

### BS CHEMISTRY PROGRAM

**BS CHEMISTRY** is a 4-years duration degree program comprising of eight (08) semesters with 130- 135 credits hours. Below is the scheme of study and courses of BS degree program for chemistry Department.

#### FIRST YEAR:

##### 1<sup>st</sup> SEMESTER:

COURSE TITLE	COURSE CODE	CREDIT HOURS
ENGLISH -I (FUNCTIONAL ENGLISH)	ENG-301	3 (3+0)
PRINCIPLE CHEMISTRY-I	GEN-311	3 (3+0)
SUSTAINABLE DEVELOPMENT	GEN-312	2 (2+0)
MATHEMATICS (CALCULUS)	MATH-302	3 (3+0)
PAKISTAN STUDIES	PAK-303	2 (2+0)
INORGANIC CHEMISTRY-I	CHEM-321	4 (3+1)
<b>TOTAL</b>		<b>18(16+2)</b>

##### 2<sup>nd</sup> SEMESTER:

COURSE TITLE	COURSE CODE	CREDIT HOURS
ENGLISH-II(COMMUNICATION SKILLS)	ENG-304	3 (3+0)
ISLAMIC STUDIES	ISL-305	2 (2+0)
PRINCIPLE CHEMISTRY-II	GEN-313	3 (2+1)
BEHAVIOR SCIENCE	GEN-314	3 (3+0)
CELL BIOLOGY	BIO-315	3 (2+1)
ORGANIC CHEMISTRY-I	CHEM-331	4 (3+1)
<b>TOTAL</b>		<b>18(15+3)</b>

#### SECOND YEAR:

##### 3<sup>rd</sup> SEMESTER:

COURSE TITLE	COURSE CODE	CREDIT HOURS
ENGLISH -III (TECHNICAL AND REPORT WRITING)	ENG-406	3 (3+0)
INTRODUCTION TO COMPUTER	COMP-407	3 (2+1)
BIOSAFETY & ETHICS	GEN-416	2 (2+0)
FORENSIC CHEMISTRY	GEN-417	3 (3+0)
APPLIED CHEMISTRY-I	CHEM-481	2 (2+0)
PHYSICAL CHEMISTRY-I	CHEM-441	4 (3+1)
<b>TOTAL</b>		<b>17(16+1)</b>

**4<sup>th</sup> SEMESTER:**

COURSE TITLE	COURSE CODE	CREDIT HOURS
STATISTICS	STAT-408	3 (3+0)
MARKETING & MANAGEMENT	GEN-419	3 (3+0)
ANALYTICAL CHEMISTRY-I	CHEM-451	4 (3+1)
ENVIRONMENTAL CHEMISTRY-I	CHEM-471	3 (3+0)
BIOCHEMISTRY-I	CHEM-461	4 (3+1)
<b>TOTAL</b>		<b>17(15+2)</b>

**THIRD YEAR:****5<sup>th</sup> SEMESTER:**

COURSE TITLE	COURSE CODE	CREDIT HOURS
INORGANIC CHEMISTRY-II	CHEM-522	4 (3+1)
ORGANIC CHEMISTRY-II	CHEM-532	4 (3+1)
PHYSICAL CHEMISTRY-II	CHEM-542	4 (3+1)
ANALYTICAL CHEMISTRY-II	CHEM-552	4 (3+1)
<b>TOTAL</b>		<b>16(12+4)</b>

**6<sup>th</sup> SEMESTER:**

COURSE TITLE	COURSE CODE	CREDIT HOURS
INORGANIC CHEMISTRY-III	CHEM-523	4 (3+1)
ORGANIC CHEMISTRY-III	CHEM-533	4 (3+1)
PHYSICAL CHEMISTRY-III	CHEM-543	4 (3+1)
BIOCHEMISTRY-II	CHEM-562	4 (3+1)
<b>TOTAL</b>		<b>16(12+4)</b>

**FOURTH YEAR:****FIELD OF SPECIALIZATION**

The Department of Chemistry, University of Turbat offers specialization in:

- I) Organic Chemistry      II) Inorganic Chemistry  
 III) Physical Chemistry      IV) Biochemistry  
 V) Analytical Chemistry

**7<sup>th</sup> SEMESTER:****INORGANIC CHEMISTRY**

COURSE TITLE	COURSE CODE	CREDIT HOURS
PAPER-I (INORGANIC REACTION MECHANISM)	CHEM-624	3 (3+0)
PAPER-II ( $\pi$ - ACCEPTOR LIGANDS AND INORGANIC POLYMERS)	CHEM-625	3 (3+0)

PAPER-III (INORGANIC SPECTROSCOPY)	CHEM-626	3 (3+0)
INORGANIC LAB-I	CHEM-627	1 (0+1)
RESEARCH METHODOLOGY	CHEM-691	3 (3+0)
RESEARCH PROJECT		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

### ORGANIC CHEMISTRY

COURSE TITLE	COURSE CODE	CREDIT HOURS
PAPER-I (HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS)	CHEM-634	3 (3+0)
PAPER-II ( REACTIVE INTERMEDIATES)	CHEM-635	3 (3+0)
PAPER-III (ORGANIC SPECTROSCOPY)	CHEM-636	3 (3+0)
ORGANIC CHEMISTRY LAB-I	CHEM-637	1 (0+1)
RESEARCH METHODOLOGY	CHEM-691	3 (3+0)
RESEARCH PROJECT		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

### PHYSICAL CHEMISTRY

COURSE TITLE	COURSE CODE	CREDIT HOURS
PAPER-I (ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS)	CHEM-644	3 (3+0)
PAPER-II (POLYMER CHEMISTRY)	CHEM-645	3 (3+0)
(QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY)	CHEM-646	3 (3+0)
PHYSICAL CHEMISTRY LAB-I	CHEM-647	1 (0+1)
RESEARCH METHODOLOGY	CHEM-691	3 (3+0)
RESEARCH PROJECT		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

### ANALYTICAL CHEMISTRY

COURSE TITLE	COURSE CODE	CREDIT HOURS
PAPER-I (ATOMIC SPECTROSCOPY)	CHEM-654	3 (3+0)
PAPER-II ELECTROANALYTICAL TECHNIQUES	CHEM-655	3 (3+0)
PAPER-III (ADVANCED SEPARATION TECHNIQUES)	CHEM-656	3 (3+0)
ANALYTICAL CHEMISTRY LAB-I	CHEM-657	1 (0+1)
PAPER-IV (RESEARCH METHODOLOGY)	CHEM-691	3 (3+0)
RESEARCH PROJECT		3 (0+3)

<b>TOTAL</b>	<b>16(12+4)</b>
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**BIOCHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER-I (BIOMEDICAL CHEMISTRY)	CHEM-663	3 (3+0)
PAPER-II ( MOLECULAR BIOLOGY)	CHEM-664	3 (3+0)
PAPER-III (PHYSICAL TECHNIQUES IN BIOCHEMISTRY)	CHEM-665	3 (3+0)
BIOCHEMISTRY LAB-I	CHEM-666	1 (0+1)
RESEARCH METHODOLOGY	CHEM-691	3 (3+0)
RESEARCH PROJECT		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

**FOURTH YEAR**

**8<sup>th</sup> SEMESTER**

**INORGANIC CHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER-IV ( ORGANOMETALLICS)	CHEM-628	3 (3+0)
PAPER-V (SYMMETRY AND MAGNETOCHEMISTRY)	CHEM-629	3 (3+0)
PAPER-VI (RADIO AND NUCLEAR CHEMISTRY)	CHEM-6210	3 (3+0)
INORGANIC LAB-II	CHEM-6211	1 (0+1)
ENVIRONMENTAL CHEMISTRY-II	CHEM-672	3 (3+0)
RESEARCH PROJECT (WRITE-UP)		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

**ORGANIC CHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER-IV (NATURAL PRODUCTS)	CHEM-638	3 (3+0)
PAPER-V (ORGANIC SYNTHESIS)	CHEM-639	3 (3+0)
PAPER-VI (MEDICINAL CHEMISTRY)	CHEM-6310	3 (3+0)
ORGANIC CHEMISTRY LAB-II	CHEM-6311	1 (0+1)
ENVIRONMENTAL CHEMISTRY-II	CHEM-672	3 (3+0)
RESEARCH PROJECT (WRITE-UP)		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

**PHYSICAL CHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER-IV (REACTION DYNAMICS)	CHEM-648	3 (3+0)
PAPER-V RADIATION AND PHOTOCHEMISTRY	CHEM-649	3 (3+0)

PAPER-VI (COLLOID AND SURFACE CHEMISTRY)	CHEM-641 0	3 (3+0)
PHYSICAL CHEMISTRY LAB-II	CHEM-641 1	1 (0+1)
ENVIRONMENTAL CHEMISTRY-II	CHEM-672	3 (3+0)
RESEARCH PROJECT (WRITE-UP)		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

### **ANALYTICAL CHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER-IV (LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS)	CHEM-658	3 (3+0)
PAPER-V NUCLEAR ANALYTICAL TECHNIQUES	CHEM-659	3 (3+0)
PAPER-VI (FOOD AND DRUG ANALYSIS)	CHEM-651 0	3 (3+0)
ANALYTICAL CHEMISTRY LAB-II	CHEM-651 1	1 (0+1)
ENVIRONMENTAL CHEMISTRY-II	CHEM-672	3 (3+0)
RESEARCH PROJECT (WRITE-UP)		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

### **BIOCHEMISTRY**

<b>COURSE TITLE</b>	<b>COURSE CODE</b>	<b>CREDIT HOURS</b>
PAPER- VI (MICROBIOLOGY AND IMMUNOLOGY)	CHEM-667	3 (3+0)
PAPER-V BIONANOTECHNOLOGY	CHEM-668	3 (3+0)
PAPER-VI NUTRITIONAL CHEMISTRY	CHEM-669	3 (3+0)
BIOCHEMISTRY LAB-II	CHEM-661 0	1 (0+1)
ENVIRONMENTAL CHEMISTRY-II	CHEM-672	3 (3+0)
RESEARCH PROJECT (WRITE-UP)		3 (0+3)
<b>TOTAL</b>		<b>16(12+4)</b>

#### **Key code:**

BIO: Biology Course  
 CHEM: Chemistry course  
 COMP: Computer Course  
 ENG: English Course  
 GEN: General Course  
 ISL: Islamic Studies / Ethics  
 MATH: Mathematics Course

PAK: Pakistan Studies

STAT: Statistics Course

The key code is followed by three digits; the 1<sup>st</sup> digit denotes level of course, the 2<sup>nd</sup> digit specifies the following subject identity:

Compulsory Course	0
General Course	1
Inorganic Chemistry	2
Organic Chemistry	3
Physical Chemistry	4
Analytical Chemistry	5
Biochemistry	6
Environmental Chemistry	7
Applied Chemistry	8
Research Methodology	9

The 3<sup>rd</sup> and 4<sup>th</sup> digit is used to indicate the number of courses within the specialty.

## FIRST SEMESTER (1<sup>ST</sup> YEAR)

### INORGANIC CHEMISTRY-I (CHEM-321) (3+1)

- **COURSE OBJECTIVES:**

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of p- block elements as well as use this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

- **COURSE CONTENTS:**

- ✓ **Chemical Bonding:** Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.
- ✓ **Acids and Bases:** Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), relative strength of acids and bases, significance of pH, pK<sub>a</sub>, pK<sub>b</sub> and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.
- ✓ **p-Block Elements:** Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

✓ **Periodic table and periodicity:**

introduction, electronic configuration and periodic table, classification of elements on the basis of s, p, d and f valence orbitals, periodicity, shielding effect, effective nuclear charge, density of elements, atomic volume, atomic and ionic size, ionization energy, electron affinity, electronegativity, application of electro negativity, electropositive and electronegative element, characteristics of elements, polarisability and polarizing power of ions, periodicity in compound (Halides, Oxides, sulphides and Hydrides) periodicity in transition elements.

● **PRACTICAL:**

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid- base titrations, preparation and standardization of acid and alkali solutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, gravimetric analysis, determination of barium in a given sample, determination of chloride in a given solution.

