K., Cummings S. D., *Integrated Approach to Coordination Chemistry,* 1st ed., John-Wiley & Sons, (2007).
13. Chaudhary, S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2013).

BS 3rd Year

Semester-V

Course Title: ORGANIC CHEMISTRY

Code: CHEM-261

Credit Hours: 3+1

Course Objectives:

Students will gain knowledge about the stereochemical behavior of organic molecules and acquire an ability to propose mechanism of simple reactions.

Course Contents:

Stereochemistry:

Types of stereoisomers, RS and EZ notation, optical activity, stereoselectivity and stereospecificity, conformational analysis.

Organic Reactions and Mechanism:

Detailed mechanism of aliphatic reactions including addition, substitution, and elimination reactions, concept of energy profile, transition state and intermediate.

CHEM-261 Lab.

Experiments using polarimeter such as to determine optical activity of a sugar solution and to determine sugar concentration by polarimeter, isomerization of maleic acid.

Experiments involving aliphatic addition, elimination and substitution reactions, e.g., synthesis of cyclohexene from cyclohexanol, addition reaction to cyclohexene etc.

Synthesis of a chalcone explaining the concept of condensation and dehydration, *N*-Alkylation of phthalimide, etc.

Recommended Books:

1. Robert, T. M., and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall,

New Jersey, (1992).
2. John, E. M., *Organic Chemistry*, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Younas, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).
4. Morris, D. G., *Stereochemistry (Basic Concepts in Chemistry),* Wiley-RSC, (2002).
5. Mislow, K., *Introduction to Stereochemistry,* Dover Publications Inc., (2003).
6. David M., *Stereochemistry (Tutorial Chemistry Texts*), Royal Society of Chemistry, (2002).
7. Furniss, B. S, Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry,* 5th ed., Longman, UK, (1989).
8. Mohan J., *Organic Analytical Chemistry*, *Theory and Practice*, 1st ed. Alpha Science International, Ltd. (2003).
9. Seiler, J. P., *Good Laboratory Practice*: *The Why and the How*, 2nd ed., Springer, (2005).
10. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry,* 6th ed., Brooks/ Cole Cengage Learning, (2012).
11. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry,* 10th ed., John-Wiley & Sons, Inc., (2011).
12. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques,* 5th ed., Brooks/ Cole Cengage Learning, (2013).
13. Eames, J. and Peach, J. M., *Stereochemistry at a Glance,* Blackwell Science, Ltd., (2003).
14. Eliel, E. L., Wilen, S. H. and Doyle, M. P., *Basic Organic Chemistry,* John-Wiley & Sons, Inc., (2001).
15. Eliel, E. L. and Wilen, S. H., *Stereochemistry of Organic Compounds,* John-Wiley & Sons, Inc., (1994).

BS 3rd Year

Semester-V

Course Title: PHYSICAL CHEMISTRY

Code: CHEM-271

Credit Hours: 3+1

Course Objectives:

Students will be able to understand and acquire knowledge about the principles and theoretical background of quantum chemistry, kinetics theory of gases and phase equilibrium. The knowledge gained thus can be applied to study various aspects of quantum mechanics, gas kinetic behavior and thermodynamics and phase equilibrium.

Course Contents:

Quantum Chemistry:

Black body radiation, photoelectric effect, line spectra of elements, Bohr atomic model, wave and particle nature of matter, de Broglie's equation,Young's double

slit experiment, Heisenberg's uncertainty principle,wavefunctions and Born interpretation of wavefunctions, probability density,eigenfunctions and eigenvalues, Hamiltonian operator, Schrödinger waveequation, wavefunctions for hydrogen-like atomic orbitals, radial distributionfunctions, shielding and penetration, effective nuclear charge, orbital energies,periodic trends in the properties of the elements in the periodic table.

Kinetic Theory of Gases:

Probability density for molecular speeds of gas molecules, Maxwell distribution of molecular speeds, average speeds, pressure of an ideal gas, calculation ofmolecular speeds, binary collisions, effusion and mean free paths, Maxwell-Boltzmann's law of energy distribution, method for the determination of theAvogadro's number (NA), statistical probability and entropy.

Phase Equilibrium:

Gibbs phase rule, Phase diagrams of one component and two componentsystems, Gibbs energy and the phase diagram of a substance, location ofphase boundaries, Clausius-Clapeyron equation, vapor-liquid equilibrium ofbinary liquid mixtures, binary phase diagrams and lever rule.

CHEM-271 Lab.

Equilibrium constant of the $KI + I_2 = KI_3$ reaction.
Kinetics of saponification of ethyl acetate.
Acid catalyzed hydrolysis of sucrose.
Study of the adsorption isotherms of acetic acid-charcoal system.
Study of the charge transfer complex formation between iodine and benzene.
Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate.
Determination of partial molar volumes.
Characterization of the given compound by UV-Vis spectroscopy.

Recommended Books:

1. Silbey, R. J., Alberty, R. A., and Bawendi, M. G., *Physical Chemistry,* 4th ed., Jojn-Wiley & Sons, (2005).
2. McQuarrie, D. A. and Simon, J. D., *Physical Chemistry – A Molecular Approach,* 1st ed., University Science Books, (1997).
3. Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry*, 9th ed., Oxford University Press, (2010).
4. Moore. W. J., *Physical Chemistry*, 4th ed., Longman Publisher (1972).
5. Coulson C. A., *Vanlence*, Oxford University Press (1980).
6. Keeler. J. and Wothers, P., *Chemical Structure and Reactivity: An Integrated Approach,* 1st ed., Oxford University Press, (2008).
7. Helpern, A. M., *Experimental Physical Chemistry: A Laboratory Textbook* 2nd ed., Prentice Hall, (1997).
8. Garland, C. W., Nibler, J. W. and Shoemaker, D., P., *Experiments in Physical Chemistry,* 8th ed., McGraw-Hill, (2003).
9. Born, Max., *Atomic Physics,* 8th ed., Blackie & Son Ltd., (1969).
10. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
11. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed.,

Longman Group Limited, New York, (1974).

BS 3rd Year

Semester-V

Course Title: ANALYTICAL CHEMISTRY

Code: CHEM-211

Credit Hours: 3+1

Course Objectives:

The main objectives of this course are to introduce the students to the basics principles, instrumental aspects and applications of separation and spectrophotometric analytical methods

Course Contents:

Separation Methods:

Principle of solvent extraction, solvent extraction of metals, analytical separations, multiple batch extraction, counter current distribution, solid-phase extraction, solvent extraction by flow injection method, principles ofchromatography, classification of chromatographic techniques, overview ofpaper, thin layer, column, ion exchange chromatography and electrophoresis.

Analytical Spectrophotometry:

Properties of light and its interaction with matter, relation between frequency,velocity and wave number, Lambert- Beer's law and its limitations, singlebeam and double beam spectrophotometers, lamps and lasers as sources of light, monochromators, detectors, photomultiplier tube, photodiode array,charged coupled device, FT-IR spectroscopy, fourier analysis, interferometry,noise and its control.

CHEM-211 Lab.

Separation of phenol from given organic mixture using solvent extraction.Separation of given mixture of cations using Paper Chromatography.

Analysis of the composition of a mixture of nitro anilines by TLC.Separation of sugars using paper chromatography.Separation of amino acids using paper/thin layer chromatography.Deionization and softening of water using ion exchange chromatography.Determination of λ_{max} of $KMnO_4$ and $K_2Cr_2O_7$ solutions and verification of Beer-Lambert's law.

Determination of stoichiometry of a metal complex by visible spectrometry.

Determination of aspirin and caffeine in a proprietary analgesic by double beam UV-Vis. spectrometer.

Quantification of iron in a given sample by using single beam spectrophotometer.

A study of characteristics infrared absorption frequencies.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th ed., Brooks Cole Publishing Company, (2013).

2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, USA, (2011).

3. Christian, G. D., *Analytical Chemistry*, 6th ed., John Wiley and Sons, New York, (2006).

4. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry,* 1st ed.,Bios Saence Publisher Ltd. Oxford UK. (2002)
5. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., *Introduction to spectroscopy,* 4th ed., Cengage Learning, (2008).
6. Wall, P. E., *Thin Layer Chromatography: A Modern Approach (RSC Chromatography Monographs),* 1st ed., Royal Society of Chemistry, (2005).
7. Deinstrop, E. H., *Applied Thin Layer Chromatography,* 2nd ed., Wiley-VCH, (2006).
8. Kellener. R, Mermet. J. M., Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry: A Modern Approach to Analytical Science*, Wiley. VCH, (2004)
9. Hollas, J. M., *Modern Spectroscopy,* 4th ed., John-Wiley & Sons, Ltd., England (2004).

BS 3rd Year

Semester-VI

Course Title: INORGANIC CHEMISTRY

Code: CHEM-351

Credit Hours: 3+1

Course Objectives:

Students will acquire knowledge about various types of inorganic materials,their structure, synthesis, characterization and applications in various fields

Course Contents:

Introduction to inorganic materials, crystalline and amorphous states, bondingin solids, non-stoichiometric compounds, binary solid solutions, mechanical,electrical, magnetic, dielectric, optical, and chemical (corrosion) properties ofadvanced materials, synthesis (e.g., sol-gel, hydrothermal techniques, etc.)and design of inorganic materials and characterization, doping and purificationof silicone, chemical vapour deposition and sputtering, introduction to nano
materials.

CHEM-351 Lab

1. Estimation of anions in mixtures:Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphatephosphate,bromide-nitrate, borate-acetate, iodide-nitrate.
2. Iodometric titration with potassium iodate.
3. Gravimetric estimation of oxalate.
4. Precipitation Titrations.

a) Determination of strength of NaCl given solution by $AgNO_3$ using Fluorescein as indicator.

b) Determination of % age purity of KBr using Fluoresceine as indicator.

c) Determination of % composition of mixture of KI & KNO_3 using Eoscein as indicator.

5. Spectrophotometric determination of cerium.
6. Separation of heavy metals using solvent extraction technique.

Recommended Books:

1. Xu, R., Pang, W., Huo, Q., *Modern Inorganic Synthetic Chemistry,* 1st ed., Elsevier, (2011).
2. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., *Vogel's Quantitative Chemical Analysis,* 6th ed., Prentice Hall, (2000).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry,* 6th ed., Wiley-Interscience, (1999).
4. Huheey, J. E., Keiter, E. A. and Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity,* 4th ed., Prentice Hall, (1997).
5. Housecraft, C. and Sharpe, A. G., *Inorganic Chemistry,* 4th ed., Prentice Hall, (2012).
6. Rodgers G. E., *Descriptive Inorganic, Coordination, and Solid State Chemistry,* 3rd ed., Brooks- Cole, (2012).
7. Smart L. E., Moore E. A., *Solid State Chemistry: An Introduction,* 4th ed., CRC Press, (2012).
8. Müller, U., *Inorganic Structural Chemistry,* 2nd ed., John-Wiley & Sons, (2006).
9. Schwarzenbach D., *Crystallography,* 1st ed., John-Wiley & Sons, (1996).

BS 3rd Year

Semester-VI

Course Title: ORGANIC CHEMISTRY

Code: CHEM-361

Credit Hours: 3+1

Course Objectives:

Students will acquire knowledge and understanding about aromaticsubstitution reactions and oxidation and reduction as well as pericyclicreactions.

Course Contents:

Aromatic Substitution Reactions:

Mechanisms of aromatic reactions including electrophilic and nucleophilicsubstitutions, effect of substituents on orientation and reactivity.

Oxidation-reductions Reactions:

Common oxidizing and reducing reagents, reactions involving elimination of H,cleavage of C-C bond, replacement of hydrogen by oxygen, and addition ofoxygen to substrates, reaction involving replacement of oxygen by hydrogen,removal of oxygen from the substrates and reduction with cleavage.

Pericyclic Reactions:

Introduction to pericyclic reactions, frontier orbital theory, mechanisms ofelectrocyclic, cycloaddition and sigmatropic reactions.

CHEM-361 Lab.

Experiments involving aromatic substitution, oxidation/reduction reactions andpericyclic reactions, nitration of nitrobenzene to meta-dinitrobenzene,reduction of meta- dinitrobenzene to meta-nitroaniline, sulphonation of aniline,oxidation of benzaldehyde, oxidation of cyclohexanol to cyclohexanone.Preparation of benzoic acid and benzyl alcohol from benzaldehyde usingCannizzaro's reaction.

Recommended Books:

1. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5th edition, Longman, UK, (1989).
3. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*,1st ed. Alpha Science Int. Ltd.New Delhi, India, (2003).
4. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).
5. Tse-Lok, H., *Symmetry: A Basis for Synthesis Design,* John-Willey & Sons, Inc., New York, (1995).
6. Pine, S. H., *Organic Chemistry*, 5th ed., Tata McGraw-Hill, India, (1987).
7. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry,* 6th ed., Pearson Education, (1986).
8. Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic Laboratory with Multistep and Multiscale Syntheses,* 5th ed., John-Wiley & Sons, Inc., (2011).
9. Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach,* 5th ed., Brooks/ Cole Cengage Learning, (2010).
10. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry,* 10th ed., John-Wiley & Sons, Inc., (2011).
11. Carey, F. A. and Giuliano, R. M., *Organic Chemistry,* 9th ed., McGraw-Hill Education, (2013).
12. Bruice, P. Y., *Organic Chemistry,* 7th ed., Perason Education, Ltd., (2013).
13. Smith, M. B*., March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,* 7th ed., John-Wiley & Sons, Inc., (2013).
14. Ansari, F. L., Qureshi, R. and Qureshi, M. L., *Electrocyclic Reactions: From Fundamentals to Research,* Wiley-VCH, Germany, (1999).
15. Kürti, L. and Czakó. B., *Strategic Applications of Named Reactions in Organic Synthesis: Background and Detailed Mechanisms,* Elsevier Inc., (2005).

BS 3rd Year

Semester-VI

Course Title: PHYSICAL CHEMISTRY

Code: CHEM-371

Credit Hours: 3+1

Course Objectives:

Students will acquire knowledge and understanding about the theoretical and instrumental as well as application related aspects of conductometric, andelectrochemical techniques and surface chemistry. They will also acquireinformation regarding nuclear binding energy, nuclear instabilities and decaymechanisms as well as the fission and fusion processes.

Conductometry:

Ions in solution, measurement of conductance and Kohlrausch's law, mobilityof ions and transport number, conductometric titrations, Debye-Hückel theoryand activity coefficient, determination of activities, application of conductancemeasurement.

Electrochemistry:

Redox reactions, spontaneous reactions, electrochemical cells, standardelectrode potentials, liquid junction potential, electrochemical series, Nernst'sequation, thermodynamic of redox reactions, measurement of pH and pKa,dynamic electrochemistry, Latimer Diagram, Frost Diagram, electrolytic cells,potentiometry, reference and indicator electrodes, voltammetry, fuel cells,corrosion and its prevention, fuel cell and hydrogen economy.

Surface Chemistry:

Interfaces, Gibbs surface excess, curved surfaces, capillary action, adsorptionand adsorption isotherms, Freundlich and Langmuir adsorption isotherms,catalysis, colloids, emulsion and their industrial applications.

