The Dean,
Faculty of Science
Mirpur University of Science and Technology (MUST)

Subject: MINUTES OF 2nd MEETING OF BOS IN CHEMISTRY

With reference to the subject cited above, please find enclosed herewith th**e** minutes of 2nd meeting of Board of Studies in Chemistry held **28th Nov. 2015** for onward transmission to the Board of Faculty.

Chairperson

Enclosed;
01. _____ Pages.

DEPARTMENT OF CHEMISTRY

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY,

(MUST) Mirpur

MINUTES OF THE 2nd MEETING OF THE BOARD OF STUDIES

28th Nov. 2015

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY

(MUST), MIRPUR

AZAD JAMMU & KASHMIR

Mirpur University of Science and Technology (MUST)

Department of Chemistry

Second meeting of the Board of Studies in Chemistry
Attendance Sheet

The second meeting of the Board of Studies in Chemistry was held on 28-11-2015 under the Chairpersonship of Dr. Tahseen Ghous. The following has participated in the meeting:

1. Dr. Tahseen Ghous
   Chairperson, Department of Chemistry — Convener ----------
   Mirpur University of Science and Technology
   (MUST), Mirpur.

2. Prof. Dr. Faiz-ul-Hassan Nasim
   Chairman
   Department of Chemistry — Member ----------
   The Islamia University of Bahawalpur

3. Prof. Dr. Muhammad Ishaq
   Department of Chemistry, — Member ----------
   QAU, Islamabad.

4. Dr. Kh. Ansar Yasin
   Chairman/Associate Professor
   Department of Chemistry — Member ----------
   The University of Azad Jammu and Kashmir
   Muzaffarabad.

5. Mr. Javed Akhtar Ch.
   Associate Professor, — Member ----------
   Postgraduate College for Boys, Mirpur

6. Prof. Dr. Muhammad Aziz Choudhary
   Department of Chemistry — Member ----------
   Mirpur University of Science and Technology
   (MUST), Mirpur.

7. Dr. Zahoor Ahmed
   Assistant Professor,
   Department of Chemistry — Member ----------
   Mirpur University of Science and Technology
   (MUST), Mirpur.

8.	The Director QEC, Mirpur University of Science & Technology, (MUST), Mirpur.	Member ----------
9.	The Registrar, Mirpur University of Science & Technology, (MUST), Mirpur.	Ex-officio Member ----------
10.	The Controller of Examinations, Mirpur University of Science & Technology, (MUST), Mirpur.	Ex-Officio Member ----------

The meeting was started with the recitation of the Holy Verses of Quran by Dr. Tahseen Ghous, Chairperson/Convener of the meeting. Chairperson welcome all members in the 2nd meeting of the Board of Studies. After brief highlights of academic achievements of the Department in past five years, Agenda Items were presented before the Board, starting with the BS program in Chemistry followed by the rest Agenda Items in sequence.
Prof. Dr. Faiz-ul-Hasan Nasim, member and expert on Biochemistry gave his valuable suggestions for the improvement of the Scheme of Studies for BS Program. He has proposed changes in credit hours of general Courses as (3+0) instead of (2+1). All members of the Board agreed with his suggestion and changes were made accordingly. He has also proposed some changes in the content of the syllabi of Biochemistry, and accordingly amendments are made in the contents of MSc/MPhil/ PhD Biochemistry syllabi.

Dr. Ansar Yasin, the member and expert on Organic Chemistry shared his experiences of running BS Program at his University and gave valuable suggestions and proposals. Both members proposed to add broad spectrum general courses in BS program which may include; Psychology, Cell biology, Biodiversity, Physics, Risk management, Human Resource Management, Entrepreneurship etc; as new discoveries are always made by cross breeding. After detailed discussion the Board unanimously agreed on the present form of the Scheme of Studies.

They have also proposed to establish a mechanism to adopt Campus Management System (CMS) for uniform Course Coding in University. The Registrar Ex-Officio member of the Board has also actively participated in discussion and told the Board that work is already in progress for the establishment of CMS. Till the Registrar office introduces its uniform and comprehensive format for Course Coding, Board agreed on the given Course Codes with the proposal to adopt uniform course codes for general courses and Allied courses at least at faculty level.

After the detailed and healthy discussion on different aspects of the contents of the Agenda

the Board has made the following recommendations:

1. Approved BS Program in Chemistry.
2. Approved Scheme of Studies for BS program.
3. Approved syllabi of BS Courses.
4. Approved New Discription of MPhil/PhD Course Codes.
5. Approved Proposed Changes in Course CHM-6443 and approved newly introduced courses in Organic Chemistry for MSC program.
6. Approved newly introduced Biochemistry courses for MSc Program with slight changes.
7. Approved newly introduced courses in Physical, Organic, Inorganic, Analytical and Biochemistry, MPhil/PhD Program.
8. Approved list of Examiners for MSc/MPhil/PhD Thesis evaluation.
9. Approved Specialization in Inorganic-Analytical Chemistry.
10. Board of Studies delegated the power to the convener to make any amendment if needed.

All members actively participated in the discussion and gave valuable suggestions for the improvement of the syllabi. They extended their willingness when ever needed by the Department of Chemistry, Mirpur University of Science and Technology (MUST), Mirpur in person and distant.

At the end the chair thanked all the members for sparing their valued time for the participation in the 2nd meeting of the Board of Studies.

AGENDA OF THE 2ND MEETING OF THE BOARD OF STUDIES
2015

DEPARTMENT OF CHEMISTRY (MUST), MIRPUR (AJ&K)

The 2nd Meeting of the Board of Studies in Chemistry was held on 28th Nov. 2015 at 2:00 pm in the Department of Chemistry with the following Agenda Items.

Item No.	**Subject**
1	Approval of BS Program in Chemistry
1.1	Admission Policy
1.2	Duration of the Program
1.3	Total Credit Hours
1.4	Scheme of Studies
1.5	Course Contents
2	New Description of MPhil/PhD Chemistry Course Codes
3	Approval of proposed changes in course; CHM-6443, Natural Products (Cr. 3) and approval of newly introduced courses in Organic Chemistry, MSc Program.
4	Approval of newly introduced courses in Biochemistry for MSc Program
5	Approval of newly introduced courses in Physical, Inorganic, Organic, Analytical and Biochemistry, MPhil/Ph.D program.
6	Approval of External Examiners for M.Sc/M.Phil/Ph.D. thesis evaluation
7	Approval of specialization in Inorganic-Analytical Chemistry

Item No. 1
Approval of BS Program in Chemistry

BS (4-YEAR) PROGRAM IN CHEMISTRY

Admission Policy: As per University Policy/HEC Guide Line

Duration:	**8-12 Semesters**
Theory Course:	**118 Credits**
Laboratory +Thesis (Cr.03)	**19 Credits**
Total	**137**

:

Scheme of Studies; BS 4-Year Program in Chemistry

Course Title	Credit hours	
Semester-I	**Theory**	**Lab.**
Compulsory courses		
CHEM-1104: Inorganic Chemistry	3	1
ENG-1107: English-I	3	0
MAT-1115: Mathematics	3	0
COM-1105: Computer Applications	3	0
List General Courses: Out of the following courses only two courses will be offered depending on the availability of faculty.		
Psychology	3	0
Cell biology	3	0
ZOO-1123 Principles of Animal Life-I	3	0
BOT-1103 Diversity of plants	3	0
Geography	3	0
Total	**18**	**1**
Semester-II	**Theory**	**Lab.**
Compulsory Courses		
ENG-1207: English-II (Functional)	3	0
ISL-1212: Islamic Studies / Ethics	2	0
STA-1220: Statistics	3	0
CHEM-1204: Organic Chemistry	3	1
List General Courses: Out of the following courses only two courses will be offered depending on the availability of faculty.		
Biodiversity	3	0
Genetics	3	0
History of Science	3	0
BOT-1203 Plant systematics, Anatomy and Development	3	0
ZOO-1223 Principles of Animal Life-II	3	0
Total	**17**	**1**
Semester –III	**Theory**	**Lab.**
Compulsory courses		
ENG-2307: English-III (Report Writing)	3	0
PS-2317: Pakistan Studies	2	0
CHEM-2398: Environmental Chemistry	3	0
CHEM-2304: Physical Chemistry	**3**	**1**
List General Courses: Out of the following courses only two courses will be offered depending on the availability of faculty.		
Calculus	3	0
Physics-I	3	0
Risk Management	3	0
Household Management	3	0
ZOO-2323 Diversity of animal life-I	3	0
BOT-2303 Cell Biology, Genetics and Evolution	3	0

Total	**17**	**1**

Semester –IV	**Theory**	**Lab.**
Compulsory courses		
ARA-2401 Arabic	3	0
CHEM-2404: Analytical Chemistry	**3**	1
CHEM-2491: Applied Chemistry	2	0
CHEM-2481: Biochemistry	2	1
List General Courses: Out of the following courses only two courses will be offered depending on the availability of faculty.		
Physics-II	3	0
Human Resource Management	3	0
Entrepreneurship	3	0
BOT-2403 Plant Physiology and Ecology	3	0
ZOO-2423 Diversity of Animal Life-II	3	0
Ethics	3	0
Total	**16**	**2**

Only four disciplines to be selected for 5th and 6th semesters each, with option between Biochemistry and Analytical Chemistry.

Semester-V*

Course code	Course title	Credit hours	Description
CHEM-3501	Physical Chemistry-I	4(3,1)	Theory + Lab
CHEM-3521	Inorganic Chemistry-I	4(3,1)	Theory + Lab
CHEM-3541	Organic Chemistry-I	4(3,1)	Theory + Lab
CHEM-3561	Analytical Chemistry-I	4(3,1)	Theory + Lab
CHEM-3581	Biochemistry-I	4(3,1)	Theory + Lab

Total Credit Hours: (16)

Semester-VI*

Course code	Course title	Credit hours	Description
CHEM-3601	Physical Chemistry-II	4(3,1)	Theory + Lab
CHEM-3621	Inorganic Chemistry-II	4(3,1)	Theory + Lab
CHEM-3641	Organic Chemistry-II	4(3,1)	Theory + Lab
CHEM-3661	Analytical Chemistry-II	4(3,1)	Theory + Lab
CHEM-3681	Biochemistry-II	4(3,1)	Theory + Lab
CHEM-3699	Applied Computer for Chemist	2(1,1)	Theory/Lab

Total Credit Hours: (18)

* Only four disciplines to be selected for 5th and 6th semesters each, with option between Biochemistry and Analytical Chemistry

Semester-VII

Students may opt for any one of the five sections namely, Physical, Inorganic, Organic, analytical and Biochemistry

Course code	Course title	Course Description	Credit Hours
CHEM-47aa	Physical Chemistry	Theory + Lab	3 (3,0), 3(0,3)
CHEM-47bb	Inorganic Chemistry	Theory + Lab	3 (3,0), 3(0,3)
CHEM-47cc	Organic Chemistry	Theory + Lab	3 (3,0), 3(0,3)
CHEM-47dd	Analytical Chemistry	Theory + Lab	3 (3,0), 3(0,3)
CHEM-47ee	Biochemistry	Theory + Lab	3 (3,0), 3(0,3)

Total Credit Hours: (12+3=15)

Semester-VIII

Course code	Course title	Credit hours	Description
CHEM-48aa	Physical Chemistry	3 (3,0), 3(0,3)	Theory + Lab
CHEM-48bb	Inorganic Chemistry	3 (3,0), 3(0,3)	Theory + Lab
CHEM-48cc	Organic Chemistry	3 (3,0), 3(0,3)	Theory + Lab
CHEM-48dd	Analytical Chemistry	3 (3,0), 3(0,3)	Theory + Lab
CHEM-48ee	Biochemistry	3 (3,0), 3(0,3)	Theory + Lab
	(OR)		
CHEM-48bb	Research Report	3 (0,3)	Research

***Three courses will be opted from the selected discipline and there will be option between research report **OR** a course from any other discipline.

Total Credit Hours (12+3=15)

Course codes (Semester VII-VIII):
1-20 Physical Chemistry; 21-40 Inorganic Chemistry; 41-60 Organic Chemistry; 61-80 Analytical Chemistry, 81-95 Biochemistry; aa, bb,cc and dd : Define the choice of the section

DETAILS OF COURSES

BS 1st Year
Semester-I

CHEM-1104 INORGANIC CHEMISTRY (Cr. 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 using 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),concept of relative strength of acids and bases, significance of pH, pKa, pKb 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.

Lab

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:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity,* 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., *Inorganic Chemistry,* Academic Press. USA, (2008).
5. Lee, J. D., *Concise Inorganic Chemistry,* 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity,* 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., *Inorganic chemistry,* 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry,* Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, *Inorganic Chemistry,* 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry,* 2nd ed., Brooks Cole, (2010).
12. Wulfsberg G., *Principles of Descriptive Inorganic Chemistry,* 1st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., *Laboratory Safety for Chemistry Students,* John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis,* 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., *Vogel's Qualitative Inorganic Analysis,* 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

ENG-1107 English-I (Cr. 3+0)

OBJECTIVES:

Enhance language skills and develop critical thinking.

CONTENTS:

Basics of Grammar

Parts of speech and use of articles

Sentence structure, active and passive voice

Practice in unified sentence

Analysis of phrase, clause and sentence structure

Transitive and intransitive verbs

Punctuation and spelling

*Comprehension:*Answers to questions on a given text

*Discussion:*General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

*Listening:*To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher

*Presentation skills:*Introduction

Note: Extensive reading is required for vocabulary building

RECOMMENDED BOOKS:

1. Functional English

a) Grammar

1. Practical English Grammar bys A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. 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 35-4

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

MAT-1115 MATHEMATICS-I (Cr. 3+0)

OBJECTIVES:

This course aims to provide students with the essential concepts of biomathematics and how these can be employed for analyzing real data.

CONTENTS:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities, binomial theorem and its use. *Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions. *Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals. Application and importance of calculus for biotechnology; the exponential growth curve and growth equation.

RECOMMENDED BOOKS:

1. Helfgott, M., and D. Moore. 2011. Introductory Calculus for the Natural Sciences. Create Space Independent Publishing Platform, USA.
2. Neuhauser, C. 2010. Calculus for Biology and Medicine. Prentice Hall.
3. Anton, H., et al., 2005. Calculus: A New Horizon. John Wiley, New York.
4. Thomas, G. B. and A. R. Finney. 2005. Calculus. Addison-Wesley, Reading, USA.
5. Kumar, A. 2011. Mathematics for biologist. First Edition; Alpha science international.

COM-1105 Computer Applications (Cr. 3+0)

OBJECTIVES:

To familiarized students with the basics of computer.

CONTENTS:

Introduction and History of Computers, Computer Characteristics, Major components of computer, Introduction to operating system, Hardware and software concepts, Computer applications in modern ages, Categories of computers, Introduction to networks, Introduction to Internet and usage of web browsers, Introduction to e-mail and web documents searching, Presentation skills, Introduction to formatting documents, Introduction to information systems, Software development life cycle.

PRACTICALS:

Word processing, Windows operating systems, Graphics software, Network introduction LANs, WANs, MANs, Presentation software practice, Excel software practice, Formatting documents

BOT-1103 DIVERSITY OF PLANTS (Cr. 3+0)

Objectives of course: To introduce the students to the diversity of plants and their structures and significance.

Theory: Comparative study of life form, structure, reproduction and economic significance of: **a) Viruses** (RNA and DNA types) with special reference to TMV; **b) Bacteria** and Cyanobacteria (Anabaena) with specific reference to biofertilizers, pathogenicity and industrial importance; **c) Algae** (Spirogyra, Pinnularia, Polysiphonia) **d) Fungi** (Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications. **e) Lichens** (Physcia), **f) Bryophytes** (Riccia , Anthoceros, Funaria), **g) Pteridophytes;** Lycopsida (Selaginella), **h) Gymnosperms** (Pinus), **i) Angiosperms** ; Monocot (Wheat), Dicot (*Solanum nigrum*)

Recommended Books:

- Prescott, L. M., Harley, J. P. and Klein, A. D. 2004. Microbiology, 3rd Ed. WM. C. Brown Publishers.
- Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4th Ed. John Wiley and Sons Publishers.
- Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
- Ingrouille , M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
- Mauseth**,** J**.** D**.** 2003**.** Botany**:** An Introduction to Plant Biology 3rd Ed., Jones and Bartlett Pub. UK
- Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP

ZOO-1123 PRINCIPLES OF ANIMAL LIFE – I (3+0)

Aims and Objectives

The course aims to impart knowledge and understanding of:

1. The concept and status of Zoology in life sciences.
2. The common processes of life through its chemistry, biochemical and molecular processes.
3. The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
4. Biochemical mechanisms eventually generating energy for animal work.

5. Animals and their relationship with their environment.

Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources. **The Chemical Basis of Animal Life:** Brief introduction to biomolecules; carbohydrates, lipids, proteins, and nucleic acids. **Cellular Organization:** Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles; ribosomes, endoplasmic reticulum, the nucleus: nuclear envelope, chromosomes and nucleolus. **Animal tissues:** Types: epithelial, connective, muscle and nervous tissue; organs and organ systems. **Enzymes:** Structure, types; function and factors affecting their activity; cofactors and coenzymes. **Energy Harvesting:** Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transport chain; fermentation, the major source of ATP. **Reproduction and Development:** Types; asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development. **Ecological Concepts:** Individuals and Populations: Animals and their abiotic environment; populations and limiting factors; Communities and Ecosystems: Community structure and diversity; interspecific interactions. Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles; Ecological problems; human population growth, pollution, resource depletion and biodiversity.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 12th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 6th Edition (International), 2005. Singapore: McGraw Hill.
3. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
4. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.
5. Hickman, C.P. and Kats, H.L., Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
6. Molles, M.C. Ecology: Concepts and Applications. 6th Edition. 2005. McGraw Hill, New York, USA.
7. Odum, E. P. Fundamentals of Ecology. 3rd Edition. 1994. W.B. Saunders.Philadelphia.

BS 1st Year
Semester-II

CHEM-1204 ORGANIC CHEMISTRY (Cr. 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, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

Chemistry of Functional Groups:

Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, carbonyl compounds, 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.

Lab

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.

Recommended Books:

1. Brown, W. and Poon, T., *Introduction to Organic Chemistry,* 3rd ed., John-Wiley & Sons, Inc., (2005).
2. John, E. M. *Organic Chemistry,* 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).
4. Younus, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).
5. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry*, 6th ed.,

Pearson Education Limited, England, (1986).
6. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry,* 10th ed., John-Wiley & Sons, Inc., (2011).
7. Furniss, B. S., Hannaford , A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Longman, UK, (1989).
8. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques,* 5th ed., Brooks/ Cole Cengage Learning, (2013).
9. Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic to Laboratory with Multistep and Multisacle Syntheses,* 5th ed., John-Wiley & Sons, Inc., (2011).
10. Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach,* 5th ed., Brooks/ Cole Cengage Learning, (2010).
11. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry,* 6th ed., Brooks/ Cole Cengage Learning, (2012).

ENG-1207 English-II (Functional) (Cr. 3+0)

OBJECTIVES:

Enable the students to meet their real life communication needs.

CONTENTS:

Paragraph writing
Practice in writing a good, unified and coherent paragraph
Essay writing
Introduction
CV and job application
Translation skills
Urdu to English
Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension
Academic skills
Letter/memo writing, minutes of meetings, use of library and internet
Presentation skills
Personality development (emphasis on content, style and pronunciation)
Note: documentaries to be shown for discussion and review

RECOMMENDED BOOKS:

a) Grammar
   1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing
   1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).

2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard Yorky.

ISL-1212 Islamic Studies (Cr. 2+0)

قرآن مجید	10فیصد
حدیث	10فیصد
دین اسلام	10فیصد
سیرۃ النبیﷺ	15فیصد
تہذیب انسانی کی تعمیر میں اسلام کاحصہ	15 فیصد
اسلام کی اخلاقی اقدار	15 فیصد
ہمارا مستقبل (ہمارے مسائل اور ان کاحل)	10فی صد
معروضی سوالات	15فیصد

تفصیل نصاب

1- مطالعہ قرآن

۱- قرآن مجید کے مطالعہ کی ضرورت و اہمیت

فضائل قرآن مجید

- سورۃ فرقان کاتعارف

آداب معاشرت (آیت 61تا 77)

❖ سورۃ الحجرات کاتعارف

- نبی ﷺ کا مقام (آیت 1 تا 5)
- تحقیق احوال وایمان یا اصلاح معاشرہ (آیت6 تا 8)
- اخوت (آیت 9 تا12)
- اعرابیوں کادعویٰ ایمان کاجائزہ (آیت 13 تا 18)

2- مطالعہ حدیث

حدیث کی اہمیت و ضرورت، مطالعہ حدیث کی اہمیت و ضرورت

- ارکان اسلام
- کثرت سوال کی ممانعت
- متشابہات سے پرہیز
- فضولیات سے پرہیز
- اخوت
- اچھی بات اور ہمسایہ اورمہمان کی عزت
- غصہ نہ کرنا
- نیکی کی اہمیت
- حیا ء کی اہمیت
- ایمان باللہ
- جنت کی شرائط
- زہد
- ضرر رسانی کی ممانعت
- قانون شہادت
- برائی روکنے کاحکم

- احسانات خداوندی
- زندگی بسر کرنے کاطریقہ
- مومن کی نشانی
- مسلمان کی شناخت
- مومن کی نشانی

3- دین اسلام

(الف) عقائد

- توحید
- رسالت
- آخرت

(ب)عبادات

- نماز
- زکوٰۃ
- روزہ
- حج
- جہاد

4- سیرۃ النبی ﷺ

- ولادت تابعثت
- بعثت
- تبلیغ
- ہجرت
- میثاق مدینہ اورمواخات
- فتح مکہ
- حجۃ الوداع
- وصال نبوی ﷺ

5- اسلام کی اخلاقی اقدار

- فضائل اخلاق
- اخلاق کی اہمیت
- تقویٰ
- صدق (سچائی)
- ایفائے عہد
- عدل وانصاف
- احسان
- صبر
- کسب حلال
- والد ین کااحترام

6- تہذیب انسانی کی تعمیر میں اسلام کاحصہ

- درمیانی امت (امت وسط)
- شرف انسانیت
- وحدت انسانیت
- اسلام کا تاریخی کردار
- اشاعت علوم
- مسلمانوں کی علمی خدمات
- تاریخی کردار: مسلمانوں کی علمی خدمات کاعالمی سطح پر اعتراف

7- ہمارا مستقبل (ہمارے مسائل اور ان کاحل)

- اسلامی تشخص
- سیاسی مسائل
- اقتصادی مسائل
- تعلیمی مسائل

8- معروضی سوالات (سلیبس میں سے)

مجوزہ کتب

اسلامیا ت لازمی(بی اے /بی ایس سی /بی کام) ، پروفیسر ڈاکٹر محمد خلیل ، پروفیسر ضیا ء الرحمن قریشی ، علمی کتاب خانہ اردو بازار لاہور۔

STA-1220 Statistics (Cr. 3+0)

OBJECTIVES:

To acquaint students with statistical techniques frequently used in biology to process real data.

CONTENTS:

Frequency distribution, exercise frequency distribution, measures of central tendency, measures of dispersion and measures of location. Second part of the study will cover the areas of statistical hypothesis and significance, null and alternative hypothesis, confidence interval, tests involving binomial distribution, tests involving normal distribution, F-distribution, student's t-distribution, chi-square test, tests of independence and contingency tables. In the third part lectures will cover the following topics: Analysis of Variance (ANOVA), LSD test, experimental designs, Completely Randomized Design (CRD), Randomized Complete Block Design (RCBD), Latin Square Design, Markov chains and Models and their applications in Bioinformatics such as gene predication, sequence analysis, profile HMMs, probabilistic approaches to phylogeny, etc.

RECOMMENDED BOOKS:

1. Mann, P.S. 2010. Introductory Statistics. Seventh Edition; John Wiley and Sons.
2. Freund, J. E. and M. B. Perles. 2005. Modern Elementary Statistics; 12th Edition. Pearson.
3. Chaudhry, S. M. 2005. Introduction to statistical theory. Sixth Edition; Markazi Kutub Khana, Lahore.
4. Chernick, M. R. and R. H. Friis. 2003. Introductory Biostatistics for the Health Sciences: Modern Applications Including Bootstrap. First Edition; Wiley Interscience.
5. Le, C. T. 2003. Introductory Biostatistics. First Edition; Wiley Interscience

BOT-1203 PLANT SYSTEMATICS, ANATOMY AND DEVELOPMENT (Cr. 3+0)

Objectives of course: This course will equip the students

To understand various systems of classification, identification and nomenclature of Angiosperms

Plant tissue types and structures and functions of tissues and organs

Development of plant body (embryology)

Course outcomes: Knowledge about systematics and its utilization in identification of plants according to rules of ICBN and understanding of plant collection and preservation protocols

knowledge of structure of plant body

Knowledge of the structure of plants from cells and tissues to organs

Skills with methods which deals with plant structures

Theory: Plant Systematic: Introduction to plant systematic its aims, objective and importance. Classification: Importance brief history, introduction various systems of classification, Engler and Prantels System, Bentham and Hooker's System. Brief introduction to nomenclature; Importance of Latin names, systems with an introduction to international code of Botanical Nomenclature (ICBN). Morphology and Phytography – a detailed account of various morphological characters of root, Stem, leaf, inflorescence, flower, placentation and fruit types. Diagnostics characters, economic importance and distribution pattern of the following families: Brassicaceae (Cruciferae), Leguminosae, Rosaceae, Cucurbitaceae, Solanaceae, Lamiaceae (Labiatae), Asteraceae and Poaceae.

