Curriculum / Scheme of Studies

of

Bachelor of Science in Chemistry

(BS Chemistry)

(Revised in 2018)

University of Education Lahore

Table of Contents

Introduction:

The policy of the government is to transform the education system to more purposeful scientific route through effective teaching and active participation of the students in the classroom. The basic qualification for a secondary school science teacher is BS/MSc in science subjects, such as Biology, Chemistry, Mathematics or Physics with a professional degree in education.The subject of Chemistry is introduced from elementary level in general science and as a subject at secondary and higher secondary levels.

Keeping in view the acute shortage of trained chemistry teachers, chemists, and realizing that the success of any country and a nation depends upon the availability of well-trainedteachers, this post graduate degree program entitled BS in Chemistry is proposed. It will cater experts not only at secondary and higher secondary school education but also chemists in industry.

The UE graduates after completion of this program will be able to compete with graduates of other universities because this program is designed so as to include the normal BS Chemistry course along with education subjects (Foundations of Education,General Methods of Teaching,Educational Assessment, Curriculum Design and Instruction& teaching practice) in the first four semesters to cater the needs of chemistry teachers/subject specialists/lecturers, and chemists.

The curriculum is designed to develop knowledge based on fundamentals of OrganicChemistry, InorganicChemistry, PhysicalChemistry, Biochemistry, Fuel Chemistry and Analytical Chemistry which ultimately lead to applied aspects during teaching, research and specialization.

Program Objectives:

The main objectives of the program are to:

1. Encourage intellectual development and scholarship in and through Chemistry.
2. Impart a sound knowledge of Chemistry to students and to guide them to apply this knowledge creatively and analytically in daily life.
3. Develop in students an awareness of the applications of Chemistry including its practical, social and economic aspects such as health, agriculture, industry and defense etc.

4. Develop and improve student's practical, written and oral communication, information retrieval, computer and problem solving skills.
5. Encourage students to become effective independent learners.
6. Develop the need based curriculum and its continuous development shall be made considering the changing global and national requirements.
7. Develop in students the ability of group work for cooperative learning so as to acquire respect for human values.
8. Encourage students to broaden their knowledge, to develop their own capabilities and self-confidence, to respect learning and to participate in continuing education.

Vision:

To develop dynamic chemists as leadersand practitioners in the teaching, research, industry and laboratory management having content excellence along with pedagogical competence, commitment and integrity who may ensure quality and sustainable development at all tiers and sectors of education and research.

Mission Statement:

To achieve the premier& utmost possible standards of teaching and research in Chemistry.

Admission Requirements:

F.Sc. (Pre-Medical or Pre-Engineering)/A-Level with Chemistry or equivalentas per UE rules.

Medium of Instructions and Examination:

The medium of instruction and examination shall be ENGLISH except Islamic Studies which is Urdu. For languages **(e.g. Arabic)**, the medium of instruction and examination shall be that language**.**

Program Design

SN	Categories of Courses	No. of Courses	Credit Hours
1	Compulsory	9	25
2	General	9	29
3	Foundation	7	25
4	Major / Core	8	32
5	Specialization	6	19
6	Elective	2	6
7	Thesis / Special Paper	1/2	6
8	*Teaching Practice	2	Non-Credited
		Total	**142**

Program Layout

Compulsory Courses

SN	Course Code	Course Title	Credit Hours
1	ISLA1111/ HUMN1111	Islamic Studies / Ethics* (*For non-Muslim Students)	2 (2+0)
2	PAKS1111	Pakistan Studies	2(2+0)
3	ENGL1114	Functional English	3(3+0)
4	ENGL1119	Communication Skills	3 (3+0)
5	ENGL2115	Technical Writing and Presentation Skills	3(3+0)
6	COMP1111	Introduction to Information Technology	3 (3+0)
7	BOTN1111/ PHYS1111	Diversity of Plants / Mechanics –I	4 (3+1)
8	MATH3116	Mathematics for Chemist	2 (2+0)
9	STAT2111	Introduction to Statistics and Probability	3 (3+0)