Nuclear Chemistry:

Atomic nucleus, nuclides, nuclear stability, modes of decay, nuclear energetics, nuclear models (shell + liquid drop model), fusion and fission, nonspontaneous nuclear processes, nuclear reactors, beta decay systematic.

CHEM-371 Lab.

Spectroscopic determination of Cu percentage in the given sample.
Conductometric determination of Cu (II)- EDTA mole ratio in the complex.
To determine the effectiveness of an extraction of I_2 solution by using Solvent Extraction method.
Determination of molecular weight of a polymer by viscosity method.
Determination of percentage composition of $KMnO_4$/ $K_2Cr_2O_7$ in a given solution by spectrophotometry.
Evaluation of pK_a value of an indicator by spectrometric method.
Conductometric determination of hydrolysis constant (K_h) of conjugate base of a weak acid.

Recommended Books:

1. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., *Physical Chemistry,* 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., *Physical Chemistry,* Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., *Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1st ed.,* Springer, (2003).
4. Choppin, G., Liljenzin, J-. O. and Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth- Heinemann, (2002).
5. Loveland, W., Morrisey, D. J. and Seaborg, G. T., *Modern Nuclear Chemistry,* John-Wiley & Sons, Inc., (2006).
6. Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry,* 9th ed., Oxford University Press, (2010).
7. Somorjai, G. A. and Li, Y., *Introduction to Surface Chemistry and Catalysis,* 2nd ed., John-Wiley & Sons, Inc., (2010).
8. Laidler. K. J., "Chemical Kinetics" 3rd ed., Prentice Hall, (1987).
9. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W.

H. Freeman, New York, (2010).
10. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Longman Group Limited, New York, (1974).

BS 3rd Year

Semester-VI

Course Title: APPLIED CHEMISTRY

Code: CHEM-322

Credit Hours: 3+1

Course Objectives:

Students will gain understanding about the importance of water and its quality requirements for the industrial uses in addition to learning about water treatment techniques. They will also learn about the composite materials.

Course Contents:

Water Treatment, Steam Production and Scale Removal:

Sources of water hardness, water treatment and conditioning for municipal and industrial purposes, steam production and its utilization for power and energy generation, boiler water treatment, chemistry involved in the formation of scale and its prevention.

Distillation:

Vapor liquid equilibrium, methods of getting equilibrium data for binary systems, construction of equilibrium diagram, designing of distillation column, reflux ratio and its importance.

Composite Materials:

Introduction to composite material, classification of composite on the basis of reinforcement (Particle–Reinforced composite, Fibre–Reinforced composite, structural composites) and classification of composites on the basis of matrix phase (Polymer–Matrix composite, Metal–Matrix composite, Ceramics–Matrix composite, Carbon-carbon composite, Hybrid-composite, Laminar composite, Sandwich panels), synthesis, properties and applications of composite materials.

CHEM-322 Lab

Measurement of water hardness with EDTA Titrations.
Estimation of total solids in water.
Estimation of chloride in water.
Estimation of Ferrous and Ferric ions in drinking water by redox titration.
Extraction of capsicum oil (soxhlet extraction).
Extraction of clove oil from cloves.
Preparation of liquid detergents.
Study of the kinetics of dissolution of Magnesium metal in dilute HCl.
Estimation of Manganese in Steel.
Estimation of Ferric Iron in Cement.

Recommended Books:

1. Erwin D. L., *Industrial Chemical Process Design,* McGraw-Hill, (2002).
2. Chawla, K. K., *Composite Materials: Science and Engineering,* 3rd ed., Springer, (2012).

3. Methews, F. L., Rawlings, R. D., *Composite Materials: Engineering and Sciences,* CRC Press, (2003).
4. Deborah, D. L., *Composite Materials: Science and Applications,* 2nd ed., Springer, (2010).
5. Gay, D. and Hoa, S. V., *Composite Materials: Design and Applications,* 2nd ed., CRC Press, LLC, (2007).
6. Kister, H., *Distillation Operation,* 1st ed., McGraw-Hill Professional, (1990).
7. Kister, H., *Distillation Design,* 1st ed., McGraw-Hill Professional, (1992).
8. Tchobanoglous, G., Burton, F. L. and Stensel, H. D., *Wastewater Engineering: Treatment and Reuse,* 4th ed., McGraw-Hill, (2003).
9. Callister, W. D. Jr., *Materials Science and Engineering: An Introduction,* 7th ed., John-Wiley & Sons, Inc., (2007).
10. Roussak, O. V. and Gesser, H. D., *Applied Chemistry: A Textbook for Engineers and Technologists,* 2nd ed., Springer, (2013).
11. Mizrahi, J., *Developing an Industrial Chemical Process: An Integrated Approach,* CRC Press, (2002).
12. Prakash, N. B., *Applied Chemistry Lab Manual*, LAP Lambert Academic Publishing, (2013).
13. Vermani, O. P., *Applied Chemistry : Theory And Practice*, 2nd ed., New Age International, (2006).
14. Goostray. S and Schwenck. R. J., *Experiments in Applied Chemistry*, Collier-Macmillan, (1966).

BS 3r d Year
Semester-VI
Course Title: BIOCHEMISTRY
Code: CHEM-331
Credit Hours: 3 +1
Course Objectives:
Students will acquire knowledge about the fundamental concepts of energy production and the mechanisms of major macromolecules (amino acids, proteins, carbohydrates, nucleic acids and lipids), and the metabolism and regulation and inhibition of the metabolic pathways.
Course Contents:
Intermediary Metabolism and Bioenergetics:
Biological oxidation-Reduction including respiratory carriers, cell bioenergetics, Oxidative phosphorylation, free energy change and redox system.
Enzymes:
Enzyme-substrate interactions and nature of active site, mechanism of enzyme action with specific reference to chymotrypsin and ribonuclease, kinetics of single substrate reactions, enzyme inhibition, regulatory enzymes, Allosteric enzymes, Multienzyme system, zymogens, and isozymes, enzymatic control of metabolic pathways, immobilized enzymes, synthesis, properties and uses.
Metabolism of Carbohydrates:
Digestion, Absorption and Transport of sugars into cell, Glycolysis, Citric Acid Cycle, HMP pathway and its significance, Uronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Photosynthesis.
Metabolism of Lipids:
Digestion of Lipids, absorption and transport of lipids and fatty Acids, Oxidation saturated and unsaturated, odd chain and branched chain fatty acids, Biosynthesis of fatty acids and eicosanoids, Biosynthesis of triglycerides, phosphides, steroid and Bitter acids, Biosynthesis and utilization of Ketone bodies.
Metabolism of Proteins:
Digestion of proteins, absorption and transport of amino acids to the cell, Biochemical reaction of amino acids: decarboxylation, deamination, transamination and transmethylation etc., metabolism of essential amino acids, metabolic disorders, urea cycle, Creatine and uric acid synthesis, interrelationship
between carbohydrate, lipid and protein metabolism.
Metabolism of Nucleic Acids:
Biosynthesis and catabolism of purines and pyrimidines and their regulation, synthesis, catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism.
CHEM-331 Lab.
Separation of proteins by Electrophoresis.
Separation of Nucleic Acids by Electrophoresis.

Column chromatographic separations of protein Resolution.
Blood Glucose estimation, RFT, LFT, Lipid Profile, Cardiac Markers, Bone Markers, Pancreatic Markers, Anemia profile, Trace Elements, Urine CSF.
Immunochemical Techniques.
Determination of type of inhibition.
Determination of Michaelis constant in the presence and absence of inhibitors.

Recommended Books:

1. Voet, D. and Voet, J. D., *Biochemistry*, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
2. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry*, 6th ed., Freeman, (2012).
3. Murray, R., Bender, D., Botham, K.M., Kennely, P. J., Rodwall, V. and Weil, P.A., *Harper's Biochemistry*, 29th ed., (2012).
4. Zubay, G. L., *Biochemistry,* 4th ed., illustrated. Publisher: WMC. Brown Publishers, (1998), digitized, (2008). ISBN: 0697219003. 9780697219008.
5. Guyton, A. C. & Hall, J. E., *Guyton & Hall Text Book of Medical Physiology*, 12th ed., Publishers: Saunders Elsevier, (2011).
6. Plummer, D.T., *An Introduction to Practical Biochemistry*, 3rd ed., TATA MCGraw-Hill Publishing Company LTD, (2010).
7. Sawhney, S. K. and Sing, R., *Introductory Practical Biochemistry*, 2nd ed., Narosa Publishing House, New Delhi, (2005).
8. Robert A. Copeland, *Enzymes: A Practical Introduction to Structure, Mechanism, and Data analysis,* 2nd ed., Publishers: John-Wiley & Sons, (2000) ISBN: 0-471-35929-7
9. R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13,* 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
10. Nelson,D.L., *Lehninger's Principles of Biochemistry,* 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
11. Voet, D. and Voet, J.D., *Biochemistry,* 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
12. Murray, R.M. and Harper, H.A., *Harper's Biochemistry,* 25th ed., Publisher:Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
13. Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry,* 5th ed., *and Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

BS 3rd Year

Semester-VI

Course Title: Fuel Chemistry
Code: Chem-381
Credit Hours: 3+1
Course Objectives:

Able the students about the chemistry of fossil fuels like coal, petroleum and natural gas and their conversion processes to get useful chemical products. Improve tier understanding about alternative fuels to be used in case of nonavailability of petroleum based oils

Course Contents:

Chemistry of fossil fuels: Classification of fossil fuels. Origin of coal, petroleum and natural gas. Preliminary treatment of crude oil. Fractionation of crude oil. Properties of petroleum products i.e. CNG, LPG, gasoline, kerosene, diesel fuels and lubricating oils. Coal storage and cleaning. Carbonization of coal: Low temperature and high temperature carbonization, Coking and non-coking coals, Separation of tar from coke oven gas, Hydrogen sulfide removal from coke oven gas Introduction to alternate sources of energy: Biomass as energy resources: Bio gas technology. Alcohols: Alcohols and its uses as alternative fuel. Hydrogen: Hydrogen production, storage, handling and its uses as alternative fuel. Fuel Cells and its application, Solar Energy: Solar energy collectors. Nuclear fuels: fission and fusion, nuclear reactors and introduction to Hydel energy.

CHEM-381 Lab

Determination of moisture contents of coal mined in different parts of Pakistan.
Determination of Ash contents of coal mined in different parts of Pakistan.
Determination of Volatile matter of coal.
Determination of fixed carbon contents of coal.
Determination of hydrogen and nitrogen contents of the coal.
Determination of chlorine and oxygen in coal.
Determination of various forms of sulfur in coal.
Determination of specific and API gravity of petroleum fractions.
Estimation of carbon residue in petroleum products (Conradson method).
Determination of ash content in petroleum products.
Determination of sulfated ash in lube oil.
Estimation of water, sediments and oil in crude oil by centrifuge method.
Determination of cloud and pour point of Lube-oil.
Estimation of asphalt in road samples

Recommended Books:

1. Gyngell, E.S. *Applied Chemistry for Engineers,* Edward Arnold Publisher, Ltd. London. (1989).
2. Harker, J.H. and Backurst, J.R. *Fuel and Energy,* Academic Press, London and New York (1988).
3. Wilson, P.J. and Wells, J.H. *Coal Coke and Coal Chemicals,* McGraw-Hill Book Company, London, (1980).
4. Hobson, G.D. *Modren Petroleum Technology,* part-I. John Wily & Sons, Toronto, (1984).
5. Goodger E.M. *Alternative Fuels (chemical energy resources),* The Macmillan press Ltd, London, (1980).
6. Twidell, J. and Weir, T. *Renewable Energy Resources,* Sopn London, New York, (1986).
7. Matar, S. and Hatch, L.W. *Chemistry of Petrochemical Processes,* 2nd Ed. Gulf Publishing Company. Houston, Texas, USA (2002).

BS 4th Year

Semester-VII (INORGANIC CHEMISTRY)

Course Title: INORGANIC REACTION MECHANISM

Code: CHEMCredit

Hours: 3

Course Objective:

Students will acquire know-how and understanding about different mechanisms of inorganic reactions and their applications towards understanding different types of complexes.

Course Contents:

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Classification of reaction mechanisms; rate laws; steady state approximation; inert and labile complexes; substitution reactions in octahedral complexes and square planar complexes, acid hydrolysis, base hydrolysis, steric effects of inert ligands, nucleophilic reactivity, trans-effect, *cis*-effect, racemization reactions. Mechanism of electron transfer reactions, oxidation reduction reactions of metal ions, outer and inner sphere mechanisms, factors affecting rate of electron transfer reactions, two electrons transfer reactions, complementary or non-complementary electron transfer reactions, oxidative addition, addition of oxygen, hydrogen, HX, organic halides and bimetallic species, Reductive Elimination Reactions.

Recommended Books:

1. Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
2. Shriver, D. F., Atkins, P. W., *Inorganic Chemistry*, 3rd ed., Oxford University Press, (2001).
3. Wilkins, R. G., *Kinetics and Mechanism of Reactions of Transition Metal Complex*, 2nd ed., (Rev.), Wiley-VCH, (1991).
4. Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
5. Jordan, R. B., *Reaction Mechanisms of Inorganic and Organomettalic Systems*, 2nd ed., Oxford University Press, New York, (1998).
6. Atwood, J. D., *Inorganic and Organometallic Reaction Mechanisms,* 2nd ed., Wiley-VCH, Inc., (1997).
7. Sharma, S. K., *Inorganic Reaction Mechanisms,* Discovery Publishing House, (2007).

BS 4th Year

Semester-VII (INORGANIC CHEMISTRY)

Course Title: π- ACEPTOR LIGANDS AND INORGANIC POLYMERS

Code: CHEMCredit

Hours: 3

Course Objective:

Student will acquire sound knowledge about π--acceptor ligands and different types of inorganic polymers.

Course Contents:

π-Acceptor Ligands:

Introduction to π-acceptor ligands, effective atomic number (EAN) rule and chemistry of metal carbonyls, nitrosyls, and isocyanides, structure elucidation based on spectroscopic evidences, applications and uses of metal carbonyls and their derivatives for catalysis and organic synthesis.

Inorganic Polymers:

Introduction to homoatomic and heteroatomic inorganic polymers, chains and cages of boron, silicon, nitrogen, phosphorous and sulphur, synthesis and applications, Polyionic species, Isopoly and heteropoly, anions of transition metals, silicates, borates, condensed phosphates, zeolites.

Recommended Books:

1. Brady, J. E., and Sense, F., *Chemistry-The Study of Matter and Its Changes,* 5th ed., Wiley Plus, (2009).
2. Miessler, G. L.,Tarr, D. A., *Inorganic Chemistry*, 4th ed., Prentice-Hall International, New Jersey, USA, (2010).
3. Douglas, B., McDanial, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, New York, (1994).
4. Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
5. Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2nd ed., Oxford University Press, (1994).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, (1999).
7. Atkins, P. and Jones, L., *Chemicals Principles: The Quest for Insight,* 5th ed., W. H. Freeman, (2010).
8. Mandelkern, L., *An Introduction to Macromolecules*, 2nd ed., Springer Verlag, New York, (1983).
9. Ravve, A., *Principles of Polymer Chemistry*, 2nd ed., Plenum Publishers, (2000).
10. Crabtree, R. H., *The Organometallic Chemistry of the Transition Metals,* 5th ed., John-Wiley and Sons, New Jersey, (2011).
11. Yamamoto, A., *Organotransition Metal Chemistry,* Prentice Hall, (1992).
12. Billmeyer, F. W., *A Text Book of Polymer Science*, 3rd, John-Wiley and Sons, (2003).
13. Malmcoim, P.S., *Polymer Chemistry: An Introduction*, 3rd ed.,Oxford University Press, (2005).