● **RECOMMENDED BOOKS:**

- ✓ Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2<sup>nd</sup> ed., Oxford University Press, (1994).
- ✓ Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley & Sons, New York, (2007).
- ✓ Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity*, 3<sup>rd</sup> ed., Harper International SI Edition, (2006).
- ✓ House, J. E., *Inorganic Chemistry*, Academic Press. USA, (2008).
- ✓ Lee, J. D., *Concise Inorganic Chemistry*, 5<sup>th</sup> ed., Chapman and Hall, (1996).
- ✓ Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3<sup>rd</sup> ed., Pearson Education, India, (2008).
- ✓ Huheey, J. E., Keiter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Benjamin-Cummings Pub Co., (1993).
- ✓ Sharpe, A. G., *Inorganic chemistry*, 3<sup>rd</sup> ed., Pearson Education India, (1981).
- ✓ Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Lahore, (2013).
- ✓ Catherine E. Housecroft, Alan G. Sharpe, *Inorganic Chemistry*, 3<sup>rd</sup> ed., Prentice Hall, (2008).
- ✓ Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry*, 2<sup>nd</sup> ed., Brooks Cole, (2010).
- ✓ Wulfsberg G., *Principles of Descriptive Inorganic Chemistry*, 1<sup>st</sup> ed., University Science Books, (1991).

- ✓ Hill, R. H. JR and Fister, D. C., *Laboratory Safety for Chemistry Students*, John-Wiley & Sons, Inc., (2010).
- ✓ Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> ed., Pearson Education, Ltd., (2000).
- ✓ Svehla, G., *Vogel's Qualitative Inorganic Analysis*, 7<sup>th</sup> ed., (7<sup>th</sup> imp.), Pearson Education, Ltd., (2009).

## PRINCIPLES OF CHEMISTRY -I (GEN-311) (3+0)

- **COURSE OBJECTIVES:**

- ✓ This subject enables the students to get the knowledge pertaining basic of Chemistry and separation techniques.

- **COURSE CONTENTS:**

- ✓ **Introduction:**

Atom, Relative atomic mass, Isotopes, Isobars and Isotones, Determination of relative atomic mass (mass spectrophotometer), Empirical formula, Molecular formula, concept of Mole, Avogadro's number, Stoichiometry, Law of conservation of mass and Law of definite proportion, Limiting reactant, the concept of Yield (theoretical, actual and percentage yield). Numerical related to the above topics.

- ✓ **Solutions:**

Concept of solutions, Concentration units of the solution, Types of solution, Ideal and non-ideal solution, Raoult's Law, Vapour pressures of solution, Solubility and solubility curve, Colligative properties of solution, Energetic of solution, Hydration and Hydrolysis. Numerical related to the above topics.

- ✓ **Separation techniques:**

Introduction to qualitative and quantitative analysis. Filtration (gravity and suction filtration), Distillation, Sublimation, Crystallization, Solvent Extraction (Distribution/Partition Law), Chromatography (introduction, classification and paper chromatography).

- **RECOMMENDED BOOKS**

- ✓ Chemistry 4th edition by John A Olmsted and Gregory M. William
- ✓ Chemistry. Student study guide by John A Olmsted.
- ✓ Chemistry Matter and its changes by James E Brady.
- ✓ World of Chemistry by Steven S Zumdahl



## **SUSTAINABLE DEVELOPMENT (CHEM-312) (3+0)**

- **COURSE OBJECTIVE:**

- ✓ The first purpose is to equip students with well-rounded systematic knowledge and an understanding of key themes of sustainable development within the development context.
- ✓ These are themes such as the nature of the environmental crisis within the global system, national and local sustainable development policy, theories of sustainable development, the cash between development and conservation as well as issues in sustainable development practice.
- ✓ The second purpose is to provide students with in-depth knowledge and critical skills that will enable qualified students to assess and apply strategies and frameworks of sustainable development.
- ✓ In addition, to provide students with the opportunity to study selected themes relating to gender and gender power relations within the context of development by reading and reflecting on texts and case studies dealing with issues such as the feminisation of poverty, urban survival strategies, women as providers of food security, appropriate technology, gender-sensitive planning and gender policy.

- **COURSE CONTENT:**

- ✓ Introduction to Sustainable Development; Global Perspective
- ✓ Culture and Sustainable Development
- ✓ Poverty and Development
- ✓ Gender and Development
- ✓ Governments and International Agreements for Sustainable Development
- ✓ Culture and Sustainable Development
- ✓ What are Sustainable Cities?
- ✓ Global Freshwater Resources
- ✓ The United Nations and Global Sustainability

- **RECOMMENDED BOOKS**

- ✓ Ann Swidler and Susan Cotts Watkins (2009). "Teach a man to fish": the sustainability doctrine and its social consequences. In *World Development*. Vol. 37, Issue 7:1182-1196.
- ✓ *Our Common Future: Toward Sustainable Development*. UNEP/UNDO document available at their website.
- ✓ Priscilla Stone (2003). Is Sustainability for Development Anthropologists. In *Human Organization*. Vol. 62, No. 2: 93-99.
- ✓ *Sustainable Development Strategy Pakistan*, [readings to be assigned]
- ✓ Maia Green (2006). *Representing Poverty and Attacking Representations: Perspectives in Poverty from Social Anthropology*. E-Quad working paper no. 27. Available at: [http://192.75.12.210/ids/documents/Q2\\_WP27\\_Green.pdf](http://192.75.12.210/ids/documents/Q2_WP27_Green.pdf)
- ✓ Abhijit Banerjee and Esther Duflo (2007). *The Economic Lives of the Poor*. In *Journal of Economic Perspective*, Vol 21, No. 1 :141-167.

- ✓ Amartya Sen (1983). Poverty and Famine: Essays on Entitlement and Deprivation. Oxford University Press. [selected chapters]
- ✓ UNDP Human Development Report, MDG and SGD [available at UNDP websites]
- ✓ Naila Kabeer (2005). Gender equality and women's empowerment: a critical analysis of the third Millennium Development Goal. In Gender and Development Vol. 13, No. 1:13-24
- ✓ Maxine Molyneux (2002). Gender and the Silences of Social Capital: Lessons from Latin America. In Development and Change Vol. 33, No. 2:167- 88.
- ✓ Aminur Rahman (1999). Micro-credit Initiatives for Equitable and Sustainable Development: Who Pays? In World Development. Vol. 27, No. 1:67-82.
- ✓ Carol Carpenter (2001). The role of economic invisibility in development: veiling women's work in rural Pakistan. In Natural Resources Forum. Vol. 25. Issue. 1: 11-19
- ✓ UN, "Resilient People, Resilient Planet Report – 2012" (web);
- ✓ UN – "Global Sustainability Panel's Vision" (web)
- ✓ Agyeman, Chapter 1: Introducing just sustainabilities, pp 4 – 34.
- ✓ The Happy Planet Index: 2012 Report: A global index of sustainable wellbeing. (PDF)
- ✓ Marks, N (2012) Happy Planet Index <https://www.youtube.com/watch?v=sZPYI8BfnBs> Marks, N et al (2012)
- ✓ Agyeman, Chapter 4, Conclusions
- ✓ Living in Denial, by Kari Marie Norgaard, Introduction and Chapter 6.
- ✓ Bottled Water: the pure commodity in the age of branding, Journal of Consumer Culture, Richard Wilk (available on PowerCampus)
- ✓ Rees, "The built environment and the ecosphere" (web)
- ✓ Rees, "Getting Serious about Urban Sustainability" (web)

### **ENGLISH I (Functional English) (ENG-301) (3+0)**

- **COURSE OBJECTIVES:**

Enhance language skills and develop critical thinking.

- **COURSE OUTLINES:**

- ✓ Comprehension
- ✓ Applied grammar and Usage
- ✓ Introduction to Critical Thinking & Reading
- ✓ Paragraph Development & Organization
- ✓ speaking ,listening , reading and writing skills
- ✓ Story writing and telling
- ✓ Skimming for general idea
- ✓ Scanning for specific information
- ✓ Note making

**RECOMMENDED BOOKS:**

- ✓ Practical English Grammar by A. J. Thomson and A.V. Martinet. Exercises 1. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN0194313492
- ✓ Practical English Grammar by A.J. Thomson and A.V. Martinet.Exercises 2. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN0194313506
- ✓ Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- ✓ Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 4534022.

### **MATHEMATICS -I (MATH-302) (3+0)**

- **COURSE OBJECTIVES:**  
Students will acquire knowledge about various basic materials of math which are very necessary for understanding physical and analytical chemistry.
- **COURSE CONTENTS:**
  - ✓ **Real number system:** Natural number, whole number, integers, prime number, composite number, even number, odd number rational number, recurring decimal, pure recurring decimal, mixed recurring decimal, irrational number and real number. Closer, commutative, associative property. Additive, multiplicative identity. Additive inverse and multiplicative inverse. Distributive property of multiplication, over addition and subtraction.
  - ✓ **Equality:** Properties, reflexive property, symmetric property, transitive property, multiplicative property, cancellation property, w.r.t multiplication, additive property, cannulation property w.r.t addition.
  - ✓ **Inequality:** Properties of inequality of real number, trichotomy property, transitive property, additive property, multiplicative property.
  - ✓ **Decimal:** Properties in working with decimal, addition, subtraction, multiplication, division.
- **RECOMMENDED BOOKS:**
  - ✓ Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
  - ✓ H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.
  - ✓ Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
  - ✓ Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.

### **PAKISTAN STUDIES (PAK-303) (2+0)**

- **COURSE OBJECTIVES:**  
To take an analytical view in the history and development of Muslim society and culture in the sub-continent, emergence of Pakistan and its constitutional development. To develop an appreciation of the issues and challenges currently

being faced in Pakistan. The strengths of its people and strategies to deal with the impediments to progress. International relations of Pakistan.

- **COURSE CONTENTS:**

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

- **RECOMMENDED BOOKS:**

- ✓ Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
- ✓ Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
- ✓ Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
- ✓ Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
- ✓ Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e- Islamia, Club Road, nd.
- ✓ Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
- ✓ Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987. 14.
- ✓ Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.
- ✓ Wilcox, Wayne. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.
- ✓ Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980

## **SECOND SEMESTER (1<sup>ST</sup> YEAR)**

### **ENGLISH-II (Communication skill) (ENG-304) (3+0)**

- **Course Objectives :**
  - ✓ Write & speak clearly, concisely, and convincingly.
  - ✓ Create impressive formal & informal presentations that are delivered with confidence and poise.
  - ✓ Develop and deliver effective speeches and talks.
- **Course Outline:**
  - ✓ Verbal communication
  - ✓ Non Verbal Communication
  - ✓ Barriers to communication
  - ✓ Business Communication at Work Place
  - ✓ Proofreading

- ✓ Elevator Pitches “Tell me about yourself”
- ✓ Professional Writing Style
- ✓ Intercultural Communication
- ✓ Soft skills for leadership and team management
- ✓ Proposal Development
- ✓ Job interviews
- ✓ Social media ( emails , blogs )
- **Recommended books:**
  - ✓ Barnes, Louis. "Managing Interpersonal Feedback." *Harvard Business School Case*. Cambridge, MA. 1989. Case No. 9-483-027.
  - ✓ Bovee, Courtland & Thill, J. V. *Business Communication Today*. 11th Edition. New York: Prentice-Hall, 2011
  - ✓ Daly, John, and Isa Engleberg. "Coping with Stagefright." *Harvard Management Communication Letter* 2, no. 6 (June 1999): 1-4.
  - ✓ DiSanza, James, R. & Legge N.J. *Business & Professional Communication: plans, processes and performance*. 5th Edition. USA: Allyn & Bacon
  - ✓ B001IOBPC4
  - ✓ Gerson, Sharon J. *Technical Writing: process & product*. India: Pearson. 2006.
  - ✓ "Handling Q&A: The Five Kinds of Listening." *Harvard Communications Update* (February 1999): 6-7.
  - ✓ Makay, J. John & Fetzer, R.C. *Business Communication Skills: principles & practices*. New jersey, Prentice-Hall Inc. 1986.