Anatomy and Development: Cell wall; structure and chemical composition**.** Tissue and Tissue System: Concept; structure and function of various tissues. e.g, Parenchyma, Chlorenchyma, Collenchyma, Sclerenchyma, Xylem and phloem**.** Primary Structure of root, stem and leaf. Definition and various type of meristems. Primary and secondary growth of dicot stem.Early development of plant body (embryology)*Capsela bursa-pastoris or Arabidopsis.*

Books Recommended

- Bold, H.C., (1997). Morphology of Plants. Harper & Row, N.Y.
- Dickison, W.C. (2000). Integrative Plant Anatomy, Academic Press, UK.
- Fahn, A. (1990) Plant Anatomy. Pergamon Press, UK.
- Malik, T.A. (1996). *Principles of Botany.* The Carvan Press Darbar Market, Lahore.
- Mauseth, J.D. (1998). An Introduction to Plant Biology: Multimedia Enhanced. Jones and BartlettPub. UK
- Moore, R.C., W.D. Clarke and Vodopich, D.S. (1998) Botany. McGraw Hill Company, USA.
- Pullaiah, T (2007). *Taxonomy of Angiosperms* 3rd Ed. Regency Publication, New Delhi.
- Raven, P.H., Evert, R.E. and Eichhom, S.E. (1999). Biology. Saunders College Publishing, USA.

- Sharma, O.P. (1993). *Plant Taxonomy*. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stuessy, T.F. (1990). Plant Taxonomy. Columbia University Press.

ZOO-1223 PRINCIPLES OF ANIMAL LIFE-II (Cr. 3+0)

Aims and Objectives

The course will imparts knowledge and understanding of:

1. Cell division and its significance in cell cycle.
2. Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
3. Animal behaviour and communication.
4. Theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle. **Inheritance Patterns:** Mendelian genetics; inheritance patterns; gene, structure, chemical composition and types. **Chromosomes and Gene Linkage:** Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations. **Molecular Genetics: Cellular Control: DNA:** the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA and applications of genetic technologies. **Animal Behaviour:** Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling animal behavior; communication; behavioral ecology; social behavior. **Evolution:** A Historical Perspective: Theories of evolution: Lamarckism and natural selection, neo larmarckism, Darwinism, and neo Darwinian. **Evolution and Gene Frequencies:** Hardy-Weinberg principle; evolutionary mechanisms: population size, genetic drift, gene flow, de Vries mutation theory and rates of evolution, polymorphism; species and speciation; molecular evolution; mosaic evolution.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. 2000. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6th Edition. Menlo Park, California: 2002. Benjamin/Cummings Publishing Company, Inc.

BS 2nd Year
Semester-III

CHEM-2398 ENVIRONMENTAL CHEMISTRY (Cr. 3+0)

Course Objectives:

Students will be able to acquire knowledge and develop understanding about the fundamental principles of environmental chemistry and different types of pollutions. Such information will be useful in studying and solving pollution related issues and experiments in the laboratory.

Course Contents:

Atmospheric Pollution:

The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution:

Water pollution and waste water treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:

Soil and mineral resources, general principles of metal extraction, heavy metals contamination of soil, toxicity of heavy metals, bio-accumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:

Atom economy, integrated pests management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water based paints.

Recommended Books:

1. Baird, C. and Cann, M., *Environmental Chemistry,* 5th ed., W. H. Freeman & Company, (2012).
2. Dara, S. S. and Mihsra, D. D., *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd., (2004).
3. Singhi, R. and Singh, V., *Green Chemistry for Environmental Remediation*, John-Willey & Sons, Inc., (2011).

4. Holloway, A. M. and Wayne, R. P., *Atmospheric Chemistry*, 1st ed., Royal Society of Chemistry, (2010).
5. Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK, (2010).
6. Manahan, S. E., *Environmental Chemistry,* 9th ed., CRC press, Taylor & Francis group, USA, (2009).
7. Girard, J. E., *Principles of Environmental Chemistry,* 2nd ed., Jones and Bartlett publishers, (2010).
8. Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., *Principles of Environmental Chemistry,* 1st ed., Royal Society of Chemistry, (2007).
9. Matalack, A., *Introduction to Green Chemistry,* 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
10. Wright, J., *Environmental Chemistry,* Routledge, (2003).
11. O'Neill, P., *Environmental Chemistry,* 3rd ed., Blackie Academic & Professional, (1998).
12. Elsom, D. M., *Atmospheric Pollution: A Global Problem,* 2nd ed., Wiley-Blackwell, (1992).

CHEM-2304 PHYSICAL CHEMISTRY (Cr. 3+1)

Course Objectives:

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will 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 virial 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 non-reversible 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 non-ideal 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 techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

Lab

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

Recommended Books:

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach,1st ed., University Science Books,(1997).
2. Atkins,P. and Paula,J.D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).
5. Glasstone, S., *Textbook of Physical Chemistry,* Macmillan London (1960*).*
6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).
7. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, (2013).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
9. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Ptv. Ltd., (2011).
10. Davis, W. M., Dykstra, C. E., Physical Chemistry: A Modern Introduction, 2nd ed., CRC Press, (2011).

ENG-2307 English III (Technical Writing and Presentation Skills) (Cr. 3+0)

OBJECTIVES:
Enhance language skills and develop critical thinking.

CONTENTS:
Presentation skills
Essay writing
Descriptive, narrative, discursive, argumentative
Academic writing
How to write a proposal for research paper/term paper
How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)
Technical Report writing
Progress report writing
Note: Extensive reading is required for vocabulary building

RECOMMENDED BOOKS:
Technical Writing and Presentation Skills
a) Essay Writing and Academic Writing
   1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
   2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
   3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

a) Presentation Skill
b) Reading: The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

PS-2317 Pakistan Studies (Cr. 2+0)

OBJECTIVES:
- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

CONTENTS:

1. *Historical Perspective***:**
   a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.
2. *Government and Politics in Pakistan:*
   Political and constitutional phases:
   a. 1947-58

b. 1958-71
c. 1971-77
d. 1977-88
e. 1988-99
f. 1999 onward

3. *Contemporary Pakistan:*
   a. Economic institutions and issues
   b. Society and social structure
   c. Ethnicity
   d. Foreign policy of Pakistan and challenges
   e. Futuristic outlook of Pakistan

RECOMMENDED BOOKS:

1. Burki, J. Shahid. 1980. *State & Society in Pakistan,* The Macmillan Press Ltd.
2. Zaidi, A. S. 2000. *Issue in Pakistan's Economy.* Karachi: Oxford University Press.
3. Burke, S.M. and L. Ziring. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
4. Mehmood, S. 1994. *Pakistan Political Roots & Development.* Lahore.
5. Wilcox, W. 1972. *The Emergence of Banglades.,* Washington: American Enterprise, Institute of Public Policy Research.
6. Mehmood, S. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road.
7. Amin, T. *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, L. 1980. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd.
9. Zahid, A. 1980. *History & Culture of Sindh.* Karachi: Royal Book Company.
10. Rafique, A. M. 1998. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
11. Sayeed, K. B.1967. *The Political System of Pakistan.* Boston: Houghton Mifflin.
12. Aziz, K.K. 1976. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research.
13. Muhammad W. 1987. Pakistan Under Martial Law, Lahore: Vanguard.
14. Haq, N. 1993. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research.

BOT-2303 CELL BIOLOGY, GENETICS AND EVOLUTION (Cr. 3+0)

Objectives of course: To understand:

Structure and function of cell.

Nature of genetic material and hereditary process

Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes. Associate the processes that unfold in individual cell compartments as preconditions for the functioning of the cell as a whole.

Familiarization with evolutionary processes

Cell Biology; Structure and Function of Bio-molecules, Carbohydrates, Lipids, Proteins, Nucleic Acids**. Cell:** Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell. **Brief description of following cell organelles** Cell wall, Cell membrane, Nucleus, Endoplasmic reticulu, Plastids, Mitochondria, RiDepertmental councilomes, Dictyosomes **,** Vacuoles. **Reproduction** in somatic and embryogenic cell, mitosis, meiosis and cell cycle

b) Genetics ; Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance. **c) Evolution: T**he nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Genetics

- Genetical problems related to transmission and distribution of genetic material.
- Identification of chromosomes in plant material. Carmine/orcein staining.
- Determination of blood groups

Recommended Books:

- Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
- Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill
- Publication Co. Ltd,, New Delhi.
- Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
- Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini
- Educational Books, New Delhi.
- Strickberger, M. V. (1988), Genetics, MacMillan Press Ltd., London.

ZOO-2323 Diversity of Animal Life-I (Cr. 3+0)

(Classification, Phylogeny and Organization of Invertebrates)

Aims and Objectives

The course is designed to provide students with:

1. Concepts of evolutionary relationship of animal kingdom.
2. Knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

Introduction: Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom. **Animal-Like Protists**: The Protozoa Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations. **Multicellular and Tissue Levels of Organization** Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations. **Triploblastics and Acoelomate Body Plan:** Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations. **Pseudocoelomate Body Plan**: Aschelminths Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations. **Molluscan Success:** Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations. **Annelida:** The Metameric Body Form Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations. **Arthropods**: Blueprint for Success Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations. Crustaceans, Hexapods and Myriapods, general nature, classification, phylogeny and adaptive diversification. **Echinoderms**: Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International), 2011. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology Of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

BS 2nd Year
Semester-IV

CHEM-2404 ANALYTICAL CHEMISTRY (Cr. 3+1)

Course Objectives:

Students will acquire knowledge about sampling and their handling and preparation and results calculation and data reporting. In addition they will learn and develop understanding about the classical techniques of analytical chemistry and quality control and quality assurance

Course Contents:

Chemometrics: Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, tests for significance, outliers

Quality Control and Quality Assurance:

Definitions, seven tools for quality control, the concept of quality assurance, quality assurance techniques, validations based on design qualification (DQ), installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ), calibrations, monitoring and quality reviews, periodical trainings, six sigma concept, ISO standards.

Classical Analytical Methods:

Acid-base, complexometric and redox titrations, gravimetric analysis.

Lab

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 barium in barium nitrate, determination of nickel in a given steel sample, determination of bicarbonates in a clinical sample using back-titration, determination of cation in a mixture by complexometric titration, studying the effect of common ions on solubility of sparingly soluble salts (e. g. AgCl / PbSO4).

Recommended Books:

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

2. Christian, G. D., *Analytical Chemistry.* 6th ed., John-Wiley & Sons, New York, (2006).
3. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York,USA, (2011).
4. Kealey, D. and Haines, P. J,Instant Notes., *Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, *CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry,* 2nd ed., Wiley-VCH, Germany, (2007).
6. Mitra A., *Fundamentals of Quality Control and Improvement,* 3rd ed., John-Wiley & Sons, (2008).
7. Miller, J. and Miller, J., *Statistics and Chemometrics for Analytical Chemistry,* 5th ed., Prentice Hall, (2005).

CHEM-2491 APPLIED CHEMISTRY (Cr. 2+0)

Course Objectives:

The objectives of the course are to educate the students about the fundamentals of chemical industry, raw materials, manufacturing and industrial processes.

Course Contents:

Fundamentals of Chemical Industry:
Basic principles and parameters for industrial plant unit operations and unit processes.

Chemical Industries:
Raw materials, flow sheet diagrams and unit operations and unit processes of sulphuric acid, nitric acid, hydrochloric acid, oxalic acid, formic acid, caustic soda and washing soda, cement industry, petroleum, textile, polymer and fuel industries, applications of these industries.

Recommended Books:

1. Kent, J. A., *Riegel's Handbook of Industrial Chemistry*, 10th ed., Kluwer Academic/ Plenum Publishers, (2003).
2. Vermani, O. P. and Narula, A. K., *Applied Chemistry; Theory and Practice,* New Age International Pvt. Ltd. Publishers, (2008).
3. Hede, P. D., Bier. S.P., *Inorganic and Applied Chemistry,* Ventus publishing app., (2007).
4. Sharma, J., Ndi., *Applied Industrial Chemistry,* Arise publishers & Distributors, (2012).
5. Heaton, A., *An introduction to Industrial Chemistry,* 3rd ed., Chapman & Hall, (1996).

CHEM-2481 BIOCHEMISTRY (Cr. 2+1)

Course Objectives:

The course of biochemistry for 4th semester is introductory. It provides fundamental concepts in biochemistry. Primary topics include structure of cell and its organelles, physical aspects of biochemistry.

Course Contents:

Brief introduction to scope of Biochemistry. Cell structures and their functions. Nature of biomolecules. Weak interactions in aqueous system. Hydrogen ion concentration. Ionic product of water. Weak acids and weak bases. The relation between pH and pKa, buffers, buffering against pH change in biological systems. The Henderson Hasselbalch equation. Diffusion, osmosis and osmotic pressure. Acid base balance. Intracellular and extracellular electrolytes, body fluids as electrolyte solutions, pH, 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 Na^+, K^+, Cl^- in acid-base disturbances.

Lab

COURSE OBJECTIVES:

The students will be able to learn

I. Detection of carbohydrates and determination of the amount of reducing sugar in the Biological fluid.

II. Qualitative tests for proteins and amino acids and determination of proteins spectrophotometrically.

1. Detection of carbohydrates, monosaccharides and polysaccharides.
2. Determination of the amount of reducing sugar in the Biological fluid.
3. Qualitative tests for proteins and amino acids.
4. Determination of proteins spectrophotometrically.
5. Estimation of proteins by Kjeldahl method.

Qualitative and quantitative analysis of carbohydrates, lipids and proteins. Laboratory work illustrating topics covered in the lecture of CHEM-2481, Determination of pH, Preparation of buffers. Preparations of standard solutions,

Recommended Books:

1. R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13,* 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
2. Nelson,D.L., *Lehninger's Principles of Biochemistry,* 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
3. Voet, D. and Voet, J.D., *Biochemistry,* 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
4. Murray, R.M. and Harper, H.A., *Harper's Biochemistry,* 25th ed., Publisher:Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
5. Zubay, G. L., *Biochemistry,* 4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
6. Guyton, A. C. & Hall, J. E., *Guyton & Hall Textbook of Medical Physiology,*

12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.
7. Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry,* 5th ed., *and Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 97814511163.

ARA-2401 Arabic (Cr. 3+0)

الأسماء الإشارة
الضمائر المتصلة
المركب الإضافي
المركب التوصيفي
الضمائر المنفصلة /حروف الجر
الجمع
الفعل الماضي
الفعل المضارع
الفعل المضعف / الضمائر المتصلة بالأفعال
الفعل الصحيح / الفعل المعتل
المذكر والمؤنث / الأسماء الخمسة
الأعداد
الإستفهام
اسم الفاعل
أعضاء الجسم / الألوان
لقاء في المطار / الحروف والأسماء مع ضمائر المتصلة
الجملة الإسمية / الجملة الفعلية
حروف الهجاء وطريقة النطق بها / حروف المد / حروف القمرية والشمسية
الأناشيد المختارة / القصة (قوة الإخلاص)
الأحاديث النبوية الأحاديث النبوية

الكتب المختارة:

- **اللسان العربي** جامعة علامة إقبال المفتوحة إسلام آباد

BOT-2403 PLANT PHYSIOLOGY AND ECOLOGY (Cr. 3+0)

Course objectives The main theme of the course is to provide basic knowledge of different metabolic processes occurring in plants, as well as the relationships of plants with their environment. Course also aims to enable the students to assess the effects of various environmental factors and stresses on plant growth and development.

Theory: **Plant Physiology; Water relations** (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation. **Mineral nutrition:** Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients. **Photosythesis:** Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C3 and C4 plants. Factors affecting this process, Products of photosynthesis. **Respiration:** Definition and respiratory substrates. chanism-Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and naerobic respiration, Respiratory quotients.

(**b) Ecology** Introduction, aims and applications of ecology. **Soil:** Physical and Chemical properties of soil (soil formation, texture. pH, EC, organism and organic matter etc) and their relationships to plants. **Light and Temperature.** Quality of light, diurnal and seasonal variations. Ecophysiological responses. **Water:** Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants. **Wind:** Wind as an ecological factor and its importance. **Population Ecology:** Introduction. A brief description of seed dispersal and seed bank. **Community Ecology** i. Ecological characteristics of plant community ii. Methods of sampling vegetation (Quadrat and line intercept) iii. Major vegetation types of the local area. **Ecosystem Ecology** i. Definition, types and components of ecosystem, ii. Food chain and Food web. **Applied Ecology:** Causes, effects and control of water logging and salinity with respect to Pakistan

Recommended Books:

- Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th. Ed. Sinauers Publ. Co. Inc. Calif.
- Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Hopkins, W. B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
- Schultz, J. C. 2005. Plant Ecology. Springer-Verlag, Berlin.
- Ricklefs, R. E. 2000. Ecology. W. H. Freeman and Co., UK.
- Larcher, W. 2003 Physiological Plant Ecology: Ecophysicology and Stress Physiology of Functions Groups – Springer Verlag.

BOT-2402 BIODIVERSITY AND CONSERVATION (Cr. 3+0)

Objective of course: To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystem.. To understand the value of biodiversity, methods of conservation and current efforts to conserve biodiversity on global, national and local scales.

Learning Outcomes: Students will be able

To describe the global biodiversity crisis

To outline the main reasons for decline and threats to biodiversity worldwide

To argue the case for and against conserving biodiversity

Theory: **Biodiversity:** Definition, types and threats. **Threats to Biodiversity;** deforestation, over grazing, erosion, desertification, ecosystem degradation, bio invasion, pollution and climate change. **Biodiversity of Pakistan**. **Measuring biodiversity:** Alpha, Beta and Gamma diversity. **Ecological services**, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources). **Sustainable and unsustainable** use of biological resources. **Biodiversity Hot spots** of Pakistan and the world. **International treaties/agreements** regarding Biodiversity and conservation; **CBD, CITES, Ramsar**. **Conservation strategies;** *in situ* and *ex situ*, *in vitro* conservation. Conservation *vs* preservation. **IUCN categorized protected areas** in Pakistan; red listing. Use of herbarium and Botanical Garden in biodiversity and conservation. Concept of pastures and wild life management. Global Biodiversity Information Facility (GBIF)

Recommended Books:

- **Maiti, Prabodh K. and Maiti, Paulam. 2017, second edition.** Biodiversity: perception, peril and preservation. PHI learning private limited, Delhi.
- Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. 2012. Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.
- Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.

- IUCN. 1994. *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.
- Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.

ZOO-2423 Diversity of Animal Life-II (Cr. 3+0)

Aims and Objectives

The course provides knowledge and understanding about the different chordates, emphasizing their phylogenetic relationships.

Course Contents

Hemichordates and Invertebrate Chordates: Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations. **Fishes**: Vertebrate Success in Water: Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Amphibians**: The First Terrestrial Vertebrates Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations. **Reptiles**: The First Amniotes Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhynchocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Birds**: Feathers, Flight, and Endothermy Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation. **Mammals**: Specialized Teeth, Endothermy, Hair, and Viviparity: Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International) 2010. Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. Latest Edition 2002. New York: McGraw Hill.
4. Campbell, N.A. BIOLOGY, 9th Edition. 2011. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

PHYSICAL CHEMISTRY

BS 3rd Year
Semester V

CHEM-3501 PHYSICAL CHEMISTRY-1 (Cr.3+1)

Course Objectives:

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

Course Contents:

Conductometry:
Ions in solution, measurement of conductance and Kohlrausch's law, mobility of ions and transport number, conductometric titrations, Debye-Hückel theory and activity coefficient, determination of activities, application of conductance measurement.

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

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

Nuclear Chemistry:
Atomic nucleus, nuclides, nuclear stability, modes of decay, nuclear energetics, nuclear models (shell + liquid drop model), fusion and fission, non-spontaneous nuclear processes, nuclear reactors, beta decay systematic.

Lab

Course Objectives:

The student would be able to learn

I. The instrumentation and principle of refractometer, polarimeter, and potentiometer.

II. Application of refractometer, polarimeter, and potentiometer.

Spectroscopic determination of Cu percentage in the given sample. Conductometric determination of Cu (II)- EDTA mole ratio in the complex.

To determine the effectiveness of an extraction of I2 solution by using Solvent Extraction method.

Determination of molecular weight of a polymer by viscosity method. Determination of percentage composition of KMnO4/ K2Cr2O7 in a given solution by spectrophotometry.

Evaluation of pKa value of an indicator by spectrometric method. Conductometric determination of hydrolysis constant (Kh) of conjugate base of a weak acid.

Recommended Books:

1. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., *Physical Chemistry,* 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., *Physical Chemistry,* Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., *Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1st ed.,* Springer, (2003).
4. Choppin, G., Liljenzin, J-. O. and Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth- Heinemann, (2002).
5. Loveland, W., Morrisey, D. J. and Seaborg, G. T., *Modern Nuclear Chemistry,* John-Wiley & Sons, Inc., (2006).
6. Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry,* 9th ed., Oxford University Press, (2010).
7. Somorjai, G. A. and Li, Y., *Introduction to Surface Chemistry and Catalysis,* 2nd ed., John-Wiley & Sons, Inc., (2010).
8. Laidler. K. J., "Chemical Kinetics" 3rd ed., Prentice Hall, (1987).
9. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
10. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Longman Group Limited, New York, (1974).

BS 3rd Year
Semester-VI

CHEM-3601 PHYSICAL CHEMISTRY-II (Cr.3+1)

Course Objectives:

The student would be able to learn the

I. Quantum chemistry to understand the dual nature of electron and its verification.

II. Basic principles of electrochemistry in order to get understanding to make and improve the Li ion battery.

III. Basic principles of IR, MW, and NMR spectroscopy.

Quantum Chemistry
Black Body radiations; photoelectric effect; Compton effect; postulates of quantum mechanics; concept of wave functions; operators, eigen and non-eigen functions; derivation of Schrodinger wave equation for one dimension and three dimensions; concept of degeneracy; orthogonal and normalized set of functions; Pauli exclusion principle. One dimensional Box.

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

Basic Spectroscopy
Interaction of electromagnetic radiation with matter. Symmetry properties of molecules. Microwave and infrared spectroscopy. Rotational, vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules. Electronic spectra of simple molecules. Nuclear magnetic resonance spectroscopy

Recommended Books

1. I.N. Levine, Physical Chemistry, 5th ed., Tata McGraw-Hill (2002).
2. P.W. Atkins and J. de Paula, Physical Chemistry, 7th ed., Oxford University Press (2002).

Supplementary Books

1. H. Kuhn and H.D. Fosterlings, Principles of Physical Chemistry, John Wiley & Sons, Ltd. (2000).
2. D.O. Hayward, Quantum Mechanics for Chemists, Royal Society for Chemistry (2002).

Lab

Course Objectives:

The student would be able to learn the

I. Conduct measurements by conductivity meter.

II. Determine the concentration of unknown solution by using colorimeter

Conductivity Meter, Conductance measurements.
Find out the strength of HCl solution by titrating it against NaOH solution conductometrically.
Colorimetry
To verify Beer's Law for solution of KMnO4 or $K_2Cr_2O_7$ using colorimeter.
Determine the concentration of unknown solution by using colorimeter.

Recommended Books

1. C.W. Garland, J.W. Nibler and D.P. Shoemaker, Experiments in Physical Chemistry, McGraw Hill, 7th ed. (1996).
2. A. Findlay, Findlay's Practical Physical Chemistry, Longman, London (1972).

Supplementary Books

1. D.A. Skoog, Principles of Instrumental Analysis, 3rd ed., New York (1998).
2. L.P. Gold, L. Gold, Physical Chemistry Laboratory, Primis Publishers (1997). ISBN: 0072902698.

BS 4th Year

Semester-VII

CHEM-4701 POLYMER CHEMISTRY (Cr.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:

1. Sperling, L. H. *Introduction to Physical Polymer Science*, 4th ed., Wiley-Interscience, New York, USA, (2006).

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

Flory, J., *Principles of Polymer Chemistry*, Cornell University Pres (1953)

CHEM-4702 QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY (Cr.3)

Course Objectives:

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

Course Contents:

Quantum Chemistry:

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

Molecular Spectroscopy:

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

Recommended Books:

1. Fayer, M. D., *Elements of Quantum Mechanics,* Oxford University Press, London, UK, (2001).
2. Becker, E. D., *High Resolution NMR; Theory & Chemical Application*, 3rd ed., Academic Press, New York, USA, (2000).
3. Graybeal, J. D., *Molecular Spectroscopy*, 1st ed., McGraw-Hill, New York, (1988).
4. Hayward, D. O., *Quantum Mechanics for Chemists*, Royal Society Of Chemistry, (2002).

5. House, J. E., *Fundamentals of Quantum Mechanics* 2nd ed., Elsevier-Academic Press, New York, USA, (2004).
6. Kirsten, H. J. W. M., *Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral* 1st ed., World Scientific Publishing Co. Pvt. Ltd., (2006).
7. Barrow, G. M., *Physical Chemistry,* 6th ed., McGraw-Hill Book Company, (1996).
8. Straughan, B. P., and Walker, S., *Spectroscopy*, Vol. 1 and 2., Chapman and Hall Ltd., (1976).
9. Coulson C. A., *Vanlence*, Oxford University Press (1980).

CHEM-4703 CHEMICAL KINETICS (Cr.3)

Course Objectives:

The student would be able to learn the

I. The order, rate and molecularity of a reaction.

II. The laws of thermodynamics and relationship of free energy change from reactant to product.

III. The laws of chain reactions,formation of byproduct and effect of media on the rate of reaction.

Course Contents:

Derivation of the rate equations. Theory of absolute reaction rate. Reversible reactions, parallel reactions and consecutive reactions. Correlation between physical properties and concentration. Comparison of collision and absolute reaction theories. Advanced theories of unimolecular reactions. Potential energy surfaces. Thermodynamic formulation of reaction rates. Calculation of entropy and enthalpy changes. Thermal decomposition of nitrogen pentaoxide.
Reactions in solutions. Influence of ionic strength on the reaction rate. Effect of dielectric constant of the medium on the rate of the reaction. Single sphere activated complex model. Double sphere activated complex model. Complex reactions. Chain reactions. Single chain carrier with second order breaking. One chain carrier with first order breaking. Two chain carrier with second order breaking. Experimental techniques for fast reactions.