General Courses

SN	Course Code	Course Title	Credit Hours
1	EDUC3111	Foundations of Education	3(3+0)
2	EDUC1112	General Methods of Teaching	3 (3+0)
3	EDUC3143	Educational Assessment	3(3+0)
4	EDUC2118	Curriculum Design and Instruction	3 (3+0)
5	MATH1111/ ZOOL1111	Calculus I / Principles of Animal Life-I	3 (3+0)/ 4 (3+1)
6	MATH1112/ ZOOL1112	Calculus II / Principles of Animal Life-II	3 (3+0)/ 4 (3+1)

7	MATH2111/ ZOOL2111	Calculus III / Animal Diversity-I	3 (3+0)/ 4 (3+1)
8	BOTN1112/ PHYS1114	Plant Systematics, Anatomy and Development /Mechanics-II	4 (3+1)
9	BOTN2111/ PHYS2111	Cell Biology, Genetics and Evolution / Electricity and Magnetism-1	4 (3+1)

Foundation Courses

SN	Course Code	Course Title	Credit Hours
1	CHEM2112	Analytical Chemistry	4 (3+1)
2	CHEM2114	Introduction to Biochemistry	3 (3+0)
3	CHEM2111	Environmental Chemistry	3(3+0)
4	CHEM2113	Industrial Chemistry	3 (3+0)
5	CHEM1111	Fundamentals of Inorganic Chemistry	4 (3+1)
6	CHEM1113	Fundamentals of Organic Chemistry	4 (3+1)
7	CHEM1112	Fundamentals of Physical Chemistry	4 (3+1)

Major / Core Courses

SN	Course Code	Course Title	Credit Hours
1	CHEM3111	Chemistry of Transition Elements	4 (3+1)
2	CHEM3112	Stereochemistry and Reaction Mechanism	4 (3+1)
3	CHEM3113	Quantum Chemistry and Gas Phase Equilibrium	4 (3+1)
4	CHEM3114	Advanced Analytical Chemistry	4 (3+1)
5	CHEM3115	Inorganic Material Chemistry	4 (3+1)
6	CHEM3116	Organic Reaction Mechanisms	4 (3+1)
7	CHEM3117	Advanced Physical Chemistry	4 (3+1)
8	CHEM3118/ CHEM3119/ CHEM3120	Applied Chemistry/ Biometabolism / Fuel Chemistry	4 (3+1)

Specialization

Inorganic Chemistry (Table - A)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4111	Inorganic Reaction Mechanism	4(3+1)
2	CHEM4113	Pi-Acceptor Ligands and Polymers	3(3+0)
3	CHEM4115	Inorganic Spectroscopy	3(3+0)
4	CHEM4118	Organometallics	3(3+0)
5	CHEM4120	Symmetry and Magnetochemistry	3(3+0)

6	CHEM4122	Radio and Nuclear Chemistry	3(3+0)
Organic Chemistry (Table - B)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4112	Heterocyclic and Organometallics	4(3+1)
2	CHEM4114	Reactive Intermediates	3(3+0)
3	CHEM4116	Organic Spectroscopy	3(3+0)
4	CHEM4119	Natural Products	3(3+0)
5	CHEM4121	Organic Synthesis	3(3+0)
6	CHEM4123	Medicinal Chemistry	3(3+0)
Physical Chemistry (Table - C)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4143	Electrochemistry and Statistical Thermodynamics	4(3+1)
2	CHEM4144	Polymer Chemistry	3(3+0)
3	CHEM4145	Quantum Chemistry and Molecular Spectroscopy	3(3+0)
4	CHEM4146	Reaction Dynamics	3(3+0)
5	CHEM4147	Radiation and Photochemistry	3(3+0)
6	CHEM4148	Colloid and Surface Chemistry	3(3+0)
Analytical Chemistry (Table - D)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4125	Atomic Spectrophotometry	4(3+1)
2	CHEM4126	Electroanalytical Techniques	3(3+0)
3	CHEM4127	Advanced Separation Techniques	3(3+0)
4	CHEM4128	Luminescence Spectroscopy and Thermal Analysis	3(3+0)
5	CHEM4129	Nuclear Analytical Techniques	3(3+0)
6	CHEM4130	Food and Drug Analysis	3(3+0)
Applied Chemistry (Table - E)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4131	Common Industries- I	4(3+1)
2	CHEM4132	Agro Based Industries and Pollution Control	3(3+0)
3	CHEM4133	Common Industries –II	3(3+0)
4	CHEM4134	Organic Based Industries	3(3+0)
5	CHEM4135	Industrial Processes	3(3+0)