## **ISLAMIC STUDIES (ISL-305) (2+0)**

- **COURSE OBJECTIVE:**

To impart an understanding of the fundamental principles and teachings of Islam through study of selected verses of the Quran and Prophetic Sayings. Important facets of the Prophet’s life and salient, features of Islamic Civilization. To provide appreciation of other prominent religions, systems of ethics and cultures to prepare students to survive in international and multicultural work place.
- **COURSE OUTLINE:**

Fundamentals of Islam (Aqaid, Ibadat, Islamic Dawah etc.), Ethical values of Islam, Serah of the Holy Prophet (PBUH). Islamic Civilization and its effects on humanity. Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint. Multicultural societies.
- **RECOMMENDED BOOKS:**
  - ✓ Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research
  - ✓ Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001).
  - ✓ H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989).
  - ✓ Hameedullah Muhammad, ‘Introduction to Islam.
  - ✓ Hameedullah Muhammad, “Emergence of Islam” , IRI, Islamabad.
  - ✓ Hameedullah Muhammad, “Muslim Conduct of State”.

- ✓ Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- ✓ Institute, International Islamic University, Islamabad (1993).
- ✓ Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982).
- ✓ Mulana Muhammad Yousaf "Islahi," .

## **PRINCIPLES OF CHEMISTRY -II (GEN-313) (3+0)**

- **COURSE OBJECTIVES:**

- ✓ This course is formulated to provide the root understanding about Chemical Equilibrium.

- **CHEMICAL EQUILIBRIUM:**

- ✓ Reversible and Irreversible reactions, State of chemical equilibrium and Law of Mass Action, equilibrium constant, application of equilibrium constant, Le-Chatelier's Principle, Application of chemical equilibrium in industry, Ionic product of water. Concepts of Acids and Bases (Arrhenius concept, Lowery-Bronsted concept, Lewis concept, Lux-Flood concept and Usanovich concept). Ionization constant of acids and bases (significance of pH, pKa, pKb). Buffer solutions. Buffer capacity. Soft and hard acid and base (SHAB). Applications of SHAB. Theory of Indicators (Acid-base, Redox and precipitation indicators). Solubility, Solubility product, common ion effect and their industrial applications. Numerical about the related topics.

- ✓ **Hydrogen:**

Introduction. Preparation of hydrogen. Natural abundance of hydrogen. Physical and chemical properties of hydrogen. Placement/position of hydrogen in periodic table. Isotopes of hydrogen. Binary compounds of hydrogen. Uses of hydrogen.

- **RECOMMENDED BOOKS:**

- ✓ John-Wiley & Sons, Inc., (1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001.
- ✓ Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
- ✓ Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5th Edition, 1996.
- ✓ Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2nd Edition, 1994.
- ✓ Hill, R. H. JR and Fister, D. C., Laboratory Safety for Chemistry Students 2010).

## **BEHAVIOR SCIENCE (GEN-314) (3+0)**

- **COURSE OBJECTIVES:**

This course will introduce students to aspects of psychology that they might not have been exposed to in the past. It will provide students with knowledge of basic psychological theory and methodological tools so that they may pursue advanced study in the discipline. Emphasis will also be placed on how psychological theory relates to the “real world”, including organizational behavior, marketing techniques and health intervention strategies.

- **COURSE CONTENT:**

**Introduction to the course;** what is psychology? Critical thinking in psychology

**How psychologists do research:** Descriptive, correlational, and experimental methods in psychology; research ethics

**Genes, evolution, and environment:** Genetics of behavior; environmental influences on behavior; nature and nurture

**The brain, mind, and self:** Biology of mind: neurons and neurochemicals; brain structures and areas; imaging the brain.

**Body rhythms and mental states:** Biological rhythms; sleep and dreams consciousness; drugs and consciousness; hypnosis

**Sensation and perception:** Introduction to the various senses; how the sensory systems perceive, organize, and interpret information.

**Learning and conditioning:** classical and operant conditioning; observational learning.

**Behavior in social and cultural context:** Obedience and compliance; attribution theory; group behavior and identity; conflict and prejudice

**Thinking and cognition:** Elements of cognition; cognitive biases; intelligence and its assessment; animal minds

**Memory:** Creation of memories; theories of memory; biology of memory

**Emotions, stress, and health:** The nature of emotions; stress; stress and emotion; coping with stress

**Motivation:** Hunger, thirst, pursuit of happiness

**Theories of personality:** Freud and psychoanalysis; humanistic theories; contemporary research on personality

**Life-span development:** Cognitive development over the life-span

**Psychological disorders:** classification of disorders; anxiety and mood disorders; dissociative identity disorder (multiple personality disorder); schizophrenia.

- **RECOMMENDED BOOKS:**

- ✓ Wade, Carole & Tavris, Carol (2011). Psychology 10th ed. New Jersey: Prentice Hall. (Chapter 1) (Chapter 2) (Chapter 3) (Chapter 4) (Chapter 5) (Chapter 6) (Chapter 7) (Chapter 8) (Chapter 9) (Chapter 10) (Chapter 11) (Chapter 14) (Chapter 13).

- **COURSE OBJECTIVES**

To acquaint students with features of eukaryotic cells, functions of different compartments and the overall structure/ultra-structure of cells as visualized by electron microscopy.

- **COURSE CONTENTS:**

Introduction to cell theory including historical perspective; prokaryotic and eukaryotic cell differences including cell wall, membrane structure and chemical constituents of the cell; function, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum, golgi bodies, ribosomes, lysosome, micro-bodies, mitochondrial ultrastructure and function, chloroplast ultra-structure and the mechanism of photosynthesis; membrane receptors and transport mechanisms; cell movement - structure and function of cytoskeleton, centriole, cilia and flagella; nucleus; structure and function of chromosomes; cell cycle, mitosis and meiosis, cell death.

- **PRACTICAL:**

Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell structure in the staminal hair of *Tradescantia*; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots.

- **RECOMMENDED BOOKS:**

- ✓ Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4<sup>th</sup> Edition; Garland Publishers, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- ✓ Karp, 2002. Cell and Molecular Biology. 3<sup>rd</sup> Edition; John Wiley and Sons, New York.
- ✓ Alberts et al., 2009. Essential Cell Biology. 3<sup>rd</sup> Edition; Garland Publishers, New York.
- ✓ Lodish et al., 2007. Molecular Cell Biology. 6<sup>th</sup> Edition; Freeman and Company, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- ✓ Cooper GM and Hausman RE, 2009. The Cell, a molecular approach. 5<sup>th</sup> Edition; Sinauer Associates, Inc.

## **ORGANIC CHEMISTRY-I (CHEM-331) (3+1)**

- **COURSE OBJECTIVES:**

Students will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of



organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

- **COURSE CONTENTS:**

- ✓ **Basic Concepts of Organic Chemistry:** Bonding and hybridization, localized and delocalized bonding, structure-aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).
- ✓ **Chemistry of Hydrocarbons:** Saturated and unsaturated hydrocarbons with emphasis on free radical, electrophilic addition and electrophilic substitution reactions.
- ✓ **Chemistry of Functional Groups:** preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

- **PRACTICAL:**

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

### **THIRD SEMESTER (2<sup>ND</sup> YEAR)**

#### **ENGLISH III (Technical Writing ) (ENG-406) (3+0)**

- **COURSE OBJECTIVES:**

To enable students to write substantive, well-organized and coherent essays are following a specified process of writing while displaying awareness of the rhetorical situation including audience awareness and a sense of purpose & style through solid grounding in the core concepts of academic writing.

- **COURSE CONTENTS:**

- ✓ The Process of Academic Writing
- ✓ Principles of clear writing
- ✓ Introduction to Writing a Research Essay
- ✓ Essential Skills for Critical Writing
- ✓ Writing Reports

- ✓ Audio Video Aids and Effective Presentation
- ✓ Summaries and abstracts
- ✓ Introduction to Argumentation
- ✓ Application writing (jobs and academic): CV, resume, cover letter, Statement of Purpose (SOP)
- ✓ Formal Correspondence
- **RECOMMENDED BOOKS:**
  - ✓ Munter, Mary. Guide to Managerial Communication. 7th ed. Upper Saddle River, NJ: Prentice Hall, 2005. ISBN: 0131467042.
  - ✓ Effective technical Communication by Barun K. Mitra, Oxford University Press
  - ✓ Technical Communication-Principles and Practice by Meenakshi Raman & Sharma, Oxford University Press, 2011, ISBN-13-978-0-19-806529- 3.
  - ✓ Contemporary Business Communication by Scot Ober , Published by Biztantra,
  - ✓ Technical Writing- Process and Product by Sharon J. Gerson & Steven M. Gerson, 3rd edition, Pearson Education Asia, 2000
  - ✓ Developing Communication skills by Krishna Mohan & Meera Banerjee

### **INTRODUCTION TO COMPUTER (COMP-407) (3+0)**

- **COURSE OBJECTIVES:**

To familiarize the student with basics of computer systems, hardware, software, networking and programming languages.
- **COURSE CONTENTS:**

Introduction to computers, Types of computers, Types of software, Hardware, Types of Hardware (input devices, output devices, and storage devices), Communication and networks, Introduction to Internet and World Wide Web, Software, Operating systems, utility programs, Programming languages, Types of programming languages, Introduction to Windows Operating system and Office applications.
- **RECOMMENDED BOOKS:**
  - ✓ Discovering Computers 2014 by Shelly, Cashman, Vermaat, Thomson course Technology, 2013
  - ✓ Microsoft® Office 2013: Brief: Brief by Gary B. Shelly, Misty E. Vermaat, 2013.

### **BIOSAFETY AND ETHICS (GEN-416) (2+0)**

- **COURSE OBJECTIVES:**

To acquaint students with principles of biosafety and ethical perspectives pertaining to biochemistry as well as biotechnology

- **COURSE CONTENTS :**

Introduction to Biosafety definition, concept, uses and abuses of genetic information, and biohazards; good laboratory practices; risks related to genetically modified organisms (GMO); international rules and regulations for biosafety and GMOs; introduction to bioethics; ethical issues related to GMOs; euthanasia, reproductive and cloning technologies, transplants and eugenics; patenting, commercialization and benefit sharing; role of national bioethics committees; biosafety guidelines from a national perspective.

- **RECOMMENDED BOOKS:**

- ✓ Altman A and Hasegawa PM, 2012. Plant Biotechnology and Agriculture: Prospects for 21<sup>st</sup> Century. 1<sup>st</sup> Edition; Academic Press.
- ✓ Laboratory Biosafety Manual, WHO, 2006. 3<sup>rd</sup> Edition; AITBS Publishers and Distributors, India. (Available online).
- ✓ Furr AK, 2000. CRC Handbook of Laboratory Safety. 5<sup>th</sup> Edition; CRC Press.
- ✓ Jose Maria A, 2003. Genes Technology and Policy. Available online at; <http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf>
- ✓ Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
- ✓ National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (Available online)

## **FORENSIC CHEMISTRY (GEN-417)**

**(3+0)**

- **COURSE OBJECTIVE:**

This course aims to explore and evaluate the biological and chemical role in crime detection. It helps to enhance understanding important biological and genetic aspects of human individuality.

- **COURSE CONTENTS:**

- ✓ **Introduction**  
definition, methods, importance
- ✓ **Biological aspects of forensic Chemistry**  
Everyday chemistry for biochemist  
Human individuality
- ✓ **Genetic aspects of human individuality**  
Phenotypic characters, blood groups, figure prints, DNA.  
Experimental biology of forensic
- ✓ **Identification of individuality**  
Collection of blood samples from different sources,  
collection of figure print from different sources,

Collection of DNA from different sources, other biological specimen used in forensic.

✓ **Generation and inference from biological evidence**

Physiological bases of aggressive behavior

Genetic bases of aggressive behavior

Legal status of biological evidence

Legislation procedure for the use of biological evidence

Polygraph machine.