Recommended Books

1. Albery J., Electrode Kinetics, Clarendon, Oxford (1975).
2. Espenson, J. H. Chemical Kinetics and Reaction Mechanism 2nd ed., McGraw Hill London (2002).
3. Espenson J.H. “Chemical Kinetics and Reaction Mechanisms” 2nd ed. McGraw Hill, New York (1995).
4. Frost A.A. and Pearson R.G. “Kinetic and Mechanism” 2nd ed. John Wiley and Sons Inc, New York (1961).
5. Laidler K.J. “Chemical Kinetics” 3rd ed. Pearson Education Company, New York (1987).
6. Laidler L.J. “Reaction Kinetic VII, II Reaction in Solution” Pergamon Press, New York (1963).

CHEM-4704 PHOTOCHEMISTRY (Cr.3)

Course Objectives:

Students will be able to study:

1. Principle and mechanism of Photochemical reactions.
2. Determination of rate law of photochemical reactions.

3. Phosphorescence, fluorescence, chemiluminescence, luminescence, photosynthesis.

Course Contents:

Kinds of chemical reactions, demonstration of a photochemical reaction, characteristic of photochemical reaction, difference between dark and photochemical reactions, types of photochemical reactions, sources of photochemical radiations, mechanism of photochemical reaction, laws of photochemistry, basic laws of photochemistry, Lambert-Beer's law, limitations of Lambert-Beer's law, (Photochemical equilibrium and equilibrium constant), quantum efficiencies, experimental determination of quantum yield, deviations in the law of photochemical equivalence, low quantum yield reactions, High quantum yield reactions, small integer quantum yield reactions. Factors affecting quantum yield.

CHEM-4705 PHOTOCHEMICAL REACTIONS AND THEIR KINETICS (Cr.3)

Course Contents:

Types of photochemical reactions, photochemical kinetics of photochemical rate law, reactions which do not involve chain, kinetics of photochemical dissociation of HI. Reactions which do not involve chain (kinetics of photochemical reactions of Hydrogen with Chlorine). Phosphorescence, fluorescence, chemiluminescence, luminescence, photosynthesis.

Recommended Books

1.P. Suppan, Chemistry and Light, The Royal Society of Chemistry, London (1994).

2.R.P. Wayne, Principles and Applications of Photochemistry, Oxford University Press (1988).

Supplementary Books

1.J.G. Calvert, and J.N. Pitts, Photochemistry, John Wiley and Sons Inc., New York (1966).

2.C.E. Wayne, Photochemistry, Oxford University Press, London (1996) ISBN:.

CHEM-4706 MOLECULAR SPECTROSCOPY (Cr.3)

Course Objectives:

Students will be able to study:

I. The Principles and classification of spectroscopy.

II. Characterization of chemical substance using spectroscopy.

III. Nuclear magnetic resonance spectroscopy: Principles; applications.

Course Contents:

Introduction: Principles and classification of spectroscopy; interaction of light and matter; de-excitation modes; various spectra and their characterization. Rotational spectroscopy: classification of molecules; diatomic rigid and non-rigid molecules; polyatomic linear molecules; symmetric tops; applications. Vibrational spectroscopy: Classification of vibrational modes; diatomic molecules; diatomic vibrating-rotator; breakdown of the Born-Oppenheimer approximation; polyatomic linear vibrotors and

vibrating symmetric tops. Electronic spectroscopy of diatomic molecules: Vibrational coarse structure; the Frank-Condon principle and dissociation. Nuclear magnetic resonance spectroscopy: Principles; applications.

Recommended Books

1.C.N. Banwell, Fundamentals of Molecular Spectroscopy, 3rd ed., McGraw-Hill, UK (1983).

2.G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill (International Student Edition) (1990).

3.G. Aruldhas, Molecular Structure and Spectroscopy, Prentice-Hall (India) (2004).

4.H. Friebolin, Basic One- and Two- Dimensional NMR Spectroscopy, VCH, Weinheim (1993).

:**CHEM-4720 PHYSICAL CHEMISTRY Lab-III (Cr. 0+3)**

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:

1. Determination of partial molar properties.
2. Determination of free energy changes, standard free energies.
3. Verification of Kohlrausch's law.
4. Study of temperature dependence of electrode potentials.
5. Determination of heat of solution, ionic reactions and other experiments from thermochemistry.
6. Determination of molecular weight of a polymer by viscosity method. Precipitation value of electrolytes.Measurement of IR spectra of simple compound and their interpretation.
7. Measurement of cyclic voltammogram of an organic compound and its interpretation.
8. Determination of dipole moment of an organic liquid.
9. Determination of percentage composition of KMnO4-K2Cr2O7 in given solution by spectrometry.
10. Evaluation of pKa value of an indicator by spectrometric method.
11. Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques.

Recommended Books:

1. Garland, C. W., Shoemaker, D. P., and Nibler, J. W., *Experiments in Physical Chemistry*, 8th ed., McGraw-Hills, New York, (2003).
2. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Prentice Hall Press, (1974).

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

BS 4th Year
Semester VIII

CHEM-4801 Surface Chemistry and Catalysis (Cr. 3)

Course Objectives:
Students will learn:

I. The concepts of adsorption, absorption, sorption and desorption, characteristics of adsorption, difference between adsorption and absorption.
II. To investigate the Freundlich and Langmuir adsorption isotherm, their success & limitations.
III. Henry's equation,Gibbs absorption equation and its application.
IV. Catalysis, criteria of catalysis or characteristics of catalytic reactions
V. Theories of catalysis, the intermediate compound formation's theory, the adsorption theory.

Course Contents:
Surface Chemistry
History of adsorption, adsorption, absorption, sorption and desorption, characteristics of adsorption, difference between adsorption and absorption, Adsorbant and adsorbate, mechanism of adsorption and their comparison, factors effecting adsorption, specific surface area and its determination. Forces involved in adsorption, types of adsorption curve, Enthalpy of adsorption and thermodynamics, types of enthalpy of adsorption, desorption and activation energies. Classical Freundlich adsorption isotherm, test of Freundlich adsorption isotherm, limitations of Freundlich's equation. The Langmuir adsorption isotherm, gas adsorption isotherms: Henry's equation, fundamental equation for surface layer: Gibbs absorption equation and its application, adsorption of mixture of gases, application of adsorption.

Catalysis
Catalysis, criteria of catalysis or characteristics of catalytic reactions, types of catalysis, promoters, catalytic poisoning and poisoning effect of catalyst, autocatalysis, negative catalysis, and inhibitors, activation energy and catalysis, theories of catalysis, the intermediate compound formation's theory, the adsorption theory, active centers on catalyst surface, acid base catalysis and its mechanism, heterogeneous catalysis, mechanism of heterogeneous catalysis, kinetics of heterogeneous (surface) catalytic reactions. Enzyme catalysis, characteristic of enzyme catalysis, mechanism of enzyme reactions.

Recommended Book

1. G.C. Bond, Heterogeneous Catalysis: Principles and Applications, 2nd ed., Clarendon Press, Oxford (1987).

Supplementary Book

1. S.J. Gregg and K.S.W. Sing, Adsorption, Surface Area and Porosity, 2nd ed., Academic Press, London (1982).

CHEM-4802 Colloidal and Solution Chemistry (Cr. 3)

Course Objectives:
Students will learn:

I. Colloids, types of colloids, phases of colloidal solution.
II. Determination of size of colloidal particles by sedimentation of suspension and ultra centrifuge method, electrokinetic phenomena.
III. Gel, types of gels, properties of gels, applications of colloids.
IV. Models for solutions, nature of interactions present in solution, non-electrolytic solution, ideal solutions, laws of dilute solutions,
V. Various techniques used to study these properties.

Course Contents:

1-Colloidal Chemistry
Colloids, difference between colloidal and true solution, types of colloids, phases of colloidal solution, difference between lyophilic and lyophobic colloids, preparation of colloidal dispersion, purification of colloidal solution, properties of colloidal suspension, determination of size of colloidal particles by sedimentation of suspension and ultra centrifuge method, electrokinetic phenomena, electrophoresis, electro osmosis, and streaming potential, coagulation of colloids, protection of the colloidal state, Gold number, origin of charge on sol particles. Stability of solution, associated colloids, Micells, mechanism of Micells formation. Emulsions, Preparation of emulsions, role of emulsifier, properties of emulsion. Gel, types of gels, properties of gels, applications of colloids.
2-Solution Chemistry
Solutions and their role in chemistry, models for solutions, nature of interactions present in solution, non-electrolytic solution, ideal solutions, laws of dilute solutions, activity, activity coefficient and equilibrium constant, colligative properties, phase rule macroscopic and microscopic properties of solutions and various techniques used to study these properties.

Recommended Books

1.J. Burgess, Metal Ions in Solutions, 2nd ed., Ellis Harwood Ltd. UK (1978).

2.C. Reichardt, Solvents and Solvent Effects in Organic Chemistry, 2nd ed., VCH, Weinheim, Germany (1988).

3.I.N. Levine, Physical Chemistry, 5th ed., Tata McGraw-Hill (2002).

4.A.W. Adamson, Physical Chemistry of Surfaces, 5th ed. Wiley-Interscience Publication, John Wiley & Sons, Inc., New York (1990).

5.P.C. Hiemenz and Rajagopalan, Principles of Colloid & Surface Chemistry, 3rd ed.

6.M.J. Rosen, Surfactants and Interfacial Phenomena, Wiley-Interscience Publication, John Wiley & Sons, New York (1978).

Supplementary Book

1.D.F. Evans and H Wennerström, The Colloidal Domain Where Physics, Chemistry, Biology and Technology Meet, VCH Publishers, Inc., New York (1994).

CHEM-4803 Electrochemistry (Cr. 3)

Course Objectives:
Students will be able to learn:

I. Applications of electrochemistry, electrochemical reactions, schematic representation of electrochemical cells.
II. Batteries and commercial cells, dry cell, lead storage cell etc.
III. Kohlrausch's law of independent migration, Faraday's laws of electrolysis, Nerst equation.

Course Contents:
Electrochemistry, History of electrochemistry, applications of electrochemistry, conduction, types of conduction, molar conduction, types of cell, electrolysis, ionic theory of electrolysis, electrochemical series, displacement reactions, schematic representation of electrochemical cell, types of electrolytic dissociation (Arrhenius theory of ionization), factors influencing the ionization, dissociation constant of acid and base, Batteries and commercial cells, dry cell, lead storage cell, Fuel cells, corrosion, Kohlrausch's law of independent migration, Faraday's laws of electrolysis, Nerst equation, antimony electrodes, Calomel electrode, types of electrode, standard electrode potential, E.M.F. of cell, oxidation potential, standard hydrogen electrode,

Books Recommended

1. Gasser R.P.H. and Richards W.G. "Entropy and Energy Levels" Oxford University Press (1974).

2. Wayatt P.A.H. "The Molecular Basis of Entropy and Chemical Equilibrium" Royal Institute of Chemistry London (1971).

3.Smith E.B. "Basic Chemical Thermodynamics" 4th ed. Oxford University Press (1990).

4.Bockris J.O.M. and Reddy A.K.N. "Modern Electrochemistry" Vol-I and II, 4th ed. Plenum Press, London (2003).

5.Muhammad M. and Amjad M. "Principles of Electrode Kinetics" Rooha Printers, Lahore (2001).

6. Seddon J.M. and Gale J.D. "Thermodynamics and Statistical Mechanics" Royal Soc Chem, UK (2002).

7. Aston J.G. and Fritz J.J. "Thermodynamics and Statistical Thermodynamics" John-Wiley, New York (1987).

8. Albery J., Electrode Kinetics, Clarendon, Oxford (1975).

9. Engel, Thomas and Philip Reid, “Thermodynamics, Statistical Thermodynamics”, and Kinetics 1st ed., Benjamin Cummings (2006).
10. Bard A.J. and Faulkner L.R. “Electrochemical Methods” John Wiley & Sons (2001).

CHEM-4804 Radiation and Nuclear Chemistry (Cr. 3)

Course Objectives:
Students will be able to learn:

1. To enable the students to understand the history, origin, nature, composition and characteristics of electromagnetic and ionizing radiations.
2. To enable them to understand the relation of radiation chemistry with photochemistry by making use of laws of photochemistry.
3. To give them knowledge of difference between nuclear and chemical reactions.
4. To enable them to understand the importance of nuclear chemistry to resolve the energy crises.
5. To transuranic elements, radioisotopes and their uses.

Course Contents:

Radiation chemistry, types of ionizing radiations, relation of radiation chemistry with photochemistry, history of the radiation, origin of radiations and their affect, ionization and excitation produced by Radiations, nuclear chemistry, difference between nuclear and chemical reactions, branches of nuclear chemistry, importance of nuclear chemistry, radioactive rays, nuclear fission, characteristics of nuclear fission, Hahn and Strassman observation, atomic bomb, nucleons, sub nucleon, hydrogen bomb, composition of nucleus, nuclear reactors, types of nuclear reactors, fission reactors, fusion reactors, energetic of nuclear reactions, how to write nuclear reactions, types of radioactive rays, types of nuclear reaction, nuclear waste and their treatment, natural and artificial transformation, transuranic elements, radioisotopes and their uses.

Recommended Books

1. Fried Landler, Kennedy and Miller, “Nuclear and Radiochemistry”, John Willey and Sons, Inc. 2nd edition, 1964.
2. Choppin, G. R. and Rydber, J., “Theory and Applications”, Pergamon 1980.
3. Arnikan, H. J., “Essentials of Nuclear Chemistry”, 4th edition, 1990.
4. Harvey, B.G. “Nuclear Physics and Chemistry”, Prentice-Hall Inc., 1990.
5. Naqvi, I. I., “Radiochemistry”, University Grants Commission,1990.

CHEM-4805 Chemical Thermodynamics (Cr.3)

Course Objectives:
Students will be able to learn:

I. Basic concepts: Relations used in thermodynamics & laws of thermodynamics
II. Phase rule: Phase equilibrium, one component system, multicomponent systems.
III. Colligative properties

Course Contents:

Basic concepts: Relations used in thermodynamics, free energy, enthalpy, entropy, laws of thermodynamics. Systems of variable compositions: Mixtures of gases; the fugacity function; partial molal quantities; ideal solutions. Laws of dilute solutions: Henry's law; Nernst's distribution law; Raoult's law; activity and activity coefficients; equilibrium constants; free energy changes in solutions. Colligative properties: Vapour-pressure lowering, freezing point depression, elevation of boiling point and osmotic pressure. Phase rule: Phase equilibrium, one component system, multicomponent systems.

Recommended Books

1.I.M. Klotz, Chemical Thermodynamics, 3rd ed., W.A. Benjamin Inc., California;

(1972).

2.I.N. Levine, Physical Chemistry, McGraw Hill, New York (2002).

Supplementary Books

1.K.S. Pitzer, Thermodynamics, 3rd ed. McGraw-Hill, New York (1995).

2.J.B. Ott and J.B. Goates, Chemical Thermodynamics, Elsevier, New York (2000)

CHEM-4806 Statistical Thermodynamics (Cr. 3)

Course Objectives:

Students will be able to learn:

I. Concepts of states, accessible states Probability and distribution.
II. Maxwell - Boltzmann's statistics for the systems of independent particles.
III. Statistical thermodynamic's applications to equilibrium and chemical kinetics.
IV. Bose-Einstein's and Fermi-Dirac's statistics

Course Contents:

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

Recommended Books

1. R. Reif, Statistical Physics, McGraw-Hill Book Co., New York (1967).
2. D.A. McQuarrie and J.D. Simen, Physical Chemistry (A molecular approach), Viva Books Pvt. Ltd., New Delhi (2004).
3. Fritz & Fritz, Statistical Thermodynamics, Wiley, New York (1959).
4. J.M. Seddon and J.D. Gale, Thermodynamics and Statistical Mechanics, RSC Publishers (2001).
5. K. Nash, Elements of Classical and Statistical Thermodynamics, Addisen-Wesley Publishing Company, London (1970).
6. Sears and W. Francis, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Adison and Wisle, London (1975).

CHEM-4807 Solid State Chemistry (Cr. 3)

Course Objectives:

Students will be able to learn:

I. Unit cells and crystal systems: Lattices and their description.

II. Point groups and their relevant classification based on symmetry.

III. Perfect and imperfect crystals: Types of defects with description & Theories of electrical conductance.

Course Contents:

Unit cells and crystal systems: Lattices and their description: Bravais lattice; Miller indices; unit cell contents. Point groups and their relevant classification based on symmetry. Space groups and crystal structures: Close-packed structures (cubic, hexagonal, tetragonal and other packing arrangements). Important structure types (Rutile, Rock Salt, Zinc Blend, Wurtzite. etc). Perfect and imperfect crystals: Types of defects with description. Diffusion of ions in solids; dislocation; mechanical properties and reactivity of solids. Theories of electrical conductance: Different types of solids, metals and non-metals.

Recommended Books

1. A.R. West, Solid State Chemistry, 2nd ed. John Wiley, Singapore (2002).
2. W.J. Moore, Seven Solid States, W.A. Benjamin Inc., New York (1967).
3. R.H. Bube, Electrons in Solids, 3rd ed., Academic Press, San Diego (1992).

Supplementary Books

1. W.D. Callister, Material Science and Engineering, 6th ed. John Wiley, New York (2003).
2. Electronic Materials Handbook, Vol. I, Packaging, ASM International Materials Park, Ohaio (1989).
3. R.E. Hummel, Electronic Properties of Materials, 3rd ed. Springer-Verlag, New York (2000).

CHEM-4808 Statistical Mechanics (Cr. 3)

Course Objectives:

Students will be able learn:

I. Basics: Probability; description of various systems.

II. Maxwell-Boltzmann's statistic (MBS) of the systems of independent particles.

III. Statistical thermodynamics: Correlation of partition functions and thermodynamic functions. Applications

Course Contents:

Historic background and basics: Probability; description of various systems;

ensembles; concepts of states and accessible states; distribution of energy; Maxwell-Boltzmann's statistic (MBS) of the systems of independent particles. Partition functions: Derivations and determinations for simple molecules. Statistical thermodynamics: Correlation of partition functions and thermodynamic functions. Applications: To chemical equilibrium and chemical kinetics; Fermi-Dirac's (FD) and Bose-Einstein's (BE) statistics.

Recommended Books

7. D.A. McQuarrie and J.D. Simen, Physical Chemistry (A molecular approach), Viva Books Pvt. Ltd., New Delhi (2004).
8. J.M. Seddon and J.D. Gale, Thermodynamics and Statistical Mechanics, RSC Publishers (2001).
9. K. Nash, Elements of Classical and Statistical Thermodynamics, Addisen-Wesley Publishing Company, London (1970).
10. Sears and W. Francis, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Adison and Wisle, London (1975).

CHEM-4809 Thermodynamics and Statistical Mechanics (Cr.3)

Foundations of Statistical Mechanics: Statistical uncertainty function and entropy; Boltzmann H-theorem, and relation to entropy. Fermi-Dirac and Bose-Einstein distributions, Review of thermodynamics: system and macroscopic observables, state functions and properties; laws of thermodynamics, Einstein, and Fermi-Dirac statistics and partition functions. Application of Fermi-dirac statistics to (1) degenerate and non- degenerate system.

CHEM-4820 Physical Chemistry Lab-IV (Cr. 0+3)

1. Sugar analysis and inversion studies by polarimetry. Study of isotherms and experiments of
2. surface chemistry. Kinetics of fading of phenolphthalein in alkaline solution.
3. Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.
4. Study of the salt effect on the rate constant of the reaction between similar charges of ions.
5. Kinetics ofautocatalytic reaction between permanganate and oxalate ions. Determination of energy of activation of the reaction between similar chargers of ions.
6. Kinetics of the reaction between methylorange and peroxodisulphate ions in presence of bromide ions. Stoichiometry of a complex in solution by Job's method.

Recommended Books

01. Physical Chemistry by Alberty, R.A and Silbey, R.J., John Wiley, New York, 1995.
02. Physical Chemistry by Atkins, P.W. 5th Ed., W.H. Freeman & Company, New York,

03. Chemical Thermodynamics/by Klotz, I.M., 3rd Ed., W.A. Benjamin Inc., California, 1972

04. Thermodynamics/by pitzer, K.S. 3rd Ed., McGraw-Hill, New York, 1995.

05. Quantum Chemistry/by Levine, I.N. 4th Ed., Prentice Hall, New Jersey, and Prentice Hall India 1991.

06. Quantum Mechanics in Chemistry/by Hanna, M.W. 3rd Ed., The Benjamin/Cummings Co., California, 1981.

07. Quantum Chemistry/by Lowe, J.P. 2nd Ed. Academic Press. Boston.2 New York,

08. Introduction to Molecular Spectroscopy by Barrow, G.M. Mc Graw-Hill, Auckland, Singapore, London, 1962.

09. Fundamentals of Molecular Spectroscopy by Banwell, C.N. 2nd Ed., McGraw-Hill, London, N.Y., 1972.

10. Spectroscopy and Molecular Structure by King, G.W., Holt, Rinchert & Winston, New York, 1964

11. Modern Electrochemistry by Bockris, J.M. and Reddy, A.K.N. 2 Vols. Plenum Press, New York, 1970.

12. Electrochemical Methods Fundamentals and Applications/by Bard. A. and Faulkner, L.R., John Wiley, New York, 1980.

13. Nuclear and Radiochemistry Friedlander, G. And Kennedy, J.W. Others 3rd Ed., John Wiley & Sons, New York, 1980.

14. Essentials of Nuclear Chemistry by Arnikar, H.J. 4th Ed. New Age International Publishers Ltd. Wiley Eastern Ltd. New Delhi, 1995.

15. An Introduction to Radian Chemistry by Spinks, J.W.T. and Woods, R.J. 2nd Ed., John Wiley, New York, 1976.

16. Kinetics and Mechanism by Frost, A.A.M Person, R.G. 2nd Ed. John Wiley & Sons, New York, 1969.

17. Elementary Reaction Kinetics by Latham, J.L. & Burgess, A.E. 3rd Ed., Butterworths, London, 1977.

18. Heterogeneous catalysis: Principles and Applications/by Bond, G.C., 2nd Ed., Oxford, Clarendon Press, 1987.

19. Surfactants and Interfacial Phenomena/Rosen, Milton J., John Wiley, New York, 1978.

20. Introduction of Photochemistry/by COX, A. And Kemp, T.J. McGraw- Hill, London, 1971.

21. Photochemistry/by Calvert, J.G. and Pitts, J.N., John Wiley New York, 1966.

22. F. Daniel and et al, Experimental physical chemistry, New York McGraw Hill, New York.

23. A.Findlay and J.A. Kitchner, Practical physical Chemistry, Longman, Green and Co.

24. D.P. Shoemaker and C. Garland, Experiments in physical chemistry, McGraw Hill, New York.

25. G. M. Barrow, Physical chemistry, McGraw Hill, Singapore.

26. Basic chemical kinetics by G. L. Agrawal, India.
27. Essentials of Physical chemistry by B.S. ball, Arum Gold G.D. Tuli.
28. Physical chemistry by R.L. Madon and G.D. Tuli.
29. Fundamental concepts in Physical chemistry by devenchra Nath Thahur.
30. Essentials of Physical chemistry by B.S. Gohl, A.Bohl and G.D. Tuli.

Thesis CHEM-4899 (Cr.3)/a Course from any other discipline (Cr.3)

INORGANIC CHEMISTRY
BS 3rd Year
Semester V

CHEM-3521 INORGANIC CHEMISTRY-1 (Cr.3+1)

Course Objectives:

Students will acquire knowledge about the physical and chemical properties of d- & f- block elements on the basis of their electronic configurations and will be able to work out structures of coordination compounds through development of understanding of VBT, CFT and MOT.

Course Contents:

Chemistry of d-block elements and coordination complexes:
Back ground of coordination chemistry, nomenclature and structure of coordination complexes with coordination number 2-6, chelates and chelate effect, theories of coordination complexes, Werner's theory, valence bond. theory (VBT), crystal field theory (CFT) and molecular orbital theory (MOT), Jahn-Teller theorem, magnetic properties, spectral properties, isomerism, stereochemistry, and stability constants of coordination complexes.

Chemistry of f-block elements:

i. Lanthanides: General characteristics, occurrence, extraction and general principles of separation, electronic structure and position in the periodic table, lanthanides contraction, oxidation states, spectral and magnetic properties and uses.

ii. Actinides: General characteristics, electronic structure, oxidation state and position in the periodic table, half-life and decay law.

Lab

Course Objectives:
The students will be able to learn:

i) Separation of metal ions by paper chromatography
ii) Estimation of pair of metal ions
iii) Acid-Base Titration

Course Contents:

Preparations of following Inorganic Complexes;
(I) Tetraamminecopper
(II) sulphate. Potassiumtrioxalatochromate
(III). Potassiumtrioxalatoaluminate
(IV). cis-Potassium dioxalatodiaquachromate

Determination of zinc and cadmium by complexometric titration
Chromatographic separations of transition metals;

Separation of Ni^{2+} & Co^{2+} ions in a mixture by paper chromatography.
Separation of Ni^{2+} & Cu^{2+} ions in a mixture by paper chromatography.
Separation of Cu^{2+} & Fe^{2+} ions in a mixture by paper chromatography.
Spectrophotometric determination of iron, manganese and nickel.

Recommended Books:

1. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, (1999).
2. Housecraft, C. and Sharpe, A. G., *Inorganic Chemistry*, 4th ed., Prentice Hall, (2012).
3. Miessler, G. L. and Tarr, D.A., *Inorganic Chemistry*, 4th ed., Pearson-Prentice Hall International, (2010).
4. Douglas, B., McDanial, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, New York, (1994).
5. Shriver, D. and Atkins, P., *Inorganic Chemistry*, 5th ed., W. H. Freeman & Company, (2010).
6. Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Blackwell Science Ltd., (1996).
7. Atkins, P. and Jones, L., *Chemicals Principles,* 5th ed., W. H. Freeman & Company, (2010).
8. Svehla, G., *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, 5th ed., Longman Group Limited, (1979).
9. Huheey, J. E., Kieter, E. A. and Kieter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity,* 4th ed., Prentice Hall, (1997).
10. Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods,* 2nd ed., Chapman and Hall (1974).
11. Müller, U., *Inorganic Structural Chemistry,* 2nd ed., John-Wiley & Sons, Ltd., (2006).
12. Marusak R. A., Doan K., Cummings S. D., *Integrated Approach to Coordination Chemistry,* 1st ed., John-Wiley & Sons, (2007).
13. Chaudhary, S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2013).