BS 4th Year

Semester-VII (INORGANIC CHEMISTRY)

Course Title: INORGANIC SPECTROSCOPY

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will acquire understanding about various types of transitions (e. g. dd transition, charge transfer) occurring in transition metal compounds and to characterize new compounds by application of electronic spectroscopy.

Course Contents:

Electronic States of transition metal complexes, Russel-Sander's coupling scheme, derivation of term symbols for d^1-d^{10} systems, d-d transitions, connecting atomic states and molecular states, correlation diagrams, Tanabe - Sugano diagrams, calculation of 10Dq values, High-spin and low-spin molecules, Jahn-Teller effect, applications of subgroups, selection rules for electronic transitions in molecules, LMCT and MLCT transitions, some examples involving different geometries.

Recommended Books:

1. Yarwood, J., Bazin, P., and Douthwaite, R., *Spectroscopic Properties of Inorganic and Organometallic Compounds,* Volume 42, The Royal Society of Chemistry, UK, (2011).
2. Lever, A. B. P., *Inorganic Electronic Spectroscopy,* 2nd ed., Elsevier, UK, (1984).
3. Brisdon, A. K., *Inorganic Spectroscopic Methods*, Oxford University Press, UK, (1998).
4. Solomon, E.I., *Inorganic Electronic Structure and Spectroscopy: Methodology,* Volume 2, Wiley, New York, (1999).

BS 4th Year

Semester-VII (INORGANIC CHEMISTRY)

Course Title: Lab-I

Code: CHEMCredit

Hours: 1

Course Contents:

The resolution of *cis*-dichlorobis (ethylenediamine) chromium (III) chloride into its optical isomers. The preparation and resolution of the tris (ethylenediamine) cobalt (III) ion into its optical antipodes. Estimation of Al (III) and Fe (III) using 8-hydroxyquinoloine. Estimation of Ni (II) in the presence of Cu (II).
Determination of chloride in the presence of iodide and evaluation of K_{sp} of AgI and AgCl.
Determination of dissociation constant Ka for acetic acid.
Determination of Ni^{+2} ions by EDTA (Back titration).
Determination of Ca^{+2} and Zn^{+2} ions by EDTA (Masking titration).
Titration of strong acid and weak acid with a strong base.
Precipitation titration involving $AgNO_3$ and KCl.

Recommended Books:

1. Bassett, J., Denny, P. C., Jeffery, G. H., Mendham, J., *Vogel's textbook of Quantitative Inorganic Analysis,* 4th ed., English Language Book Society, (1978).
2. Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods,* 2nd ed., Chapman and Hall, (1974).

BS 4th Year

Semester-VII (ORGANIC CHEMISTRY)

Course Title: HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS

Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about C-Hetero atom bond with emphasis on how it is formed and how it reacts. The importance and applications of compounds containing hetero atom should also be discussed.

Course Contents:

Aromatic Heterocycles:

Structure, classification and nomenclature; aromaticity; basicity and acidity of the nitrogen heterocycles; synthesis and reactions, chemistry of furan, pyrrole and thiophene, pyridine;

Organometallic Compounds:

Principles, organomagnesium, organolithium, organocopper, organocadmium, organomercury and organozinc compounds: their structure and reactivity, methods of preparation and synthetic applications.

Chemistry of organic compounds containing sulfur, phosphorus, boron and silicon: synthesis, reactions and application.

Recommended Books:

1. Claydem, J., Greeves,N. and Warren, S., *Organic Chemistry,* 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. Norman, R. O. C., *Principles of Organic Synthesis*, 3rd ed., CRC Press, (1993).
3. Joule, J. A., Mills, K., *Heterocyclic Chemistry*, 5th ed., John-Wiley & Sons, UK, (2010).
4. Crabtree, R. H., *The Organometallic Chemistry of the Transition Metals,* 5th ed., John-Wiley & Sons, New Jersey, (2009).

BS 4th Year

Semester-VII (ORGANIC CHEMISTRY)
Course Title: REACTIVE INTERMEDIATES
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge regarding the rearrangement reactions and their types including some name reactions, and different intermediates involved in organic reactions. Students are expected to learn the underlying concepts and synthetic applications.

Course Contents:

Reactive Intermediates:

Carbocations, carbanions, free radicals, carbenes, nitrenes, and arynes, their generation, stability, reactions and synthetic applications. Chemistry of Enolates and Enols: Acidity of carbonyl compounds, enolization of carbonyl compounds, α-halogenation of carbonyl compounds; aldol-addition and aldolcondensation,
condensation reactions involving ester enolate ions, alkylation
of ester enolate ions.

Rearrangement Reactions:
Types of rearrangements, general mechanisms of nucleophilic, free radical and electrophilic rearrangements, hydrogen and/or carbon migration to electron-deficient carbon, nitrogen and oxygen, carbon migration to electronrich carbon, aromatic rearrangements, inter- and intra-molecular carbon migration from oxygen to carbon.

Recommended Books:

1. Clayden, J., Greeves, N. and Warren, S., *Organic Chemistry*, 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. and Norman, R.O.C., *Principles of Organic Synthesis*, 3rd ed., Chapman and Hall, UK, (1993).
3. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry*, 6th ed., Brooks/Cole Learning, (2012).
4. John, E. M., *Organic Chemistry,* 8th ed., Brooks/Cole Publishing Co., USA, (2012).
5. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).

BS 4th Year

Semester-VII (ORGANIC CHEMISTRY)
Course Title: ORGANIC SPECTROSCOPY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire an adequate knowledge about fundamental and instrumental aspects of different spectroscopic techniques and will be able to perform structural elucidation of organic compounds using spectral data.

Course Contents:

UV-Visible:
Basic concepts, electronic transitions, Lambert-Beer's law, factors influencing the lambda max (λ_{max}) values, Woodward rules for calculation of wavelength values.

IR spectroscopy:
Basic concepts, absorption mechanisms, functional group determination and factors affecting the absorption frequencies.

^{1}H-NMR and ^{13}C-NMR:
Chemical shift, factors affecting chemical shift, spin relaxation, spin-spin coupling, coupling constants, nuclear overhauser effect, 2-D NMR, COSY and HETCOR.

Mass Spectrometry:
Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation, combined usage of IR, UV, NMR and Mass spectrometric data for structure elucidation of organic compounds having medium complexity.

Recommended Books:

1. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1st ed.,

Alpha Science Int. Ltd., (2003).
2. Kalsi, P. S., *Spectroscopy of Organic Compounds,* 6th ed., New Age International, New Delhi, India, (2007).
3. Yadav, L. D. S., *Organic Spectroscopy*, Springer, UK, (2005).
4. Kemp, W., *Organic Spectroscopy*, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).
5. Younas, M., *Organic Spectroscopy*, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).
6. Hollas, J. M., *Modern Spectroscopy,* 4th ed., John-Wiley & Sons, Inc., (2004).
7. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., *Introduction to Spectroscopy,* 4th ed., Brooks/ Cole Cengage Learning, (2009).
8. Silverstein, R. M., Webster, F. X. and Kiemle, D., *Spectrometric Identification of Organic Compounds,* 7th ed., John-Wiley & Sons, Inc., (2005).
9. Williams, D. H. and Flemming, I., *Spectroscopic Methods in Organic Chemistry,* 6th ed., McGraw-Hill Higher Education, (2008).

BS 4th Year

Semester-VII (ORGANIC CHEMISTRY)

Course Title: Lab.I

Code: CHEMCredit

Hours: 1

Course Contents:

Experiments based on available spectroscopic techniques may be arranged, both of qualitative and quantitative nature. One- and two-step synthesis using available starting material are recommended.

Recommended Books:

1. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1st ed.,Alpha Science Int.Ltd., (2003).
2. Williams, D. H. and Flemming, I., *Spectroscopic Methods in Organic Chemistry,* 6th ed., McGraw-Hill Higher Education, (2008).
3. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5th edition, Longman, UK, (1989).

BS 4th Year

Semester-VII (PHYSICAL CHEMISTRY)

Course Title: ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will develop understanding of the electrochemical processes, thermodynamic principles and mechanisms involved in aqueous salt solutions

as well as colloidal solutions. In the second part of the course, students will acquire knowledge about the molecular level treatment of the thermodynamic functions/properties using partition functions and Boltzmann statistics.

Electrochemistry:

Electrical double layer, interface, a look into the interface, OHP (Outer Helmholttz Plane) and IHP (Inner Helmholttz Plane) , contact adsorption, Gibbs Surface Excess, potential differences across metal solution interfaces, outer and surface potential differences, galvanic potential difference, electrochemical potential difference, interfacial tension, electro-capillary thermodynamics, Lippmann's equation, Helmholtz-perrin model, Gouy-Chapmann model, Stern model of electrical double layer, and BDM (Bockris-Devanathan-Muller) model, charge density, differential capacitance, shape of capacitance-charge curve, the Capacitance hump.

Electrochemical devices, charge transfer processes in the absence and presence of electrical field, the over potential, Butler-Volmer's equation,the idea of equilibrium exchange current density, the symmetry factor, high field and low field approximation, Tafel's equation, cyclic voltammetry and its applications, Fuel cell, corrosion and its prevention, electrochemical impedance spectroscopy.

Statistical Thermodynamics:

Description of various systems, Concepts of states, accessible states and distribution, Probability concepts, Maxwell-Boltzmann's statistics for the systems of independent particles, Partition functions, The relationship of partition function to the various thermodynamic functions, Transitional, vibrational and rotational partitional functions and equilibrium constant, Statistical thermodynamics, Applications to equilibrium and chemical kinetics, Bose-Einstein's and Fermi-Dirac's statistics.

Recommended Books:

1. Gasser, R. P. H., *Entropy and Energy Level,* Rev. ed., Oxford University Press, New York, (1986).
2. Wayatt, P. A. H., *The Molecular Basis of Entropy and Chemical Equilibrium,* Royal Institute of Chemistry London, UK, (1971).
3. Bockris J. O. M., and Reddy, A. K. N., *Modern Electrochemistry: Ionics*, Vol. I, 2nd ed., Plenum Press, London, (1998).
4. Seddon, J. M. and Gale, J. D., *Thermodynamics and Statistical Mechanics,* Royal Society of Chemistry, (2001).
5. Engel, T., Reid, P., *Thermodynamics, Statistical Thermodynamics, and Kinetics,* 3rd ed., Prentice Hall, (2012).
6. Bard, A. J. and Faulkner, L. R., *Electrochemical Method*: *Fundamentals and Applications* 2nd ed., John-Wiley & Sons, New York, (2001).
7. Kondepudi D., *Introduction to Modern Thermodynamics,* John-Wiley & Sons, (2008).
8. Hamann, C. H., Hamnett, A. and Veilstich, W., *Electrochemistry,* 2nd ed., Wiley-VCH Verla Gnb H and Co. KGaA, (2007).
9. Braun R. D. and Walters F., *Application of Chemical Analysis,* McGraw-Hill, (1982)

10. McQuarrie, D. A., *Statistical Mechanics*, Viva Books Private Ltd. (2008).

BS 4th Year

Semester-VII (PHYSICAL CHEMISTY)
Course Title: POLYMER CHEMISTRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will learn the fundamental principles of polymerization, synthesis methods and reaction mechanisms, thermodynamic and kinetic aspects of the polymerization, and physical and mechanical properties of polymers. Students will also know about the polymer characterization techniques and various applications of polymers.

Polymer Chemistry:

Introduction to Polymers, step-growth polymerization, polymer chain growth, kinetics of polymer chain growth, co-polymerization, emulsion polymerization, natural and inorganic polymers, physical aspects of polymers, molecular weight of polymers, distribution, averages, and methods of determination, viscosity, osmometry, light scattering method, diffusion, sedimentation, optical rotation method, structure of polymer chain, introduction to chain isomerism, stereochemistry, configurations, and conformations (not in Hiemenz), amorphous state of polymers, in-depth examination of polymer conformation, microstructure, and dynamics in the amorphous state, polymer viscoelasticity, stress relaxation, mechanical models of polymer behavior, time-temperature superposition, polymer rheology, crystalline state of polymers, crystallization and kinetics, crystalline structures, experimental methods, polymer solutions and blends.

Recommended Books:

1. Sperling, L. H. *Introduction to Physical Polymer Science*, 4th ed., Wiley-Interscience, New York, USA, (2006).
2. Boyd, R. H. and Phillips, P. J., *The Science of Polymer Molecules*, Cambridge, UK, (1993).
3. Odian, G., *Principles of Polymerization,* 4th ed., Wiley Interscience, (2004).
4. Carraher Jr, C. E., *Carraher's, Polymer Chemistry,* 8th ed., CRC Press, Inc., (2010).
5. Ravve, A., *Principles of Polymer Chemistry,* 3rd ed., Springer, (2012).
6. Stevens, M. P., *Polymer Chemistry: An Introduction,* 3rd ed., Oxford University Press, (1998).
7. Allcock, H., Lampe, F. and Mark, J., *Contemporary Polymer Chemistry,* 3rd ed., Prentice Hall, (2003).
8. Flory, J., *Principles of Polymer Chemistry*, Cornell University Pres (1953)

BS 4th Year

Semester-VII (PHYSICAL CHEMISTRY)
Course Title: QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY

Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about quantum chemistry including Schrödinger wave equation and its applications to define the behavior and properties of different systems. In addition they will learn about different molecular spectroscopic techniques.

Course Contents:

Quantum Chemistry:

Operators and their properties, Schrödinger wave equation, particle in a box and a ring, quantum mechanical tunneling, angular momentum, postulates of quantum mechanics, central field problem, approximate methods, perturbation methods and variation principle, many electron systems, treatment of simple harmonic oscillator, diatomic rigid rotor, valence bond and molecular orbital theories, Hũckel method for pi-electron approximation in aromatic compounds.

Molecular Spectroscopy:

Interaction of electromagnetic radiation with matter, symmetry properties of molecules, microwave and infrared spectroscopy, rotational, vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules, electronic spectra of simple molecules, nuclear magnetic resonance spectroscopy.

Recommended Books:

1. Fayer, M. D., *Elements of Quantum Mechanics,* Oxford University Press, London, UK, (2001).
2. Becker, E. D., *High Resolution NMR; Theory & Chemical Application*, 3rd ed., Academic Press, New York, USA, (2000).
3. Graybeal, J. D., *Molecular Spectroscopy*, 1st ed., McGraw-Hill, New York, (1988).
4. Hayward, D. O., *Quantum Mechanics for Chemists*, Royal Society Of Chemistry, (2002).
5. House, J. E., *Fundamentals of Quantum Mechanics* 2nd ed., Elsevier-Academic Press, New York, USA, (2004).
6. Kirsten, H. J. W. M., *Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral* 1st ed., World Scientific Publishing Co. Pvt. Ltd., (2006).
7. Barrow, G. M., *Physical Chemistry,* 6th ed., McGraw-Hill Book Company, (1996).
8. Straughan, B. P., and Walker, S., *Spectroscopy*, Vol. 1 and 2., Chapman and Hall Ltd., (1976).
9. Coulson C. A., *Vanlence*, Oxford University Press (1980).
10. Sathyanarayana, D. N., *Vibrational Spectroscopy, Theory and Applications*, New Age International Publishers (2004).