● **RECOMMENDED BOOKS:**

- ✓ Annas, G.J and Elias, S (1992) using law and Illics as guide. New York: Oxford university press.
- ✓ Griffiths, I. J. F., Gelbart, W. M., Miller, J. M and Lewonten, R. C (1991). Modern genetic analysis. New York : W. H Treana
- ✓ Litken, C. G. G. (1995), Statistics and the evolution of guidance for forensic scientists. New York: john wiley
- ✓ Weir, B. S. (1995). Human Identification. The use of DNA Markers. Netherlands: Kluwer Academic publishers

**APPLIED CHEMISTRY-I (CHEM-481) (2+0)**

● **COURSE OBJECTIVES:**

- ✓ This course provides the knowledge of introduction to applied chemistry, soaps and detergents, pesticides and explosives.

● **COURSE CONTENTS:**

● **INTRODUCTION:**

- ✓ Introduction to industrial chemistry and its importance, flowcharts, material balance, cost and yield, functions of chemist, chemical process control; in process and finished products control.

✓ **SOAPS AND DETERGENTS:**

Introduction of soap, Batch Kettle process, flow diagram and details, Monas Avon process, Delaval process, sharpness process. Introduction to detergent, classification, examples of cationic, anionic, nonionic and amphoteric detergents and their action with water, binders, opacifying agents, flavors, moisturizers of soap industry.

**Pesticides:**

Introduction, classification of insecticides (chlorinated hydrocarbons, carbamates, organophosphates) Classification and examples of herbicides (contact herbicides, systematic herbicide sand soil sterilants), rodenticides, fungicides (inorganic and organic fungicides) and germicides.

**RECOMMENDED BOOKS:**

- ✓ Austin GT "Shreve's Chemical Process Industries" 5th Ed (1984) McGraw Hill
- ✓ Clark "Isolation and Identification of Drugs and Toxic Substances" (1979).
- ✓ Kent JA "Riegel's Handbooks of Industrial chemistry" 9th Ed (1992) Chapman & Hall
- ✓ Shreve N "Chemical Process Industries" John Wiley (1982) New York
- ✓ Vogel AI "Quantitative Organic Analysis" 5th Ed (1994) Longman Group

### PHYSICAL CHEMISTRY-I (CHEM-441) (3+1)

- **COURSE OBJECTIVES:**

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibrium and to investigate the physical properties of ideal/non-ideal binary solutions. Students should also be able to study the rates of reactions and perform related calculations.

- **COURSE CONTENTS:**

- ✓ **Chemical Thermodynamics:** Equation of states, ideal and real gases, the real gas equation and the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and nonreversible processes, spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.
- ✓ **Chemical Equilibrium:** General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle.
- ✓ **Solution Chemistry:** Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and nonideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.
- ✓ **Chemical Kinetics:** The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental techniques for rate determination and methods for determination

of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

- **PRACTICAL:**

Determination of viscosity and refractive index of liquids; Determination of percent composition of liquid solutions viscometrically; Determination of refractive index and molar refractivity; Determination of percent composition of liquid solutions by refractive index measurements; Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method); Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method); Determination of heat of solution by solubility method; Determination of heat of neutralization of an acid with a base; Kinetic study of acid catalyzed hydrolysis of ethyl acetate; Determination of partition coefficient of a substance between two immiscible liquids.

- **RECOMMENDED BOOKS:**

- ✓ McQuarrie, D. A. and Simon, J. D., *Physical Chemistry – A Molecular Approach*, 1<sup>st</sup> ed., University Science Books, (1997).
- ✓ Atkins, P. and Paula, J.D., *Atkin's Physical Chemistry*, 9<sup>th</sup> ed., Oxford University Press, (2010).
- ✓ Shoemaker, D., *Experiments in Physical Chemistry*, 8<sup>th</sup> ed., McGraw-Hill Publishing Company Limited, (2003).
- ✓ Silbey, R., Alberty, R. and Bawendi, M., *Physical Chemistry*, 4<sup>th</sup> Ed., (2005).
- ✓ Atkins, P., Jones, L., *Chemical Principles*, 5<sup>th</sup> ed., W. H. Freeman and Company, New York, (2010).
- ✓ James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3<sup>rd</sup> ed., Longman Group Limited, New York, (1974).
- ✓ Chaudhary, S. U., *Ilmi Textbook of Physical Chemistry*, 2<sup>nd</sup> ed., Ilmi Kitab Khana, Lahore, (2013).
- ✓ Atkins, P., Jones, L., *Chemical Principles: The Quest for Insight*, 5<sup>th</sup> ed.,
  - W. H. Freeman, (2010).
- ✓ Linder, B., *Elementary Physical Chemistry*, World Scientific Publishing Co. Ptv. Ltd., (2011).
- ✓ Davis, W. M., Dykstra, C. E., *Physical Chemistry: A Modern Introduction*, 2<sup>nd</sup> ed., CRC Press, (2011).

## FORTH SEMESTER (2<sup>ND</sup> YEAR)

### STATISTICS (STAT-409) (3+0)

- **COURSE OBJECTIVES:**

To introduce the concept of statistics, randomness and probability and build on these concepts to develop tools and techniques to work with random variables

- **COURSE OUTLINE:**

Introduction to Statistics, Descriptive Statistics, Statistics indecision making, Graphical representation of Data Stem-and Lead plot, Box-Cox plots, Histograms and O give, measures of central tendencies, dispersion for grouped and ungrouped Data, Moments of frequency distribution; examples with real life, use of Elementary statistical packages for explanatory Data analysis. Counting techniques, definition of probability with classical and relative frequency and subjective approaches, sample space, events, laws of probability. General Probability Distributions, Conditional probability and Bayes theorem with application to Random variable (Discrete and continuous) Binomial, Poisson, Geometric, Negative Binomial Distributions; Exponential Gamma and Normal distributions. Regression and Correlation.

● **RECOMMENDED BOOKS:**

- ✓ Advances in Statistical Analysis and Statistical Computing III Mariano R (Ed.), (1993), JAI Press, Greenwich, Conn.
- ✓ Introduction to Statistics, Walpole, 1982 Prentice Hall, ISBN: 0024241504.
- ✓ Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar, Faisalabad.
- ✓ Statistical Data Analysis, G. Cowan G, 1998, Clarendon, Oxford.
- ✓ Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.

**MARKETING MANAGEMENT (GEN-419) (3+0)**

● **COURSE OBJECTIVES:**

The course investigates marketing from a managerial perspective, including the critical analysis of functions of marketing opportunity assessment, marketing planning, marketing implementation, evaluation and control of the marketing effort. The course provides the student with a necessary mix of: (1) critical analysis, (2) application of concepts and techniques, and (3) communication.

● **COURSE OUTLINES**

Introduction to marketing management, Elements of marketing strategy and planning, Customer relationship management & marketing information management, Decision making processes in B2C and B2B contexts, Segmentation, Targeting, Positioning, Product strategy and brand management, New product development, Managing pricing decisions,

Managing marketing channels and supply chain, Integrated Marketing Communications , Metrics for measuring marketing performance.

- **RECOMMENDED BOOKS**

- ✓ Aaker, D. (2003) Strategic Marketing Management. Wiley
- ✓ Crouch, S. & Housden, M. (2002) Marketing Research for Managers, 3 rd ed. Butterworth-Heinemann
- ✓ De Chernatony, L. (2001) From Brand Vision to Brand Evolution: Strategically Building and Sustaining Brands. Butterworth-Heinemann

**ANALYTICAL CHEMISTRY-I (CHEM-451) (3+1)**

- **OBJECTIVES:**

The main objectives of this course are to teach the basic concepts of analysis, error and data handling, and gravimetric analysis.

- **COURSE CONTENTS:**

- ✓ **Basic Concepts of Analysis:** Introduction to analytical Chemistry, analytical process. Defining the problem, sampling, handling the sample, performing necessary chemical separations, performing the measurement, calculation and interpretation of the measurement
- ✓ **Errors and Data Handling:** Determinate and indeterminate errors, significant figures, rounding off, accuracy and precision, arithmetic means, medians, average deviation, standard deviation, confidence limit, testing for significance, Q-test, T-test, correlation coefficient
- ✓ **Gravimetric Analysis:** General principle, steps of gravimetric analysis: Solution preparation, precipitation, digestion, washing, filtration, drying and ignition of precipitates, calculation, applications of gravimetric analysis.

- **PRACTICAL:**

Calibration of volumetric glassware, electronic and analytical equipment, statistical evaluation of analytical data including linear regression analysis, constructing a calibration curve from a given analytical data using spread sheet software. Determination of hardness of water using EDTA. Determination of chloride in tap water sample. Estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry, gravimetric analysis. Determination of cation in a mixture by complexometric titration, studying the effect of common ions on solubility of sparingly soluble salts (e. g. AgCl / PbSO<sub>4</sub>).

- **RECOMMENDED BOOKS:**

- ✓ Analytical Chemistry, 5 edition, By G.D. Christian, John Wiley & Sons, Inc., 1994.
- ✓ Analytical Chemistry An introduction 7<sup>th</sup> edition), By Skoog Holler. Edition 2000.
- ✓ Analytical Chemistry R. M. Verma CBS publications India.
- ✓ Analytical Spectroscopy by Bensal K.



- ✓ Christian, G. D., Analytical Chemistry. 6th ed., John-Wiley & Sons, New York, (2006).
- ✓ Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, USA, (2011).
- ✓ Kealey, D. and Haines, P. J., Instant Notes., Analytical

### **ENVIRONMENTAL CHEMISTRY-I (CHEM-471) (3+0)**

- **COURSE OBJECTIVES:**

- ✓ This course is designed to provide the knowledge that what chemicals hazard our environment and how we protect our lovely environment from the detrimental chemicals.

- **COURSE CONTENT:**

- ✓ Introduction to environmental chemistry, components of environment, history and significance of environmental degradation, environmental pollutants, impact of the modern life style on environmental quality, resource depletion, environmental conservation and sustainability, poverty and environmental degradation, environmental education, institutions for the protection of environment. Energy resources and their environmental consequences, fossil fuels nuclear energy, synthetic chemical fuel, emission from thermal units, nuclear waste and its disposal.

- ✓ **Atmospheric Pollution:**

Introduction to atmospheric pollution. Components of atmosphere, temperature and pressure profiles of different components of atmosphere, air pollutants and their types, effect of air pollutants on atmosphere.(Acid rain, Ozone depletion, Greenhouse effect).photochemical smog, Biogeochemical cycles, and importance of atmosphere.

- ✓ **Water Pollution And Water Treatment:**

Introduction to water, properties of water, methods for determining the quality of water (BOD, COD).Water pollutants and sources of water pollutants (industrial, agricultural, municipal, and natural sources.Primary, secondary and advanced treatment of water.

- **RECOMMENDED BOOKS:**

- ✓ J. W. Moore and E.M. Moore, Environmental Chemistry, Academic Press, New York.
- ✓ S. K. Benerji, Environmental Chemistry, Prentice Hall, Delhi.
- ✓ S. K. Benerji, Environmental Chemistry, Tata Publishers, Delhi
- ✓ Staneley E. Manahan, Environmental Chemistry, Brooks, California.
- ✓ Neil .P.O. Environmental Chemistry, Chapmann, London.
- ✓ P.O. Heil, Environmental Chemistry, Chapmann London.
- ✓ T. G. Spiro and W.M. Stringliant, Chemistry of the Environment, Printice Hall.

- ✓ T.F. Yen, Environmental Chemistry, Prentice Hall.
- ✓ Dara, A text of Environmental Chemistry and pollution control, Paramount Books.

### **BIOCHEMISTRY-I (461) (3+1)**

- **COURSE OBJECTIVES:**

- ✓ Students will gain knowledge about fundamental concepts of biochemistry as well as be able to learn about the structures, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

- **COURSE OBJECTIVES:**

- ✓ **Introduction to Biochemistry:** Brief introduction to the scope and history of Biochemistry, molecular logic of the living organism, cell structures and their functions, origin and nature of biomolecules.

- ✓ **Acid-Base and Electrolyte Chemistry:** Intracellular and extracellular electrolytes, body fluids as electrolyte solutions, pH, Henderson-Hasselbalch equation and buffers, amino acids, peptides and proteins, buffer capacity, buffers of body fluids, haemoglobin as an acid-base system, renal control of acid-base, balance, acid-base disorders: acidosis, alkalosis. haemoglobin and omeostasis, variation of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$  in acid-base disturbances.