BS 3rd Year
Semester-VI

CHEM-3621 INORGANIC CHEMISTRY-II (Cr.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

Course Objectives:
The students will be able to learn:

i) Complexometric Titrations of EDTA
ii) Redox Titrations

Course Contents:

1. Estimation of anions in mixtures:
   Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphate-phosphate, bromide-nitrate, borate-acetate, iodide-nitrate.
2. Iodometric titration with potassium iodate.
3. Gravimetric estimation of oxalate.
4. Precipitation Titrations.
   a) Determination of strength of NaCl given solution by AgNO3 using Fluorescein as indicator.
   b) Determination of % age purity of KBr using Fluoresceine as indicator.
   c) Determination of % composition of mixture of KI & KNO3 using Eoscein as indicator.
5. Spectrophotometric determination of cerium.
6. Separation of heavy metals using solvent extraction technique.

Recommended Books:

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

BS 4th Year
Semester VII

CHEM-4721 Coordination Chemistry (Cr.3)

Course Objectives:
The students will be able to learn:

I. Stability, kinetics and mechanisms of reactions of complexes

II. Theories of coordinate bond. Preparation, absorption spectra and magnetic properties of complexes.

III. Introductory ligand field theory. John Teller distortion, preparation methods.

IV. Octahedral VS tetrahedral co-ordination, Tetragonal distortion for octahedral symmetry, square planner coordination.

V. Russell-Sanders coupling scheme, derivation of term symbols of for p^1 - p^6 and d^1 - d^{10} systems

Course Contents:

Coordination Chemistry

Introduction, theories of coordinate bond. Preparation, absorption spectra and magnetic properties of complexes. Stereochemistry, stability, kinetics and mechanisms of reactions of complexes. Crystal field effects in various environments, pairing energies, factors effecting the magnitude of 10 Dq. Evidence for crystal field stabilization. Octahedral VS tetrahedral co-ordination, Tetragonal distortion for octahedral symmetry, squre planner coordination, Introductory ligand field theory. John Teller distortion, preparation methods, Role of stability constants in coordination compounds. Applications of coordination compounds in various fields such as agriculture, medicine and industry.

Magnetochemistry

Theory of magnetism, diamagnetism, paramagnetism, ferro-, ferri- and antiferromagnetism, magnetic susceptibility, magnetic moments, Faraday's & Gouy's methods, orgital contribution to magnetic moment, Russell-Sanders coupling scheme, derivation of term symbols of for p^1 - p^6 and d^1 - d^{10} systems, pigeon holes diagram, effect of temperature on magnetic properties of complexes. Magnetic moment of lanthanides.

Recommended Books

1. F. Basolo and R.C. Johnson, Coordination Chemistry, NBF Pakistan (1988).
2. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, 4th ed., Addison-Wesley, Reading/Singapore (1993).
3. F.A. Cotton, et al., Advanced Inorganic Chemistry, 6th ed., John Wiley, New York (1999).
4. Douglas, B., McDaniel, D. and Alexander, J., "Concepts of Models of Inorganic Chemistry", John Wiley & Sons Inc., 3rd Edition, 1994
5. Mackay, K. M., Mackay, R. A. and Henderson, W., "Introduction to Modern Inorganic Chemistry", 5th Edition, Stanley Thomas Publisher Ltd. 1996
6. Miessler, G. L. and Tarr Donald, A., "Inorganic Chemistry", Prentice Hall International, 1991.
7. Purcell, K.F. and Kotz, J.C., "An Introduction to Inorganic Chemistry" W.B. Saunders Company Holt-Saunders Internal editions, 1980.

CHEM-4722 Group Theory and Spectroscopy (Cr.3)

Course Objectives:
The students will be able to learn:

I. Symmetry, symmetry elements and operations

II. Point groups, group representations

III. Reducible and irreducible representations

IV. Application of group theory to VB, MOT and CFT

Course Contents:
Symmetry, symmetry elements and operations, point groups, group representations and character table, reducible and irreducible representations. Application of group theory to valence bond, molecular orbital, crystal field theories and IR spectra.

Recommended Books:

1. K.C. Molloy, Group Theory for Chemists, Harward Publishing Ltd. (2007)
2. F.A. Cotton, Chemical Applications of Group Theory, 3rd ed., John Wiley, New York (1990).
3. A.B.P. Lever, Introduction to Electronic Spectroscopy, Elsevier, Amsterdam (1968).
4. J.P. Facer, Symmetry in Coordination Chemistry, Academic Press, New York (1971).

Supplementary Books:

1. Alan and Vincent, Molecular Symmetry and Group Theory, John Wiley, London (1977).
2. J. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Addison-Wesley, Reading/Singapore (1993).

CHEM-4723 Inorganic Polymers (Cr.3)

Course Objectives:
The students will be able to learn:

I. Introduction of polymers

II. Preparation of polyorganosiloxanes and systems containing P-N; S-N and transition-metal polymers.

III. Characterization of polymeric materials

IV. Thermo-gravimetry, scanning electron microscopy and applications.

Course Contents:
Introduction of polymers materials. Preparation of polyorganosiloxanes and various systems containing P-N; S-N and transition-metal polymers. Characterization of polymeric materials by using IR, NMR, molecular weight determination, thermo-gravimetry, scanning electron microscopy and applications.

Recommended Books

1. F.G.A. Stone and W.A.G. Graham, Inorganic Polymers, Academic Press, Inc., London (1962).
2. F.G.R. Gimblett, Inorganic Polymer Chemistry, Butterworths, London (1963).
3. C.E. Carraher, Jr., J.E. Sheads amd C.U. Pittman, Jr., Advances in Organometallic and Inorganic Polymer Science, Marcel Dekker, Inc., New York (1982).

Supplementary Book

1. C.E. Carraher, Jr., Polymer Chemistry, 5th ed., Marcel Dekker, Inc., New York (2000).

CHEM-4724 Inorganic Chemistry-III (Cr. 3)

Course Objectives:
The students will be able to learn:

I. Introduction; Classification of solvents
II. Study of reactions in non-aqueous solvent
III. Study of reactions in
IV. Organic reagent used in inorganic analysis
V. Chelates and chelate-effect.

Course Contents:
Non-Aqueous Solvents:
Introduction; Classification of solvents; Types of reactions in solvents; Effect of Physical and Chemical properties of solvents, Study of reactions in liquid NH_3, liquid SO_2 liquid HF, liquid H_2SO_4 and liquid BF_3. Reactions in molten salt system.
Organic Reagents Used In Inorganic Analysis:
Types of reagent, specificity and sensitivity of the reagents, methods of application with specific examples, complexometric and gravimetric methods involving various reagents, chelates and chelate-effect.

Recommended Books

1. A.K. Holliday and A.G. Massey, Inorganic Chemistry in non-aqueous solvents, Pergamon Press Ltd. (1965).
2. H.H. Sisler, Chemistry in Non-aqueous solvents, Chapman & Hall Ltd. (1965).
3. J.E. Huheey, Inorganic Chemistry, Principles of Structures and Reactivity, 4th ed., Addison Wesley, Reading (1993).

CHEM-4725 Industrial Chemistry (Cr. 3)

Course Objectives:
The students will be able to learn:

I. Basic development of the industrial unit

II. Chemical processes

III. Chemistry and technology of industries

Course Contents:
Basic data for the development of the industrial unit e.g. basic chemical data, chemical control, raw materials etc. Chemical processes i.e. unit operations, unit process. Chemistry and technology of industries like water conditioning, cement, glass, ceramic, chloralkali, leather, fertilizers, sugar and starch, steel , petroleum, oil, fats and waxes, soap and detergent , pulp and paper etc.

Recommended Books

1. Riegel, E. R., Industrial Chemistry, 5th Ed., Reinhold Publishing Corporation NewYork, (1997).
2. James, Handbook of Industrial Chemistry, (1974).
3. J. C Kuriacase & J Rajaran., Chemistry in Engineering and Technology, 2nd Ed., (1984).
4. Chuis A. Clauses III Guy Matison., Principles of Industrial Chemistry, (1978).
5. P. C. Jain., A Textbook of Applied Chemistry, (1993).
6. Shukla., A Textbook of Chemical Technology, (1977).
7. B. N. Chakrabarty, Industrial Chemistry, (1991).
8. George T. Auston., Shreve's Chemical Process Industries, 5th Edition., McGraw Hill Book Company Inc. New York, (1984)

CHEM-4740 Inorganic Chemistry Lab-III (Cr. 0+3)

Course Objectives:
The students will be able to learn:

I. Use of organic reagents for the estimation of various elements.
II. Conductivity meter and potentiometer
III. Synthesis of at least six coordination compounds

Course Contents:
1.Use of some organic reagents for the estimation of various elements.
2. Preparation of at least six coordination compounds in a pure state and determination of their state of purity.
3. The experiments may be set making use of conductivity meter and potentiometer .

Recommended Books

1. Bassette, J., Denney, G. H. and Mendham, J., “Vogel’s Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis” English Language Book Society, 4th Edition, 1981.
2. Fritz, J. S. and Schenk, G. H., “Quantitative Analytical Chemistry”, Allyn and Bacon Inc., 4th Edition, 1979

3 Pass, G and Sutcliffe, H., “Practical Inorganic Chemistry”, Van Nostrand Reinhold Company, 1972

BS 4th Year
Semester VIII

CHEM-4821 Inorganic Reaction Mechanism (Cr. 3)

Course Objectives:
The students will be able to learn:

I. Classification of reaction mechanisms
II. Substitution reactions
III. Electron Transfer Reactions
IV. Periodic Anomalies and Bonding in Electron deficient Compounds
V. Three center two electron bond (3c-2e) and three-center, four-electron (3c-4e) bond model

Course Contents:
Kinetics and Reaction Mechanism of Inorganic Reactions
Classification of reaction mechanisms; rate laws; steady state approximation; inert and labile complexes; substitution reactions; octahedral complexes: acid hydrolysis, acid catalyzed aquation, anation reactions, base hydrolysis, attack on ligands, steric effects of inert ligands; square planar complexes: nucleophilic reactivity, trans-effect, cis-effect, effect of leaving group, mechanism of substitution, racemization reactions.

Electron Transfer Reactions
Electron transfer reactions in co-ordination compounds, mechanism of electron transfer reactions, outer sphere or tunneling mechanism, inner sphere or ligand bridge mechanism, factors effecting the rate of electron transfer reactions, two electrons transfer reactions, complementary or non complementary electron transfer reactions, oxidation reduction reactions of metal ions.

Periodic Anomalies and Bonding in Electron deficient Compounds
First- and second- row anomalies; the use of d- orbitals by non-metals; reactivity and d-orbital participation; pπ-dπ bonds; the use of p- orbitals in π- bonding; periodic anomalies of non-metals and post-transition metals. Multicenter bonding in electron deficient molecules, three centre two electron bond (3c-2e) and three-center, four-electron (3c-4e) bond model

Recommended Books:

1. Basolo, F., and Pearson, R. G., “Mechanism of Inorganic Reactions”, Wiley, New York, 1982.
2. Huheey, J. E, Keiter, E. A. and Keiter, R. L., “Inorganic Chemistry: Principles of Structure and Reactivity”, 4th Ed., Harper & Row, New York, 2001.
3. Benson, D., Mechanisms of Inorganic Reactions in solution: McGraw Hill. 1968.

4. Purcell, K.F. and Kotz, J.C., “Inorganic Chemistry” W.B. Saunders Company Holt-Saunders Internal editions 1977.
5. Shirve D.F. Atkins P.W. and Langford C.H. “Inorganic Chemistry”, Oxford University Press 1990.
6. Wilkins R.G. “Kinetics and Mechanism of Reactions of Transition Metal Complex” VCH Publishers, Inc., 1991.
7. William. J., Modern inorganic chemistry second edition McGraw Hill Company 1991.
8. Porter Field. W.W., Inorganic Chemistry a Unified Approach 2nd ed. Elsevier Publishers, 2005 Douglas, McDaniel & John Alexander. “Concepts and Models of Inorganic Chemistry” by John Willey and Sons, 1994.
9. R.B. Jordan, Reaction Mechanisms of Inorganic and Organomettalics Systems. Oxford University Press, New York, 1991. An excellent introduction.
10. R.G. Wilkins, The study of kinetics and Mechanisms of Reactions of transition metal complexes 2nd ed., VCH Publishers, New York, 1991. Excellent discussions of rate laws, their interpretation and experimental establishment.

CHEM-4822 Organometallic Chemistry (Cr. 3)

Course Objectives:
The students will be able to learn

I. Organometallic compounds
II. Oxidative Addition & Reductive Elimination
III. Homogenous catalytic hydrogenation
IV. Catalytic polymerization
V. Uses of organometallic compounds in organic synthesis.

Course Contents:
History and introduction to organometallic compounds, types of bonding. Transition metals; single, double and triple bonds to carbon (compound types, acyls, alkylidene complexes and alkylidyne complexes), delocalized hydrocarbon systems (alkenes, olefins, allyl and butadienes), alkyne complexes, cyclic π-complexes (five- and six-member rings). Oxidative Addition: one electron oxidative addition, addition of oxygen, addition of bimetallic species, hydrogen addition, HX addition, organic halides, Reductive Elimination Reactions. Homogenous catalytic hydrogenation, dimerization, oligomerization, polymerization, oxidation, hydrosilation, hydroformylation of olefins. Catalytic polymerization of acetylenes, insertion reactions, use of organometallic compounds in organic synthesis.

Recommended Books

1. Powell, P., “Principles of Organometalics Chemistry”, 2nd edition London, 1995.
2. Akio Yamamoto “Organotransition Metal Chemistry”, Printice Hall, 1992.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, “Advanced Inorganic Chemistry”, 6th Ed., Wiley-Intersceince, New York, 1999.

4. Miessler G.L. and Tar Donald, A. “Inorganic Chemistry” Prentice Hall Int. edition, 1991.
5. Douglas, McDaniel & John Alexander. “Concepts and Models of Inorganic Chemistry” by John Willey and Sons, 1994.
6. Zuckerman, H., “Basic Organometallic Chemistry”, 2nd Ed, 1985.
7. William. J., Modern inorganic chemistry second edition McGraw Hill Company, 1991.
8. Porter Field. W.W., Inorganic Chemistry a Unified Approach 2nd ed. Elsevier Publishers, 2005.

CHEM-4823 Bioinorganic Chemistry (Cr. 3)

Course Objectives:
The students will be able to learn

I. Essential and trace elements in biological systems.
II. Metallobiomolecules
III. Electron careers and metallo-enzymes
IV. Metal based drugs

Course Contents:

Essential and trace elements in biological systems. Metallobiomolecules. The classification of biomolecules containing metal ions. Biochemistry of iron. Electron careers and metallo-enzymes. The distribution of dioxygen carriers. Structures of oxygen binding site at Fe II. Models of dioxygen binding. Photosynthesis and respiration. Metal based drugs.

Recommended Books

1. R.W. Hay, Bioinorganic Chemistry, Ellis, Harwood, London (1991).
2. D.F. Fenton, Bio-coordination Chemistry, Oxford Primer Series (No.25), Oxford University Press (1995).
3. P.C. Wilkins and R.G. Wilkins, Inorganic Chemistry in Biology, Oxford Primer Series (No.46), Oxford University Press (1997).
4. J. McMaster, Annu. Rep. Prog. Chem., Sect. A, 101, 607-630 (2005); 102, 564-583 (2006); 103, 492-517 (2007) (Reviews).

CHEM-4824 Chemical Crystallography (Cr. 3)

Course Objectives
The students will be able to learn

I. Structures and energetic of metallic and ionic solids
II. Born-Haber cycle
III. Symmetry & crystal systems
IV. Diffraction data collection

Course Contents:

Structures and energetic of metallic and ionic solids. Packing of solid, polymorphism, alloys and inter-metallic compounds, lattice energy. Born-Haber cycle, application of lattice energy, defect in solid state. Symmetry, unit cells, crystal systems, lattice lattice point and space group X-rays, production and diffraction; Bragg's equation; diffractional data collection, date reduction. Application of XRD and method towards structure elucidation (including geometry and other parameters) of crystalline solids.

Recommended Books

1. B.D. Culity and S.R. Stock, Elements of X-ray Diffraction, 3rd ed., Prentice Hall (2003).
2. L. Smart and M. Gagan, The Molecular World: The Third Dimensions, RSC, UK (2002).
3. M.M. Woolfon, An Introduction to X-ray Crystallography, Cambridge University Press (1970).

CHEM-4825 Nuclear Chemistry (Cr. 3)

Course Objectives:

The students will be able to learn

I. Fundamental particles and nuclear structure
II. Radioactivity, types of radioactive decay
III. Nuclear Reactions
IV. Applications of Nuclear Isotopes.

Course Contents:

The development of Nuclear Chemistry. Fundamental particles and nuclear structure. Radioactivity, types of radioactive decay, half life nuclear fusion, nuclear fission, nuclear forces, the atomic nucleus, production of isotopes and radio-nuclides, the binding energy, exchange forces, nuclear quantum numbers, the shell model, pairing energy, properties of nuclear radiations, Nuclear Reactions, measurement of radioactivity, types of GM counters, Nuclear Reactors, Applications of Nuclear Isotopes.

Recommended Books

1. Fried Landler, Kennedy and Miller, "Nuclear and Radiochemistry", John Willey and Sons, Inc. 2nd edition, 1964.
2. Choppin, G. R. and Rydber, J., "Theory and Applications", Pergamon 1980.
3. Arnikan, H. J., "Essentials of Nuclear Chemistry", 4th edition, 1990.
4. Harvey, B.G. "Nuclear Physics and Chemistry", Prentice-Hall Inc., 1990.
5. Naqvi, I. I., "Radiochemistry", University Grants Commission,1990

CHEM-4826 Material Chemistry (Cr.3)

Course Objectives

The students will be able to learn

I. Reinforcements-matrix interface properties

II. Mechanical, dynamic mechanical and thermal properties of composite materials

III. Composite materials and their classification

IV. Their Spectroscopic and microscopic analyses.

Course Contents:

Materials, composite materials and their classification, matrices and reinforcements for composites. Reinforcements-matrix interface properties and processing of composites with metallic, ceramic and polymeric matrices. Mechanical, dynamic mechanical and thermal properties of composite materials. Toughening mechanisms and mechanical failure in polymeric composites. Spectroscopic and microscopic analyses.

Recommended Books:

1. D.D.L. Chung, Composite Materials: Functional Material of Modern Technologies, Springer-Verlag, London (2003).
2. F.L. Mathews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman and Hall, London (1994).
3. T.L. Vigo and B.J. Kinzig, Composite Applications: The role of Matrix, Fiber and Interface, VCH, New York (1992).

Supplementary Books:

1. B.C. Hoskin and A.A. Baker, Composite Materials for Aircraft Structures, American Institute of Aeronautics and Astronautics, Inc. New York (1986).
2. M.M. Schwartz, Composite Materials: Processing, Fabrication and Applications, Prentice Hall, PTR, New Jersey (1997).
3. L. Nicolais and G. Carotenuto, Metal-Polymer, Nanocomposites, Wiley Interscience (2005).
4. T.S. Pinnavaia and G.W. Beall, Polymer-Clay Nanocomposites, John Wiley & Sons (2000).

CHEM-4840 Inorganic Chemistry Lab-IV (Cr.0+3)

Course Contents:

1. Spectroscopic determination of some metal ions.
2. Recording and characterization of at least five coordination compounds by IR and UV spectrophotometer ..
3. Estimation of different metals in food, tap water and brass etc. by Atomic Absorption Spectrometer/ flame photometer / UV / Visible spectrophotometer.

Recommended Books:

1. Advanced Inorganic Chemistry, 5th Ed, Cotton, F.A. and Wilkinson, G.New York, John Wiley & Sons.
2. Inorganic Chemistry, Principles of Structure and Reactivity by James Huheey, E, 3rd. Ed, Cambridge, Harper International London, 1983.
3. Coordination Chemistry by Basolo, F. and Johnson, R, New York, W.A. Benjamin.
4. Pi-Acceptor Ligands by M. Zafar Iqbal 1982 UGC Islamabad.
5. Hand Book of organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Harwood Limited, London.
6. Structural Inorganic Chemistry by Wells, A.F. 1975, Charenden Press, London.
7. Stereochemistry and bonding in Inorganic Chemistry by J.E. Ferguson 1974, Prentice-Hall, New Jersy.
8. Molecular Symmetry and Group Theory: A Programmed Introduction to Chemical Applications by Vincent, A London, John Wiley and Sons,1977.
9. Chemistry in Non-Aqueous Solvents/ Sisler, H. H. London, Chapman and Hall, 1961.
10. Organotransition metal chemistry by Akio Yamamoto, 1986 A. Wiley Intersience Publication London.
11. Mechanisms of Inorganic Reactions in Solution by Benson, 1969, McGraw Hill, London.
12. Quantitative Chemical Analysis, 5th Edition, Daniel C. Harris, Freeman and Company, N.Y, 1999.
13. Quantitative Analysis, 6th Edition, R.A. Day and A.L. Underwood, Prentice hall, new Delhi, 1999.
14. Analytical Chemistry, 7th Edition, Douglas A Skoog & Donated M. West, Saunders Publishers, London, 2000.
15. Fundamentals of Analytical Chemistry, Skoog, West and Holler, Saunders Publishers, UK, 1996,
16. Environment Chemistry, R. Bockris, MeMillan, USA, 1995.
17. International Analysis by Gary D. Christian by James E. O. Reiliy, 1986, Allyn and Bacon Inc, London.
18. Braun R.D., “Introduction to Chemical Analysis” McGraw Hill Publisher (1982).
19. Harris D.C., “Quantitative Chemical Analysis” 4th Ed., Freeman (1995).
20. Ewing G.W., “Instrumental Methods of Chemical Analysis” 5th Ed., McGraw Hill Publisher (1985).
21. Skoog D.A. & J.J. Leary, “Principles of Instrumental Analysis” 4th Ed., Saunders College Publishing (1992).
22. Willard H.H., L. L. Merritt (Jr), J.A. Dean, & F.A. Settle, “Instrumental methods of Analysis” 7th Ed., Wadsworth Publishing Co., (1988).
23. Christian, G.D., “Analytical Chemistry” John Wiley & Sons.

Thesis CHEM-4899 (Cr.3)/a Course from any other discipline (Cr.3)

ORGANIC CHEMISTRY

BS 3rd Year
Semester-V

CHEM-3541 Organic Chemistry-I (Cr. 3+1)

Course Objectives:

The program is aimed that students should be able to learn

I. The Systematic study of nomenclature of organic compound.

II. Basic concepts of organic chemistry.

III. Chemistry of organic acids and bases.

IV. Mechanistic study of organic reactions.

V. Simple stereo configuration.

Course Contents:

1) IUPAC Nomenclature of basic classes of organic compounds and mono heterocyclic compounds upto five membered ring.
2) Basic concepts of organic chemistry: Atomic orbitals; hybrid orbitals and bonds; organic structures; inductive effect; resonance; mesomerism; hyperconjugation; hydrogen bonding; aromaticity.
3) Acids and Bases: concept of weak acids and bases; organic acids and bases; scale of acidity and basicity; pKa values; effect of resonance, induction, electrostatic, steric and hydrogen bonding on strength of acids and bases.
4) Organic chemical reactions and their mechanistic classification.
   Brief and Introductory description of:
   - Substitution Reaction: Free radical, Electrophilic, and Nucleophilic substitution reactions.
   - Addition Reactions: Addition to C-C multiple bonds, C-O double bonds.
   - Elimination Reaction: E1and E2 reactions
5) Basics of stereochemistry: structure; chirality; enantiomers, optical activity; RS-convention of configuration; racemic mixture and their resolution.

Recommended Books:

1. J. McMurry, Organic Chemistry, 5th ed., Brooks/Cole, Boston (2007).
2. J.G. Smith, Organic Chemistry, McGraw-Hill, New York/Boston (2006).
3. L.G. Wade, Organic Chemistry, 5th ed., Pearson Education, Delhi (2003).

Supplementary Books:

1. M.B. Smith and J. March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, John Wiley & Sons (2007).
2. F.A. Carey, Organic Chemistry, McGraw-Hill, Higher Education, New York (2006).

Lab

Course Objectives:

The program is aimed that the students should be able to learn

I. Organic functional groups in a compound.

II. Compound in a mixture.

III. To learn techniques of organic chemistry lab.

Course Contents:

a) Functional Group Analysis of organic compounds.
b) Analysis of three component mixtures by solubility methods. (5 mixtures at least)
c) Introduction to basic lab techniques: distillations; recrystallization; solvent extraction; chromatography (PC, TLC).

Recommended Books:

1. B.S. Furniss, Vogel's Textbook of Practical Organic Chemistry Including Qualitative Organic, Longman Group, London (1978)

2. R. Adams, J.R. Johnson and Wilcox Jr., Laboratory Experiments in Organic Chemistry, 6 Ed., Collier-M London (1970).

Supplementary Books:

1. A.M. Schoffstall, and B.A. Gaddis, Microscale and Miniscale Organic Chemistry Laboratory Experiments, (Druelinger, Melvin L.), McGraw-Hill, Boston (2004).
H. Becker and I. Hazzard, Organicum: Practical Handbook of Organic Chemistry, Reading, Masachuse Addison-Wesley Publishing Co.