BS 4th Year

Semester-VII (PHYSICAL CHEMISTRY)
Course Title: Lab-I
Code: CHEMCredit
Hours: 1

Course Objectives:

The course will provide the practical grounds for the verification of fundamental principles of physical chemistry and applications of these principles. In addition it will enable the students to apply these practical methods in other branches of chemistry. Students will also learn the advance techniques like XRD and cyclic voltammetry for characterization of materials.

Course Contents:

Determination of partial molar properties.
Determination of free energy changes, standard free energies.
Verification of Kohlrausch's law.
Study of temperature dependence of electrode potentials.
Determination of heat of solution, ionic reactions and other experiments from thermochemistry.
Determination of molecular weight of a polymer by viscosity method.
Precipitation value of electrolytes.Measurement of IR spectra of simple compound and their interpretation.
Measurement of cyclic voltammogram of an organic compound and its interpretation.
Determination of dipole moment of an organic liquid.
Determination of percentage composition of $KMnO_4$-$K_2Cr_2O_7$ in given solution by spectrometry.
Evaluation of pKa value of an indicator by spectrometric method.
Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques.

Recommended Books:

1. Garland, C. W., Shoemaker, D. P., and Nibler, J. W., *Experiments in Physical Chemistry*, 8th ed., McGraw-Hills, New York, (2003).
2. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Prentice Hall Press, (1974).
3. Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd ed., W. H. Freeman, (2006).
4. Athawale, V. D., and Mathur. P., *Experimental Physical Chemistry*, New Age International (2001).
5. Farrington, D., *Experimental Physical Chemistry*, BiblioBazaar, (2011).
6. Palmer, W. G., *Experimental Physical Chemistry,* 2nd ed., Cambridge University Press (2009).

BS 4th Year

Semester-VII (APPLIED CHEMISTRY)
Course Title: COMMON INDUSTRIES-I
Code: CHEM
Credit Hours: 3

Course Objectives:

Students will acquire knowledge and technical know-how about sugar manufacturing industry, starch production industry and leather tanneries.

Sugar Industry:

Scope of sugar industry, Manufacture of raw sugar from cane and beet,

Refining of raw sugar, Methods of clarification of cane juice and chemistry involved in the clarification processes, Defecation Remelt Carbonation (DRC), Defecation Remelt Sulphitation (DRS), Defecation Remelt Phosphitation (DRP) and Double Carbonation Double Sulphitation (DCDS), Utilization of byproducts
of sugar industry.

Starch Industry:

Scope of starch industry, Raw materials for starch production, Manufacture of starch from various raw materials such as corn, rice, wheat, potatoes, Industrial applications of starch, Chemistry involved in the conversion of starch, Synthesis of d-glucose and dextrin from starch.

Leather Industry:

Leather, gelatin and adhesives, Preparation of hides, Methods of tanning, vegetable and chrome tanning processing of leather, Production of glue and gelatin.

Recommended Books:

1. Rao, G. P., Mogarey, R. C., Solomn, S., Rewal, S. S. and Li,Y-., *Sugar Cane: Production Managemnet and Agro-Industrial Imperatives*, Ibdc Publisher, (2005).
2. Covington, A. D., *Tanning Chemistry: The Science of Leather,* Royal Society of Chemistry, (2009).
3. Kent, J. A., *Riegel's Handbook of Industrial Chemistry,* 10th ed., Kluwer Academic/ Plenum Publishers, (2003).

BS 4th Year

Semester-VII (APPLIED CHEMISTRY)

Course Title: AGRO BASED INDUSTRIES AND POLLUTION CONTROL

Code: CHEM

Credit Hours: 3

Course Objectives:

Students will acquire knowledge about various fertilizers, pesticides and herbicides used in agriculture sector as well as know about the environmental pollution and its protection.

Fertilizers:

Importance of chemical fertilizers, classification of chemical fertilizers, manufacture and chemistry involved in the production of various fertilizers i.e. Urea, Single Super phosphate (SSP), Triple superphosphate (TSP), Nitrophos (NP), Diammonium phosphate (DAP), Calcium ammonium nitrate (CAN), Ammonium nitrate (AN), Ammonium sulphate (AS), Zinc sulphate (ZS) and Complex fertilizers.

Agrochemicals:

Classification of pesticides, formulation and toxicity of pesticides, future trends of pest control, control of weeds, household agrochemicals, plant growth regulators and background chemistry, hazards associated with the use of agrochemicals and environmental aspects.

Industrial Pollution and Its Abatement:

Sources of air, water and soil pollution, Industrial waste control for the protection of environment, modern trends of waste management.

Recommended Books:

1. Afonso, C. A. M. Crespo, J. P. G. and Anastas, P. T., *Green Separation Process: Fundamentals and Applications,* Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, (2005).
2. Manahan, S. E., *Fundamentals of Environmental Chemistry*, 2nd ed., CRC Press, (2001).
3. Lister, J. and Ennis, B., *The Science and Engineering of Granulation Processes,* Kluwer Academic Publishers, (2004).
4. Park, M., *The Fertilizer Industry,* Woodhead Publishing Limited, (2001).
5. Anastas, P. T. and Warmer, J. C., *Green Chemistry: Theory and Practice,* Oxford University Press, (2000).
6. Kumar, A., *Industrial Pollution: Problems and Solution,* Daya Publishing House, India, (2006).
7. Kent, J. A., *Riegel's Handbook of Industrial Chemistry,* 10th ed., Kluwer Academic/ Plenum Publishers, (2003).

BS 4th Year

Semester- VII (APPLIED CHEMISTRY)
Course Title: COMMON INDUSTRIES-II
Code: CHEM
Credit Hours: 3

Course Objectives:

Students will acquire knowledge for extraction, production and processing oil, fats and waxes. They will also gain knowledge about soap and detergent industries as well as surface coating industries.

Oils and Fats:

Oils, Fats and Waxes, extraction of oils such as soya bean and cotton seed oils, purification and refining of oils, chemistry involved in the production of vegetable ghee, selective hydrogenation of oil and fats during the manufacture of vegetable ghee, inter-esterification of crude fats.

Soaps and Detergents:

Raw materials for the manufacture of soap and detergents, chemistry involved in the production of soap and detergents, action of builders, additives brighteners and surfactants, cleansing action of soaps, effect of acidic species and hard water on soap, Production of transparent soap.

Paints:

Raw materials for paints and pigments, classification and properties of surface-coating constituents, classification and manufacture of pigments, production of paints, varnishes, distempers, enamels and lacquers, chemistry involved in the drying phenomena of paints, drying oils for paint and classification of drying oils.

Recommended Books:

1. Vermani, O. P, Narula, A.K, *Applied Chemistry, Theory and Practice*, 2nd ed., New Age International. Publisher, India, (1995).

2. Balasaraf, V. M, *Applied Chemistry*, I. K. International House Pvt. Ltd, India, (2009).
3. P. K. Chattopadyay, *Modern Technology of Soaps, Detergents and Toilries: with formulae and project profile, 2nd ed.,* National Institute of Industrial Research, India, (2003).
4. Bockisch M., *Fats and Oils Handbook,* American oil Chemists and Society, (1998).
5. Gunstone F., *Oils and Fats in Food Industry,* Wiley Black Well, (2008).
6. Gunstone F., *Vegetable Oil in Food Technology: Composition, Properties and Uses,* John-Wiley & Sons, (2011).
7. Lambourme, R., Strivens, T.A., *Paint and Surface Coatings: Theory and Practice, 2nd ed.,* Woodhead Publishing Limited, (1999).

8. Board. B, *Paint, Pigment, Solvent, Coating, Emulsion, Paint additives and formulations,* Engineers India Research Incorporation, (2008).
9. Kent, J. A., *Riegel's Handbook of Industrial Chemistry,* 10th ed., Kluwer Academic/Plenum Publishers, (2003).

BS 4th Year

Semester- VII (APPLIED CHEMISTRY)
Course Title: Lab-I
Code: CHEM
Credit Hours: 1

Course Objectives:

The practical design for this course code will polish the psychomotor skills of students and enable them to acquire acquire knowledge about various industrial preparation fertilizers, pesticides and herbicides used in agriculture sector as well as know about the environmental pollution and its protection. Select suitable practicals for respective courses of Applied Chemistry

Course Contents:

Determination of iodine value of the given oil.
Determination of acid value of the given oil.
To find out the percentage purity of fatty acid.
Preparation of gum sample.
Preparation of liquid detergent or liquid soap.
To determine the temporary and permanent hardness of a given water sample by EDTA method.
To determine the alkalinity of given water sample.
Determination of magnesium and aluminum by EDTA titration.
Analysis of caustic soda and soda ash in mixtures.
Analysis of effluents from tanneries.
Preparation and Testing of: Varnish and Enamel Paints. Adhesives. Emulsion Paints.

Recommended Books:

1. Roger's Industrial Chemistry. Von Norstand Co. N. Y.
2. Reigel's Handbook of industrial chemistry. Von Norstand Reeinhold Co. N. Y.

3. Chemical Process Industries by Shreve and Dum. McGraw Hill.
4. An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.
5. Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.
6. Concise Engineering Chemistry, Neetu Goel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).
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7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
8. Vogel's Textbook of Qantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

BS 4th Year

Semester-VII (ANALYTICAL CHEMISTRY)
Course Title: ATOMIC SPECTROSCOPY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about theoretical aspects and instrumentation of different atomic spectroscopic methods as well as learn about the applications of these techniques in the field of chemical sciences.

Course Contents:

Flame Photometry:
Origin and classification of atomic spectroscopic methods, origin of atomic spectrum, position of the signal, intensity of the signal, spectral line width, principle of flame photometry, fate of the sample in the flame, flame and its characteristics,instrumentation for flame photometry, merits and limitations.

Atomic Fluorescence Spectrometry:
Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomic fluorescence transitions, principle of atomic fluorescence spectrometry, fluorescence intensity and analyte concentration, instrumentation for atomic fluorescence spectrometry, applications of atomic fluorescence spectrometry, interferences, merits and limitations.

Atomic Absorption Spectrophotometry:
Principle of atomic absorption spectrophotometry, concentration dependence of absorption, quantitative methodology, instrumentation for atomic absorption spectrophotometry, radiation sources, atomizers, flames, graphite furnaces and electrochemical atomizers, monochromators, detectors, handling background absorption, interferences in atomic absorption spectrophotometry, sample handling in atomic absorption spectrophotometry, preparation of the sample, use of organic solvents, microwave, digestion, sample introduction methods, applications of atomic absorption spectrophotometry.

Atomic Emission Spectrophotometry:
Introduction, principle of atomic emission spectrometry, atomic emission spectrometry using plasma sources, plasma and its characteristics, inductively

coupled plasma, direct current plasma, microwave induced plasma, choice of argon as plasma gas, instrumentation for ICP-MS.

Recommended Books:

1. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
4. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Skoog, D. A. and West., D. M., *Fundamentals of Analytical Chemistry*, 8th ed., Hot Reinehart Inc., London, (2008).
6. Ebdon,L., Evaus, E.H, Fischer, A., and Hill, S.J., *An Introduction to Analytical Atomic Spectrometry,* John Wiley & Sons, England. (1998).
7. Bernhard Welz, Michael Sperling, *Atomic Absorption Spectrometry,* 3rd ed., Wiley-VCH, Germany, (1998).
8. Farrukh, M. A., *Atomic Absorption Spectroscopy,* In Tech, (2012).
9. Kellner, R., Mermet, J. M, Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry : A Modern Approach to Analytical Science*, Wiley-VCH,(2004)

BS 4th Year

Semester-VII (ANALYTICAL CHEMISTRY)
Course Title: ELECTROANALYTICAL TECHNIQUES
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire sound knowledge regarding the theoretical, instrumental as well as application related aspects of different electroanalytical techniques

Course Contents:

Potentiometry:

Electrode potential, Nernst equation and its use for measuring half-cell potential, different kinds of electrodes including glass and calomel electrodes, working of potentiometer and its applications including pH measurements, Ion selective electrode systems, Ion exchange membrane electrode, solid state membrane electrodes, and bio-membrane electrodes, Potentiometric titrations.

Coulometry and Electrogravimetry:

Basic electrochemistry, principle, instrumentation of coulometry, principle, instrumentation of electrogravimetry, consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.

Voltammetry and Polarography:

Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry. voltammetric equation, basic concept of polarography and interpretation of various polarographic curves, measurement of decomposition

potential, diffusion and limiting currents, derivation of Ilkovic equation, logarithmic analysis of polarographic wave, advantages and limitation of dropping mercury electrode.

Recommended Books:

1. Christian, G. D., *Analytical Chemistry,* 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis 8*th ed.,W.H. Freeman and Company, New York, (2009).
3. Kealey, D. and Haines , P. J., *BIOS Instant Notes in Analytical Chemistry,* Bios Scientific Publishers Limited, Oxford, UK, (2002).
4. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Skoog, D. A. and West, D. M., *Fundamentals of Analytical Chemistry,* 8th ed., Hot Reinehart Inc., London, (2008).
6. Fritz, Schulz, *Electranalytical Methods: Guide to Experiments and Applications.* 2nd revised, Springer-Verlag Berlin, Germany, (2010).
7. Monk,P.M.S, *Fundamentals of Electroanalytical Chemistry,* John-Wiley & Sons Ltd, England, (2001).

BS 4th Year

Semester-VII (ANALYTICAL CHEMISTRY)
Course Title: ADVANCED SEPARATION TECNIQUES
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about the principles and instrumentation of advanced chromatographic techniques namely GLC, HPLC and capillary electrophoresis along with their applications in different fields such as food, pharmaceuticals, petroleum, environmental and other industrial sectors.

Course Contents:

Introduction:
Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.
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Gas Liquid Chromatography:
General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.
HPLC:
General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.
Capillary electrophoresis:
Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J. and Crouch, S. R., *Fundamentals*

of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
2. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, New York, (2004).
3. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry,* 1st ed., Taylor & Francis, (2002).
4. Sharma, B.K. *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Grob, R. L., Eugene, F. Barry, *Modern Practice of Gas Chromatography,* 4th ed., John-Wiley & Sons, USA, (2004).
6. Kellner, R., Mermet, J-. M., Otto, M., Valcarcel, M. and Widmer, H. M., *Analytical Chemistry: A Modern Approach to Analytical Science,* Wiley-VCH, (2004).
7. Meyer, V. R., *Practical High-Performance Liquid Chromatography,* 5th ed., John-Wiley & Sons, Ltd., (2010).
8. Lindsay, S., *High Performance Liquid Chromatography,* 2nd ed., John-Wiley & Sons, Ltd., (1992).
9. Braitwaite, A. and Smith, F. J., *Chromatographic Methods,* 5th ed., Kluwer Academic Publishers, (1999).
10. Miller, J. M., *Chromatography: Concepts and Contrasts,* 2nd ed., John-Wiley & Sons, Inc., (2005).
11. Camilleri, P., *Capillary Electrophoresis: Theory and Practice,* 2nd ed., CRC Press, (1998).