- ✓ **Carbohydrates, Lipids and Proteins:** Definition and classification, chemistry, physical and chemical properties of various classes of carbohydrates, biological functions of starch, glycogen, cellulose, and cell wall polysaccharides, acid mucopolysaccharides and proteoglycans. Definition and classification of lipids, chemistry and biological importance of fatty acids, waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols and prostaglandins. Significance of lipids in biological membranes and transport mechanism. Chemistry and classification of amino acids, physical and chemical properties of amino acids, biological significance of amino acids, peptides, proteins, their classification, properties and biological significance, primary, secondary tertiary and quaternary structure of proteins, denaturation of proteins.

- ✓ **Nucleic Acids:** Chemical composition of nucleic acids, structure and biological significance of nucleic acids, chemical synthesis of oligonucleotides, nucleic acids hydrolysis, isolation and separation of nucleic acids, introduction to recombinant DNA technology.

- **Practical:**

- ✓ Qualitative and quantitative analysis of carbohydrates, lipids and proteins.
- ✓ Laboratory work illustrating topics covered in the lecture of Chem.
- ✓ Determination of pH, Preparation of buffers.
- ✓ Enzyme catalysis, Progress curve for enzyme catalyzed reactions, Determination of values.
- ✓ To study the effect of different factors on the rate of enzyme catalyzed reactions.

- **RECOMMENDED BOOKS:**

- ✓ Biochemistry by Donald Voet
- ✓ Biochemistry by Jermy M. Berg
- ✓ Biochemistry by LubertStryer 2006. Pub: Freeman and Company

- ✓ Biochemistry by Voet, and Pratt, 2004, John Wiley and Sons Inc.
- ✓ Guyton, A. C. & Hall, J. E., Guyton & Hall Textbook of Medical Physiology, 12th ed., Publishers: Saunders Elsevier, (2011).
- ✓ Harpers Biochemistry, 27th ed. 2006 Pub: McGraw Hill Inc. CHEM-131 Lab.
- ✓ Lippincott's Biochemistry by Champe, P. C.; Harvey, R. A. and Ferrier, D. R. 3rd ed., 2004 Pub: J. B. Lippincott Company
- ✓ Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed., Publisher: Appleton & Lange, (2000).
- ✓ Principles of Biochemistry by Lehninger A.L., Nelson D.L. and Cox M.N., 2000 Pub: Worth Publishers
- ✓ Zubay, G. L., Biochemistry, 4th ed., illustrated, Publisher W. M. C. Brown Publishers

### **FIFTH SEMESTER (3<sup>RD</sup> YEAR)**

#### **INORGANIC CHEMISTRY-II (CHEM-522) (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:**
    - ✓ 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.
    - ✓ Actinides: General characteristics, electronic structure, oxidation state and position in the periodic table, half-life and decay law.
- **Lab.**
  - ✓ Preparations of following Inorganic Complexes; Tetraamminecopper (II) sulphate.
  - ✓ Potassiumtrioxalatochromate (III).
  - ✓ Potassiumtrioxalatoaluminate (III).
  - ✓ cis-Potassium dioxalato diaquachromate (III).

- ✓ Determination of zinc and cadmium by complexometric titration
- ✓ Chromatographic separations of transition metals;
- ✓ Separation of Ni<sup>2+</sup> & Co<sup>2+</sup> ions in a mixture by paper chromatography.
- ✓ Separation of Ni<sup>2+</sup> & Cu<sup>2+</sup> ions in a mixture by paper chromatography.
- ✓ Separation of Cu<sup>2+</sup> & Fe<sup>2+</sup> ions in a mixture by paper chromatography.
- ✓ Spectrophotometric determination of iron, manganese and nickel.
- **RECOMMENDED BOOKS:**
- ✓ Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6<sup>th</sup> ed., Wiley-Interscience, (1999).
- ✓ Housecraft, C. and Sharpe, A. G., *Inorganic Chemistry*, 4<sup>th</sup> ed., Prentice Hall, (2012).
- ✓ Miessler, G. L. and Tarr, D.A., *Inorganic Chemistry*, 4<sup>th</sup> ed., PearsonPrentice Hall International, (2010).
- ✓ Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> ed., John-Wiley & Sons, New York, (1994).
- ✓ Shriver, D. and Atkins, P., *Inorganic Chemistry*, 5<sup>th</sup> ed., W. H. Freeman & Company, (2010).
- ✓ Lee, J. D., *Concise Inorganic Chemistry*, 5<sup>th</sup> ed., Blackwell Science Ltd., (1996).
- ✓ Atkins, P. and Jones, L., *Chemicals Principles*, 5<sup>th</sup> ed., W. H. Freeman & Company, (2010).
- ✓ Svehla, G., *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, 5<sup>th</sup> ed., Longman Group Limited, (1979).
- ✓ Huheey, J. E., Keiter, E. A. and Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Prentice Hall, (1997).
- ✓ Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods*, 2<sup>nd</sup> ed., Chapman and Hall (1974).
- ✓ Müller, U., *Inorganic Structural Chemistry*, 2<sup>nd</sup> ed., John-Wiley & Sons, Ltd., (2006).
- ✓ Marusak R. A., Doan K., Cummings S. D., *Integrated Approach to Coordination Chemistry*, 1<sup>st</sup> ed., John-Wiley & Sons, (2007).
- ✓ Chaudhary, S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2013).

## ORGANIC CHEMISTRY-II

(CHEM-532)

(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.

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

- **COURSE OBJECTIVES:**

- ✓ In this course Kinetic Theory of Gases, Chemical Thermodynamics and Chemical Kinetics are taught to the students.

- **COURSE CONTENTS:**

- ✓ **Kinetic Theory of Gases:** Laws of gases. Kinetic Molecular Theory and non-ideal behavior of gases. Van der Waal's equation and the critical point. Van der Waal's equation and the law of corresponding states. Maxwell Boltzmann distribution law of molecular velocities and its significance. Maxwell Boltzmann distribution law for molecular energies and its application. Mean free path and its determination. Collision frequency. Calculation of molecular velocities of gases. Velocities of gases, its measurement and effect of temperature. Avogadro's number and its determination.

- ✓ **Chemical Thermodynamics:** The first Law of thermodynamics and their applications. Partial molar quantities and their determinations. Heat capacity and adiabatic processes. Prove that  $C_p - C_v = R$ . Isothermal processes in ideal gases. Carnot cycle for any substance. Carnot cycle for ideal gases. The efficiency of an engine. Second law of thermodynamics. Entropy. Entropy change in isolated system. Third law of thermodynamics. Helmholtz free energy. The Gibbs free energy. Gibbs Helmholtz equation. The relation of free energy with equilibrium constant. The Clausius Calpeyron equation and its simple applications.

- ✓ **Chemical Kinetics:** Order of reaction. 1st. 2nd. And 3rd. order rate laws. Kinetics of simultaneous reactions (opposing, consecutive and side reactions). Energy of activation. Collision and absolute theories of reaction rate and their comparison. Lindeman's mechanism with few examples.

- **LAB:**

- ✓ To determine the heat of neutralization of strong acid (HCl) and strong base (NaOH).
- ✓ To determine the heat of solution by solubility method.
- ✓ To determine the heat of solution of (KNO<sub>3</sub>) salt.
- ✓ To determine hydrolysis constant of methyl acetate in acidic medium
- ✓ To determine the velocity of saponification of ethyl acetate by NaOH.
- ✓ Preparation of solution.

- **RECOMMENDED BOOKS:**

- ✓ Arun Bahl, B. S. Bahl and G. D. Tuli. Essential of Physical Chemistry. S. Chand & co. (2008). Ram Nagar, New Delhi.
- ✓ Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed. Oxford University Press, (2010).

- ✓ Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
- ✓ Ball D. W., Physical Chemistry, Brooks/Cole Co. Inc., (2003).
- ✓ Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, (2013).
- ✓ Choppin, G., Liljenzin, J. O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).
- ✓ Experiment in Physical Chemistry by Brennan and Tipper.
- ✓ Experimental Physical Chemistry by Dr.M.Jaffar.
- ✓ Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co.
- ✓ Loveland, W., Morrissey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).
- ✓ Practical physical chemistry by Alex: Finolpy.
- ✓ Practical Physical Chemistry By Alexander Frindlay
- ✓ Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).
- ✓ Somorjai, G. A. and Li, Y., Introduction to Surface Chemistry and Catalysis, 2nd ed., John-Wiley & Sons, Inc., (2010).
- ✓ Vertes, A., Nagy, S. and Klencsar, Z., Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1<sup>st</sup>ed. Springer, (2003).

## **ANALYTICAL CHEMISTRY II (CHEM-452) (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 of chromatography, classification of chromatographic techniques, overview of paper, 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, single beam 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.
- **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  $\lambda_{\max}$  of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  solutions and verification of BeerLambert'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:**
- ✓ Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9<sup>th</sup> ed., Brooks Cole Publishing Company, (2013).
- ✓ Harris, D. C., *Quantitative Chemical Analysis*, 8<sup>th</sup> ed., W. H. Freeman and Company, New York, USA, (2011).
- ✓ Christian, G. D., *Analytical Chemistry*, 6<sup>th</sup> ed., John Wiley and Sons, New York, (2006).
- ✓ Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry*, 1<sup>st</sup> ed., Bios Saence Publisher Ltd. Oxford UK. (2002)
- ✓ Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., *Introduction to spectroscopy*, 4<sup>th</sup> ed., Cengage Learning, (2008).
- ✓ Wall, P. E., *Thin Layer Chromatography: A Modern Approach (RSC Chromatography Monographs)*, 1<sup>st</sup> ed., Royal Society of Chemistry, (2005).
- ✓ Deinstrop, E. H., *Applied Thin Layer Chromatography*, 2<sup>nd</sup> ed., Wiley-VCH, (2006).
- ✓ Kellener. R, Mermet. J. M., Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry: A Modern Approach to Analytical Science*, Wiley. VCH, (2004)
- ✓ Hollas, J. M., *Modern Spectroscopy*, 4<sup>th</sup> ed., John-Wiley & Sons, Ltd., England (2004).

### **SIXTH SEMESTER (3<sup>RD</sup> YEAR)**

#### **INORGANIC CHEMISTRY-III (CHEM-523) (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, bonding in solids, non-stoichiometric compounds, binary solid solutions, mechanical, electrical, magnetic, dielectric, optical, and chemical (corrosion) properties of advanced materials, synthesis (e.g., sol-gel, hydrothermal techniques, etc.) and design of inorganic materials and characterization, doping and purification of silicone, chemical vapour deposition and sputtering, introduction to nano materials.

- **LAB**

- ✓ Estimation of anions in mixtures:  
Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphatephosphate, bromide-nitrate, borate-acetate, iodide-nitrate.
- ✓ Iodometric titration with potassium iodate.
- ✓ Gravimetric estimation of oxalate.
- ✓ Precipitation Titrations.  
Determination of strength of NaCl given solution by AgNO<sub>3</sub> using Fluorescein as indicator.  
Determination of % age purity of KBr using Fluoresceine as indicator.  
Determination of % composition of mixture of KI & KNO<sub>3</sub> using Eoscein as indicator.
- ✓ Spectrophotometric determination of cerium.
- ✓ Separation of heavy metals using solvent extraction technique.