BS 3rd Year
Semester-VI

CHEM-3641 Organic Chemistry-II (Cr. 3+1)

Course Objectives:

The program is aimed that the students should be able to learn

I. Chemistry of carbonyl compound.

II. Organic name reactions.

III. Introductory spectroscopy.

Course Contents:

1) Chemistry of carbonyl compounds with special reference to condensation reactions;
2) Active methylene compounds

Alkylation, Arylation of active methylene compounds. Acid and base catalysed aldol condensation.

Conditions, mechanism and synthetic applications of the following reactions:

Claisen- Schmidt reaction, Claisen reaction, knoevenagel reaction, Perkin reaction, Reformatsky reaction, Mannich reaction, Stobbe's condensation, and Wittig reaction.

3) Basic spectroscopy: introduction; detailed account of ultraviolet and infrared spectroscopy.

Recommended Books

1. F.A. Carey, Organic Chemistry, 6th ed., McGraw-Hill, Higher Education, Boston (2006).
2. J.G. Smith, Organic Chemistry, McGraw-Hill, Boston (2006).

Supplementary Books

1. T.W.G. Solomon and C.B. Fryhle, Organic Chemistry, 8th ed., John-Wiley, New York (2004).
2. L.G. Wade, Organic Chemistry, 5th ed., Pearson Education, New Delhi (2003).
3. M.A. Fox and J.K. Whitesell, Organic Chemistry, 3rd ed., Jones and Bartlett, Boston (2003).

Lab

Course Objectives:

The program is aimed that the students should be able to learn

I. Organic functional groups in a compound.

II. Compound in a mixture.

III. To learn techniques of organic chemistry lab.

Course Contents:

i) Separation of three component mixtures by chromatographic (CC, TLC) methods.
(10 mixtures)
ii) Simple preparations: at least four by the choice of teacher concerned.

Recommended Books

1. A.M. Schoffstall and B.A. Gaddis, Microscale and Miniscale Organic Chemistry Laboratory Experiments, (Druelinger, Melvin L.), McGraw-Hill, Boston (2004).
2. R. Adams, JR. Johnson and Wilcox Jr., Laboratory Experiments in Organic Chemistry, 6th ed., Collier-M, London (1970).

Supplementary Books

1. B.S. Furniss, Vogel's Textbook of Practical Organic Chemistry Including Qualitative Organic, Longman Group, London (1978).
2. H. Becker and I. Hazzard, Organicum: Practical Handbook of Organic Chemistry, Reading, Masachuse Addison-Wesley Publishing Co. (1973).
J.C. Gilbert, and S.F. Martin, Experimental Organic Chemistry: A Miniscale and Microscale Approach, Saunders College Publishing, Fort Worth (1998).

BS 4TH Year
Semester-VII

CHEM-4741 Reaction Mechanism-I (Cr. 3)

Course Objectives:

The program is aimed that the students should be able to learn

I. Kinectics of organic reactions.

II. Determination of organic reaction mechanism.

III. Advance chemistry of aliphatic Nucleophilic Substitution Reaction.

IV. Advance chemistry of elimination reaction of organic molecules.

Course Contents:

Determination of Organic Reaction Mechanism by Kinetic and Non-kinetic Methods
Concept of mechanism; requirement of a reaction; Kinetic approach---- measurement of rates, order and molecularity of reactions, use of steady state approximation, kinetic isotope effects; Non-kinetic approach---- identification of product, testing, trapping and physical detection of intermediates evidences for reaction catalysis; crossover experiments, isotopic labelling; stereochemical studies.

Aliphatic Nucleophillic Substitution Reactions
Study of S_N1, S_N2, S_Ni, S_N1', S_N2', Ionpair mechanism; study of effects of substrate, leaving group, attacking nucleophile, solvent system on mechanism and rates of reaction.

Elimination Reactions
Study of E_1, E_2 and $E1_{CB}$; study of effects of substrate, leaving group, attacking nucleophile, solvent system on mechanism and rates of reaction; orientation of double bond and competition between substitution and elimination reactions.

Recommended Books

1. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th ed., Longman Scientific & Technical, London (1986).
2. M.B. Smith and J. March, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, John Wiley & Sons, New York (2007).
3. B.K. Carpenter, Determination of Organic Reaction Mechanisms, John Wiley & Sons, New York (1984).

Supplementary Books

1. T.H. Lowry and K.W. Richardson, Mechanism and Theory in Organic Chemistry, Harper & Row Publishers, New York (1987).
2. Jacobs, Understanding Organic Reaction Mechanisms, The University Press, Cambridge (1997).
3. M.G. Moloney, Reaction Mechanisms at a Glance: a Stepwise Approach to Problem-Solving in Organic Chemistry, Blackwell Science, Oxford (2000).
4. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, Harcourt Science, San Diego (2002).

CHEM-4742 Spectroscopy-I (Cr. 3)

Course Objectives:

The program is aimed that the students should be able to learn

i) To make students understand basics of NMR spectroscopy
ii) Basics of mass spectrometry
iii) To apply the basic knowledge for the structure determination of organic compounds
iv) To determine the molecular formulae form, the molecular weight of the compounds.

Course Contents:

Introduction: Fundamentals of spectroscopy. **UV-Visible spectroscopy:** Introduction, theory instrumentation and sample handling. **Infra Red spectroscopy:** Introduction, theory, instrumentation and sample handling. **Mass spectrometry:** Introduction, theory, instrumentation and sample handling. Applications: Structure elucidation of simple organic molecules by UV, IR and MS.

Recommended Books:

1. R.M. Silverstein, F.X. Webster and D.J. Keimle, Spectrometric Identification of Organic Compounds, John Wiley & Sons Inc., USA (2005).
2. D.L. Pavia, G.M. Lampan, and G.S. Kriz, Introduction to Spectroscopy: a Guide for Students of Organic Chemistry, Thomson Learning, Australia (2001).

Supplementary Books:

1. D.W. Brown, A.J. Floyed and M. Sainsbury, Organic Spectroscopy, I. Wiley and Sons, Chichester (1998).
2. D.H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4th ed., McGraw-Hill Book Co., London (1987).
3. M. Hesse, H. Nleir and U. Zech, Spectroscopic Methods in Organic Chemistry, George Thiemc, Stuttgart, New York (1997).
4. Y.C. Ning, Spectral Identification of Organic Compounds with Spectroscopic Techniques, Wiley-VCH, Weinheim (2005).
5. M. Younas, Organic Spectroscopy, Ilmi Kitam Khana, Lahore (2004).

CHEM-4743 Stereochemistry (Cr. 3)

Course Objectives:

The program is aimed that the students should be able to learn

i) The basic principles of stereochemistry
ii) To understand the sterioiosmers
iii) To differentiate between the stereoiosmers
iv) Know the stereochemical nomenclature

Course Contents:

Structure and symmetry; Symmetry elements and point groups; Relative and absolute configurations; Conformation and conformational analysis of ethane, propane and butane. Cyclohexane and derivatives; Geometric Isomerism Stereochemical nomenclature, Stereochemical reactions; Asymmetric synthesis; Reactions and resolution of enantiomers.

Recommended Books

1. E.L. Eliel, S.H. Wilen, M.P. Doyle, and P. Michael, Basic Organic Stereochemistry, Wiley Interscience, New York (2003).
2. P.S. Kalsi, Stereochemistry and Mechanism through Solved Problems, New Age International Publishers, New Delhi, India (2001).
3. K. Mislow, Introduction to Stereochemistry, W.A. Benjamin, New York (1966).

Supplementary Books

1. J. Eames (Queen Mary and Westfield College, University of London) and J.M. Peach, Stereochemistry at a Glance, Blackwell Publishing (2003).
2. D.G. Morris, Stereochemistry, Royal Society of Chemistry, U.K (2001).
3. M. North, Principles and Applications of Stereochemistry, Stanley Thornes: Cheltenham, UK (1998).

CHEM-4744 Name Reactions in Organic Chemistry (Cr.3)

Course Objectives:

The program is aimed that the students should be able to learn

i) Advance study of organic name reactions.

ii) Application of important organic reactions.

iii) Contribution of famous organic chemists in organic reactions.

Course Contents:

Detailed study of at least twenty name reactions including Arndt-Eitr Synthesis; Blaise Reaction; Bouvealt-Blanc Reaction; Hel-Volhard-Zelinsky reaction; Meerwein-Pondhof-Verley Oxidation; Mannich Reaction; Schotten-Baumen Reaction; Mitsonubo Coupling; Suzuki Coupling; Wittig reaction. Heck reaction, Pollazari reaction, Corey-House synthesis, Simmon-Smith reaction, Streacker synthesis, Micheal reaction, Williamson ether synthesis, Prins reaction, Wurts reaction, Robinson annelation reaction, Hinsberg reaction.

Recommended Book

1. B.P. Mundy, M.G. Ellerd, F.G. Favalozo and F.G Favalozo, jr., Name Reactions and Reagents in Organic Synthesis, John Wiley, New York (2005).

Supplementary Books

1. M.B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanism and Structure, 5th ed., John Wiley, New York (2001).
2. R.O.C. Norman, Principles of Organic Synthesis, 3rd ed., Chapman-Hall, London (1993).

CHEM-4745 Chemistry of Heterocyclic Compounds (Cr. 3)

Course Objectives:

The program is aimed that the students should be able to learn

i) To learn the basics of heterocyclic compounds

ii) Learn the nomenclature of the heterocyclic compounds

iii) To design the synthesis of the simple heterocyles.

iv) The applications of heterocycles in vaious fields of life

Course Contents:
Introduction; Nomenclature; Synthesis and chemistry of upto six membered heterocycles, containing one heteroatom like nitrogen, oxygen and sulphur.

Recommended Book:

1 Bansal, R. K., "Heterocyclic Chemistry", Wiley Eastern Ltd., New Delhi.

2. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.

Supplementary Books:

1. Lambert, J. B, Shurvell, H. F., Lightner, D. A. and Cooks, R. G., "Introduction to Organic Spectroscopy", Macmillan Publishing Company, New York.
2. Anderson, R. J., Bendell, D. and Groundwater, P., "Organic Spectroscopic Analysis", The Royal Society of Chemistry, Cambridge.
3. Gilchrist, T. L., "Heterocyclic Chemistry", Longman, Singapore.
4. Joule, J. A. and Mills, K., "Heterocyclic Chemistry", Blackwell Science, Tokyo.

CHEM-4746 Organic synthesis-I (Cr. 3)

Course Objectives:

The program is aimed that the students should be able to learn

i) To introduce the students to some intermediates in various chemical reactions

ii) To develop the skill of designing synthesis

iii) To enable the learner about the role and importance of protecting groups

iv) To enable the learner to predict molecular rearrangements in different bond formations and the scope of molecular rearrangements in organic synthesis.

Course Contents:
Reactive intermediates:
Study of carbenes, nitrenes and benzynes with respect to their structure generation, important reactions and synthetic applications.
Introduction to Protecting groups
Introduction conditions and requirements of a good protecting group Protection of hydroxyl, Amino, Aldehyde and Carboxylic acid.

Molecular Rearrangements:
Introduction to basic concepts; study of following rearrangements:

C-C: Wagner-Meerwein rearrangement; pinacol-pinacolone rearrangement; Favorskii rearrangement; benzillic acid rearrangement; benzidine rearrangement.
C-N: Hoffmann rearrangement; Beckmann rearrangement; Curtius rearrangement; Losen rearrangement; Wolf rearrangement; Schmidt rearrangement.
C-O: Baeyer-Villiger rearrangement; dienone- phenol rearrangement; Dakin rearrangement; cumene-hydroperoxide rearrangement.

Recommended Books

1. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York
2. Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.
3. Bruckner, R., "Advanced Organic Chemistry-Reaction Mechanisms", Harcourt Science & Technology Company, New York.
4. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
5. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry Part A: Structure and Mechanisms", Kluwer Academic /Plenum Publishers, New York.
6. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
7. Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.
8. Gilchrist, T. L. and Rees, C. W., "Carbenes, Nitrenes and Arynes", Nelson, London.

CHEM-4747 Organic Chemistry Lab-III (Cr. 0+3)

Course Objectives:

The program is aimed that the students should be able to learn

i) Multi step organic synthesis

ii) Extraction of organic compound from plants.

Course Contents:

Preparation:
Aromatic nitration reactions; Reduction of aromatic nitro compounds; Diazotization reactions; Esterification reactions; Aldol condensation; Benzaldehyde to benzillic acid synthesis; synthesis of benzopinacol; Pinacol-Pinacolone rearrangement; HNO_3 oxidation; Polymerization reaction; any other preparation by teacher's choice (minimum 8)

Isolation:
a) Caffeine from tea leaves
b) Lycopenes/ carotene from tomatoes.

Recommended Books

1. B.S. Furniss, Vogel's Textbook of Practical Organic Chemistry Including Qualitative Organic, Longman Group, London (1978).

2. H. Becker and I. Hazzard, Organicum: Practical Handbook of Organic Chemistry, Reading, Masachuse Addison-Wesley Publishing Co. (1973).

3. R. Adams, J.R. Johnson and Wilcox Jr., Laboratory Experiments in Organic Chemistry, 6th ed., Collier-M, London (1970).

Supplementary Books

1. A.M. Schoffstall, and B.A. Gaddis, Microscale and Miniscale Organic Chemistry Laboratory Experiments, (Druelinger, Melvin L.), McGraw-Hill, Boston (2004).

2. J.C. Gilbert, and S.F. Martin, Experimental Organic Chemistry: a Miniscale and Microscale Approach, Saunders College Publishing, Fort Worth (1998).

BS 4TH Year
Semester-VIII

CHEM-4841 Reaction Mechanism-II (Cr. 3+0)

Course Objectives:

The program is aimed that the students should be able to learn

i) Chemistry of redox reaction of organic molecules with reference to different functional group.

ii) Aromatic substitution reactions with reference to electrophile and nucleophile.

Courese Contents:

Oxidation & Reduction Reactions:
Oxidation: Introduction; oxidation of hydrocarbons; olefinic bonds; oxygenated systems including alcohols, aldehydes and ketones.
Reduction: Introduction; reduction of hydrocarbons; cycloalkanes; conjugated olefins; alkynes; aromatic rings; hydrgenolysis of aldehydes and ketones.

Aromatic Electrophillic Substitution:
$ArSE_1$, $ArSE_2$ and $ArSE_3$ Mechanisms. Brief account of arenium ion mechanism; orientation and reactivity in mono substituted and di substituted benzene; study of halogenation, nitration, sulfonation, formulation Friedel Craft's alkylation and acylation reactions.
Aromatic Nucleophilic substitution:
Study of following mechanisms

i. Intermediate complex mechanism
ii. Benzyne mechanism
iii. SN_1
iv. ANRORC mechanism
v. Radical nucleophilic mechanism

Recommended Books:

1. J. March. Advanced Organic Chemistry: Reaction, Mechanism and Structure, 5th ed., John Wiley, New York (2007).

2. W. Caruthers, Some modern Methods of Organic Synthesis, 3rd ed., Cambridge University Press, Cambridge (1986).

3. F.L. Ansari, R. Quershi and M.L. Quershi, Electrocyclic Reactions, John Wiley & Sons (1999).

Supplementary Books:

1. R.O.C. Norman, Principles of Organic Synthesis, 3rd ed., Chapman and Hall, London (1993).
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th ed., Prentice Hall, New Jersey (1992).
3. P. Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th ed., Longman Scientific and Technical, London (1986)

CHEM-4842 Spectroscopy-II (Cr. 3+0)

Course Objectives:

i) To enable the learner to determine the structure of the unknown from the spectral data
ii) To develop the skill of spectral interpretation especially ^{1}H&^{13}CNMR and mass spectrometry
iii) To make students, determine the structure form the spectral data and prove the structural features
iv) To introduce the learner with applications of NMR in synthetic chemistry.

Course Contents:

Nuclear magnetic resonance: Introduction, theory, instrumentation and sample handling. Chemical shifts: Chemical shifts in ^{1}H-and ^{13}C-NMR, factors affecting chemical shifts, chemical shift equivalence and magnetic equivalence. Spin couplings: Spin couplings and factors affecting spin couplings, first order spin systems. Double resonance experiments: Selective spin decoupling, nuclear overhauser effect. NOE difference spectra, ^{1}H BB decoupled and DEPT spectra. Applications: Shift reagents, dynamic NMR, stereochemical assignments in different types of compounds, NMR in biochemistry and medicine, structure elucidation of organic compounds by joint applications of UV, IR, NMR and MS.

Recommended Books:

1. M. Hesse, H. Meier and B. Zeeh, Spectroscopic Methods in Organic Chemistry, George Thieme Verlag, Stuttgart, Germany (1997).
2. D.L. Pavia, G.M. Lampman and G.S. Kirz, Introduction to Spectroscopy, Brooks/Cole Thomson Learning, USA (2001)
3. R.M. Silverstein F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds, John Wiley & sons Inc., USA (2005).

Supplementary Books:

1. L.M. Harwood and T.D.W. Claridge, Introduction to Organic Spectroscopy, Oxford University Press Inc., New York (1997).
2. R.S. Macomber, NMR Spectroscopy: Basic Principles and Applications, Harcourt Brace Jovanovich Publishers, San Diego (1988).
3. H. Friebolin, Basic one-and two-dimensional NMR spectroscopy, 4th Ed., Wiley-VCH, New York (2005).
4. J.K.M. Sanders and B.K. Hunter, Modern NMR Spectroscopy: and Guide for Chemists, The University Press, Oxford (1993).
5. E. Breitmaier, Structure Elucidation by NMR in Organic Chemistry: a Practical Guide, John Wiley, West Sussex (2002).
6. M. Younas, Organic Spectroscopy, Ilmi Kitab Khana, Lahore (2004).

7. Y.C. NIng, Spectral Identification of Organic Compounds with Spectroscopic Techniques, Wiley-VCH, Weinheim (2005).
8. C.J. Creswell, O.A. Runquist and M.M. Cambell, Spectral Analysis of Organic Compounds, 2nd Edition, Longman, London (1972).

CHEM-4843 Natural Products (Cr. 3+0)

Course Objective:

From this course, the students will be able to,

i) Classify the different types of natural products like alkaloids, terpenoids, steroids etc.
ii) Understand the methods of isolation of different classes of natural products.
iii) The most important one is to understand the methods of structural elucidation of natural compound. After completing this course, students will be familiar with is tricky technique.

iv) Understand the biosynthetic processes of alkaloids, terpeniods and steroids.

Course Contents:
Classification, structure, occurrence and pharmaceutical perspectives of alkaloids, terpenoids, antibiotics and selected molecules of medicinal interest. Biosynthetic pathways for some classes of natural product i.e. Acetate, shikimate and mavalonate pathways. New developments in the separation of natural products. Brief introduction of bioassays for screening of natural products.

Recommended Books:

1. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, Oxford University (2001).
2. J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural Products, Longman Group Ltd., U.K. (1994).
3. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).

Supplementary Books:

1. I.L. Finar, Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, Vol. 2, Pearson Education, Delhi (1975).
2. R.O.C. Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd ed., Chapman Hall, London (1993).

CHEM-4844 Introduction to Organic Polymers (Cr. 3+0)

Course Objectives:

The students would be able to learn:

i) Chemistry of organic polymerization.
ii) Polymerization processes.

iii) Basic techniques of characterization.

Course Contents:
Definition; Classification; Types of polymerization reactions; Step-growth and chain-growth polymerization; Polymer characterization and molecular weight determination. Stereochemistry of polymers. Applications of different polymers.

Recommended Books:

1. F.W. Billmeyer, Textbook of Polymer Science, Inter science (1994).
2. G. Odian, Principles of Polymerization, 3rd ed., John Wiley & Sons (2004).

Supplementary Books:

1. H.R. Ailcock and F.W. Lampe, Contemporary Polymer Chemistry, 4th ed., Prentice Hall (2003).
2. M.S. Bhatnagagar, A Textbook of Polymers, Vol. I, II, III, S. Chand & Co. Ltd. (2004).
3. J.R. Fried, Polymer Science & Technology, Prentice Hall, Inc. (1995).

CHEM-4845 Pericyclic Reactions and Photochemistry (Cr. 3+0)

Course Objectives:

This course introduces the students with:

i) the basic types of pericyclic reactions
ii) the mechanism of pericyclic reactions and role of molecular orbitals
iii) the theories governing the principles of concerted reactions
iv) the principles and applications of photochemistry

Course Contents:

Pericyclic Reactions:
Introduction; Classification; Examples of thermal and photochemical electrocyclic, cycloaddition and sigmatropic reactions. Symmetry of orbitals and correlation diagrams. Theories of concerted pericyclic reactions---- Woodward-Hofmann theory, Fukui's theory of Frontier Orbital method, Mobius-Huckel theory.

Photochemistry:
Introduction; 1st and 2nd law of photochemistry; Quantum yield; Norish Type I and Type II reactions; Jablonskii diagram; Phosphorescence; Fluorescence.

Recommended Books:

1. Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.
2. Rinehart Jr., K. L., "Oxidation and Reduction of Organic Compounds", Prentice-Hall, London.
3. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.

CHEM-4846 Basic Organometallic Chemistry (Cr. 3+0)

Course Objectives:

The objective of the course is to introduce the student to;

i) the basic of metal carbon bonds
ii) the features of organometallic compounds
iii) the number of electron determining a type of organometallic reaction
iv) the applications of organometallic reagents in organic synthesis

Course Contents:

Transition metals and their complexes; oxidation states; the d^n notations; electron counting: the 16- and 18- electron rules; fundamental reactions of transition metal complexes; the Heck reaction and other examples of transition metal catalyzed reactions.

Recommended Books

1. Bruckner, R., "Advanced Organic Chemistry-Reaction Mechanisms", Harcourt Science & Technology Company, New York.
2. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.
3. Powell, P., "Principles of Organometallic Chemistry", Chapman & Hall, New York.
4. Parkins, A. W. and Poller, R. C., "An Introduction to Organometallic Chemistry", Macmillan, London.
5. Waren, S., "Organic Synthesis-The Disconnection Approach", John Wiley & Sons, New York.
6. Waren, S., "Workbook for Organic Synthesis-The Disconnection Approach", John Wiley & Sons, New York

CHEM-4847 Organic synthesis-II (Cr. 3+0)

Course Objectives:

To introduce the learner:

i) The basic principles of retrosynthesis
ii) The basic types and stability of bonds
iii) The ways of interconverting functional groups
iv) the synthesis by using retrosynthesis principles

Course Contents:

Introduction to reterosynthesis; Functional Group Interconversion; C-C, C-N and C-O bond formation; Analysis and synthesis of 1,1-, 1,2- and 1,3-difunctionalized compounds.

Recommended Books:

1. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York
2. Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.

3. Bruckner, R., “Advanced Organic Chemistry-Reaction Mechanisms”, Harcourt Science & Technology Company, New York.
4. Morrison, R. T. and Boyd, R. N., “Organic Chemistry”, Prentice-Hall of India, New Delhi.
5. Carey, F. A. and Sundberg, R. J., “Advanced Organic Chemistry Part A: Structure and Mechanisms”, Kluwer Academic /Plenum Publishers, New York.
6. Sykes, P., “A Guide Book to Mechanism in Organic Chemistry”, Longman, London.
7. Clayden, J., Greeves, N., Warren, S. and Wothers, P., “Organic Chemistry”, Oxford University Press, New York.
8. Gilchrist, T. L. and Rees, C. W., “Carbenes, Nitrenes and Arynes”, Nelson, London.

CHEM-4848 Organic Chemistry Lab-IV (Cr. 0+3)

Course Objectives:

The students would develop the skill of

i) designing multistep synthesis

ii) Purification and characterization of synthesized compounds

iii) Compilation of the characterization data

practicals will include at least ten preparations by the choice of teacher and facility available.

Recommended Books

1. Organic Chemsitry, J.B. Hendrickson, D.J. Charm and G.S. Hammond, 3rd Ed, MacGraw-Hill, Tokyo, 1970.
2. Organic Chemistry, R.T. Morrison and R.N. Boyde, 6th Ed. Prentice Hall, Englewood Cliffs, New Jersey, 1992.
3. A Guidebook to Mechanism in Organic Chemistry, P. Sykes, 6th Ed., Longman Scientific & Technical, London, 1986.
4. Heterocyclic Chemistry, D.W. Young.
5. Chemistry of Hetrocyclic Compounds, M. H. Palmer, Edward Arnold Publishers, London, 1967.
6. Advanced Organic Chemistry, J. March, 4th Ed., John Wiley & Sons, New York, 1992.
7. Mechanism and Theory in Organic Chemistry, T.H. Lowry & K.W. Richardson, 3rd Ed., Harper & Row Publishers, New York, 1987.
8. Stereochemistry of Carbon Compounds, E.L. Eliel, S.H. Wilen and L.N. Mander, 4th Ed., John Wiley & Sons, New York, 1994.
9. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, 3rd Ed., Blackie Academic and Professional, London, 1993.

10. Organic Synthesis, The Disconnection Approach, S. Warren, John Wiley & Sons, Chichester, 1992.
11. Organic Chemistry, I.L. Finar, 6th Ed., Vol. 1 & 2, Longman, London, 1973.
12. Spectral Analysis of Organic Compounds, C.J. Cresswell, O.A. Runquist & M.M. Compbell, 2nd Ed., Longman, London.
13. The Conservation of Orbital Symmetry, Woodward & Hoffman. Veriag Chemie, G. Mb. H.
14. Vogels Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.N.G. Smith & A.R. Taldull, 5th Ed., Longman Scientific & Technical, London, 1989.
15. Laboratory Experiments in Organic Chemistry, R.Adams, J.R. Johnson & Wilcox Jr., 6th Ed., Collier-Macmillan, London, 1970.
16. Fundamentals of Organic Chemistry, J. McMurry, 4th Ed., Brooks/Cole Publishing Co., California, 1994.
17. Organic Spectroscopy, D.W. Brown, A.J. Floyed and M.Sainsbury, J.Wiley and sons, Chichester, 1998.
18. Spectroscopic Methods in Organic Chemistry, D.H. Williams & I. Fleming, 4th Ed., McGraw-Hill Book Co., London, 1987.
19. Spectroscopic Methods in Organic Chemistry, M.Hesse, H.Meir and B.Zech, Georg Thieme Verlog, Stuttgart, New York, 1997.
20. Organic Spectroscopy by Younas, M., A. H. Publisher, Lahore.
21. NMR Spectroscopy, by Atta-ur-Rehman, Vol. 1, National Academy of Higher Education, University Grants Commission Islamabad.
22. Introduction to polymers, P. Young & P.A. Lovell, Chapman & Hall Publishers, UK.
23. Polymers chemistry and physics of Modern materials, J.M.G. Cowie, Billing & Soms Ltd. UK.
24. Physical Organic Chemistry, Neil S. Isaa's, Longman Scientific and Technical Publishers, USA.