BS 4th Year

Semester-VII (ANALYTICAL CHEMISTRY)

Course Title: Lab-I

Code: CHEMCredit

Hours: 1

Course Objectives:

Separation of hydrocarbons using GLC, Separation of essential oils, fatty acids, To determine pKa values for the given samples of weak acids by potentiometric method. Quantitative determination of sodium hydroxide by potentiometric titration. Preparation of buffer solutions of definite pH. Electrogravimetric determination of copper in given samples. Study of thermal decomposition of copper sulfate pentahydrate and calcium oxalate monohydrate.

Recommended Books:

1. Harris, D. C., *Quantitative Chemical Analysis*., 8th ed., W. H. Freeman and Company, New York, (2011).
2. Braitwaite, A. and Smith, F. J., *Chromatographic Methods,* 5th ed., Kluwer
3. Camilleri, P., *Capillary Electrophoresis: Theory and Practice,* 2nd ed., CRC Press, (1998).
4. Weinberger, R., *Practical Capillary Electrophoresis,* 2nd ed., Academic Press, (2000).

BS 4t h Year

Semester-VII (BIOCHEMISTRY)

Course Title: BIOMEDICAL CHEMISTRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about the fundamental biochemical and molecular aspects of endocrinology and chemistry of blood and other extracellular fluids.

Course Contents:

Endocrinology:

General introduction, chemical nature of hormones, common characteristics, mode of action of hormones, hormones receptors, chemistry, biosynthesis, metabolism and biological functions of pituitary, adrenal, thyroid, parathyroid, pancreatic and gonadal hormones, hormones of GIT, renal and pineal Glands.

Blood and Other Body Fluids:

General composition of blood, function of blood plasma, plasma protein, composition and functions, composition, development and functions of red blood cells, white blood cells and platelets, Hemoglobin, chemistry properties, synthesis, functions and derivatives, degradation of hemoglobin, respiration and gas transport, blood coagulation and clotting of blood, blood pressure, blood groups, composition of urine, extracellular fluids like: cerebrospinal fluid, lymph, sweat, tears, synovial and interstitial fluid.

Recommended books:

1. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry,* 6th ed., W. H. Freeman, (2012).
2. Voet, D. and Voet, J. D, *Biochemistry,* 4th ed., illustrated. John Wiley & Sons, (2011).
3. Hall, J. E., *Guyton & Hall Textbook of Medical Physiology,* 12th ed., Elsvier Health Sciences,(2011).
4. Orten, James. M. and Neuhaus, O. W., *Human Biochemistry,* 10th ed., Mosby, Incorporated, (1982),
5. Devlin, T. M., *Textbook of Biochemistry with Clinical Correlations,* 7th ed., Wiley, (2010).
6. Frisell, W. R., *Human Biochemistry,* 1st ed., Macmillan Publication Company, (1982).
7. Hadley, M. and Levine, J. E., *Endocrinology,* 6th ed., pearson, (2006).

BS 4th Year

Semester-VII (BIOCHEMISTRY)

Course Title: MOLECULAR BIOLOGY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about the structural and functional features of DNA and RNA.

Course Contents:

DNA: the primary genetic material, structure, replication in prokaryotes and

comparison with eukaryotes, DNA sequencing, chemical synthesis of polynucleotides, DNA repair and recombination. Different types of RNA and their role in protein synthesis, transcription and its regulation, genetic code, post transcriptional processing, structure of transfer RNA, protein synthesis inhibitors, control of translation, post translational modification, plasmids, bacteriophage and cosmids, *invitro* mutagenesis, deletion, insertion and substitution, recombinant DNA and genetic diseases.

Recommended Books:

1. Watson, J. D., Baker, A. T., Bell, S. P., Gann A., Levine, M. and Losick, M. R., *Molecular Biology of the Gene,* 7th ed., Benjamin Cummings, (2013).
2. Watson, J. D., Myers, R. M., Caudy A. A., and Witkowski, J. A., *Recombinant DNA: Genes and Genome. A Short Course,* 3rd ed., W. H. Freeman, (2006).
3. Krabs, J., *Genes X* 10th ed., Jones and Bartlett Learning, (2011).
4. Alberts, B., *Molecular Biology of the Cell,* 5th ed., Publisher: Garland Science, (2008). ISBN: 0815341113, 9780815341116.
5. Brown, T.A., *Genomes 3,* 3rd ed., Publisher: Garland Science Publishing, (2007). ISBN: 0815341385, 9780815341383.

BS 4th Year

Semester-VII (BIOCHEMISTRY)

Course Title: PHYSICAL TECHNIQUES IN BIOCHEMISTRY

Code: CHEM

Credit Hours: 3

Course Objectives:

Students will gain knowledge and in depth understanding about the fundamental biochemical techniques such as extraction, purification, fractionation and centrifugation being applicable for macromolecules separation as well as those techniques which are used for characterization of biomolecules.

Course Contents:

Extraction, Fractionation and Purification of Macrobiomolecules:
Homogenization, solubilization and concentration including ultrasonication, lyophilization and ultradecantation, purification based on differential solubility techniques, ion-exchange chromatography, gel chromatography, affinity chromatography, paper & thin layer chromatography and HPLC.

Electrophoresis:
Paper and gel electrophoresis, two-dimensional electrophoresis, capillary electrophoresis.

Electrofocusing:
Preparative and analytical electrofocusing.

Centrifugation:
Principle, preparative centrifugation, application of density gradient and differential centrifugation, ultracentrifugation sedimentation equilibrium and sedimentation velocity methods, application of analytical centrifugation.

Tracer techniques:
Detection and measurement of radioactivity, application of radioisotopes in

biological system.

U.V. and Visible Spectroscopy:

Basic principles, instrumentation and applications.

Enzyme linked immunosorbent assay (ELISA):

Basic principle, instrumentation and applications.

Recommended Books:

1. Cooper, T. C., *The Tools of Biochemistry,* 2nd ed., John Wiley, (2007).
2. Wilson, K. and Golding, K. H., *A Biologist's Guide to Principles and Techniques of Practical Biochemistry*, 3rd ed., Edward Arnold, (1986).
3. Dawes, E. A., *Quantitative Problems in Biochemistry,* 5th ed., Williams & Wilkins, (1972).
4. Morris, J. G., *A Biologist's Physical Chemistry,* 2nd ed., Addison-Wesley, (1974).
5. Scopes, R. K., *Protein Purification: Principles and Practice,* 3rd ed., Springer (1994).

BS 4th Year

Semester-VII (BIOCHEMISTRY)

Course Title: Lab-I

Code: CHEM

Credit Hours: 1

Course Contents:

Estimation of water soluble vitamin-C and fat soluble vitamin-D.
Estimation and kinetics studies of amylase and peroxidases.
Estimation of total protein in egg.
Characterization of proteins by SDS-PAGE.
Isolation and characterization of DNA by Agarose gel electrophoresis.

Recommended Books:

1. Boyer, R., *Modern Experimental Biochemistry,* 3rd ed., Pearson Education Inc., (2009). ISBN: 978-81-7758-884-2.
2. Shankara, Y. M.S., *Laboratory Manual for Practical Biochemistry,* 1st ed., Jaypee Brothers Medical Publishers (P) Ltd., India, (2008). ISBN: 978-81-8448-259-1.

BS 4th Year

Semester: VII (FUEL CHEMISTRY)

Title of the Course: CHEMISTRY OF COAL CONVERSION PROCESSES-I

Code: CHEMCredit

Hours: 3

Course Objectives:

The students will acquire knowledge about environmentally friendly utilization of coal and how to extract maximum energy and convert coal in to a variety of highly demanding chemicals used as feed stock in a number of Industries.

Course Contents:

Coal: Composition, structure, coalification and classification of coal, ASTM international and coal Standards. Use of coal in different industries like power

generation, steel and other metallurgical operations. Coal exploration, mining and mining risk handling, pretreatment and preparation of coals. Innovations in coal using industry.

Environmental Aspects:

Pollution problems associated with coal combustion, mining and flue gases.

Gasification:

Thermodynamics, kinetics and catalytic aspects of coal gasification, fixed bed gasifier, fluidized bed gasifier, transport reactor, liquid medium gasifier and underground gasification. Gas upgrading by carbon monoxide shift, gas purification, methanation and dehydration, properties and processing of gaseous fuels, environmental consideration.

Recommended Books:

1. Wen, C.Y. and Stanley, E. *Coal conversion Technology,* Addison-Wesley, New York. (1979).
2. Probstein, R.F and Hicks, R.E. *Synthetic Fuels,* McGraw Hill, New York. (1982).
3. Francis, W. *Fuels and Fuel Technology,* Pergamon Press, London. (1980).
4. Merick, D. *Coal Combustion and Conversion Technology,* McMillan Ltd., London (1984).
5. Berkowitz, N. *The Chemistry of Coal,* Elsevier Amsterdam. (1985).

BS 4th Year

Semester-VII (FUEL CHEMISTRY)

Title of the Course: PETROLEUM AND PETROCHEMICALS-I

Code CHEMCredit

Hours: 3

Course Objectives:

The students will acquire knowledge about the modern refining operations for maximum recovery of petroleum products and to get knowledge using crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts. Mechanism of cracking and reforming. Effect of operating conditions on cracking and reforming products. Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane. Propane and naphtha. Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

Recommended Books:

1. Hobson, G.D. *Modern Petroleum Technology,* Part 2, John Wiley and Sons, New York. (1984).

2. Gates, B.C, Katzer, J.R and Schuit, G.C.A. *Chemistry of Catalytic Processes,* McGraw Hill Book company, London (1979).
3. List, H.L. *Petrochemical Technology,* Printice-Hall Englewood Cliffs, New Jersey. (1986).
4. Goodger, E.M. *Hydrocarbon Fuels,* Union Brothers Ltd, London. (1975).
5. Maleev, V.L. *Internal Combustion Engines,* McGraw Hill Book Company London, (1985).
6. Hughes, J.R., and Swindells, N.S. *Storage and Handling of Petroleum Liquids,* Charless Griffin and Company Ltd, London. (1987).
7. Wiseman, P. *An Introduction to Industrial Organic Chemistry,* Wiley Interscience, New York (2001).

BS 4th Year

Semester-VII (FUEL CHEMISTRY)

Title of the Course: CHARACTERIZATION OF FOSSIL FUELS

Code: CHEMCredit

Hours: 3

Course Objectives:

The students will acquire knowledge of the physicochemical and instrumental analysis of fuels

Course Contents:

Physicochemical: Determination and data interpretation using ASTM methods of API Gravity, Flash Point, Pour Point, Analine Point, Distillation behaviors, Octane no. Cetane number and RVP.

Analytical Methods: Analytical methods in the production of analytes and quality assurance of fuels using GC-FID, GC-MS, Calorimetry, Atomic absorption, ICP.

Recommended Books:

1. Ewing, G.W. *Instrumental Methods of Chemical Analysis*, McGraw Hill, London. (1985).
2. Chrisition, G.D. *Instrumental Analysis,* Allyn and Bacon, Inc, Boston, London. (1986).
3. Kagler, S.H. *Spectroscopic and Chromatographic Analysis of Mineral Oils,* John, Wiley and Sons, New York. (1983).
4. Karr. C. *Analytical Methods for Coal and Coal Products,* Academic Press, New York. (1978).
5. Harker, J.H. and Backurst, J.R. *Fuel and Energy,* Academic Press, London and New York (1988).
6. Skooge, D.A.*Instrumental Analysis,* Sanat Printer, Indian Edition, 2009.

BS 4th Year

Semester: VII (FUEL CHEMISTRY)

Title of the Course: Lab-I

Code: CHEMCredit

Hours: 1

Course Objective:

Determination of the electrical conductivity of aviation and distillate fuels,

containing static dissipator additives. Determination of the total base number of petroleum products by potentiometric titration. Determination of total salt content in crude petroleum by conductivity method. Determination of the kinematic viscosity of asphalt (bitumen). Determination of heat of combustion of liquid hydrocarbon fuels. Determination of neutralization number of lubricating oils by potentiometric titration. Determination of the calorific value of coal by bomb calorimeter. Determination of total sulfur in coal by bomb calorimeter. Determination of chlorine in coal by bomb calorimeter. Determination of the distillation behavior of petroleum fractions. Determination of sulfur in petroleum products by bomb calorimeter method. Determination of sulfur in petroleum products by lamp method.

Recommended Books:

1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)
2. Speight, J. G. Handbook of Coal Analysis. John Wiley and Sons, New Jersey, (2005)
3. ASTM, 2000, Annual Book of ASTM Standards, American Society for Testing and Materials, West Consbohockm, PA, USA

BS 4th Year

Semester-VIII (INORGANIC CHEMISTRY)

Course Title: ORGANOMETALLICS

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will acquire knowledge about chemistry of organometallics especially with reference to their types and bonding, and reactivity of organometallic compounds in homogeneous catalysis.

Course Contents:

Fundamentals of organometallic compounds, types of bonding in organometallics, single, double and triple bonds to carbon (compound types, acyls, alkylidene complexes and alkylidyne complexes), delocalized hydrocarbon systems (alkenes, olefins, allyl and butadienes), alkyne complexes, cyclic π-complexes (five and six membered rings). Homogeneous catalytic hydrogenation, dimerization, oligomerization, polymerization, hydroformylation of olefins, catalytic polymerization of acetylenes. Insertion reactions and uses of organometallic compounds in organic synthesis.

Recommended Books:

1. Powell, P., *Principles of Organometallics Chemistry*, 2nd ed., Springer, (1998).
2. Yamamoto A., *Organotransition Metal Chemistry*: *Fundamental Concepts and Applications,* 1st ed., John-Wiley & Sons, Inc., (1986).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Intersceince, New York, (1999).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).
5. Douglas, B., McDaniel, D. and Alexander, J., *Concepts and Models of*

Inorganic Chemistry, 3rd ed., John-Wiley & Sons, Inc., (1994).
6. Haiduc, I. and Zuckerman, J. J., *Basic Organometallic Chemistry,* Walter De Gruyter Inc., (1985).
7. Jolly, W. L., *Modern Inorganic Chemistry,* 2nd ed., McGraw-Hill Company, (1991).
8. Porterfield, W. W., *Inorganic Chemistry: A Unified Approach,* 2nd ed., Academic Press, (1993).
9. Vincet, A., *Molecular Symmetry and Group Theory:* 2nd ed., John-Wiley & Sons, Ltd., (2001).
10. Malik, W. U., Tuli, G. D., Madan, R. D., *Selected Topics in Inorganic Chemistry, S. Chand and Co. Ltd.,* (2010).

BS 4th Year

Semester-VIII (INORGANIC CHEMISTRY)
Course Title: SYMMETRY AND MAGNETOCHEMSITRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about magnetic properties from chemistry point of view and group theory.

Course Contents:

Symmetry and Group Theory:
Symmetry and group theory, point groups, multiplication tables, group representation and development of character tables. Introduction to the interpretation of spectra and structure elucidation.