- **RECOMMENDED BOOKS:**

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

- **COURSE OBJECTIVES:**
- ✓ Students will acquire knowledge and understanding about aromatic substitution reactions and oxidation and reduction as well as pericyclic reactions.
- **COURSE CONTENTS:**
- ✓ **Aromatic Substitution Reactions:** Mechanisms of aromatic reactions including electrophilic and nucleophilic substitutions, 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 of oxygen 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 of electrocyclic, cycloaddition and sigmatropic reactions.
- **LAB.**
- ✓ Experiments involving aromatic substitution, oxidation/reduction reactions and pericyclic 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 using Cannizzaro's reaction.
- **RECOMMENDED BOOKS:**
- ✓ Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5<sup>th</sup> ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
- ✓ Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5<sup>th</sup> edition, Longman, UK, (1989).
- ✓ Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1<sup>st</sup> ed. Alpha Science Int. Ltd. New Delhi, India, (2003).
- ✓ Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6<sup>th</sup> ed., Prentice Hall, New Jersey, (1992).
- ✓ Tse-Lok, H., *Symmetry: A Basis for Synthesis Design*, John-Wiley & Sons, Inc., New York, (1995).
- ✓ Pine, S. H., *Organic Chemistry*, 5<sup>th</sup> ed., Tata McGraw-Hill, India, (1987).
- ✓ Sykes, P., *A Guide Book to Mechanism in Organic Chemistry*, 6<sup>th</sup> ed., Pearson Education, (1986).
- ✓ Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic Laboratory with Multistep and Multiscale Syntheses*, 5<sup>th</sup> ed., John-Wiley & Sons, Inc., (2011).
- ✓ Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach*, 5<sup>th</sup> ed., Brooks/ Cole Cengage Learning, (2010).
- ✓ Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry*, 10<sup>th</sup> ed., JohnWiley & Sons, Inc., (2011).

- ✓ Carey, F. A. and Giuliano, R. M., *Organic Chemistry*, 9<sup>th</sup> ed., McGraw-Hill Education, (2013).
- ✓ Bruice, P. Y., *Organic Chemistry*, 7<sup>th</sup> ed., Perason Education, Ltd., (2013).
- ✓ Smith, M. B., *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, 7<sup>th</sup> ed., John-Wiley & Sons, Inc., (2013).
- ✓ Ansari, F. L., Qureshi, R. and Qureshi, M. L., *Electrocyclic Reactions: From Fundamentals to Research*, Wiley-VCH, Germany, (1999).
- ✓ Kürti, L. and Czakó. B., *Strategic Applications of Named Reactions in Organic Synthesis: Background and Detailed Mechanisms*, Elsevier Inc., (2005).

### PHYSICAL CHEMISTRY-III (542) (3+1)

- **COURSE OBJECTIVES:**

- ✓ In this course of study students will learn about Electrochemistry, quantum chemistry and Nuclear Chemistry.

- **COURSE CONTENTS:**

- ✓ **Electrochemistry:** Idea of various fundamental concepts. The Arrhenius theory of electrolytic dissociation and conductance (Equivalent conductance at infinite dilution and calculations). Kohlrausch's law and its applications. Debye-Huckel theory of strong electrolytes and its importance. Debye-Huckel limiting law. Transport number and its determination. Activity, activity co-efficient and its determination. Electrochemical cells and their applications. Measurement of pH by different electrodes.
- ✓ **Quantum Chemistry:** Basic concepts. Schrodinger wave equation. Physical significance of the wave function. Eigen-function, eigen-values, orthogonal and normalized wave functions. Derivation of quantum numbers from wave equation particle in a box Tunnel effect. The solution of Schrödinger wave equation for hydrogen atom. The hydrogen molecule, ion and the molecular orbital treatment of diatomic molecules. The H<sub>2</sub> molecule and its valence bond treatment. Concept of Molecular Orbital (MO) and Valance Bond (VB) approaches for diatomic and polyatomic molecules.
- ✓ **Nuclear Chemistry:** Historical introduction. Interconversion of mass and energy. Nuclear binding energy. Alpha, beta, gamma and positron decay processes. Group displacement law. Nuclear reactions. Induced radioactivity. Nuclear forces. Radioactive decay rates, half-life and average life. Nuclear fission. Atomic bomb. Nuclear fusion. Hydrogen bomb. Various types of nuclear reactors. Radioactive isotopes and their applications. (Including numerical relating to the above cited topics)

- **LAB:**

- ✓ To determine the percentage composition of the given solution by means of polarimeter.
- ✓ To prepare solution of  $As_2S_3$  and to study the precipitation value of NaCl and  $AlCl_3$ .
- ✓ Conductometric determination of hydrolysis constant of conjugate base of a weak acid.
- ✓ Conductometric determination of  $Cu^{+2}$ -EDTA mole ratio in the complex.
- ✓ Determination of %age composition of  $KMnO_4$  in a solution by spectrophotometry.
- ✓ Spectroscopic determination of Cu in the given sample.
- **RECOMMENDED BOOKS:**
  - ✓ Aziz, F. and Rodgers, M. A. J. Radiation Chemistry Principles and Applications, 1st ed. VCH Publishers, Inc. (1987).
  - ✓ Barrow, G. M., Physical Chemistry, 6th ed. McGraw-Hill Book Company (1996).
  - ✓ Choppin, G., Liljenzin, J-O. Rydberg, J. Radiochemistry and Nuclear Chemistry, 3rd ed. Butterworth-Heinemann (2002).
  - ✓ Dunkin, I. Photochemistry, Vol. 36, RSC Publishing (2007).
  - ✓ Experiment in physical chemistry by Brennan and Tipper Practical physical chemistry by Alexander Frindlay Experimental physical chemistry by Dr. M. Jaffar.
  - ✓ Fayer M. D., Elements of Quantum Mechanics, Oxford University Press, London, UK (2001). Hayward, D. O., Quantum Mechanics for Chemists, Royal Society of Chemistry (2002).
  - ✓ Hayward, D. O. Quantum Mechanics for Chemists, Royal Society of Chemistry (2002).
  - ✓ House, J. E. Fundamentals of Quantum Mechanics. 2<sup>nd</sup> ed. Elsevier-Academic Press, New York, USA (2004).
  - ✓ House, J. E., Fundamentals of Quantum Mechanics 2<sup>nd</sup> ed. Elsevier-Academic Press, New York, USA, (2004).
  - ✓ Kirsten, H. J. W. Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral 1<sup>st</sup> ed. World Scientific Publishing Co. Pvt.Ltd. (2006).
  - ✓ Konya, J. and Nagy, N. M., Nuclear and Radiochemistry, 1st ed., Elsevier, (2012)
  - ✓ Mostafavi, M. Douki, T. Radiation Chemistry. From Basic to Applications in Material and Life Sciences, EDP Science (2008).
  - ✓ Scaglia, B. The Fundamentals. An Understanding of Photochemistry, Biblio Bazaar, (2011).

## **BIOCHEMISTRY (CHEM-562) (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, phospholipids, 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 involved in metabolism.

- **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:**

- ✓ Voet, D. and Voet, J. D., *Biochemistry*, 4<sup>th</sup> ed., illustrated. Publisher: JohnWiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.

- ✓ Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry*, 6<sup>th</sup> ed., Freeman, (2012).

- ✓ Murray, R., Bender, D., Botham, K.M., Kennely, P. J., Rodwall, V. and Weil, P.A., *Harper's Biochemistry*, 29<sup>th</sup> ed., (2012).
- ✓ Zubay, G. L., *Biochemistry*, 4<sup>th</sup> ed., illustrated. Publisher: WMC. Brown Publishers, (1998), digitized, (2008). ISBN: 0697219003. 9780697219008.
- ✓ Guyton, A. C. & Hall, J. E., *Guyton & Hall Text Book of Medical Physiology*, 12<sup>th</sup> ed., Publishers: Saunders Elsevier, (2011).
- ✓ Plummer, D.T., *An Introduction to Practical Biochemistry*, 3<sup>rd</sup> ed., TATA McGraw-Hill Publishing Company LTD, (2010).
- ✓ Sawhney, S. K. and Sing, R., *Introductory Practical Biochemistry*, 2<sup>nd</sup> ed., Narosa Publishing House, New Delhi, (2005).
- ✓ Robert A. Copeland, *Enzymes: A Practical Introduction to Structure, Mechanism, and Data analysis*, 2<sup>nd</sup> ed., Publishers: John-Wiley & Sons, (2000) ISBN: 0-471-35929-7
- ✓ R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13*, 13<sup>th</sup> ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
- ✓ Nelson, D.L., *Lehninger's Principles of Biochemistry*, 6<sup>th</sup> ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 978142922631.
- ✓ Voet, D. and Voet, J.D., *Biochemistry*, 4<sup>th</sup> ed., illustrated. Publisher: JohnWiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
- ✓ Murray, R.M. and Harper, H.A., *Harper's Biochemistry*, 25<sup>th</sup> ed., Publisher: Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
- ✓ Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry*, 5<sup>th</sup> ed., and *Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

## SEVENTH SEMESTER (4<sup>TH</sup> YEAR)

### RESEARCH METHODOLOGY (CHEM-691)

(3+0)

- **COURSE OBJECTIVES:**

- ✓ To study about the importance of research, literature survey, error analysis, statistical treatment. To study about the conventions of writing thesis.

- **COURSE CONTENT:**

- ✓ Nature and importance of research, objective, principles and problems selection of research problem. Survey of scientific literature, primary and secondary sources. Citation index for scientific papers, journals and patent.
- ✓ **Research Work:** Physical properties useful in analysis and methods of separation prior to analysis. Isolation technique, extraction, solvent extraction, crystallization, sublimation, methods for vacuum sublimation and distillation under reduced pressure. Chemistry of working with hazardous materials, acid / water sensitive, corrosive, toxic, explosive and radioactive materials.

- ✓ **Evaluation of Analytical Data:** Precision and accuracy, reliability, determinate and random errors, distribution of random errors and normal distribution curve.
- ✓ **Statistical Treatment of Analytical Data:** Statistical treatment of finite samples, the students test and F test. Criteria for rejection of an observation, the Q test, significant figures and computation rules, data plotting and least square analysis.
- ✓ **Thesis and Assignment Writing:** Conventions of writing the general format, page and chapter format, use of quotations and footnotes, preparation of tables and figures, referencing, appendices. Revising editing and evaluating the final product, proof reading. Meanings and examples of commonly used abbreviations.
- **REFERENCE BOOKS:**
  - ✓ Advanced organic chemistry - reactions, Mechanism & Structure. J. March, McGraw Hill Student Edition.
  - ✓ Fundamental of analytical chemistry, Douglas A. Skoog & Donald, M. West, Halt Saundersons International Edition.
  - ✓ Thesis and assignment writing - J. Anderson, H.M. Durston and M.Poole, Wiley Eastern Ltd., (1970).
  - ✓ Vogel's textbook of quantitative chemical analysis, ELBS edition.

## SPECIALIZED COURSES OF INORGANIC CHEMISTRY

### PAPER-I (INORGANIC REACTION MECHANISM) (CHEM-624) (3+0)

- **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:**
  - ✓ 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:**

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

**PAPER-II ( $\pi$  - ACCEPTOR LIGANDS AND INORGANIC POLYMERS) (CHEM-625)  
(3+0)**

- **COURSE OBJECTIVE:**

- ✓ Student will acquire sound knowledge about  $\pi$ -acceptor ligands and different types of inorganic polymers.

- **Course Contents:**

- ✓  **$\pi$ -Acceptor Ligands:** Introduction to  $\pi$ -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:**

- ✓ Brady, J. E., and Senese, F., *Chemistry-The Study of Matter and Its Changes*, 5<sup>th</sup> ed., Wiley Plus, (2009).
- ✓ Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 4<sup>th</sup> ed., Prentice-Hall International, New Jersey, USA, (2010).
- ✓ Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> ed., John-Wiley & Sons, New York, (1994).
- ✓ Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Prentice Hall, (1997).



- ✓ Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2<sup>nd</sup> ed., Oxford University Press, (1994).
- ✓ Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6<sup>th</sup> ed., Wiley-Interscience, (1999).
- ✓ Atkins, P. and Jones, L., *Chemicals Principles: The Quest for Insight*, 5<sup>th</sup> ed., W. H. Freeman, (2010).
- ✓ Mandelkern, L., *An Introduction to Macromolecules*, 2<sup>nd</sup> ed., Springer Verlag, New York, (1983).
- ✓ Ravve, A., *Principles of Polymer Chemistry*, 2<sup>nd</sup> ed., Plenum Publishers, (2000).
- ✓ Crabtree, R. H., *The Organometallic Chemistry of the Transition Metals*, 5<sup>th</sup> ed., John-Wiley and Sons, New Jersey, (2011).
- ✓ Yamamoto, A., *Organotransition Metal Chemistry*, Prentice Hall, (1992).
- ✓ Billmeyer, F. W., *A Text Book of Polymer Science*, 3<sup>rd</sup>, John-Wiley and Sons, (2003).
- ✓ Malmcoim, P.S., *Polymer Chemistry: An Introduction*, 3<sup>rd</sup> ed., Oxford University Press, (2005).