Thesis CHEM-4899 (Cr.3) /a Course from any other discipline (Cr.3)

ANALYTICAL CHEMISTRY

BS 3rd Year
Semester-V

CHEM-3561 Analytical Chemistry-I (Cr. 3+1)

Course Objectives:

i) This course will introduce you to the vocabulary and concepts used in basic Analytical Chemistry.
ii) You will learn the details of steps involved in the preparation and analysis of a sample, the chemical basis and variou techniques of analysis.
iii) You will also learn and use statistical methods to determine the precision and accuracy of experimental results.

Course Contents:

Chemical Analysis And Data Handling:

a. Accuracy of analytical processes such as sampling, weighing, volume measurement, precipitation, washing, filtration and ignition.

b. Statistical analysis; Random and systemic errors. Rounding off the data, arithmetic mean, median, standard deviation. Relative standard deviation, student T-Test, F-test quality control and quality assurance. Constructing and interpreting plot. Use of computers in data handling.

Ionic Equilibria In Aqueous Solutions:

Calculation of activity co-oefficients for simple ionic systems. Hydrogen ion activity for strong and weak acids. Determination of pKa values. pH calculations and measurements, Buffer solutions and buffer capacity. Stability constants of complexes and methods for their determination.

Electroanalytical Techniques:

Principles, instrumentation and applications of potentiometry, conductometry, polarography. Use of ions selective electrode and chemical analysis.

Recommended Books:

1. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
2. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).
3. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th ed., Thomson Books/Cole, Belmont, USA (2004).

Supplementary Books

1. D.C. Harris, Quantitative Chemical Analysis, 5th ed., W.H. Freeman Company, New York (1999).
2. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).
3. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, Vogel's Textbook of Quantitative Analysis, 6th ed., Pearson Education Ltd. (2000).
4. R.B. Fischer, D.C. Peters, Basic theory and concepts of Quantitative Chemical Analysis, W.B. Saunders Company (1986).

Lab

1. Potentionmetric titration of polyprotic acids.
2. Potentionmetric titration involving strong/weak acids.
3. Conductometric determination of chloride.
4. Spectrophotometric determination of lead.
5. Determination of phosphate contents in commercial fertilizers by spectrophotometry.

Recommended Books:

1. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
2. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).

BS 3rd Year
Semester-VI

CHEM- 3661 Analytical Chemistry-II (Cr. 3+1)

Course Contents:

Separation Techniques:

a. Solvent Extraction

Principles, factors affecting the extraction systems, practical applications in chemical analysis.

b. Chromatographic Techniques

General theory of chromatography, classification of chromatographic methods, column, paper, thin layer and ion-exchange chromatography and their applications. Gas chromatography, HPLC and Electrophoresis.

Spectroscopic Methods of Analysis:

Interaction of electromagnetic radiation with matter. Principle, instrumentation and applications of absorption spectroscopy (UV visible, IR and AAS) and emission spectroscopy (Flame photometry).

Recommended Books

1. D.C. Harris, Quantitative Chemical Analysis, 5th ed., W.H. Freeman Company, New York (1999).
2. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders College Publishing, USA (1992).
3. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, Instrumental Methods of Analysis, Wiley, New York (2003).

Supplementary Books

1. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th ed., Thomson Books/Cole, Belmont, USA (2004).
3. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).
4. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).
5. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, Vogel's Textbook of Quantitative Analysis, 6th ed., Pearson Education Ltd. (2000).
6. R. de Levie, Principles of Quantitative Chemical Analysis, McGraw-Hill Companies, Inc. (1997).

Lab

Course Contents:

1. Determination of sodium and potassium in biological/ environmental samples by flame photometry.
2. Determination of iron in soil samples by spectrophotometry.
3. Determination of Molybedate ion by spectrophotometry.
4. Separation of dyes using column/paper/TLC chromatography.
5. Separation of sugars using paper chromatography.
6. Separation of amino acids using paper/Thin Layer Chromatography.

Recommended Books

1. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
2. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).

BS 4th Year
Semester-VII

CHEM-4761 Spectroscopic Methods of Analysis (Cr. 3+0)

Course Contents:

Making Measurements with Light

- Instruments for Measuring Absorption
- Calculations Involving Absorption
- Atomic Spectroscopy

CHEM-4762 Thermal Methods of Analysis (Cr. 3+0)

Course Contents:

- Thermogravimetry
- Differential Thermal Analysis
- Differential Scanning Calorimetry
- Thermo-Mechanical Analysis

Recommended Books

1. T. Hatakeyama and F.X. Quinn, Thermal Analysis: Fundamentals and Applications to Polymer Science, Chichester, John Wiley & Sons (1999).
2. M.E. Brown, Introduction to Thermal Analysis: Techniques and Applications, Chapman and Hall, London (1988).
3. P.J. Haines, Thermal Methods of Analysis: Principles, Applications and Problems, Blackie Academic and Professional, London (1995).

Supplementary Books

1. B. Wunderlich, Thermal Analysis, Academic Press, Boston (1990).
2. W.W.M. Wendlandt, Thermal Methods of Analysis, 3rd ed., John Wiley and Sons, New York (1986).
3. J.W. Dodd and K.H. Tonge, Thermal Methods: Analytical Chemistry by Open Learning, Chichester, John Wiley and Sons (1987).
4.

CHEM-4763 Nuclear Techniques (Cr. 3+0)

Course Contents:

- Radioactivity
- Neutron Activation Analysis
- Nuclear Quadrupole Resonance
- Isotope Dilution Method
- Isotope Ratio Mass Spectrometry

- Mössbauer Spectroscopy
- Radio-Immuno Assay
- X-Ray Technique

CHEM-4764 Introduction to Chromatography (Cr. 3)

Course Contents:

High Performance Liquid Chromatography

- Fast Protein Liquid Chromatography
- Thin Layer Chromatography
- Gel Permeation Chromatography
- Paper Chromatography

CHEM-4780 Analytical Chemistry Lab–III (Cr. 3)

Course Contents:

Calibration of a uv-visible spectrophotometer as per requirements of British Pharmacopoeia

1. Experimental determination of limits of detection and quantitation by use of spectrophotometry
2. Experimental determination of precision, accuracy and specificity
3. Two experiments for quantitative determination of analytes of interest by spectrophotometry
4. Two experiments for quantitative determination of analytes of interest by atomic spectrometry
5. Three experiments based on electrochemical techniques

Recommended Books:

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, Inc.
2. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch; 8th ed. 2003; Saunders College Publishing, Philadelphia.
3. Instrumental Methods of Analysis by Hobert H.Willard D.L. Merrit & J.R.J.A. Dean, Frank A. Settle; 7th Sub edition 1988; Wadsworth Publishing Company.
4. British Pharmacopoeia
5. United States Pharmacopoeia
6. Laboratory Manual of Analytical Chemistry by C. Reilly; Allyn and Bacon, London
7. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N.Y.

8. Most of the experiments prescribed can be found on various websites.

BS 4th Year
Semester-VIII

CHEM-4861 Advanced Hyphenated Techniques (Cr. 3)

Course Contents:

1. Gas Chromatography-Mass Spectrometry (GC-MS)
2. Liquid Chromatography-Mass Spectrometry (LC-MS)
3. MS-MS
4. LC-FTIR
5. Inductively Coupled Plasma-Mass Spectrometry

CHEM-4862 Advanced Mass spectrometry (Cr. 3)

Course Contents:

1. Matrix-assisted Laser Desorption/Ionization-Time of Flight (MALDI-TOF) Mass Spectrometry
2. Tanden Mass Spectrometry
3. Ion Trap Mass Spectrometry

CHEM-4863 Molecular Spectroscopy (Cr. 3)

Course Contents:

Molecular structure and spectral transitions: Measurement of spectra, light scattering-elastic and inelastic, absorption and emission spectroscopy. Absorption spectroscopy in UV-Visible region: Absorbance and transmittance, applications and deviations of Beer-Lambert law, spectral resolution and errors in concentration measurements, applications and comparison of fluorescence and phosphorescence spectroscopy, spectral interferences and spectra of mixtures, chemical interferences, instrumental interferences. Instrumentation: Wavelength separations, sources and detectors for electromagnetic radiations. Derivative spectroscopy: Theory and applications. IR and Raman spectroscopy: Vibrational frequencies, qualitative analysis, IR spectra and Raman spectra, samples for IR and Raman spectroscopy, band intensities, quantitation, IR and Raman spectrophotometers, correlation charts and tables. NMR Spectroscopy: Introduction, principles and applications of NMR.

Recommended Books:

1. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).
2. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH, Verlag GmbH & Co. KGaA, Weinheim (2004).
3. D.L. Pavia, G.M. Lampman, and G.S. Kriz, Introduction to Spectroscopy, 3rd ed., Thomson Learning Inc. (2001).

Supplementary Books:

1. K.A. Rubinson and J.F. Rubinson, Contemporary Instrumental Analysis, Prentice-Hall, Inc., USA (2000).
2. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, Vogel's Textbook of Quantitative Analysis, 6th ed., Pearson Education Ltd. (2000).
3. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th ed., Thomson Books/Cole, Belmont, USA (2004).
4. F. Rouessac and A. Rouessac, Chemical Analysis – Modern Instrumental Methods and Techniques, John Wiley & Sons, Ltd., UK (2000).
5. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
6. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders College Publishing, USA (1992).
7. D.C. Harris, Quantitative Chemical Analysis, 5th ed., W.H. Freeman Company, New York (1999).

CHEM-4864 Atomic Spectroscopy (Cr. 3)

Course Contents:

Origin of spectral transitions in atoms: Atomic spectra and spectral notations, intensities and line widths of gas-phase atomic spectra and its variations with temperature and pressure. Absorption & emission spectra: Boltzman distribution, spectral line broadening, background correction, factors affecting atomization/ionization. Atomic absorption and emission methodologies: Optimization of analytical conditions, concentration ranges in atomic spectroscopy. Interferences: Spectral, physical, chemical and instrumental and their elimination. Optical components of atomic absorption/emission spectrophotometers: Radiation sources, atomizers, monochromators and detectors, modulation in atomic spectroscopy. Flame Vs. Electrothermal atomic absorption spectroscopy: Qualitative and quantitative applications of absorption and emission measurements. Flame photometry: Flame characteristics and spectral interferences, components of flame photometer, non-metals and flame photometry. Sampling: Sample and standard preparation methods for atomic spectroscopy.

Recommended Books:

1. F. Rouessac and A. Rouessac, Chemical Analysis – Modern Instrumental Methods and Techniques, John Wiley & Sons, Ltd., UK (2000).
2. K.A. Rubinson and J.F. Rubinson, Contemporary Instrumental Analysis, Prentice-Hall, Inc., USA (2000).
3. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).

Supplementary Books:

1. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th ed., Thomson Books/Cole, Belmont, USA (2004).
2. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).
3. R.D. Braun, Introduction to Instrumental Analysis, McGraw-Hill Book Company (1987).
4. E.H. Evans, An Introduction to Analytical Atomic Spectrometry, John Wiley & Sons Ltd., New York (1998).
5. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders College Publishing, USA (1992).
6. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).
7. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, Vogel's Textbook of Quantitative Analysis, 6th ed., Pearson Education Ltd. (2000).

CHEM-4880 Analytical Chemistry Lab-IV (Cr. 3)

Ten experiments based on theory topics as per facilities available.

Recommended Books

1. Quantitative Chemical Analysis, 5th Edition, Daniel C. Harris, Freeman and Company, N.Y, 1999.
2. Quantitative Analysis, 6th Edition, R.A. Day and A.L. Underwood, Prentice hall, new Delhi, 1999.
3. Analytical Chemistry, 7th Edition, Douglas A skoog & Donated M.West, Saunders Publishers, London, 2000.
4. Fundamentals of Analytical Chemistry, Skoog, West and Holler, Saunders Publishers, UK, 1996,
5. Environment Chemistry, R. Bockris, MeMillan, USA, 1995.
6. International Analysis by Gary D. Christian by James E. O. Reiliy, 1986, Allyn and Bacon Inc, London.
7. Braun R.D., "Introduction to Chemical Analysis" McGraw Hill Publisher (1982).
8. Harris D.C., "Quantitative Chemical Analysis" 4th Ed., Freeman (1995).
9. Ewing G.W., " Instrumental Methods of Chemical Analysis" 5th Ed., McGraw Hill Publisher (1985).
10. Skoog D.A. & J.J. Leary, "Principles of Instrumental Analysis" 4th Ed., Saunders College Publishing (1992).

11. Willard H.H., L. L. Merritt (Jr), J.A. Dean, & F.A. Settle, “Instrumental methods of Analysis” 7th Ed., Wadsworth Publishing Co., (1988).

Christian, G.D., “Analytical Chemistry” John Wiley & Sons.

Thesis CHEM-4899 (Cr.3)/a Course from any other discipline (Cr.3)

BIOCHEMISTRY

BS 3rd Year
Semester V

CHEM-3581 Biochemistry- I (Cr. 3+1)

Course Objectives:

Students will gain knowledge about, structure, classification, properties and functions of lipids and carbohydrates.

Course Contents:

Lipids:
Classification, properties and biological significance of lipids. Types and significance of ketone bodies. Structure of biological membrane. Membrane transport.
Carbohydrates:
Classification of carbohydrates, chemistry, biological significance and properties of glucose, fructose, sucrose, starch, cellulose and glycogen. Carbohydrates acting as dietary fibers. Chemistry and biological significance of muco polysaccharides and proteoglycan.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.
2. A. L. Lehninger, D. L. Nelson, M. M. Cox, "*Principles of Biochemistry"*, 3rd Ed., Worth Publishers, New York, 2000.
3. G. Zubay, "*Biochemistry"*, W. C. B. Publishers, Toronto, 1998.
4. L. Stryer, "*Biochemistry*" 5th Ed., W. H. Freeman & Co., 2002.
5. R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.
6. Guyton and Hall, "*Text Book of Biochemistry"*, Barcourt Brace Asia, 1998.
7. D. E. Schumm, "*Essential of Biochemistry"*, Medical Edition series New York, 1999.
8. M. Ahmed, "*Essentials of Medical Biochemistry"*, Merit publishers Faisalabad, 1982.
9. P. C. Champe, A. R. Harvey, "*Biochemistry"*, Lippincott-Raven Publishers, 1994.
10. G. L. Zubay, "*Principles of Biochemisty"*, Mc Millan Publishing Co., 1995.
11. L. Stryer, "*Biochemistry"*, W. H. Freeman & Co., N. Y., 1995.

Lab

Course Objectives:

In this course there is an adequate coverage of the qualitative ad quantitative tests for students of the first semester. They will be ale to learn about the physical as well as chemical properties of carbohydrates and lipids.

Course Outlines:

1. Detection of carbohydrates, monosaccharides and polysaccharides.
2. Determination of the amount of reducing sugar in the biological fluid.
3. Estimation of non-reducing sugars in the given simple.
4. Detection of lipids on the basis of physical and chemical properties.
5. Determination of the sponification value of fat.
6. Determination of the iodine value of fat.
7. Determination of the acid value of fat.

Recommended Books

1. D. T. Plummer, "*An Introduction to Practical Biochemistry",* Tata Mc Graw-Hill Publishing company Ltd. New Delhi, 1988.
2. G. Rajagopal, S. Ramakrishnan, "*Practical Biochemistry for Medical Students*", Orient Longman Ltd., Hyderabad, 1983.
3. S. P. Singh, "*Manual of Biochemistry"*, CBS Publishers, New Delhi, 1988.

BS 3rd Year
Semester VI

CHEM-3681 Biochemistry- II (Cr. 3+1)

COURSE OBJECTIVES:

This course is also introductory which imparts the knowledge about amino acids and proteins, their levels of organization, reactions and biological roles. Chemistry of nucleic acids is taught along with their biological significance especially focusing on DNA. It also includes the basic introduction and classification of vitamins and also their biomedical importance.

Course Contents:

Nucleic Acids

Purines, pyrimidines and nucleotides. Structure and functions of DNA and different types of RNA. RNA acting as enzymes, Nucleases, DNA polymerases, RNA polymerases and ligases.

Proteins

Amino acids; classification and properties. Amino acid sequencing. Proteins; Classification, covalent structure and biological functions with specific reference to hemoglobin, creatine, creatinine. Different stages of protein structure. General introduction to enzymes.

Vitamins

Introduction, classification, chemistry, RDA, biological significance and effect of deficiency and excess of vitamins A, B complex, C, D, E, and K.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.
2. A. L. Lehninger, D. L. Nelson, M. M. Cox, "*Principles of Biochemistry"*, 3rd Ed., Worth Publishers, New York, 2000.
3. G. Zubay, "*Biochemistry"*, W. C. B. Publishers, Toronto, 1998.
4. L. Stryer, "*Biochemistry*" 5th Ed., W. H. Freeman & Co., 2002.
5. R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.
6. Guyton and Hall, "*Text Book of Biochemistry"*, Barcourt Brace Asia, 1998.
7. D. E. Schumm, "*Essential of Biochemistry"*, Medical Edition series New York, 1999.
8. M. Ahmed, "*Essentials of Medical Biochemistry"*, Merit publishers Faisalabad, 1982.
9. P. C. Champe, A. R. Harvey, "*Biochemistry"*, Lippincott-Raven Publishers, 1994.
10. G. L. Zubay, "*Principles of Biochemisty"*, Mc Millan Publishing Co., 1995.
11. L. Stryer, "*Biochemistry"*, W. H. Freeman & Co., N. Y., 1995.

Lab

COURSE OBJECTIVES:

This course is of great importance because it helps the students to learn an important lab technique, Spectrophotometry. They will also learn to use Soxhlet as well as Kjeldahl's apparatus.They will get a practical knowledge for estimation of proteins and fats in real samples. They will also learn to make buffer solutions of different pH.

Course Contents:

1. Qualitative tests for proteins and amino acids.
2. Determination of proteins spectrophotometrically.
3. Estimation of proteins by Kjeldahl method.
4. Determination of crude fats by Soxhlet apparatus.
5. Preparation of buffers of different pH.
6. Precipitation of proteins.

Recommended Books

1. D. T. Plummer, "*An Introduction to Practical Biochemistry",* Tata Mc Graw-Hill Publishing company Ltd. New Delhi, 1988.
2. G. Rajagopal, S. Ramakrishnan, "*Practical Biochemistry for Medical Students*", Orient Longman Ltd., Hyderabad, 1983.
3. S. P. Singh, "*Manual of Biochemistry"*, CBS Publishers, New Delhi, 1988.

BS 4th Year
Semester VII

CHEM-4781 Metabolism Cr.3)

Course Objectives:

The course begins with an introductory part that provides an overview of metabolic pathways. The central metabolic pathways are also included so that students can understand how individual enzymes catalyze reactions work in concert to perform complicated biochemical tasks.
The Specific objectives of this course are as follows:
To understand the fundamental concepts about energy intake and Expenditure
To study the digestive and metabolic process of human body and mechanism of degradation and synthesis of biomolecules.
To study the regulation and inhibition of the metabolic pathways.

Course Contents:

Introduction to metabolism of carbohydrates, lipids, proteins and nucleic acids.
Carbohydrates: Glycolysis, the citric acid cycle, hexose monophosphate shunt, uronic acid pathway, glycogenesis, glycogenolysis, gluconeogenesis, Regulation of carbohydrate metabolism.
Proteins: Transamination, deamination, Decarboxylation, urea cycle, Creatine, Creatinine metabolism. Oxidation and synthesis of amino acids, urea cycle. Metabolic disorders.

Lipids: Synthesis and B-oxidation of even, odd, saturated, unsaturated fatty acids. Metabolism of triglycerides, ketone bodies. Metabolism of cholesterol.

Nucleic acid: Purine, Pyrimidine nucleotide metabolism. One carbon pool, digestion and absorption of food. Bio energetics.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.
2. A. L. Lehninger, D. L. Nelson, M. M. Cox, "*Principles of Biochemistry"*, 3rd Ed., Worth Publishers, New York, 2000.
3. G. Zubay, "*Biochemistry"*, W. C. B. Publishers, Toronto, 1998.
4. L. Stryer, "*Biochemistry*" 5th Ed., W. H. Freeman & Co., 2002.
5. R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.
6. T. M. Devlin, "*Text book of Biochemistry with Clinical Correlations*", 2nd Ed., John Wiley & Sons, New York, 1982.

CHEM-4782 Immunobiochemistry (Cr.3)

Course Objectives:

To give basic concept of immunity, resistance, theories and mechanisms responsible for antibody formation.To study immunological disorders.

Course Contents:

Concept of immunity and resistance, inflammation, phagocytosis, kinds of immunity. Antigen, condition of antigenicity, chemical basis of antigenic specificity. Antibody, composition of blood, plasma and serum. Nature of antibody. Theories of antibody formation, rate of antibody formation. Antigen-antibody reaction. Chemistry of Immunoglobulin. Monoclonal antibodies, Immune system and its abnormalities, complement system, peripheral leukocytes and macrophages.

Recommended Books

1. E. Benjamini, R. Coico, G. Sunshine, "*Immunology: A short course"*, 4th Ed., Wiley- Liss Inc., Canada, 2000.
2. J. G Cappuccino, N. Sherman, *"Microbiology: A laboratory manual",* 4th Ed., Benjamin/ Cummings Publishing Co., N. Y., 1996.
3. J. Kurby, "*Immunology*", 2nd Ed., W. H. Freeman and Co., N. Y., 1994.
4. I. Riott, J. Brostoff, D. Male, "*Immunology*", 3rd Ed., Mosby-Year Book, Europe Ltd., London, 1993.

CHEM-4783 Physiological Biochemistry (Cr.3)

Course Objectives:
The beauty of Physiology is that it integrates the individual functions of all the body's different cells and organs into a functional whole, the human or animal body. The main objective for introducing this course in 3rd semester of M. Sc is that the students will hopefully be able to understand the chemistry, composition and functions of specialized tissues and organs of human body.

Course Contents:
Introduction to physiology, Functional organization of human body and Homeostasis. Nutrition and Physiology of digestion, role of liver, gall bladder and pancreas. Resiratory system, pulmonary ventilation, gaseous exchange and its regulation. Circulatory system, heart as a pump. Nervous system organization. Urinary system, urine formation, glomerular filtration, tubular function and acid-base balance. Membrane physiology, physiology of connective tissues and muscles including smooth and skeletal muscles.

Recommended Books

1. Guyton and Hall, "*Text Book of Biochemistry"*, Barcourt Brace Asia, 1998.
2. M. Gerhard, W. H. Sinnons, " *Principles of Medical Biochemistry"*, 2nd Ed., Mosby, N. Y., 2006.
3. R. R. Seeley, D. Trent, "*Anatomy and Physiology",* 4th Ed., Mosby-Year Book, Inc., USA., 1998.
4. J. W. Hole, "*Essential of Human Anatomy Physiology"*, 4th Ed., Collin. H. Wheatley. Win. C. Brown Publishers, USA., 1992.

CHEM-4784 Hematology (Cr.3)

Course Objectives:
This course will orientate the students to an over view of blood composition, its formation, haemoglobinopathies, mechanism of blood coagulation and clinical importance of blood components for diagnosis of diseases.

Course Contents:
Basic examination of blood and bone marrow. Red blood cells: Production and destruction. Formation of hemoglobin, Iron metabolism. The anemias, polycythemia, effect of anemia and polycythemia on circulatory system. Leukocytes: Types, General characteristics, Genesis, Life span and their Roles.ABO blood groups, Transfusion, Hemostasis, Events in hemostasis, Mechanism of Blood Coagulation, Conditions that cause excessive bleeding in human beings. Thromboembolic conditions in human being, anticoagulants for clinical use, blood coagulation tests.

Recommended Books

1. Hoffbrand, *"Essential Haematology"* 5th Ed., 2006.

2. Ersalovic, *"Therapeutic Microbiology: Probiotics and Related Strategies",* 2008.
3. Guyton and Hall, "*Text Book of Biochemistry",* Barcourt Brace Asia, 1998.
4. A. Richard, Mc Pherson, R. Mathew, *"Clinical Diagnosis and Management by Laboratory Method"*, 21st Ed., Elsevier New Delhi, 2007.

CHEM-4785 Molecular Biology (Cr.3)

Course Objectives:
To give a brief overview of expression, regulation, post transcriptional and translational modification of DNA and RNA as well as protein synthesis in prokaryotes and eukaryotes. It will also highlight the importance of sequences responsible for elongation and termination of transcription and translation.

Course Contents:
Introduction: gene theory, structure of DNA, concept of gene, mutations, gene structure and function. Prokaryotic, eukaryotic and viral DNA replication, recombination and repair; transposones and their insertion sequences; gene expression, transcription and translation; prokaryotic and eukaryotic biosynthesis of RNA and its regulation, initiation, elongation, and termination; RNA polymerase function and modulation of its activity; promoters, operators repressor, terminator; post transcriptional processing of tRNA, mRNA; Bacterial protein synthesis and regulation; Eukaryotic protein synthesis and regulation; post translational modification.