Magnetochemistry:
Theory of magnetism, diamagnetism, paramagnetism, ferro, ferri and antiferromagnetism, magnetic susceptibility, magnetic moments, Faraday's & Gouy's methods, effect of temperature on magnetic properties of complexes. Electron spin resonance spectroscopy, Magnetic moment of lanthanides.

Recommended Books:

1. Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons Inc., (1997).
2. Huheey, J. E, Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*", 4th ed., Prentice Hall, (1997).
3. Mackay, K. M., Mackay, R. A. and Henderson, W., *Introduction to Modern Inorganic Chemistry*, 6th ed., CRC Press, (2002).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).

5. Purcell, K. F., Kotz, J. C., *An Introduction to Inorganic Chemistry*, W. B. Saunders, Company Holt-Saunders, International ed., (1980).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Intersceince, New York, (1999).
7. Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
8. Carter, R. L., *Molecular Symmetry and Group Theory*, 1st ed., John-Wiley

& Sons, Inc., New York, (1997).
9. Orchin, M., Jaffe, H. H., *Symmetry, Orbitals, and Spectra,* John-Wiley & Sons, Inc., New York, (1971).
10. McWeeny, R., *Symmetry: An Introduction to Group Theory and its Applications,* Dover Publications, Inc., (2002).
11. Vincet, A., *Molecular Symmetry and Group Theory*, 2nd ed., John Wiley & sons Ltd, (2001).

BS 4th Year

Semester-VIII (INORGANIC CHEMISTRY)

Course Title: RADIO AND NUCLEAR CHEMISTRY

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will acquire knowledge about radio and nuclear chemistry and nuclear reactions.

Course Contents:

Fundamentals and applied aspects of radioactivity and nuclear chemistry. types and characteristics of nuclear radiation, structure of nucleus, half-life, nuclear binding energy, and artificial radioactivity, fission and fusion reactions, acceleration of charged particles and applications of radioisotopes.

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Miller, J. M. and Maciuas, E. S., *Nuclear and Radiochemistry*, 3rd ed., John-Wiley & Sons, Inc., (1981).
2. Choppin, G. R., Rydberg, J., Liljenzin, J., *Radiochemistry and Nuclear Chemistry*, 3rd ed., Butterworth-Heinemann Ltd., (2002).
3. Arnikar, H. J., *Essentials of Nuclear Chemistry*, 4th ed., New Age International Pvt. Ltd. Publishers, (1996).
4. Naqvi, I. I. and Farrukh, M. A., *Radiotracers in Chemical Applications* VDM Verlag Dr. Müller, Germany, (2010).
5. Loveland,W., Morrissey, D. J. and Seaborg, J. T., *Modern Nuclear Chemistry*, John Wiley and Sons, Inc.,(2006)

BS 4th Year

Semester-VIII (INORGANIC CHEMISTRY)

Course Title: Lab-II

Code: CHEMCredit

Hours: 1

Use of organic reagents for the estimation of various metal ions;

1. Synthesis of ferrocene and acetyl ferrocene
2. Synthesis of triaryl phosphines
3. Reduction of anisole by lithium-Birch-reduction.
4. Preparation of ferrocenyl oximes
5. Preparation of Zinc-porphyrin complexes
6 Synthesis of Zinc-Phthalocyanine
7. Synthesis of coordination polymers of transition metals.

Recommended Books:

1. Angelici, R. J. (1977). *Synthesis and technique in inorganic chemistry*, pp. 157-168 Philadelphia: W. B. Saunders Company.
2. Elschenbroich, Ch., & Salzer, A. (1992). *Organometallics*. VCH Weinheim.
3. Hartley, F. R. (1974). *Elements of organometallic Chemistry*. London
4. Lucas, C. R., & Walsh, K. A. (1987). Organometallic chemistry of molybdenum. *Journal of Chemical Education*, *64*, 265–266.
5. McNeese, T. J., & Ezbiansky, K. A. (1996). Photochemical preparation and reactivity of cis- Cr(CO)4(CH3CN)2. *Journal of Chemical Education*, *73*, 548–550.
6. Miessler, G. L., & Spessard, G. O. (1991). Organometallic chemistry – A course designed for sophomore chemistry students. *Journal of Chemical Education*, *68*, 16–18.
7. Rabideau, P. W. (1989). The metal–ammonia reduction of aromatic compounds.
8. *Tetrahedron*, *45*, 1579–1603.
9. Spessard, G. O., & Miessler, G. L. (1996). *Organometallic chemistry*. Upper Saddle River, New Jersey: Prentice Hall.
10. Szafran, Z., Pike, R. M., & Singh, M. M. (1991). *Microscale inorganic chemistry*. New York: John Wiley & Sons.
11. ZAVIX Holzbecher and other, Hand Book of Organic reagents in Inorganic Analysis Ellis Hurwod Limited, London. (1976)
12. J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's Text Book of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008)
13. James S. Pritz, George H. Sehenk, Quantitative Analysis Chemistry, Alby and Becon Inc. London. (2001)
14. Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods,* 2nd ed., Chapman and Hall, (1974).

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: NATURAL PRODUCTS
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about different types of natural products with emphasis on their structure, synthesis and applications.

Course Contents:

Alkaloids:

Introduction, classification, isolation methods, structure elucidation and discussion with particular reference to structure and synthesis and biosynthesis of typical alkaloids such as ephedrine, nicotine, atropine, quinine, papaverine and morphine.

Terpenoids:

Introduction, classification, isolation techniques and discussion with particular reference to structure and synthesis and biosynthesis of typical terpenoids such as citral, α-terpineol, α-pinene, camphor and α-cadinene.

Steroids:
Study of cholesterol and steroidal hormones with emphasis on their structure and biosynthesis.
Flavonoids:
Introduction and classification of flavonoids, general biosynthetic pathway, synthesis of flavone, flavonol and cyanidin.

Recommended Books:

1. Dewick, P. M., *Medicinal Natural Products: A Biosynthetic Approach,* 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).
2. Sell, C. S., A *Fragrant Introduction to Terpenoid Chemistry*, The Royal Society of Chemistry, UK, (2003).
3. De la Rosa, L. A., Parrilla, E. A. and Aguitar, G. A. G., *Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability,* Wiley-Blackwell, (2009).
4. Shahidi, F. and Naczk M., *Phenolics in Food and Nutraceuticals*, CRC Press, (2004).
5. Oyvind, M. A., and Kenneth, R. M., *Flavonoids: Chemistry, Biochemistry and Applications*, CRC, Taylor & Francis, New York, (2010).
6. Finar, I. L., Organic Chemistry, Vol. 2, *Stereochemistry and the Chemistry of Natural Products,* 5th ed., Pearson Education Ltd., Delhi, (2008).
7. Hesse, M., *Alkaloid Chemistry,* John-Wiley & Sons, New York, (1981).
8. Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., *Chemistry of Natural Products,* Narosa Publishing House, (2005).

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: ORGANIC SYNTHESIS
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge and understanding to design protocols for synthesis of small to medium sized organic compounds and be able to carry out retrosynthetic analysis, and propose alternative reactions to synthesize a compound.

Course Contents:

Principles and importance of organic synthesis, Introduction to reterosynthesis and disconnection approach, synthesis of aromatic compounds; one and two group carbon C-X disconnections, donor and acceptor synthons, C-C disconnections and 1,2-, 1,3-, 1,4-, 1,5- and 1,6- difunctionalized compounds, synthesis of cyclic compounds (3-6 membered), chemo-, regio- and stereoselectivity.
Synthetic strategies:
Functional group protection: hydroxyl, amino, carbonyl, carboxylic, sulfanyl, C=C, solid phase synthesis, phase-transfer catalysis.

Recommended Books:

1. Warren, S. and Wyatt, P., *Workbook for Organic Synthesis: The*

Disconnection Approach, 2nd ed., John-Wiley & Sons, Inc., (2010).
2. Fox, M. A. and Whitsell, J. K., *Organic Chemistry*, 3rd ed., Jones & Bartlett Publishers (1997).
3. Clayden, J., Greeves, N., and Warren, S., *Organic Chemistry*, 2nd ed., Oxford University Press, New York, (2012).
4. Loudon, M., *Organic Chemistry,* 5th ed., Roberts Company Publishers, (2009).
5. Smith, J. G., *Organic Chemistry*, 3rd ed., McGraw-Hill, (2010).
6. Norman, R. O. C. and Coxon, J. M., *Principles of Organic Synthesis,* 3rd ed., CRC Press, (1993).

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: MEDICINAL CHEMISTRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge and learn about the nature, types and properties of drugs and medicines, and the role of an organic chemist in drug designing and drug discovery.

Course Contents:

Chemistry of biomolecules; introduction to drugs and drug discovery, sources of therapeutic agents, structure activity relationship (SAR), drug-receptor interaction, , drug formulation and its methods, different types of drugs; chemistry and modes of action of some common drugs.

Recommended Books:

1. Paul, M. D., *Medicinal Natural Products: A Biosynthetic Approach*, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd, (2009).
2. Wolff, M. E., *Burger's Medicinal Chemistry,* 4th ed., Part III, John-Wiley & Sons, New York, (2006).
3. Williams, D. A. and Lemke, T. L., *Foye's Principles of Medicinal Chemistry*, 6th ed., Lippincott Williams & Wilkins, New York, (2008).
4. D. Sriram, P. Vogeeswari, *Medicinal Chemistry,* 2nd ed., BITS Pilani, Pearson, Publisher: Darling Kindernley, India, (2010).
5. Carins D., *Essential of Pharmaceutical Chemistry,* 3rd ed., Pharmaceutical Press, London, (2008)

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: Lab-II
Code: CHEMCredit
Hours: 1

Course Contents:

Experiments based on isolation of natural products from plants are recommended. These may include isolation of caffeine from tea, isolation of nicotine from tobacco, isolation of carvone from mint, isolation of limonene from orange peels, isolation of piperine from black pepper, etc.

Experiments involving multi-step synthesis may also be included, such as the synthesis of methyl orange.
Literature survey for Laboratory work is to be carried out during the course of studies.

Recommended Books:

1. Clarke, H. T., *A Handbook of Organic Analysis-Qualitative and Quantitative*, John-Wiley & Sons, New York, (2007).
2. Mann, F. G. and Saunders, B. C., *Practical Organic Chemistry*, 4th ed., Longman, London, (1960).
3. Vogel, A. I., *Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis*, Longman, London, (1987).
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., *Vogel's Text Book of Practical Organic Chemistry*, 5th ed., National Book Foundation, Islamabad, (2008).
5. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., *The Systematic Identification of Organic Compounds*, 7th ed., John-Wiley & Sons, (1997).
6. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., *Vogel's Text Book of Chemical Analysis*, Prentice Hall, (2000).
7. Beckett, A. H. and Stenlake, J. B., *Practical Pharmaceutical Chemistry,* Part II, 4th ed., Continuum International Publishing Group, (1988).

BS 4th Year

Semester-VIII (PHYSICAL CHEMISTRY)
Course Title: REACTION DYNAMICS
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge and learning about reaction dynamics and kinetic theories. They will also know about the factors which can influence the rates of reactions under different reaction conditions.

Reaction Dynamics:

Correlation between physical properties and concentration, Kinetics of the complex reactions, reversible, parallel, consecutive bimolecular reactions, Theory of absolute reaction rate, Lindemann's theory of unimolecular reactions, bimolecular collision theory, transition state theory, comparison of collision and absolute reaction theories, Potential energy surfaces, Thermodynamic formulation of reaction rates, Calculation of entropy and enthalpy changes, Thermal decomposition of nitrogen pentaoxide.

Reactions in solutions:

Influence of ionic strength on the reaction rate, effect of dielectric constant of the medium on the rate of the reaction, single sphere activated complex model, double sphere activated complex model, complex reactions, chain reactions, single chain carrier with second order breaking, one chain carrier with first order breaking, two chain carrier with second order breaking, experimental techniques for fast reactions.

Recommended Books:

1. Espenson, J. H., *Chemical Kinetics and Reaction Mechanism* 2nd ed., McGraw-Hill, London (2002).
2. Connors, K. A., *Chemical Kinetics: The Study of Reaction Rates in Solution,* VCH Publishers, Inc., (1990).
3. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., *Physical Chemistry,* 4th ed., John-Wiley & Sons, (2005).
4. Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry,* 9th ed., Oxford University Press, (2010).
5. Houston, P. L., *Chemical Kinetics and Reaction Dynamics,* Dover Publications, (2006).
6. Levine, R., *Molecular Reaction Dynamics,* Cambridge University Press, (2005).
7. Laidler, K. J., *Chemical Kinetics*, 3rd Edition, Prentice Hall, (1987).
8. Frost, A. A., and Pearson, R. G., *Reaction Mechanism,* 2nd Edition John Wiley and sons, Inc; (1961).
9. Benson, S. W., *Foundation of Chemical Kinetics*, Krieger Publication Co. (1980).

BS 4th Year

Semester-VIII (PHYSICAL CHEMISTRY)
Course Title: RADIATION AND PHOTOCHEMISTRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will learn about the mechanisms of radiation induced chemical changes in molecules, radiation dosimetery and applications of the radiation chemistry. They will also learn about radioactive decays, and how radioisotopes are produced and applied in Mössbauer spectroscopy. Students will be able to understand the principles of fluorescence, phosphorescence and other photochemical processes, and their applications.

Course Contents:

Radiation Chemistry:

Development and advancement in radiation chemistry, radiation dosimetry, Fricke dosimeter, dosimetry in pulse radiolysis, energy states in radiation chemistry, excited states, fragmentation, pre-dissociation, photochemical decay, ions and electrons, radiolysis of gases, liquids, solids, frozen liquids and ions in radiation chemistry, recent application of radiation chemistry.

Photochemistry:

Principles of photochemistry, laws of photochemistry, Einstein's law of photochemical equivalence, rates of intramolecular processes, chemical reactions and quantum yields with examples, energy transfer in photochemical reaction, quantum yield of emission process radiation and nonradiation process, kinetics and quantum yields of radiative and nonradiative process (fluorescence, phosphorescence, inter-system crossing, internal conversion, quenching) and Stern-Volmer reactions, photosensitized reactions.

Recommended Books:

1. Spinks, J. W. T. and Woods, R. J., *An introduction to Radiation Chemistry*,

3rd ed., Wiley Inter Si. Pub., USA, (1990).
2. Aziz, F. and Rodgers, M. A. J., *Radiation Chemistry Principles and Applications,* 1st ed*.,* VCH Publishers, Inc., (1987).
3. Choppin, G., Liljenzin, J-O., Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth-Heinemann, (2002).
4. Mostafavi, M., Douki, T., *Radiation Chemistry: From Basic to Applications in Material and Life Sciences,* EDP Science, (2008).
5. Dunkin, I., *Photochemistry,* Vol. 36, RSC Publishing, (2007).
6. Dickson, D. P. E., Berry, F. J., *Mossbauer Spectroscopy,* Cambridge University Press, (1986).
7. Scaglia, B., *The Fundamentals: An Understanding of Photochemistry, B*iblio Bazaar, (2011).
8. Konya, J. and Nagy, N. M., *Nuclear and Radiochemistry,* 1st ed., Elsevier, (2012).