### PAPER-III (INORGANIC SPECTROSCOPY) (CHEM-626) (3+0)

- **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:**

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

## INORGANIC LAB-I (CHEM-627) (0+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-hydroxyquinoline.
- ✓ 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  $K_a$  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:**

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

## SPECIALIZED COURSES OF ORGANIC CHEMISTRY

### PAPER-I (HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS) (CHEM-634) (3+0)

- **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:**

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

**PAPER-II (REACTIVE INTERMEDIATES) (CHEM-635) (3+0)**

- **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,  $\alpha$ -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:**

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

**PAPER-III (ORGANIC SPECTROSCOPY) (CHEM-636) (3+0)**

- **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 ( $\lambda_{\max}$ ) values, Woodward rules for calculation of wavelength values.
  - ✓ **IR spectroscopy:** Basic concepts, absorption mechanisms, functional group determination and factors affecting the absorption frequencies.
  - ✓ **<sup>1</sup>H-NMR and <sup>13</sup>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:**
  - ✓ Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1<sup>st</sup> ed., Alpha Science Int. Ltd., (2003).
  - ✓ Kalsi, P. S., *Spectroscopy of Organic Compounds*, 6<sup>th</sup> ed., New Age International, New Delhi, India, (2007).
  - ✓ Yadav, L. D. S., *Organic Spectroscopy*, Springer, UK, (2005).
  - ✓ Kemp, W., *Organic Spectroscopy*, 3<sup>rd</sup> ed., W. H. Freeman & Company, New York, USA, (1991).
  - ✓ Younas, M., *Organic Spectroscopy*, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).
  - ✓ Hollas, J. M., *Modern Spectroscopy*, 4<sup>th</sup> ed., John-Wiley & Sons, Inc., (2004).
  - ✓ Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., *Introduction to Spectroscopy*, 4<sup>th</sup> ed., Brooks/ Cole Cengage Learning, (2009).
  - ✓ Silverstein, R. M., Webster, F. X. and Kiemle, D., *Spectrometric Identification of Organic Compounds*, 7<sup>th</sup> ed., John-Wiley & Sons, Inc., (2005).
  - ✓ Williams, D. H. and Flemming, I., *Spectroscopic Methods in Organic Chemistry*, 6<sup>th</sup> ed., McGraw-Hill Higher Education, (2008).

#### ORGANIC CHEMISTRY LAB-I (CHEM-637) (0+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:**

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

## SPECIALIZED COURSES OF PHYSICAL CHEMISTRY

### PAPER-I (ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS) (CHEM-644) (3+0)

- **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 Helmholtz Plane) and IHP (Inner Helmholtz 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, GouyChapmann model, Stern model of electrical double layer, and BDM (BockrisDevanathan-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:**

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

## **PAPER-II (POLYMER CHEMISTRY) (CHEM-645) (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.

- **COURSE CONTENTS**

- ✓ **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:**

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

**PAPER-III (QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY) (CHEM-646)**  
**(3+0)**

- **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, Hückel 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:**

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

#### PHYSICAL CHEMISTRY LAB-I (CHEM-647) (0+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  $\text{KMnO}_4$ - $\text{K}_2\text{Cr}_2\text{O}_7$  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:**
  - ✓ Garland, C. W., Shoemaker, D. P., and Nibler, J. W., *Experiments in Physical Chemistry*, 8<sup>th</sup> ed., McGraw-Hills, New York, (2003).
  - ✓ James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3<sup>rd</sup> ed., Prentice Hall Press, (1974).
  - ✓ Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd ed., W. H. Freeman, (2006).
  - ✓ Athawale, V. D., and Mathur. P., *Experimental Physical Chemistry*, New Age International (2001).
  - ✓ Farrington, D., *Experimental Physical Chemistry*, BiblioBazaar, (2011).
  - ✓ Palmer, W. G., *Experimental Physical Chemistry*, 2<sup>nd</sup> ed., Cambridge University Press (2009).

## **SPECIALIZED COURSES OF ANALYTICAL CHEMISTRY**

### **PAPER-I (ATOMIC SPECTROSCOPY) (CHEM-653) (3+0)**

- **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:**

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

## PAPER-II (ELECTROANALYTICAL TECHNIQUES) (CHEM-654) (3+0)

- **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:**

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

### **PAPER-III (ADVANCED SEPARATION TECHNIQUES) (CHEM-655) (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.
- ✓ **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:**
  - ✓ Skoog, D. A., West, P. M., Holler, F. J. and Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9<sup>th</sup> ed., Cengage Learning, (2013).
  - ✓ Christian, G. D., *Analytical Chemistry*, 6<sup>th</sup> ed., John-Wiley & Sons, New York, (2004).
  - ✓ Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry*, 1<sup>st</sup> ed., Taylor & Francis, (2002).
  - ✓ Sharma, B.K. *Instrumental Methods of Chemical Analysis*, 24<sup>th</sup> ed., Goel Publishing House, Meerut, India, (2005).
  - ✓ Grob, R. L., Eugene, F. Barry, *Modern Practice of Gas Chromatography*, 4<sup>th</sup> ed., John-Wiley & Sons, USA, (2004).
  - ✓ Kellner, R., Mermet, J.- M., Otto, M., Valcarcel, M. and Widmer, H. M., *Analytical Chemistry: A Modern Approach to Analytical Science*, WileyVCH, (2004).
  - ✓ Meyer, V. R., *Practical High-Performance Liquid Chromatography*, 5<sup>th</sup> ed., John-Wiley & Sons, Ltd., (2010).
  - ✓ Lindsay, S., *High Performance Liquid Chromatography*, 2<sup>nd</sup> ed., JohnWiley & Sons, Ltd., (1992).
  - ✓ Braitwaite, A. and Smith, F. J., *Chromatographic Methods*, 5<sup>th</sup> ed., Kluwer Academic Publishers, (1999).
  - ✓ Miller, J. M., *Chromatography: Concepts and Contrasts*, 2<sup>nd</sup> ed., JohnWiley & Sons, Inc., (2005).
  - ✓ Camilleri, P., *Capillary Electrophoresis: Theory and Practice*, 2<sup>nd</sup> ed., CRC Press, (1998).

**ANALYTICAL CHEMISTRY LAB-I (456) (0+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:**

- ✓ Harris, D. C., *Quantitative Chemical Analysis.*, 8<sup>th</sup> ed., W. H. Freeman and Company, New York, (2011).
- ✓ Braitwaite, A. and Smith, F. J., *Chromatographic Methods*, 5<sup>th</sup> ed., Kluwer

- ✓ Camilleri, P., *Capillary Electrophoresis: Theory and Practice*, 2<sup>nd</sup> ed., CRC Press, (1998).
- ✓ Weinberger, R., *Practical Capillary Electrophoresis*, 2<sup>nd</sup> ed., Academic Press, (2000).

## SPECIALIZED COURSES OF BIOCHEMISTRY

### PAPER-I (BIOMEDICAL CHEMISTRY) (CHEM-663) ( 3+0)

- **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:**

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

### PAPER-II (MOLECULAR BIOLOGY) (CHEM-664) (3+0)

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

### **PAPER-III (PHYSICAL TECHNIQUES IN BIOCHEMISTRY) (CHEM-665) (3+0)**

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

#### **BIOCHEMISTRY LAB-I (CHEM-666) (0+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:**
  - ✓ Boyer, R., *Modern Experimental Biochemistry*, 3<sup>rd</sup> ed., Pearson Education Inc., (2009). ISBN: 978-81-7758-884-2.
  - ✓ Shankara, Y. M.S., *Laboratory Manual for Practical Biochemistry*, 1<sup>st</sup> ed., Jaypee Brothers Medical Publishers (P) Ltd., India, (2008). ISBN: 978-818448-259-1.

#### **EIGHT SEMESTER (4<sup>TH</sup> YEAR)**

#### **ENVIRONMENTAL CHEMISTRY-II (CHEM-672) (3+0)**

- **COURSE OBJECTIVE:**

This course of advanced Environmental Chemistry will provide knowledge about the environment and toxicological chemistry of chemical substances.
- **COURSE CONTENTS:**
- ✓ **Introduction:**

Biotic and abiotic factors. Concept of eco systems. Atmosphere (composition, temperature, pressure, air pollutants, green house effect and global warming,

ozone and ozone depletion, CFCs, acid rain, photochemical smog, vehicular and industrial emissions and role of hydroxyl radicals). Water (properties, water quality, eutrophication water pollution and water treatment). Land (composition, pH, soil erosion and soil pollutants).

✓ **Toxicological Chemistry of Chemical Substances:**

Toxic elements and elemental forms. Toxic inorganic and organic compounds. Environmental Chemical Analysis. Classical methods vs instrumental methods. Analysis of Water Samples. Air Monitoring and Analysis.

✓ **Green Revolution:**

Pest control, pesticides, toxicity of pesticides, integrated pests management.

✓ **Renewable Energy:**

Nuclear energy, solar energy, geothermal and tidal energy.

● **REFERENCE BOOKS:**

- ✓ Kumar, Environmental Chemistry, Willey Eastern, New Delhi.
- ✓ C. Baird and M. Cann, Environmental Chemistry, Freeman, 2012 (5th ed.).
- ✓ D. W. Comell. Basic concepts of environmental chemistry.
- ✓ Derek M Elsom. atmospheric Pollution, Blackwell Publishers, Oxford, 1992.
- ✓ Geoffrey Lean and Don Hinrichsen, Atlas of the Environment, Helicon Publishing Ltd. Oxford, 1992.
- ✓ Manahan, Stanley E. "Environmental Chemistry," (9th or earlier ed.) Lewis, 2009. Peter O. Neill, "Environmental Chemistry", C.

## **SPECIALIZED COURSES OF INORGANIC CHEMISTRY**

### **PAPER-IV (ORGANOMETALLICS) (CHEM-628) (3+0)**

● **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  $\pi$ -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:**

- ✓ Powell, P., *Principles of Organometallics Chemistry*, 2<sup>nd</sup> ed., Springer, (1998).
- ✓ Yamamoto A., *Organotransition Metal Chemistry: Fundamental Concepts and Applications*, 1<sup>st</sup> ed., John-Wiley & Sons, Inc., (1986).
- ✓ Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., *Advanced Inorganic Chemistry*, 6<sup>th</sup> ed., Wiley-Interscience, New York, (1999).
- ✓ Miessler, G. L., Fisher, P. J. and Tar, D. A., *Inorganic Chemistry*, 5<sup>th</sup> ed., Prentice Hall, (2013).
- ✓ Douglas, B., McDaniel, D. and Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> ed., John-Wiley & Sons, Inc., (1994).
- ✓ Haiduc, I. and Zuckerman, J. J., *Basic Organometallic Chemistry*, Walter De Gruyter Inc., (1985).
- ✓ Jolly, W. L., *Modern Inorganic Chemistry*, 2<sup>nd</sup> ed., McGraw-Hill Company, (1991).
- ✓ Porterfield, W. W., *Inorganic Chemistry: A Unified Approach*, 2<sup>nd</sup> ed., Academic Press, (1993).
- ✓ Vincet, A., *Molecular Symmetry and Group Theory*: 2<sup>nd</sup> ed., John-Wiley & Sons, Ltd., (2001).
- ✓ Malik, W. U., Tuli, G. D., Madan, R. D., *Selected Topics in Inorganic Chemistry*, S. Chand and Co. Ltd., (2010).

**PAPER-V (SYMMETRY AND MAGNETOCHEMISTRY) (CHEM-629) (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:**

- ✓ Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> ed., John-Wiley & Sons Inc., (1997).