Recommended Books

1. Griffiths, J. F. Anthony. *et. al* ., *" Modern genetic analysis: integrating genes and genomes",* 2nd Ed., W. H. freeman, New York, 2002.
2. G. Karp, *"Cell and Molecular Biology: Concepts & Experiments",* 3rd Ed., John Willey Sons, Inc., N.Y., 2002.
3. F. Weaver, F. Robert F, "*Molecular biology",* Mc Graw-Hill, Boston, 1999.
4. Garrett, H. Reginald, M. Charles, "*Molecular aspects of cell biology"*, Saunders College Publishing, Fort Worth, 1995.
5. T. Strachen, A. P. Read, "*Human Molecular Genetics"*, 2nd Ed., BIOS Scientific Publications Ltd., 2000.

CHEM-4786 Applied Microbiology (Cr.3)

Course Objectives:
To give basic concept and classification of microorganism, their cultivation, growth and application in industry**.**

Course Contents:
Introduction to microbiology, introduction to bacteria, fungi, viruses, protozoa and algae. Cultivation and growth of bacteria and microorganisms used in

industry, Fermentation, commercial production of alcohol, lactic acid and citric acid.

Recommended Books

1. Slonczewski, "*Microbiology: An Evolving Science",* 2008.
2. Versalovic "*Therapeutic Microbiology: Probiotics and Related Strategies",* 2008.

CHEM-4787 Enzymology (3 Credits)

Course Objectives:

This course will enable the students to understand:

- The role of enzymes as bio catalyst.
- The mechanism and kinetics of enzyme-catalyzed reactions.
- The effect of various factors on rate of reaction.

Course Contents:

Introduction and basic concepts of enzymology, chemical nature, nomenclature and classification of enzymes, cofactors, effect of different factors on enzyme activity. Kinetic of single substrate and bisubstrate reaction, Michaelis-Menten equation. Substrate specificity. Mechanism of the enzyme action Ping pong mechanism. Enzyme inhibition. Competitive, uncompetitive and non competitive inhibition. Enzyme applications in medicine and industry, biotechnological applications of enzymes, immobilization of enzymes, immobilization techniques, mode of reaction, factors affecting immobilization, Isoenzymes; structure, formation, identification, functional significance of isoenzymes. Regulatory enzymes. Allosteric enzymes. Multienzyme systems. Zymogens. Immobilized enzymes.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.
2. A. L. Lehninger, D. L. Nelson, M. M. Cox, "*Principles of Biochemistry"*, 3rd Ed., Worth Publishers, New York, 2000.
3. G. Zubay, "*Biochemistry"*, W. C. B. Publishers, Toronto, 1998.
4. L. Stryer, "*Biochemistry*" 5th Ed., W. H. Freeman & Co., 2002.
5. R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.

CHEM-4795 Biochemistry Lab-III

Course Objectives:

Labs for 3rd semester are designed to give students practical experience in clinical biochemistry. Students are trained to collect blood and urine samples and analyze them by titrimetric and spectrophotometric methods for clinically significant constituents.

Course Contents:

1. Determination of calcium in the blood sample.
2. Determination of cholesterol in the blood sample.
3. Determination of Chloride in the blood sample.
4. Determination of Hemoglobin in the blood sample.
5. Determination of lactose in the Milk sample.
5. Effect of pH, temperature, metal ions and time on enzyme stability and activity
6. Estimation of creatine and creatinine in serum/ Urine.
7. Separation of serum proteins by agarosa gel electrophoresis.
9. Estimation of Na and K using flame photometer.
10. Preparation of plasmid DNA.
11. Restriction enzyme digestion of DNA.

Recommended Books

1. D. T. Plummer, "*An Introduction to Practical Biochemistry"*, Tata Mc Graw-Hill Publishing company Ltd., New Delhi, 1988.
2. K. K. Pillai, J. S. Qadry, "*Biochemistry and Clinical Pathology"* CBS Publishers & Distributors, 1996.
3. S. P. Dandekar, S. A. Rane, "*Practical and viva in Medical Biochemistry",* Reed Elsevier India PrivateLtd., 2004.

BS 4th Year
Semester VIII

CHEM-4881 Animal and Plant Biotechnology (Cr.3)

Course Objectives:

To introduce students, principle and applications of plant and animal biotechnology in science and industry.

To expose students to issues and challenges in the area of biotechnology

Course Contents:

Transgenic plants and animals, use of plant and animal products in agriculture, industry and medicine, introduction of transgenic plants and animals in the environment. Biological hazards.

Recommended Books

1. J. M. Walker, E. B. Gingold, "*Molecular Biology and Biotechnology"*, Royl society of Chemistry, London, 1993.
2. R. W. Old, S. B. Primrose, "*Principles of gene manipulations"*, Blackwell Science, England, 1994.

CHEM-4882 Protein Chemistry (Cr.3)

Course Objectives:

To give an overview of protein structure, function and its role in DNA expression and immune system.

Techniques used for isolation and purification of proteins.

Course Contents:

Protein structure (primary, secondary, tertiary), protein folding, protein purification, peptide mapping, protein cleavage, protein sequencing, structure and functions of Motifs identified in transcription factors, DNA protein interaction, Protein-protein interaction, protein engineering, structure of receptors and adaptor proteins involved in apoptosis, structure of receptors and other proteins involved in immune systems.

Recommended Books

1. J. M. Berg, J. L. Tymczko, L. Stryer, "*Biochemistry"*, 6th Ed., W. H. Freeman & Co. Ltd., 2006.

2. C. Branden, E. J. Tooze, "*Introduction to Protein Structure",* 2nd Ed., Garland Publishing Inc., N. Y., 1999.

3. E. Buxbaum, "*Fundamentals of Protein Structure and Function".*1st Ed., 2007.

4. J. Kyte, "*Structure in Protein Chemistry*", 2nd Ed., Garland Science, 2006.

6. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.

CHEM-4883 Clinical Biochemistry (Cr.3)

Course Objectives:

1. To discuss aspects of immunological, neurological and cardiovascular disorders.
2. Clinical diagnosis of these disorders.
3. Biochemical aspects of cancer and genetic and constitutional factors in disease of organs.

Course Contents:

Biochemistry of blood, biochemical aspect of cardiovascular, neurological and endocrine disorders; in born errors of metabolism, immunology of human diseases, immunodiagnostics, biochemical aspects of cancer, etiology, clinical diagnosis and treatment, interferon discovery and implications, infection and antibacterial agents, diseases due to infection and infestation, diseases due to chemical and physical agents, genetic and constitutional factors in diseases of organs.

Recommended Books

1. G. J. Beckett, S. W. Walker, P. Rae, P. Ashby, "*Lecture Notes: Clinical Biochemistry",* 7th Ed., Wiley Blackwell, 2005.
2. A. T. Cameron, "*A course in Practical Biochemistry- For Students of Medicine",* Cameron Press, 2007.
3. A Graw, R. Cowan, D. O. Reilly, M. Stewart, J. Shepherd, "*Clinical Biochemistry: An Illustrated Colour Text*", 3rd Ed., Churchill Livingstone, 2004.

CHEM-4884 Clinical Pharmacology (Cr.3)

Course Objectives:

Importance of Clinical Pharmacology in this period cannot be ignored. Aim of introducing this course to M. Sc students is to give them basic knowledge about clinical pharmacology. This course will definitely enable them to look into a new area for research and will broaden their job scope in pharmaceutical companies.

Course Contents:

Pharmacology: Introduction, General Principles. Purpose of drug therapy. Drug distribution in body. Factors affecting on drug distribution. Drug absorption, Factors affecting on drug absorption,. Drug elimination. Concept of half life. Agonists and Antagonists.Drug potency. Drug metabolism. Toxicology: Mode of action.

Recommended Books

1. M. D. Michael Cowely, "*International Pharmacology; The Basis"*.
2. H. Kappeler, D. Pharm, "*General Principlesof Pharmacology"*, 2002.

CHEM-4885 Cell Biology (Cr.3)

Course Objectives:

The course will cover almost all aspects which are most related to the cell. These include:

- cell theory
- structure and function of prokaryotic and eukaryotic cell
- ultra structures of cell organelles
- role of cell organelles in cell

- All aspects of cell division
- Some important topics are also introduced like immune system, aging and cloning for general awareness of the students.

Course Contents:
Introduction to cell theory and structure, chemical composition of cell, types of cell organelles; structure and their functions. Transport properties of cell membrane, structure of membrane, Lysosomes, microbodies, mitochondria and the conversion of chemical energy, mitochondrial structure and the mechanism of photosynthesis. Cell movements, structure and function of cytoskeleton, centriole, cilia and flagella, the mitotic apparatus, the nucleus, structure and function of nuclear envelop, the nucleolus, chromosomes. The nature of gene, the cell cycle, mitosis and meiosis, cytokinesis. Introduction of special topics; immune system, cancer, aging and cloning.

Recommended Books

1. . Alberts, " *Essential Cell Biology",* 3rd Ed., 2010.
2. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, "*Molecular Biology of the Cell*", 5th Ed., Garland Sciences, Taylor and Francis, 2008.
3. H. Lodish, A. Berk, L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell, "*.Molecular Cell Biology*", 4th Ed., W.H. Freeman, 2000.
5. G. Karp John, "*Cell and Molecular Biology: Concepts and Experiments",* Wiley & Sons, 2008.

CHEM-4886 Nucleic Acids (Cr.3)

Course Objectives

a. To give an overview of organization of Nuclear and Mitochondrial genome.
b. Mechanism of gene expression and its mapping on chromosome.
c. Mutation identification and transcript mapping.

Course Contents:
Chromosome and DNA, flow of genetic information, organization of nuclear and mitochondrial genomes, gene structure, RNA splicing, pseudogenes, classess of mutations, repetitive DNA sequences, gene expression, cloning of genes, mapping genes on chromosomes, transcript mapping, mutation identification, gene structure and functions.

Recommended Books

1. Garrett, H. Reginald, Grisham, M. Charles, *"Molecular aspects of cell biology"*, Saunders College Publishing, Fort Worth, 1995.

2. T. Strachen, A. P. Read, "*Human Molecular Genetics"*, 2nd Ed., BIOS Scientific Publications Ltd., 2000.
3. G. Karp, "*Cell and Molecular Biology: Concepts & Experiments*", 3rd Ed., John Wiley Sons, Inc., N.Y., 2002.
4. J. Darnell, H. Lodish, D. Balimore, *"Molecular Cell Biology"*, Scientific American Inc., N.Y., 2004.
5. Malacinski, M. George, "*Essential of Molecular Biology*", 4th Ed., Jones and Bartlett publishers, Boston, 2003.

CHEM-4887 Bioenergetics (Cr.3)

Course Objectives:
This course covers the molecular basis of energy for living systems, its production and regulation.

Course Contents:
Introduction, Basic thermodynamic, Concepts of energy and free Energy, Enthalpy, Entropy and their relations. Endothermic and exothermic reactions. Biological oxidation and reduction. High energy compounds and metabolism, Glycolysis, Citric acid cycle; Energetics and Regulation, Mitochondrial anatomy, Mitochondrial transport system. Substrate level phosphorylation, oxidative and photo phosphorylation. Self-regulation of energy production. sequence and different complexes involved in electron transport, Theories about ATP synthesis, P/O ratio, Control of oxidative phosphorylation, Physiological implications of Aerobic Metabolism.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, "*Biochemistry"*, John Wiley & Sons, New York, 1999.
2. L. Stryer, "*Biochemistry*" 5th Ed., W. H. Freeman & Co., 2002.
3. R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.

CHEM-4888 Nutritional Biochemistry (Cr.3)

Course objectives:
The Specific objective of this course is to impart awareness about global nutritional challenges. This course will enable students to understand the concept of nutrition and health. Different nutrients which should be the components of a balanced diet, their importance, sources, functions and problems due to deficiency are introduced in this course. Students will be able to understand the menu efficiently and the principles of food nutrition in the practical field effectively.

Course Contents:

Body composition, functions of proteins, fats, carbohydrates, vitamins, minerals, water and their requirements. Digestion, absorption and excretion of nutrients functions of liver energy metabolism. Nutrients and energy needs. Factors affecting total energy requirement. Energy balance, calculating energy from foods and energy allowances, balanced diet. Sources of water and water loss from body, water balance and daily allowances. Dietary fiber, composition, characteristics, functions, digestion and daily requirements. Role of nutrition in growth, development, disease and dental health. Nutritional disorder. Strategies for improving nutritional well being. The aging process. Guide for eating.

Recommended Books:

R. K. Murray, D. K. Granner, P. A. Mayes, "*Harper's Biochemistry"*, Rodwell, 2000.
Wardlaw, Insel, "*perspectives in nutrition*", Mosby, New York, 1999.

CHEM-4889 Endocrinology (Cr.3)

Course Objectives:

Students will be able to understand the fundamental concepts, biochemical and molecular aspects of endocrinology and its role in regulation of homeostasis process.

Course Contents:

Introduction to endocrinology. Endocrine glands. Nature of hormones, chemistry storage secretion of endocrine hormones. Hormone receptions and their activation. Mechanisms of hormonal action. Chemistry, concentration in blood, metabolism, mechanism of action, biological roles and disorders related to important endocrine hormones including pituitary hormones, thyroid and parathyroid hormones, adrenocortical hormones, insulin, glucagon, epinephrine and nor-epinephrine.

Recommended Books

1. Guyton and Hall, "*Text Book of Biochemistry",* Barcourt Brace Asia, 1998.

CHEM-4895 Biochemistry lab-IV (Cr.3)

Determination of titrable acidity of urine.
Determination of ascorbic acid in food materials.
Determination of bilirubin in blood sample.
Determination of organic and inorganic constituents in normal and abnormal human urine.
5. Estimation of Phosphorus in serum /urine.
6. Estimation of Uric Acid in serum/ urine.

7. Assays of some selected enzymes.
8. Estimation of serum alkaline phosphatase.
9. Chromatographic methods for the separation of sugars, amino acids and lipids.
10. Enzymatic methods in flow injection analysis
11. Isolation of acetylcholine esterase from chicken brain.

ITEM NO. 2

NEW DISCRIPTION OF MPhil/PhD CHEMISTRY COURSE CODES

M.Phil. and Ph.D. COURSE CODES

I. Physical Chemistry

CHM-701 Physical Chemistry of Polymers (Cr. 3)
CHM-702 Advanced Quantum Chemistry (Cr. 3)
CHM-703 Electrode Process (Cr. 3)
CHM-704 Magnetic Resonance Spectroscopy (Cr. 3)
CHM-705 Advanced Chemical Kinetics (Cr. 3)
CHM-706 Advanced Molecular Spectroscopy (Cr. 3)
CHM-707 Advanced Photochemistry (Cr.3)
CHM-708 Advanced Surface Chemistry (Cr. 3)
CHM-709 Advanced Solution Chemistry (Cr. 3)
CHM-710 Chemistry of Advanced Materials (Cr. 3)
CHM-711 Advanced Statistical Mechanics (Cr. 3)
CHM-712 Solid State chemistry (Cr. 3)
CHM-713 Colloid Chemistry (Cr. 3)
CHM-714 Advanced Nuclear and Radiation Chemistry (Cr. 3)
CHM-715 Applied Chemical Thermodynamics (Cr. 3)
CHM-716 Electroanalytical Methods and Techniques (Cr. 3)
CHM-717 Special Topics in Physical Chemistry (Cr. 3)
CHM-718 Physical Chemistry of Environment (Cr.3)
CHM-719 Special Topics in Physical Chemistry (Cr. 3)
CHM-720 Polymer Physics (Cr. 3)

II. Inorganic Chemistry

CHM-721 Multinuclear NMR Spectroscopy (Cr. 3)
CHM-722 Inorganic Electronic Spectroscopy (Cr. 3)
CHM-723 Kinetics and Mechanisms of Inorganic Reactions (Cr. 3)
CHM-724 Organo-transition Metal Chemistry (Cr. 3)
CHM-725 Bio-Inorganic Chemistry (Cr. 3)
CHM-726 Physical Methods in Inorganic Chemistry (Cr. 3)

CHM-727 Inorganic Material Chemistry (Cr. 3)

CHM-728 Catalysis (Cr. 3)

CHM-729 Special Topics in Inorganic Chemistry (Cr. 3)

CHM-730 Advanced Material Chemistry (Cr. 3)

III. Organic Chemistry

CHM-741 Protecting Groups in Organic Synthesis (Cr. 3)

CHM-742 Organic Synthesis-Retrosynthetic Approach (Cr. 3)

CHM-743 Advanced Stereochemistry (Cr. 3)

CHM-744 Physical Organic Chemistry (Cr. 3)

CHM-745 Nuclear Magnetic Resonance in Organic Chemistry (Cr. 3)

CHM-746 Advances in Chromatographic Techniques (Cr. 3)

CHM-747 Chemistry of Isoprenoids and Steroids (Cr. 3)

CHM-748 Chemistry of Glycosides (Cr. 3)

CHM-749 Biosynthesis of Natural Products (Cr. 3)

CHM-750 Chemistry of Organometallic Compounds (Cr. 3)

CHM-751 Reactive Intermediates in Organic Chemistry (Cr. 3)

CHM-752 Advanced Heterocyclic Chemistry (Cr. 3)

CHM-753 Advanced Mass Spectrometry (Cr. 3)

CHM-754 Organic Photochemistry (Cr. 3)

CHM-755 Organic Polymer Chemistry (Cr. 3)

CHM-756 Pericyclic Reactions (Cr. 3)

CHM-757 Advanced Stereoselective Synthesis (Cr. 3)

CHM-758 Modern Name Reactions in Organic Synthesis (Cr. 3)

CHM-759 Special Topics in Organic Chemistry (Cr. 3)

CHM-760 Advanced Natural Product Chemistry (Cr. 3)

IV. Analytical Chemistry

CHM-761 Frontiers Nanomaterials for Bio-applications (Cr. 3)

CHM-762 Advanced Analytical Instrumental Techniques (Cr. 3)

CHM-763 Advanced Thermal Analysis (Cr. 3)

CHM-764 Water and Soil Chemistry (Cr. 3)

CHM-765 Analysis and Characterization of Polymers (Cr. 3)

CHM-766 Advanced Atomic Spectroscopy (Cr. 3)

CHM-767 Atmospheric Chemistry (Cr. 3)

CHM-768 Chromatographic Methods of Analysis (Cr. 3)

CHM-769 Special Topics in Analytical Chemistry (Cr. 3)

CHM-770 X-Ray Methods of Analysis (Cr. 3)

CHM-771 Applied Industrial Processes (Cr. 3)

CHM-772 Special Topics in Analytical Chemistry (Cr. 3)

CHM-773 Diffraction Methods of Analysis (Cr. 3)

V. Biochemistry

CHM-781 Biochemistry of Disease (Cr. 3)

CHM-782 Advances in enzyme structure and function (Cr. 3)

CHM-783 Fermentation and Biotransformation(Cr. 3)

CHM-784 Fundamentals of Molecular Biology (Cr. 3)

CHM-785 Metabolomics (Cr. 3)

CHM-786 Metabolic regulations (Cr. 3)

CHM-787 Biological Oxidations (Cr. 3)

CHM-788 Lab Techniques in Biochemistry (Theory + Lab Work) (Cr. 3)

CHM-789 Biostatistics (Cr. 3)

CHM-790 Research Methodology and scientific writing (Cr. 3)

CHM-791 Techniques in Molecular Biology (Cr. 3)

CHM-792 Special Topics in Bio Chemistry (Cr. 3)

CHM-793 Forensic Chemistry (Cr. 3)

ITEM NO. 3

Approval of proposed changes in Course; CHM-6443, Natural Products (Cr. 3) and approval of newly introduced courses in Organic Chemistry, MSc. Program

CHM-6443 Natural Products (Cr. 3)

Course Objective:

From this course, the students will be able to,

i) Classify the different types of natural products like alkaloids, terpenoids, steroids etc.

ii) Understand the methods of isolation of different classes of natural products.

iii) The most important one is to understand the methods of structural elucidation of natural compound. After completing this course, students will be familiar with is tricky technique.

iv) Understand the biosynthetic processes of alkaloids, terpeniods and steroids.

Existing	**Proposed**
Title: Natural Product	Natural Product Chemistry
Course Contents Alkaloids: Introduction, classification, isolation and general methods of structure determination. Chemistry of Ephedrine, Conine, Nicotine. Biosynthesis of alkaloids. Terpenoids: Introduction, classification, isolation and general methods of structure determination. Chemistry of Citral, α-Pinene and Camphor. Biosynthesis of terpenoids. Steroids: Introduction, classification, isolation and general methods of structure determination. Chemistry of Cholesterol, Vitamin D. Biosynthesis of steroids.	Course Contents 1. Classification, structure, occurrence and pharmaceutical perspectives of alkaloids, terpenoids, antibiotics and selected molecules of medicinal interest. 2. Brief introduction of bioassays for screening of natural products.

Recommended Books

4. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, OxfordUniversity (2001).
5. J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural Products, Longman Group Ltd., U.K. (1994).
6. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).
7. N. H. Fischer, M. B.Isman, H. A. Staffard. Modern Phytochemical Methods, Springer International Edition, New York, USA. (1991).
8. P. S.Kalsi, S. Jagtap. Pharmaceutical, Medicinal and Natural Product Chemistry. Narosa Publishing House, New Delhi, India. ((2013).

Supplementary Books

3. I.L. Finar, Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, Vol. 2, Pearson Education, Delhi (1975).
4. R.O.C. Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd ed., Chapman Hall, London (1993).
1. M. Hesse, H. Meier and B. Zeeh, Spectroscopic Methods in Organic Chemistry, George Thieme Verlag, Stuttgart, Germany (1997).
2. D.L. Pavia, G.M. Lampman and G.S. Kirz, Introduction to Spectroscopy, Brooks/Cole Thomson Learning, USA (2001)
3. R.M. Silverstein F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds, John Wiley & sons Inc., USA (2005).

ITEM NO. 4
Approval of newly introduced courses in Biochemistry for MSc Program

CHM-6386 Metabolism-I (Cr.3)

Course Objectives

The course begins with an introductory part that provides an overview of metabolic pathways. The central metabolic pathways are also included so that students can understand how individual enzymes catalyze reactions and work in concert to perform complicated biochemical tasks.

The Specific objectives of this course are as follows:

To understand the fundamental concepts about energy intake and expenditure

To study the digestive and metabolic process of human body and mechanism of degradation

and synthesis of biomolecules.

To study the regulation and inhibition of the metabolic pathways.

Course Outlines

Introduction to metabolism of carbohydrates, lipids, proteins and nucleic acids.

Carbohydrates: Glycolysis, the citric acid cycle, hexose monophosphate shunt, uronic acid pathway, glycogenesis, glycogenolysis, gluconeogenesis, Regulation of carbohydrate metabolism.

Proteins: Transamination, deamination, Decarboxylation, urea cycle, Creatine, Creatinine metabolism. Oxidation and synthesis of amino acids, urea cycle. Metabolic disorders.

Lipids: Synthesis and B-oxidation of even, odd, saturated, unsaturated fatty acids. Metabolism of triglycerides, ketone bodies. Metabolism of cholesterol.

Nucleic acid: Purine, Pyrimidine nucleotide metabolism. One carbon pool, digestion and absorption of food. Bio energetic

Recommended Books:

1. D. Voet, J. G. Voet, C. W. Pratt, “Biochemistry”, John Wiley & Sons, New York, 1999.

2. A. L. Lehninger, D. L. Nelson, M. M. Cox, “Principles of Biochemistry”, 3rd Ed., Worth Publishers, New York, 2000.

3. G. Zubay, “Biochemistry”, W. C. B. Publishers, Toronto, 1998.

4. L. Stryer, “Biochemistry” 5th Ed., W. H. Freeman & Co., 2002.

5. R. K. Murray, D. K. Granner, P. A. Mayes, “Harper’s Biochemistry”, Rodwell, 2000.

6. T. M. Devlin, “Text book of Biochemistry with Clinical Correlations”, 2nd Ed., John Wiley & Sons, New York, 1982.

CHM-6484 Enzymology (Cr.03)

Course Objectives

This course will enable the students to understand:

- The role of enzymes as bio catalyst.
- The mechanism and kinetics of enzyme-catalyzed reactions.
- The effect of various factors on rate of reaction.

Course Contents:

Introduction and basic concepts of enzymology, chemical nature, nomenclature and classification of enzymes, cofactors, effect of different factors on enzyme activity. Kinetic of single substrate and bisubstrate reaction, Michaelis-Menten equation. Substrate specificity. Mechanism of the enzyme action Ping pong mechanism. Enzyme inhibition. Competitive, uncompetitive and non competitive inhibition. Enzyme applications in medicine and industry, biotechnological applications of enzymes, immobilization of enzymes, immobilization techniques, mode of reaction, factors affecting immobilization, Isoenzymes; structure, formation, identification, functional significance of isoenzymes. Regulatory enzymes. Allosteric enzymes. Multienzyme systems. Zymogens. Immobilized enzymes.

Recommended Books

1. D. Voet, J. G. Voet, C. W. Pratt, “Biochemistry”, John Wiley & Sons, New York, 1999.
2. A. L. Lehninger, D. L. Nelson, M. M. Cox, “Principles of Biochemistry”, 3rd Ed., Worth Publishers, New York, 2000.
3. G. Zubay, “Biochemistry”, W. C. B. Publishers, Toronto, 1998.
4. L. Stryer, “Biochemistry” 5th Ed., W. H. Freeman & Co., 2002.
5. R. K. Murray, D. K. Granner, P. A. Mayes, “Harper’s Biochemistry”, Rodwell, 2000.

CHM-6485 Metabolism-II (Cr. 03)

Course Objectives:

This course covers the molecular basis of energy for living systems, its production and regulation.