BS 4th Year

Semester-VIII (PHYSICAL CHEMISTRY)
Course Title: COLLOID AND SURFACE CHEMISTRY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about the important physical and chemical aspects of nano and colloidal systems and the basics of thermodynamically and kinetically stabilized nanoparticles and colloidal solutions. They will also learn about the surfactant chemistry, characterization methods and applications of nanoparticles and colloidal solutions.

Course Contents:

Colloid and Surface Chemistry:

Colloidal solutions, catalyst preparation methods, industrial catalysts, emulsion, surfactant, nanoscale chemistry, nanomaterials and their applications, dimensional control in nanostructures, macromolecular surface films, charged films and Langmuir-Blodgett layers, characterization methods and applications.

Solid surfaces, surface structures, clean surface structures, gas solid interface, thermodynamics of adsorption, heterogeneous catalysis, kinetic and mechanisms of catalyzed reactions, adsorption at liquid surfaces, chemisorption, physiosorption and dynamics, enzymatic catalysis, organized molecular assemblies, experimental probes for surface and adsorbent structures, scanning probe techniques, low energy electron diffraction (LEED), electron spectroscopy, and other surface analysis techniques.

Recommended Books:

1. Hunter, R. J., *Introduction to Modern Colloid Science*, Oxford University Press, Oxford, (1994).
2. Poole, C. P. and Owens, F. J., *Introduction to Nanotechnology,* 1st ed., Wiley-Interscience, (2003).
3. Klabunde, K. J., *Nanoscale Materials in Chemistry*, John-Wiley & Sons, Inc., (2003).

4. Kolunsiki, K. W., *Surface Science: Foundations of Catalysis and Nanoscience*, 3rd ed., John-Wiley & Sons, Ltd., (2012).
5. Adamson, A. W. and Gast, A. P., *Physical chemistry of Surfaces,* 6th ed., Wiley-Interscience, (1997).
6. Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry,* 8th ed., Oxford University Press, (2006).
7. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, (2004).

BS 4th Year

Semester-VIII (PHYSICAL CHEMISTRY)
Course Title: Lab-II
Code: CHEMCredit
Hours: 1

Course Objectives:

The course will provide basic as well as the advance understandings of experimental methods of kinetics using different interface methods like spectroscopy and polarimetry. The course will also enable the students to understand the effect of operational conditions on reactions and mechanism of surface reactions.

Course Contents:

Sugar analysis and inversion studies by polarimetry.
Study of isotherms and experiments of surface chemistry.
Kinetics of fading of phenolphthalein in alkaline solution.
Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.
Study of the salt effect on the rate constant of the reaction between similar charges of ions.
Kinetics of autocatalytic reaction between permanganate and oxalate ions.
Determination of energy of activation of the reaction between similar charged ions.
Kinetics of the reaction between methyl orange and peroxodisulphate ions in presence of bromide ions.
Stoichiometry of a complex in solution by Job's method using spectroscopic methods.

Recommended Books:

1. Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook,* 3rd ed., W. H. Freeman, (2006).
2. Palmer, W. G., *Experimental Physical Chemistry,* 2nd ed., Cambridge University Press, (2009).
3. Athawale, V. D., and Mathur. P., Experimental Physical Chemistry, New Age International (2001).
4. Farrington, D., Experimental Physical Chemistry, BiblioBazaar, (2011).
5. James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3rd ed., Prentice Hall Press, (1974).

BSc 4th Year

Semester-VIII (APPLIED CHEMISTRY)

Course Title: ORGANIC BASED INDUSTRIES
Code: CHEM
Credit Hours: 3

Course Objectives:

Students will acquire knowledge to understand the structure, mechanism, properties and synthesis of various polymers. The course will also provide technical know- how about perfumes and cosmetics and surface coating industries.

Course Contents:

Paper and Pulp:

Raw materials for pulp and paper industries, classification of paper products, chemistry involved in the processing of Kraft pulp, sulphite pulp and semichemical
pulp, manufacture of paper and regeneration of spent liquor.

Polymers:

General classification and characterization of polymers, mechanism and chemistry of polymerization, thermoplastic and thermosetting polymerization, A brief outline for the production and applications of polymers i.e. polyethylene, polystyrene, polyurethanes, polyesters and urea phenol formaldehyde resins, and production of drug delivery polymers.

Cosmetics and Perfumes:

Chemistry and production of hair products and shampoos, chemistry involved in hair curling and styling products, hair tonics and depilatory products, production of cold cream, vanishing cream, bleach cream and shaving creams, tooth paste and face powders, production of nail polish, lipsticks and mascaras.

Recommended Books:

1. Odian, G., *Principles of Polymerization*, 4th ed., John-Wiley & Sons, Inc., (2004).
2. Carraher, C. E. Jr., *Polymer Chemistry,* 6th ed., Marcel Dekker Incorporation, New York, (2003).
3. Roussak, D. V., Gesser, H. D., *Applied Chemistry; A Textbook of Engineers and Technologists,* 2nd ed., Springer, (2013).
4. Bajpai, P., *Environmentally Friendly Production of Pulp and Paper,* John-Wiley & Sons, Inc., (2010).
5. Schueller, R. and Romanowski, P., *Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry,* 3rd ed., Allured Publishing Corporation, (2009).
6. Barel, A. O., Paye, M. and Maibach, H. I., *Handbook of Cosmetic Science and Technology,* 3rd ed., Informa Healthcare, (2009).

BS 4th Year

Semester-VIII (APPLIED CHEMISTRY)
Course Title: INDUSTRIAL PROCESSES
Code: CHEM
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about pharmaceutical industries and nuclear industry as well as about oil refinery and production of various petrochemicals.

Course Contents:

Pharmaceuticals:

Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Petroleum and Petrochemicals:

Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

Recommended Books:

1. Austin, G. T., Nelson, W. L., *Petroleum Refinery Engineering*, 4th ed., Aukland. Mcgraw Hill, (1985).
2. Shreve, R. M., George, T. A., *Shreve's Chemical Process Industries*, 5th ed., McGraw-Hill Book Company Inc., New York, (1984).
3. Kent, J. A., *Riegel's Handbook of Industrial Chemistry*, 10h ed., Kluwer Academic/Plenum publishers, (2003).
4. Vermani, O. P., Narula. A. K, *Applied Chemistry*, Theory and Practice, 2nd ed., New Age International Publisher, India, (1995).
5. D. G. Watson, *Pharmaceutical Chemistry, Churchill Living Stone,* (2007).
6. Cairms, D., *Essentials of Pharmaceutical Chemistry,* Pharmaceutical Press, (2003).
7. Loveland, W. D., Morrisey, D. J, *Modern Nuclear Chemistry,* Wiley Interscience, (2005).
8. Speight, J. G., *The Chemistry and Technology of Petroleum, 3*rd ed., Taylor & Francis, (2013).

BS 4th Year

Semester-VIII (APPLIED CHEMISTRY)

Course Title: METALLURGY AND EXPLOSIVES

Code: CHEMCredit

Hours: 3

Course Objectives:

The course is designed to give sufficient knowledge about iron, steel and its alloys. The course also provides the knowledge about corrosion and its preventions. The course will also give the knowledge about organic Dyes industries, different lubricants used in industrial processes.

Course Contents:

Iron, Steel and Alloys:

Iron ores, constituents and their classification, manufacture of iron and steel, types of iron and steel, metal extractions and production of Alloys.

Explosives and Propellants:

Raw materials, manufacture of industrial explosives and propellants, types of explosives and their safety measures, chemistry involved in production of military explosives.

Nuclear Materials:

Extraction of uranium from rocks, importance of nuclear technology, nuclear energy and its peaceful applications, production of nuclear energy and control of nuclear reactors, chemistry of fission and fusion reactions, reprocessing of nuclear spent fuel, industrial application of nuclear radiations.

Recommended Books:

1. Akhawan, J., *The Chemistry of Explosives,* 2nd ed., Royal Chemical Society, (2004).
2. Campball, F. C., *Elements of Metallurgy and Engineering Alloys,* ASM. International, (2008).
3. Davis, T. L., *The Chemistry of Powder and Explosives,* Angriff Press, (2012).
4. Reddy, L. K., *Principles of Engineering Metallurgy,* 2nd ed., New Age Publishers, (2009).
5. Loveland, W., Morrissey, D. J. and Seaborg, G. T., *Modern Nuclear Chemistry,* John-Wiley & Sons, Inc., (2006).
6. Choppin, G., Liijenzin, J-O. and Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth-Heinemann, (2002).
7. Vermani, O. P, Narula, A. K, *Applied Chemistry, Theory and Practice*, 2nd ed., New Age Publishing House,India, (1995).
8. Balsaral, V. M, *Applied Chemistry*, I.K. International House Pvt. Ltd., India, (2009)

BS 4th Year

Semester-VIII (APPLIED CHEMISTRY)

Course Title: Lab-II

Code: CHEMCredit

Hours: 1

Course Contents:

Analysis of Lithium in industrial effluents, barium in ores, potassium in soil samples.

Spectrophotometry:

Iron in pharmaceuticals, chromium in steel, phosphate in fertilizers.

Preparations:

Calcium gluconate, detergents, cosmetics and vanishing creams. Analysis of Steel and Industrial Alloys. Purification and analysis of waste lubricating oils. Evaluation of edible and industrial oils. Determination of acid value. Saponification value and Iodine value. Extraction and characterization of essential oils from fragment plants. Preparation and characterization of Nylon. Analysis of effluent form industrial wastes. Recovery of chromium from tannery effluents. Preparation of Shaving creams. To determine the percentage of available chlorine in the supplied sample of bleaching powder. To determine the iron contents in the given iron ore solution by using external indicator.

Recommended Books:

1. Roger's Industrial Chemistry. Von Norstand Co. N. Y.
2. Reigel's Handbook of industrial chemistry. Von Norstand Reeinhold Co. N. Y.
3. Chemical Process Industries by Shreve and Dum. McGraw Hill.
4. An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.
5. Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.
6. Concise Engineering Chemistry, Neetu Goel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).
7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
8. Vogel's Textbook of Qantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

BS 4th Year

Semester-VIII (ANALYTICAL CHEMISTRY)

Course Title: LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will acquire knowledge about the theoretical and instrumental aspects of luminescence spectroscopy and thermal techniques of analysis in addition to learning about their applications.

Course Contents:

Luminescence Spectrophotometry:

Introduction, origin of fluorescence and phosphorescence spectra, Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent species; photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching, quantum yield, instrumentation for fluorescence measurement, sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement, sampling, recording procedure, applications of fluorescence and phosphorescence.

Thermal Methods of Analysis:

Introduction, instrumentation, sources of errors, interpretation of data, Factors affecting curve, applications of TGA, DTA and DSC.

Recommended Books:

1. Christian, G. D., *Analytical Chemistry.* 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Braun, R. D., *Introduction to Chemical Analysis*, International Student Edition, (1985).
4. Haines, P. J., Whitby, On Canada Mcgraw Hill Ltd., *Thermal Methods of*

Analysis Principles, Applications and Problems, 1st ed., Springer, (1995).
5. Lakowicz, J. R., *Principles of Fluorescence Spectroscopy,* 3rd ed., Springer (2006).
6. Gabbot, P., *Principles & Applications of Thermal Analysis,* Wiley-Blackwell, (2007).
7. Brown, M. E., *Introduction to Thermal Analysis: Techniques and Applications,* 2nd ed., Kluwer Academic Publishers, (2001).
8. Skoog, D. A., West, D. M. and Holler, F. J. and Crouch, S. R., *Fundamentals of Analytical Chemistry,* 8th ed., (Int.), Cengage Learning, (2004).
9. Burgess, C. and Jones, D. G., *Spectrophotometry, Luminescence and Colour; Science and Compliance,* Vol. 6, Elsevier Science, (1995).

BS 4th Year

Semester-VIII (ANALYTICAL CHEMISTRY)
Course Title: NUCLEAR ANALYTICAL TECHNIQUES
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about different nuclear analytical techniques with special emphasis on the theoretical, instrumental and applications

Course Contents:

Radiotracer techniques, choice of radiotracers, factors affecting choice of radiotracers, isotope dilution analysis (IDA), principle and equation, instrumentation, applications, advantages and limitations, sub-stoichiometric isotope dilution analysis (SIDA), activation analysis (AA), principle of NAA, neutron sources, interferences, sensitivity and detection limits, classification, instrumentation, applications, advantages and limitations, comparison of NAA and IDA with other methods, radiometric titrations (RT), procedure, advantages and limitations, radio chromatography and radioimmunoassay.

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Macias, E. S. and Miller. M. J., *Nuclear and Radiochemistry*, 3rd ed., Wiley, New York, (1981).
2. Arnikan, H. J., *Essentials of Nuclear Chemistry*, 4th ed., New Age International Pvt. Ltd.(1995)
3. Harvey, B. G., *Nuclear Physics and Chemistry,* 2nd ed., Prentice Hall Inc., (1969).
4. Naqvi, I. I., Farrukh, M. A, *Radiotracers in Chemical Applications: Radiochemistry, VDM* Verlog Dr. Muller, (2010).

BS 4th Year

Semester-VIII (ANALYTICAL CHEMISTRY)
Course Title: FOOD AND DRUG ANALYSIS
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will acquire knowledge about sample preparation, derivations and

analysis of different types of foods, pharmaceuticals and forensics.

Course Contents:

Food Products:

Introduction to food analysis, sampling of food, general methods of analysis. Analysis of milk, butter, wheat flour, meat, beverages, tea, coca, honey and soft drinks.

Pharmaceuticals:

Classification of drugs, tests for analysis of different pharmaceuticals, introduction to US and British pharmacopeia.

Forensics:

History and scope of Forensic Science, Forensic Ethics, Forensic Toxicology. Classification and analysis of narcotics & dangerous drugs, examination of crime scene evidences, fingerprinting, skeletal material to provide scientific opinion for legal.

Recommended Books:

1. Skoog, D. A., West, D. M. and Holler, F. J., *Fundamentals of Analytical Chemistry*, 7th ed., Saunders College Publishing, (1995).
2. Christian, G. D., *Analytical Chemistry*, John-Wiley & Sons, Inc., 6th ed., (2004).
3. Eckert, W. G., *Introduction to Forensic Science*, 2nd ed., CRC Press, (1997).
4. Nielsen, S. S., *Food Analysis,* 4th ed., Springer, (2010).
5. Thomas, G., *Medicinal Chemistry: An Introduction,* 2nd ed., John-Wiley & Sons, (2007).
6. Kobilinsky, L. F., *Forensic Chemistry Handbook, 1st ed.,* John-Wiley & Sons, USA, (2012).
7. Watson, D. G., *Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists,* Elsevier, (2012).
8. Stuart H. Barbara, *"Forensic Analytical Techniques",* 1st ed., John-Wiley & Sons, (2013).
9. Jackson, A. R. W. and Jackson, J. M., *Forensic Science,* 2nd ed., Pearson Education, (2008).

BS 4th Year

Semester-VIII (ANALYTICAL CHEMISTRY)

Course Title: Lab-II

Code: CHEMCredit

Hours: 1

Course Contents:

Determination of fat content in milk.
Quantification of Proteins.
Determination of cholesterol in food.
Quantification of reducing sugars and total sugars.
Water analysis for drinking purpose.
Determination of caffeine.
Determination of heavy metals in food items.
Determination of citric acid in juices.