- ✓ Huheey, J. E, Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Prentice Hall, (1997).
- ✓ Mackay, K. M., Mackay, R. A. and Henderson, W., *Introduction to Modern Inorganic Chemistry*, 6<sup>th</sup> ed., CRC Press, (2002).
- ✓ Miessler, G. L., Fisher, P. J. and Tar, D, A., *Inorganic Chemistry*, 5<sup>th</sup> ed., Prentice Hall, (2013).
- ✓ Purcell, K. F., Kotz, J. C., *An Introduction to Inorganic Chemistry*, W. B. Saunders, Company Holt-Saunders, International ed., (1980).
- ✓ Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry*, 6<sup>th</sup> ed., Wiley-Interscience, New York, (1999).
- ✓ Jolly, W. L., *Modern Inorganic Chemistry*, 2<sup>nd</sup> ed., McGraw-Hill Company, (1991).
- ✓ Carter, R. L., *Molecular Symmetry and Group Theory*, 1<sup>st</sup> ed., John-Wiley & Sons, Inc., New York, (1997).
- ✓ Orchin, M., Jaffe, H. H., *Symmetry, Orbitals, and Spectra*, John-Wiley & Sons, Inc., New York, (1971).
- ✓ McWeeny, R., *Symmetry: An Introduction to Group Theory and its Applications*, Dover Publications, Inc., (2002).
- ✓ Vincet, A., *Molecular Symmetry and Group Theory*, 2<sup>nd</sup> ed., John Wiley & sons Ltd, (2001).

#### **PAPER-VI (RADIO AND NUCLEAR CHEMISTRY) (CHEM-6210) (3+0)**

- **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:**

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

## INORGANIC LAB-II (CHEM-6211) (1+0)

- **Use of organic reagents for the estimation of various metal ions;**
- ✓ Synthesis of ferrocene and acetyl ferrocene
- ✓ Synthesis of triaryl phosphines
- ✓ Reduction of anisole by lithium-Birch-reduction.
- ✓ Preparation of ferrocenyl oximes
- ✓ Preparation of Zinc-porphyrin complexes
- ✓ Synthesis of Zinc-Phthalocyanine
- ✓ Synthesis of coordination polymers of transition metals.
- **RECOMMENDED BOOKS:**
- ✓ Angelici, R. J. (1977). *Synthesis and technique in inorganic chemistry*, pp. 157-168 Philadelphia: W. B. Saunders Company.
- ✓ Elschenbroich, Ch., & Salzer, A. (1992). *Organometallics*. VCH Weinheim.
- ✓ Hartley, F. R. (1974). *Elements of organometallic Chemistry*. London
- ✓ Lucas, C. R., & Walsh, K. A. (1987). Organometallic chemistry of molybdenum. *Journal of Chemical Education*, 64, 265–266.
- ✓ McNeese, T. J., & Ezbiansky, K. A. (1996). Photochemical preparation and reactivity of cis-  $\text{Cr}(\text{CO})_4(\text{CH}_3\text{CN})_2$ . *Journal of Chemical Education*, 73, 548–550.
- ✓ Miessler, G. L., & Spessard, G. O. (1991). Organometallic chemistry – A course designed for sophomore chemistry students. *Journal of Chemical Education*, 68, 16–18.
- ✓ Rabideau, P. W. (1989). The metal–ammonia reduction of aromatic compounds. *Tetrahedron*, 45, 1579–1603.
- ✓ Spessard, G. O., & Miessler, G. L. (1996). *Organometallic chemistry*. Upper Saddle River, New Jersey: Prentice Hall.
- ✓ Szafran, Z., Pike, R. M., & Singh, M. M. (1991). *Microscale inorganic chemistry*. New York: John Wiley & Sons.
- ✓ ZAVIX Holzbecher and other, Hand Book of Organic reagents in Inorganic Analysis Ellis Hurwod Limited, London. (1976)
- ✓ 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)
- ✓ James S. Pritz, George H. Sehenk, Quantitative Analysis Chemistry, Alby and Becon Inc. London. (2001)
- ✓ Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry: Preparation*
- ✓ *Reactions and Instrumental Methods*, 2<sup>nd</sup> ed., Chapman and Hall, (1974).
- ✓ Chapman and Hall, London, 1993.

## SPECIALIZED COURSES OF ORGANIC CHEMISTRY

**PAPER-IV (NATURAL PRODUCTS) (CHEM-638)**  
**(3+0)**

- **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,  $\alpha$ -terpineol,  $\alpha$ -pinene, camphor and  $\alpha$ -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:**

- ✓ Dewick, P. M., *Medicinal Natural Products: A Biosynthetic Approach*, 3<sup>rd</sup> ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).
- ✓ Sell, C. S., *A Fragrant Introduction to Terpenoid Chemistry*, The Royal Society of Chemistry, UK, (2003).
- ✓ 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).
- ✓ Shahidi, F. and Naczki M., *Phenolics in Food and Nutraceuticals*, CRC Press, (2004).
- ✓ Oyvind, M. A., and Kenneth, R. M., *Flavonoids: Chemistry, Biochemistry and Applications*, CRC, Taylor & Francis, New York, (2010).
- ✓ Finar, I. L., *Organic Chemistry, Vol. 2, Stereochemistry and the Chemistry of Natural Products*, 5<sup>th</sup> ed., Pearson Education Ltd., Delhi, (2008).
- ✓ Hesse, M., *Alkaloid Chemistry*, John-Wiley & Sons, New York, (1981).
- ✓ Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., *Chemistry of Natural Products*, Narosa Publishing House, (2005).

**PAPER-V (ORGANIC SYNTHESIS) (CHEM-639) (3+0)**

- **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 retrosynthesis 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:**

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

#### **PAPER-VI (MEDICINAL CHEMISTRY) (CHEM-6310) (3+0)**

- **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:**

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

- ✓ Carins D., *Essential of Pharmaceutical Chemistry*, 3<sup>rd</sup> ed., Pharmaceutical Press, London, (2008)

## **ORGANIC CHEMISTRY LAB-II (CHEM-6311) (0+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:**

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

## **SPECIALIZED COURSES OF PHYSICAL CHEMISTRY**

### **PAPER-IV (REACTION DYNAMICS) (CHEM-648) (3+0)**

#### ● **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:**

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

### **PAPER-V (RADIATION AND PHOTOCHEMISTRY) (CHEM-649) (3+0)**

- **COURSE OBJECTIVES:**

- ✓ Students will learn about the mechanisms of radiation induced chemical changes in molecules, radiation dosimetry 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:**
  - ✓ Spinks, J. W. T. and Woods, R. J., *An introduction to Radiation Chemistry*, 3<sup>rd</sup> ed., Wiley Inter Si. Pub., USA, (1990).
  - ✓ Aziz, F. and Rodgers, M. A. J., *Radiation Chemistry Principles and Applications*, 1<sup>st</sup> ed., VCH Publishers, Inc., (1987).
  - ✓ Choppin, G., Liljenzin, J-O., Rydberg, J., *Radiochemistry and Nuclear Chemistry*, 3<sup>rd</sup> ed., Butterworth-Heinemann, (2002).
  - ✓ Mostafavi, M., Douki, T., *Radiation Chemistry: From Basic to Applications in Material and Life Sciences*, EDP Science, (2008).
  - ✓ Dunkin, I., *Photochemistry*, Vol. 36, RSC Publishing, (2007).
  - ✓ Dickson, D. P. E., Berry, F. J., *Mossbauer Spectroscopy*, Cambridge University Press, (1986).
  - ✓ Scaglia, B., *The Fundamentals: An Understanding of Photochemistry*, Biblio Bazaar, (2011).
  - ✓ Konya, J. and Nagy, N. M., *Nuclear and Radiochemistry*, 1<sup>st</sup> ed., Elsevier, (2012).

## PAPER-VI (COLLOID AND SURFACE CHEMISTRY) (CHEM-6910) (3+0)

- **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, physisorption 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:**

- ✓ Hunter, R. J., *Introduction to Modern Colloid Science*, Oxford University Press, Oxford, (1994).
- ✓ Poole, C. P. and Owens, F. J., *Introduction to Nanotechnology*, 1<sup>st</sup> ed., Wiley-Interscience, (2003).
- ✓ Klabunde, K. J., *Nanoscale Materials in Chemistry*, John-Wiley & Sons, Inc., (2003).
- ✓ Kolunsiki, K. W., *Surface Science: Foundations of Catalysis and Nanoscience*, 3<sup>rd</sup> ed., John-Wiley & Sons, Ltd., (2012).
- ✓ Adamson, A. W. and Gast, A. P., *Physical chemistry of Surfaces*, 6<sup>th</sup> ed., Wiley-Interscience, (1997).
- ✓ Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry*, 8<sup>th</sup> ed., Oxford University Press, (2006).
- ✓ Christian, G. D., *Analytical Chemistry*, 6<sup>th</sup> ed., John-Wiley & Sons, (2004).

## PHYSICAL LAB-II (CHEM-6411) (0+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:**
  - ✓ Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook*, 3<sup>rd</sup> ed., W. H. Freeman, (2006).
  - ✓ Palmer, W. G., *Experimental Physical Chemistry*, 2<sup>nd</sup> ed., Cambridge University Press, (2009).
  - ✓ Athawale, V. D., and Mathur. P., *Experimental Physical Chemistry*, New Age International (2001).
  - ✓ Farrington, D., *Experimental Physical Chemistry*, BiblioBazaar, (2011).
  - ✓ James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3<sup>rd</sup> ed., Prentice Hall Press, (1974).

## **SPECIALIZED COURSES OF ANALYTICAL CHEMISTRY**

### **PAPER-IV (LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS) (CHEM-657) (3+0)**

- **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:**
  - ✓ Christian, G. D., *Analytical Chemistry*. 6<sup>th</sup> ed., John-Wiley & Sons, New York, (2006).
  - ✓ Harris, D. C., *Quantitative Chemical Analysis*, 8<sup>th</sup> ed., W. H. Freeman and Company, New York, (2011).
  - ✓ Braun, R. D., *Introduction to Chemical Analysis*, International Student Edition, (1985).

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

#### **PAPER-V (NUCLEAR ANALYTICAL TECHNIQUES) (CHEM-658) (3+0)**

- **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:**

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

## **PAPER-VI (FOOD AND DRUG ANALYSIS) (CHEM-659) (3+0)**

- **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:**

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

## **ANALYTICAL CHEMISTRY LAB-II (CHEM-6510) (0+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  $\alpha$ -amylase activity.
- ✓ Finger print analysis by  $\text{AgNO}_3$ , 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:**
  - Latimer, Jr., G. W., *AOAC Official Methods of Analysis*, 19<sup>th</sup> ed., (2012).
  - Ranganna, S., *Handbook of Analysis & Quality Control for Fruits & Vegetables*, 2<sup>nd</sup> ed., TATA McGraw-Hill Education, (1986).
  - Stuart H. Barbara, "*Forensic Analytical Techniques*", 1<sup>st</sup> ed., John-Wiley & Sons, (2013).

## **SPECIALIZED COURSES OF BIOCHEMISTRY**

### **PAPER- VI (MICROBIOLOGY AND IMMUNOLOGGY) (CHEM-467) (3+0)**

- **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 IgE-mediated hypersensitivity, other types of hypersensitivity autoimmune disorders, immunodeficiency disorders.
- **RECOMMENDED BOOKS:**

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

### **PAPER-V (BIONANOTECHNOLOGY) (CHEM-668) (3+0)**

- **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:**

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

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

#### **PAPER-VI (NUTRITIONAL CHEMISTRY) (CHEM-669) (3+0)**

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

#### **BIOCHEMISTRY LAB-II (CHEM-6610) (0+1)**

- **COURSE CONTENTS:**

- ✓ Estimation of Na<sup>+</sup> ions in blood.
- ✓ Estimation of K<sup>+</sup> 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*, 2<sup>nd</sup> ed., Narosa publishing House, New Delhi, (2005).
- ✓ Gosling, J. P. and Basso, L., *Immunoassay: Laboratory Analysis and Clinical Application*, 1<sup>st</sup> 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).