Course Contents:

Introduction, Basic thermodynamic, Concepts of energy and free Energy, Enthalpy, Entropy and their relations. Endothermic and exothermic reactions. Biological oxidation and reduction. High energy compounds and metabolism, Glycolysis, Citric acid cycle; Energetics and Regulation, Mitochondrial anatomy, Mitochondrial transport system. Substrate level phosphorylation, oxidative and photo phosphorylation. Self-regulation of energy production. sequence and different complexes involved in electron transport, Theories about ATP synthesis, P/O ratio, Control of oxidative phosphorylation, Physiological implications of Aerobic Metabolism.

Recommendded Books

1. D. Voet, J. G. Voet, C. W. Pratt, “Biochemistry”, John Wiley & Sons, New York, 1999.
2. L. Stryer, “Biochemistry” 5th Ed., W. H. Freeman & Co., 2002.
3. R. K. Murray, D. K. Granner, P. A. Mayes, “Harper’s Biochemistry”, Rodwell, 2000.
4. M. D. Michael Cowely, “International Pharmacology; The Basis”.

5. H. Kappeler, D. Pharm, “General Principlesof Pharmacology”, 2002.

Item No. 5
Approval of newly introduced courses in Physical, Inorganic, Organic, Inorganic, Analytical and Biochemistry, MPhil. and Ph.D. Programs

CHM-718 Physical Chemistry of Environment (Cr.3) [Physical Chemistry]

Course Contents:

Environment and its resources:

Resource depletion and environmental pollution; green house effect; green house gases; mechanism of reactions causing pollution; interaction of pollutants with materials; noxious emission from industrial processes; aerosol production. **Chemistry of pollutants:** Nuclear waste and its management. Kinetic and thermodynamic aspects of atmospheric phenomena. Clean energy for future. **Experimental techniques for environmental monitoring.**

Recommended Books:

1. W.W. Eckenfelder, Jr., Industrial Water PollutionControl, McGraw-Hill International Edition (2000).
2. J.O.M. Bockris, Environmental Chemistry, Plenum Press, New York (1992).
3. S.E. Manahan, Environmental Science and Technology, Lewis Publishers, New York (1997).
4. J. Colls, Air Pollution-An Introduction, SPON Press, Taylor & Francis Group, London (1997).
5. R. Miroslav and N.B. Vladimir, Practical Environmental Analysis, The Royal Society of Chemistry, UK (1999).
6. J.H. Seinfeld, Atmospheric Chemistry and Physics of Air Pollution, John Wiley & Sons, New York (1986).
7. J.H. Seinfeld and S.N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley & Sons, New York (1998).
8. WHO, Guidelines for Air Quality, World Health Organization, Geneva (2000), (wwwwhoint/environmental information/Air/Guidelines/agguide7pdf)
9. P. Patnaik, Handbook of Environmental Analysis, CRC Press Inc., Florida, USA (1997).
10. S.T. Holgate, J.M. Samet, H.S. Koren and R.L. Maynard, Air Pollution and Health, Academic Press, New York (1999).
11. R.A. Bailey, H.M. Clark, J.P. Ferris, S. Krause and R.L. Strong, Chemistry of the Environment, 2nd ed., Academic Press, London (2002).
12. R.M. Harrison, An Introduction to Pollution Science, The Royal Society of

Chemistry, UK (2006).

CHM-730 Advanced Material Chemistry [Inorganic Chemistry]

Course Content:

Introduction of material chemistry, solid state chemistry, metal materials, semi conducting materials, organic soft materials, smart and peizo electric material, Structural Comparison, Synthetic Approaches; CVD, Sole Gel Method, Solvothermal Method, Electro Deposition, etc in each case, and material characterizations.

Recommended Books:

1. Flegler, S. L.; Heckman, J.W.; Klomparens, K. L. Scanning and Transmission Electron Microscopy: An Introduction, W. H. Freeman: New York, 1993.
2. Williams, D. B.; Carter, C. B. Transmission Electron Microscopy: A Textbook for Materials Science, Plenum Press: New York, 1996.
3. Egerton, R. F. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer: New York, 1986.
4. Goldstein, J.; Newbury, D.; Joy, D.; Lyman, C.; Echlin, P.; Lifshin, E.; Sawyer, L.; Michael, J. Scanning Electron Microscopy and X-Ray Microanalysis, 3rd ed., Kluwer: New York, 2003.
5. Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Brundle, C. R.; Evans, C. A.; Wilson, S. eds., Elsevier: New York, 1992.
6. Campbell, D.; Pethrick, P. A.; White, J. R. Polymer Characterization, 2nd ed., Stanley Thornes: Cheltenham, UK, 2000.
7. Criddle, W. J.; Ellis, G. P. Spectral and Chemical Characterization of Organic Compounds: A Laboratory Handbook, 3rd ed., Wiley: New York, 1990.
8. Dinardo, N. J. Nanoscale Characterization of Surfaces and Interfaces, 2nd ed., Wiley: New York, 2004.

9. Surface Characterization: A User's Sourcebook, Brune, D.; Hellborg, R.; Hunderi, O. eds., Wiley: New York, 1997.
10. Beam Effects, Surface Topography, and Depth Profiling in Surface Analysis (Methods of Surface Characterization), Czanderna, A. W.; Madey, T. E.; Powell, C. J. eds., Plenum Press: New York,1998.
11. Ion Spectroscopies for Surface Analysis (Methods of Surface Characterization), Czanderna, A. W.; Hercules, D. M. eds., Springer: New York, 1991.
12. Brandon, D. D.; Kaplan, W. D. Microstructural Characterization of Materials, Wiley: New York, 1999.
13. Pecharsky, V.; Zavalij, P. Fundamentals of Powder Diffraction and Structural Characterization ofMaterials, Springer: New York, 2005.
14. Concise Encyclopedia of Materials Characterization, 2nd ed., Cahn, R. ed., Elsevier: San Diego, CA, 2005.
15.

CHM-760 Advance Natural Product Chemistry [Organic Chemistry]

Biosynthetic pathways for different classes of natural products i.e. Acetate, shikimate and mavalonate pathways. New developments in the separation of natural products. Biological screening of plant extracts.

Recommended Books:

1. P. S.Kalsi, S. Jagtap. Pharmaceutical, Medicinal and Natural Product Chemistry. Narosa Publishing House, New Delhi, India. ((2013).
2. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, OxfordUniversity (2001).
3. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural Products, Longman Group Ltd., U.K. (1994).
4. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).
5. N. H. Fischer, M. B.Isman, H. A. Staffard. Modern Phytochemical Methods, Springer International Edition, New York, USA. (1991).

CHM-720 Polymer Physics [Physical Chemistry]

Course Contents:

Introduction of polymer materials, thermodynamics, weight, size and conformation of polymers, amorphous vs crystalline state of polymer, and methods of its determination, liquid crystalline state of polymer, mechanical behavior of polymer, effect of fillers on mechanical behavior of polymers, thermal behavior of polymer, effect of filler on thermal behavior of polymer, polymer modification and blending, modern topics in polymer physics.

Recommended Books:

1. M. J. Bowden, in Electronic and Photonic Applications of Polymers,M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society, Washington, DC, 1988.
2. D.Williams, in Electronic and Photonic Applications of Polymers, M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society,Washington, DC, 1988.
3. D. J.Williams, ed., Nonlinear Optical Properties of Organic and Polymeric Materials, ACS Symposium Series No. 283, American Chemical Society,Washington, DC, 1983.
4. N. A. Plate, R.V.Talroze, and V. P. Shibaev, in Polymer Yearbook 3, R. A. Pethrick and G. E. Zaikov, eds., Harwood, London, 1986.
5. P. Georlette, J. Simons, and L. Costa, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
6. J. Green, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
7. J.M. J. Fréchet and D.A.Tomalia, eds., Dendrimers and Other DentriticPolymers,Wiley, Chichester, England, 2001.

CHM-761 Frontiers Nanomaterials for Bio-applications [Organic Chemistry]

Course Contents:

Foundation of Nano: Feyman talk, Discovery of Carbon Nanotube and bucky Balls, Nanomaterials; Definition, classification (Size, Shape and nature), Methodologies of Nanomaterial Synthesis, Characterization techniques, etc. Introduction of Biomolecules: Basic molecular Biology and classification of Biomolecules, self-organization of Biomolecules into functional Units (bio-macromolecules), biological motors and pumps.Merging nanotechnology with biotechnology; Biological properties of nanomaterials, theoretical study of biomolecules and nanomaterials interaction, interfacial study between nanomaterials and biomacromolecules, analysis of bio-nano interactions etc. Applications of nanomaterials in biotechnology: Cancer diagnosis and treatment, Labeling and image analysis, Drug targeting, Drug encapsulation and delivery, nanotherapeutics, nanomedicines, bio nanosensor, bio nanochips, nanodevices in medicines, future of nanobiotechnology.

Recommended Books:

1. Neimeyer, C. M. and C. A. Mirkin, 2004. Nanobiotechnology: Concepts, Applications and Perspectives. 1st Ed. Wiley VCH. Germany.
2. Nicolini, C. 2008. Nanobiotechnology and Nanobiosciences. 1st Ed. Pan Stanford Publishing Pvt Ltd. Singapore.
3. Jain, K. K. 2006. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications. Horizon Bioscience.UK.
4. Prasad, S. K. 2008. Advanced Nanotechnology. Discovery Publishing House Pvt Ltd. New Delhi, India.
5. Prasad, S. K. 2008. Progress in Nanotechnology. Discovery Publishing House Pvt Ltd. New Delhi, India.
6. Storrs, H. J. 2006. Nanofuture: What'sNext for Nanotechnology. Manas Publications. New Delhi, India.

7. Shalini, S. 2006. Nanotechnology: Basic Science to Emerging Techology. APH Publishing Corporation. New Delhi, India.
8. Wiwanitkit, V. 2008. Advanced Nanomedicine and Nanobiotechnology. 1st Ed. Nova Science Publishers Inc. New York , USA.

CHM-771 Applied Industrial Processes (Cr. 3) [Analytical Chemistry]

Course Contents:

The importance of chemical industries for the economic development of Pakistan; chemistry of ceramics and its processing; the agrochemical industry; chemistry of structural adhesives; dyes and pigments; chemistry of silicone technology; chemistry of fuel technology; corrosion; quality control (analytical and statistical).

Recommended Books

1. G.T.Austin, Shreve's Chemical Processes Industries. 5th ed., McGraw-Hill. International Editions, New York (1984).

2. K.H. Davis, Hand Book of Industrial Chemistry, Vol. 2. CBS Publshers, New Delhi (2004).

3. R. J. Farrauto, Fundamental of Industrial Catalytic Processes. Blackie Ac demic, London (1997)

Details of Courses in Biochemistry

CHM-781 Biochemistry of Disease (Cr.3)

Course Contents:

Etiology, pathogenesis, diagnosis, and immunobiology of the major microbial diseases, with emphasis on their prevention. Identification, antibiotic sensitivity and treatment of disease causing microorganisms. Haematology assessments of the numbers and quality of the various blood and bone marrow cells to identify diseases such as iron deficiency anaemia and leukaemia. Blood tests including blood grouping and antibody screening to ensure safety of transfusions. Biochemical analysis of clinical samples including blood and body fluids to assist in the diagnosis and monitoring of patients with metabolic or physiological diseases, such as diabetes. Endocrinology measures to interpret and assess hormone levels and hormonal actions (eg. thyroid hormones) in patients with dysfunctional endocrine states that can result in a wide range of conditions and diseases. Understanding the immune system and how it protects us from the

outside world to use and interpret laboratory tests that help understand where things go wrong (eg autoimmune diseases). Use of the specialized techniques at the cutting edge of science to investigate the genetic basis of disease and assessing the risk of developing disease based on genetic make-up. Histology of tissues or lesions removed from a patient to enable the microscopic diagnosis of disease processes such as cancer or infection. Cytological examination of smears of cells such as pap smears to enable the early detection of cells that may indicate the presence of malignancy.

CHM-782 Advances in Enzyme structure and function (Cr.3)

Three-dimensional conformations of proteins and protein folding with emphasis on structure-function relationships. Basic concepts of proteomic techniques and theinvestigations of protein structures. Introduction to enzyme catalysis with respect to coenzyme requirements, kinetics, catalytic mechanism and regulation of enzymatic activities. Enzyme diversity. Structure of enzyme-substrate complexes. Multienzyme complexes. Chemical catalysis. The basic equations of enzyme kinetics. Enzymatic rate constants. pH dependence of enzyme catalysis. Stereochemistry of enzymatic kinetics. Enzyme inhibition. Allosteric interactions. Specificity and editing mechanisms. Structure and mechanisms of selected enzymes. Practical kinetics. Genetic engineering and enzymology.

CHM-783 Fermentation and Biotransformation (Cr.3)

Microbial physiology and molecular genetics. Bacterial structure, energy production,nutrition and growth. Gene transfer in bacteria. Expression of the genetic information. History and Introduction to Biocatalysis. Production, Purification and Use of Biocatalysts. Comparison Enzymes vs. Whole Cell Biotransformation. Scale-Up (From Lab to Industry). Industrial Application and Processes (Food, Detergents, Pharmaceutical Intermediates, Fine Chemicals), Down Stream Processing. Glycerol fermentation. Acetone-butanol fermentation. Production of lactic acid by fermentation. Propionic acid fermentation. Production of vitamin B12. Citric acid fermentation. Fumaric acid

fermentation. Production of amino acids by microorganisms. Microbiological transformations of steroids. Antibiotics. Biochemical engineering aspects of fermentations. Drug Biotransformation.

CHM-784 Fundamentals of Molecular Biology (Cr.3)

Cell theory and the Mendelian world. Independent segregation. Independent assortment. Theory of heredity. Chromosomes, Genes and nucleic acids. Gene protein relationship. Cellular life and the laws of chemistry. Nucleic acids and the flow of genetic information. Structure of DNA, RNA and proteins. Replication. Recombination. Mutation and DNA repair. Transcription. Translation. The genetic code.Recombinant DNA technology. Molecular biology of development. Development, differentiation, rearrangements and amplifications and morphogenesis. Gene cloning. Genetic engineering and biotechnology. Applications of biotechnology in health, agriculture and environment.

CHM-785 Metabolomics (Cr.3)

Glycolysis, Regulatory Control Exerted by Phosphofructokinase. Gluconeogenesis, Reciprocal Regulation of Glycolysis and Gluconeogenesis. Pyruvate Dehydrogenase, Shuttling Metabolites. Citric Acid Cycle, Amphibolic Nature of the Pathway. Glucokinase and Diabetes Susceptibility. Electron-Transferring Reactions. Free Energy Changes Accompanying Electron Transfer. ATP Synthase. Pentose Phosphate Pathway. Regulatory Control of ATP Synthase. Glycogen Degradation, reversible Control by Phosphorylation. Fatty Acid Oxidation, Carnithine Shuttle of Fatty Acids into the Mitochondria. Reciprocal Regulation of Fatty Acid Synthesis and Breakdown, Fatty Acid Synthase Complex. Regulation of Cholesterol Biosynthesis, LDL Receptors and. Hypercholesterolemia. Amino Acid Degradation, Transaminase Action and Vitamin B6. Energy Cost of Urea Synthesis. Nitrogen Fixation, Synthesis of Amino Acids from Major Metabolic Intermediates. Synthesis of Amino Acids from Major Metabolic Intermediates. Amino Acids as Precursors to Neurotransmitters. Nitric Oxide Synthase and NO. Purine Nucleotide Synthesis, Pyrimidine

Nucleotide Synthesis and Degradation. Nucleotide Metabolism Disorders, Gout, Lesch-Nyhan Syndrome, Adenosine Deaminase Deficiency. Hormonal Regulation of Metabolism. Integration of Metabolism.

CHM-786 Metabolic regulations (Cr.3)

Enzymatic regulation. Receptor-mediated regulation. Biosynthesis of carbohydrates, lipids, DNA, RNA and proteins. The metabolism of amino acids and components of nucleic acids; prokaryotic gene regulation; DNA mutation and repair. The integration of metabolic pathways. Regulation and integration of metabolism in mammals. Molecular and cellular aspects of carbohydrate, lipid and amino acid metabolism. Supply of and demand for different fuels by different tissues. Handling of dietary carbohydrate and fat; fasting, starvation and diabetes. Influence of dietary fats on cardiovascular risk markers.

CHM-787 Biological Oxidations (Cr.3)

oxidation of food stuff, the mitochondrion transport of ions and metabolites through shuttle system, thermodynamics of electron transport chain, Redox reactions, Applications of redox reactions in biochemical reactions, high energy phosphate compounds, co-enzymes involved in biochemical redox reactions, reducing equivalents, flow of electron through electron transport chain, ATP formation, ROS, enzyme complexes involved in electron transport chain, Antioxidants, clinical problems associated with deficiency of some of enzymes and co-enzymes.

CHM-788 Lab Techniques in Biochemistry (Theory + Lab Work) (Cr.3)

Introduction. Techniques used for isolation, purification, quantification and characterization of various bio-molecules such as Homogenization, Sonication, Electrophoresis, Centrifugation, Chromatography, Spectroscopy etc.

CHM-789 Biostatistics (Cr.3)

Population and samples. Measures of central tendency. Measures of dispersion and variability. Probabilities. The normal distribution. Sample hypotheses. The analysis of variance. Multiple comparisons. Two-factor analysis of variance. Data

transformations. Factorial analysis of variance. Multivariate analysis of variance. Simple linear regression. Simple linear correlation. Polynomial regression. Testing for goodness fit. Testing for randomness.

CHM-790 Research Methodology and scientific writing (Cr.3)

Introduction. Developing a scientific hypothesis. Synopsis writing. Literature review. Primary and secondary resources. Plagiarism. Designing experimental strategies. Importance of appropriate controls. Basic laboratory procedure and precautions.Computation and analysis of the experimental data. Data presentation. Tables, diagrams, graphs, illustrations and computation. Quantification and Statistical analysis.Using appropriate computer softwares. Making conclusions. Dissertation write-up.Making a thesis statement. Writing a preliminary report. Literature citation. Preparing the manuscript: structure, substance, style, language and layout. Impact factor. Editing and proof reading. Formats and guidelines. Progress reports. Research ethics.

CHM-791 Techniques in Molecular Biology (Cr.03)

DNA isolation and purification from microbial, animal and plant cells. Basic microbiological techniques. Ultracentrifugation. PAGE and agarose gel electrophoresis. Capillary electrophoresis. Restriction endonucleases. Restriction digestion, analysis and mapping. DNA sequencing. Primer extension and reverse transcription. DNA ligation. Plasmids, vectors, cosmids and bacteriophages. DNA amplification through plasmid preps and PCR technology. DNA ligation and selection of recombinants. Transformation of bacterial and non-bacterial cells. Cloning vectors of E. coli. Cloning vectors for organisms other than E. coli. Cloning vectors for higher plants. Cloning vectors for mammalian cells. Expression vectors. Southern, Northern and Western blottings. Protein purification and analysis. Techniques to study protein-nucleic acid and protein-protein interactions.

CHM-792 Forensic Chemistry (Cr.03)

Forensic Science: Evidence and the Scene of the Crime. Identification, characterization, recovery and weighing of trace evidence types. Crime scene searching methodologies; the integrity and continuity of evidence. Introduction to laboratory testing dealing with glass, tool-mark, shoe-mark and tire impressions. Procedures at crime scenes illustrated by reference to crimes of burglary, murder and sexual offences. Fingerprint history, classification, recovery and chemical enhancement of fingerprints. Blood pattern analysis supporting the advances in DNA techniques. Sexual offence investigation and body fluid identification. Clinical indicators of death and murder scene investigation. Drug Abuse, Alcohol and Forensic Toxicology. Drugs of abuse and their identification. Drugs, alcohol poisons and their metabolism. Toxicology and the role of the forensic toxicologist. Qualitative and quantitative laboratory analysis. Signature and handwriting identification. Paper, inks and printed documents. Damage characterization. Fires and Explosions: Arson. Fire and combustion. Types of explosives and the nature of explosions. The crime scene investigation: sampling and laboratory analysis.

Item No.6
Approval of External Examiners for M.Sc./M.phil./Ph.D. thesis evaluation

LIST OF EXAMINERS

1.	Dr. M. Siddique (Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: m_sidiq12@yahoo.com
2.	Dr. Afzal Shah (Assistant Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: Afzals-qau@yahoo.com
3.	Dr. Hazrat Hussain (Associate Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: Hazrat.hussain@gmail.com
4.	Dr. Syed Mujtaba Shah (Assistant Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: Smschem69@yahoo.com
5.	Dr. Naveed Kausar Janjua (Assistant Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: Nkausarjanjua@yahoo.com Email: Nkjanjua@qau.edu.pk
6.	Dr. Azhar Iqbal Assistant Professor Department of Chemistry Quaid-e-Azam University Islamabad. Email: Aiqbal@qau.edu.pk,
7.	Dr. Safeer Ahmed (Assistant Professor) Department of Chemistry Quaid-e-Azam University Islamabad. Email: Safeerad@qau.edu.pk

8.	Dr. Zahoor Hussain Farooqi (Assistant Professor) Institute of Chemistry Punjab University, Lahore. Email: zhfarooqi@gmail.com
9.	Dr. Mohsin Nawaz (Assistant Professor) Institute of Chemistry Hazarat University.
10.	Dr. Jan Nisar (Associate Professor) Centre of Excellence in Physical Chemistry, University of Peshawar, KPK
11.	Dr. Atta ur Rehman Assistant Professor, Institute of Chemical Sciences University of Peshawar, Peshawar Pakistan Cell# 0333 9101711
12.	Dr. Qaisar Mahmood Malik PS, Head (CDG), DGRE, PAEC Head Quarter, Opposite K block, Pakistan Secretariat Islamabad. Cell # 0334 5065519, 0300 3679491, 0333 9101711
13.	Dr. Muhammad Faizan Nazar (Assistant Professor) Department of Chemistry University of Gujrat Hafiz Hayat Campus, Gujrat Cell # 0301 6942411
14.	Dr. Adeel Mehmood Assistant Professor Department of Environment Sciences COMSATS, Islamabad. Cell # 0333-5805776
15.	Dr. Tariq Hussain Bhatti

	PIEAS, Islamabad
16.	Dr. Muhammad Rafi PS NILOPE Islamabad, Pakistan. Cell # 0333 5434857
17.	Dr. M. Amin Abid (Assistant Professor) Department of Chemistry Narowal Campus UET Lahore Email: mabiduet@gmail.com
18.	Dr. M. Toseef Tanveer PIEAS, Islamabad Pakistan. Email: ttanvir@pieas.edu.pk
19.	Dr. Tahir Mehmood Assistant Professor Department of Chemistry University of Wah, Wah Cantt, Pakistan. Cell # 0300 9799452
20.	Dr. Umer Rashid Assistant Professor Department of Chemistry Hazara University, Garden Campus, Mansehra Pakistan. Email: umer.rashid@hu.edu.pk Cell# 03125161999
21.	Dr. Obaid Ur Rehman Assistant Professor Department of Chemistry Hazara University, Garden Campus, Mansehra Pakistan. Cell# 0333 5503410

22.	Dr. M. Naeem Ahmad Assistant Professor Department of Chemistry UAJ&K Muzaffarabad.
23.	Prof. Dr. Faiz-ul-Hassan Nasim Chairman Department of Chemistry The Islamia University of Bahawalpur Email: faiznasim@hotmail.com
24.	Prof. Dr. Mukhtiar Hasan Chairman Department of Biochemistry Hazara University Email: mukhtiarh@gmail.com
25.	Dr. Muhammad Sajid Assistant Professor Department of Biochemistry Hazara University Email: sajid931@hotmail.com
26.	Dr. Umer Rashid Assistant Professor Department of Bio Chemistry University of Gujrat Email: umer.rashid@uog.edu.pk
27.	Dr. Sajid Mehmood Assistant Professor Department of Chemistry University of Gujrat, Gujrat Email: sajid.mehmood@uog.edu.pk
28.	Dr. M. Javid Asad Associate Professor Department of Bio-Chemistry

	Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi
29.	Dr. Abdul Rehman Khan Assistant Professor Department of Chemistry University of Azad Jammu & Kashmir, Muzaffarabad
30.	Dr. Syed Mubashar Sabir Assistant Professor Department of Chemistry University of Poonch Rawalakot.
31.	Dr. Muhammad Yasin Assistant Professor Institute of Chemical Sciences University of Peshawar, Peshawar Pakistan. Cell #0334 9824696
32.	Dr. Muhammad Rafique GM, Project Management Organization (PMO) Opposite EME College Rawalpindi E-10A, Gulshan Colony CPO 177 Taxila Cantt. Rawalpindi Email: muhammadrafiquepk@gmail.com Cell# 0320 5454014
33.	Dr. Saifullah Jaam Associate Professor Department of chemistry Govt. Post graduate college Bahawalpur. Cell # 0300 6853600
34.	Dr. Shahid Saeed Qureshi Assistant Professor Government Post Graduate College Jhelum Pakistan.

	Cell # 0333 5832123
35.	Dr. Umer Farooq Assistant Professor Department of applied chemistry UET Lahore. Cell # 0315 4168928
36.	Dr. M. Arif Nadeem (Inorganic/Analytical) Assistant Professor Department of Chemistry Quaid-e-Azam Islamabad.
37.	Dr. Kousar Yasmin Assistant Professor Department of Chemistry Federal Urdu University of Arts Sciences & Technology Karachi. Cell # 0300 9213109
38.	Dr. Abdul Jabbar Kandhro Assistant Professor Peoples University of Health Sciences Nawab Shah Sindh, Pakistan. Cell # 0301 3586270
39.	Prof. Dr. Imtiaz Ahmad Department of Chemistry Islamia College University Peshawar.
40.	Prof. Dr. Muhammad Nawaz Tahir Department of Physics, Sargodha University, Sargodha, Pakistan.
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Item No.7
Approval of Specialization in Inorganic Analytical Chemistry

- Department intends to offer specialization in Inorganic Analytical Chemistry by offering half credit hour courses in inorganic and half in analytical chemistry in 3rd and 4th semester of two year program and in 7th and 8th semester of B.S. four year program, respectively.