Determination of ascorbic acid in fruit juices.
Evaluation of Rancidity of edible oil [Acid value].
Evaluation of Iodine value of edible oils.
Evaluation of Ester value of edible oils.
Determination of Aflatoxin in grains.
Extraction of DNA from Saliva, Cheek cells and blood.
Detection of Saliva by α-amylase activity.
Finger print analysis by $AgNO_3$, iodine vapour method.
Spot test/TLC of arsons and explosive (i.e. picric acid, nitrobenzenes and nitro-toluene)
Calibration and validation of HPLC system as per requirements of British or US pharmacopoeia.
Analysis of the binary mixture of pharmaceutical dosage by HPLC and statistical evaluation of data (RSD, CV, precision, accuracy, LOD, LOQ, resolution, Tailing factor).

Recommended Books:

1. Latimer, Jr., G. W., *AOAC Official Methods of Analysis,* 19th ed., (2012).
2. Ranganna, S., *Handbook of Analysis & Quality Control for Fruits & Vegetables,* 2nd ed., TATA McGraw-Hill Education, (1986).
3. Stuart H. Barbara, *"Forensic Analytical Techniques",* 1st ed., John-Wiley & Sons, (2013).

BS 4th Year

Semester-VIII (BIOCHEMISTRY)
Course Title: MICROBIOLOGY AND IMMUNOLOGGY
Code: CHEMCredit
Hours: 3

Course Objectives:

Students will learn about fundamentals of microbiology and immunology as well as the related disorders such as microbial borne infectious diseases, allergy, inflammation, and hypertension and their control.

Course Contents:

Fundamentals of Microbiology:
Prokaryotic cell structure and function, Prokaryotic growth and nutrition, prokaryotic genetics. Virus and eukaryotic microorganisms, virus, bacteria, fungi and parasites. Bacterial diseases, airborne, foodborne and waterborne bacterial diseases. Industrial microbiology and biotechnology, microorganism in industry, alcoholic beverages, other important microbial products.
Immunology:
Chemistry of immunoglobulins, myeloma and hybridoma immunoglobulins, immune system and its abnormalities, allergy and inflammation, complement system, Peripheral leucocytes and macrophages, Type I lgE-mediated hypersensitivity, other types of hypersensitivity autoimmune disorders, immunodeficiency disorders.

Recommended Books:

1. Nester, E., Nester, M., Anderson, D. and Roberts, C. E. Tr., *Microbiology: A*

Human Perspective, 7th ed., McGraw-Hill, (2011).
2. Duan, T., Melvold, R., Viselli, S. and Waltenbaugh, C., *Lippincott's Illustrated Reviews, Immunology,* 2nd ed., Lippincott William & Wilkins, (2012).
3. Harvey, R. A., Cornelissen, C. N. and Fischer, B. D., *Lippincott's Illustrated Reviews: Microbiology,* 3rd ed., Lippincott William & Wilkins, (2012).
4. Wiley, J. M., Sherwood, L. M. and Woolnerton, C. J., *Prescott's Microbiology,* 7th ed., McGraw-Hill Education, (2011).
5. Male, D., Brostoff, J., Roth, D. B. and Roitt, I. M., *Immunology,* 8th ed., Elsevier, (2012).

BS 4th Year

Semester-VIII (BIOCHEMISTRY)

Course Title: BIONANOTECHNOLOGY

Code: CHEMCredit

Hours: 3

Course Objectives:

The aim of the course is to acquire knowledge about bionanotechnology in general and its potential applications in particular. Bionanotechnology aims to exploit attributes of new materials like biosensors for medical applications. Understanding of the structure and assembly of nanoparticles opens some exciting possibilities to construct artificial structures in applied nanotechnology, which will mimic the functions of the biological systems.

Course Contents:

Introduction to nanoparticles, overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, bionanotechnology systems, protein based nanostructures, nanobiosensors, challenges and opportunities associated with biology on the nanoscale, green nanoparticle production, self-assembly and templating, surface patterning and functionalization, characterization techniques of nanostructures.

Recommended Books:

1. Ratner, M.A. and Ratner, D., *Nanotechnology: A Gentle Introduction to the Next Big Idea*, Prentice Hall Professional, upper saddle river, New Jersey (2003).
2. Goodsell, D.S., Bionanotechnology: Lessons from Nature, Wiley-Liss, Inc., Hoboken, New Jersey (2004).
3. Papazoglou, E. S., *Bionanotechnology*, Morgan & Claypool Publishers, California, USA (2007).
4. Renugopalakrishnan V., Lewis, R. V., *Bionanotechnology: Proteins to Nanodevices*, Springer (2006).
5. Iqbal, S., *Bionanosensors*, Morgan & Claypool Publishers, California USA (2008).
6. Kotov, N. A., *Nanoparticle Assemblies and Superstructures*, CRC press, USA (2006).
7. Dinh, T.V., *Nanotechnology in Biology and Medicine: Methods, Devices and Application* CRC press, USA (2007).
8. Kumar, C., *Nanomaterials for Biosensors,* Wiley-VCH, Germany (2007).

9. Niemeyer, C.M., and Mirkin, C.A., *Nanobiotechnology: Concepts, Applications and Perspectives,* Wiley-VCH, Germany(2004).

BS 4t h Year

Semester-VIII (BIOCHEMISTRY)

Course Title: NUTRITIONAL CHEMISTRY

Code: CHEMCredit

Hours: 3

Course Objectives:

Students will acquire knowledge about dietary components; energy needs based nutritional requirements of different age groups as well as the importance of minerals and vitamins.

Course Contents:

Major Dietary Constituents:

Nutritional importance of carbohydrates, proteins and amino acids, lipids, and dietary fiber.

Energy Needs:

Assessment and requirement of energy in different age groups nutrition in growth and aging, nutritional requirement during infancy and childhood, diet, nutrition and adolescence, nutrition in the elderly minerals, biochemical role of Calcium, Chromium, Copper, Iron, Iodine, Magnesium, Phosphorous, Selenium and Zinc, their dietary source daily requirements and deficiency diseases.

Vitamins:

Role of vitamins as coenzymes structure, physiological functions, deficiency diseases and recommended dietary allowances of the following vitamins, fat soluble vitamins: A, D, E, and K, water soluble vitamins: Thiamine, Riboflavin, Niacin, Pantothenic acid, Folic acid, Blotin and Ascorbic acid.

Recommended Text Books:

1. Wilson, K. and Walker, J., *Principles and Techniques of Biochemistry,* 5th ed., Cambridge University Press, (2000)
2. Belitz, H. D., Grosch, W. and Schieberle, P., *Food Chemistry,* 4th ed., Springer-Verlag Berlin, Germany, (2009).
3. Spallholz, J. E., Boylan, L. M. and Driskell, J. A., *Nutrition: Chemistry & Biology,* 2nd ed., CRC Press Inc., USA, (1999).
4. Ross, A. C., Caballero, B., Cousins, R. J., Tucker, K. L. and Ziegler, T. R., *Modern Nutrition in Health and Disease,* 11th ed., Lippincott Williams & Wilkins, (2012).
5. McDowell, L. R., *Vitamins in Animal and Human Nutrition,* 2nd ed., Iowa State University Press, (2000).
6. Zempleni, J., Rucker, R. B., McCormick, D. B. and Suttie, J. W., *Handbook of Vitamins,* 4th ed., CRC Press, (2007).
7. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry, 6*th ed., W. H. Freeman, (2012).

BS 4t h Year

Semester-VIII (BIOCHEMISTRY)

Course Title: Lab-II
Code: CHEMCredit
Hours: 1

Course Contents:

Estimation of Na^{+1} ions in blood.
Estimation of K^{+1} ions in blood.
Determination of blood group of the patient.
Determination of serum aldolase in heart patient
Determination of protease activity of bacterial enzymes
Enzyme purification by ion-exchange chromatography
Synthesis of silver nanoparticles by using plant extracts
Synthesis of nanoparticles and study of surface plasmon response by UVVisible Spectrophotometry

Recommended Text Books:

Sawhney, S. K. and Sing, R. *Introductory Practical Biochemistry*, 2nd ed., Narosa publishing House, New Delhi, (2005).
Gosling, J. P. and Basso, L., *Imunoassay: Laboratory Analysis and Clinical Application,* 1st ed., CRC Press, (1994).
Cameron, A. T. and White, F. D., *A Course in Practical Biochemistry,* J. and A. Churchill Limited, (2005).
Shankara, Y. M. S., *Practical Biochemistry,* Jaypee Brothers Medical Pub., (2008).

BS 4th year

Semester-VIII (FUEL CHEMISTRY)
Course Title: CHEMISTRY OF COAL CONVERSION PROCESSES-II
Course Code: CHEMCredit
Hours: 3

Course Objectives:

The students will acquire knowledge about the coal conversion processes like solvent extraction, hydrogenation, and importance of catalysis in such reactions, product up gradation and analysis and environmental problems relating to synthetic fuels obtained from coal.

Course Contents:

Liquefaction of Coal
Historical Developments: Historical developments of coal liquefaction, earlier coal liquefaction processes; (a) Pott and Broch Process (b) Bergius process.
Solvent Extraction: Solvent extraction of coal, some experiments on solvent extraction, mechanism of solvent extraction, types of solvent extraction, solvent systems, super critical gas extraction, commercial processes of solvent extraction like SRC-I, SRC-II, EDS, Super critical gas extraction.
Direct Liquefaction: Direct liquefaction of coal through catalytic hydrogenation, mechanism, catalysts' system, catalyst poisoning, catalytic role of coal minerals, commercial processes of catalytic hydrogenation like H-coal and Synthoil process.

Indirect Liquefaction: Indirect liquefaction through Fischer Tropsch synthesis, methanol synthesis and MTG (Methanol to Gasoline) processes.
Effect of Parameters: Effect of coal properties, catalyst and solvent on liquefaction behaviour of coal, effect of coal properties like rank, maceral components and mineral matter on liquefaction, effect of operating condition like temperature, pressure, residence time, solvent, catalyst, etc.
Processing of Coal Liquids: Purification of liquefaction products, solidseparation, fractionation, upgrading and characterization of coal derived liquids, properties of coal derived liquids.
Liquefaction Reactor: Description of high pressure coal liquefaction reactor and auxiliary devices, ebulated bed reactor, fluidization.
Environmental Aspects: Environmental consideration, aerial emissions, water effluents, solid waste disposal.
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Recommended Books:

1. Wen, C. Y. and Stanley, E. *Coal Conversion Technology.* Addison-Wesley, New York. (1979).
2. Probstein, R. F and Hicks, R. E. *Synthetic Fuels.* McGraw Hill, New York. (1982).
3. Francis, W. *Fuels and Fuel Technology.* Pergamon Press, London (1980).
4. Merick, D. *Coal Combustion and Conversion Technology.* McMillan Ltd., London (1984).
5. Berkowitz, N. *The chemistry of Coal.* Elsevier Amsterdam (1985).

BS 4th year

Semester-VIII (FUEL CHEMISTRY)
Course Title: PETROLEUM AND PETROCHEMICALS-II
Course Code: CHEMCredit
Hours: 3

Course objectives:

The students will acquire knowledge about the modern thermodynamics and combustion of hydrocarbons fuels. The students will also be able to learn about the safe storage and transportation of hydrocarbons fuels.

Course Contents:

Thermo chemistry and Combustion of Hydrocarbon Fuels: Basic thermodynamics principles, standard enthalpy of formation, standard enthalpy of reaction, enthalpy of combustion products, mechanism of combustion of gaseous and liquid hydrocarbon, theory of flame propagation, method of measuring flame speed, fuel performances in reciprocating piston engines, environmental pollution from hydrocarbon fuel utilization.
Storage and Handling of Hydrocarbon Fuels: Various types of storage tanks, different methods of transportation of crude and refined petroleum products. Health hazards associated with petroleum handling, volatility losses, fire hazards and its prevention. Extinguishing of oil fire methods.

Recommended Books:

1. Hobson, G. D. *Modern Petroleum Technology*. Part 2, John Wiley and Sons, New York. (1984).

2. Gates, B. C, Katzer, J. R, and Schuit, G. C. A. *Chemistry of Catalytic Processes*.. McGraw Hill Book company, London (1979).
3. List, H. L. *Petrochemical Technology*. Printice-Hall Englewood Cliffs, New Jersey. (1986).
4. Goodger, E. M. *Hydrocarbon Fuels*. Union Brothers Ltd, London. (1975).
5. Maleev, V. L. Internal Combustion Engines. McGraw Hill Book Company London, (1985).

6. Hughes, J.R., and Swindells, N. S. *Storage and Handling of Petroleum Liquids*. Charless Griffin and Company Ltd, London (1987).

BS 4th Year

Semester-VIII (FUEL CHEMISTRY)
Course Title: ALTERNATE ENERGY RESOURCES
Course Code: CHEMCredit
Hours: 3

Course objectives:

This course will enable students to know about the challenging sources of alternate sources of energy. The students will also be able to learn about the safe uses of natural resources.

Course Contents:

Biomass Resources: Biomass conversion processes, bio gas technology. Various traditional methods of alcohol production. Alcohols and its uses as alternative fuel.
Biofuels: Production of Bio-ethanol and biodiesel, uses of bioethanol as supplement with petroleum gasoline as E_{10} and E_{20} etc
Hydrogen: Hydrogen production, storage, handling and its uses as alternative fuel. Fuel cells: Fuel Cells and its application,
Solar Energy: Photovoltaic power conversion & solar energy collectors.
Nuclear fuels: Nuclear fuels processing, fission and fusion, nuclear reactors.
Hydel Energy: introduction to Hydel energy. Prospecting of hydel powers in Pakistan.

Recommended Books:

1. Gyngell, E. bS. *Applied Chemistry for Engineers*. Edward Arnold Publisher, Ltd. London. (1989).
2. Harker, J.b . and Backurst, J.R. *Fuel and Energy*. Academic Press, London and New York (1988).
3. Goodger E. M. *Alternative fuels (chemical energy resources)* . The Macmillan press Ltd, London, (1980).
4. Twidell, J. and Weir, T. *Renewable Energy Resources*. John Wiley and Sons, London, New York, (1986).

BS 4th Year

Semester-VIII (FUEL CHEMISTRY)
Course Title: Lab-II
Course Code: CHEM
Credit Hours: 1

Course Contents:

Determination of ash in petroleum products.
Determination of calcium and barium in lube-oil.
Determination of the acidity and alkalinity of greases.
Determination of mercaptane sulfur in motor fuels, kerosene, and similar petroleum products.
Determination of total solids in used engine oils.
Determination of total sediments in residual fuel oils.
Determination of total sulfur in coal and coke by Eschka mixture method.
Determination of chlorine in coal by Eschka mixture method.
Cleaning of coal using gravity separation and froth flotation method.
Determination of aniline point, diesel index and approximate Cetane number of diesel fuel.

Recommended Books:

1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)
2. Speight, J. G. Handbook of Coal Analysis. John Wiley and Sons, New Jersey, (2005)
3. ASTM, 2000, Annual Book of ASTM Standards, American Society for Testing and Materials, West Consbohockm, PA, USA