6	CHEM4136	Metallurgy and Explosives	3(3+0)
Biochemistry (Table - F)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4137	Biomedical Chemistry	4(3+1)
2	CHEM4138	Nucleic Acid and Protein Synthesis	3(3+0)
3	CHEM4139	Physical Techniques in Biochemistry	3(3+0)
4	CHEM4140	Microbiology and Immunology	3(3+0)
5	CHEM4141	Bionanotechnology	3(3+0)
6	CHEM4142	Nutritional Chemistry	3(3+0)
Fuel Chemistry (Table - G)			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4149	Chemistry of Coal Conversion	4(3+1)
2	CHEM4150	Petroleum and Petrochemicals-I	3(3+0)
3	CHEM4151	Characterization of Fossil Fuels	3(3+0)
4	CHEM4149	Coal Conversion Processes	3(3+0)
5	CHEM4153	Petroleum and Petrochemicals-II	3(3+0)
6	CHEM4154	Alternate Energy Resource	3(3+0)
Elective Courses			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEMXXXX	Elective Course-I	3 (3+0)
2	CHEMXXXX	Elective Course-II	3 (3+0)
Thesis/Special Paper/Research Project			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEMXXXX	Special Paper–I	3 (3+0)
2	CHEM4117/ CHEMXXXX	Thesis/ Special Paper–II	6 (0+6) / 3 (3+0)

Teaching Practice

SN	Course Code	Course Title	Credit Hours
1	EDUC2127	*** Short Term Teaching Practice-I	Non-Credit Course
2	EDUC3160	*** Short Term Teaching Practice-II	Non-Credit Course

***Six Credit Hours (Non-credited) Teaching Practice is mandatory to fulfill degree requirement. It will comprise of 3 weeks and it will be conducted twice, i.e., before start of 3rd and 5th semester. It will have 3 credit hours (each time) for teaching / evaluation purpose; however, it will be reflected as non-credited course on the Transcript of 3rd and 5th semester.

Semester Breakup

Semester-I

SN	Course Code	Course Title	Credit Hours
1	ENGL1114	Functional English	3 (3+0)
2	ISLA1111/ HUMN1111	Islamic Studies / Ethics**	2 (2+0)
3	EDUC3111	Foundations of Education	3 (3+0)
4*	BOTN1111	Diversity of Plants	4 (3+1)
	PHYS1111	Mechanics-I	4 (3+1)
5*	ZOOL1111	Principles of Animal Life-I	4 (3+1)
	MATH1111	Calculus-I	3 (3+0)
6	CHEM1111	Fundamentals of Inorganic Chemistry	4 (3+0)
* Student may opt any one course ** For non-Muslim Students			

Semester-II

SN	Course Code	Course Title	Credit Hours
1	ENGL1119	Communication Skills	3 (3+0)
2	PAKS1111	Pakistan Studies	2 (2+0)
3	EDUC1112	General Methods of Teaching	3 (3+0)
4*	BOTN1112	Plant Systematics, Anatomy and Development	4 (3+1)
	PHYS1114	Mechanics-II	4 (3+1)
5*	ZOOL1112	Principles of Animal Life-II	4 (3+1)
	MATH1112	Calculus- II	3 (3+0)
6	CHEM1113	Fundamentals of Organic Chemistry	4 (3+0)
* Student may opt any one course			

Six Credit Hours (Non-credited) Teaching Practice is mandatory to fulfill degree requirement. It will comprise of 3 weeks and it will be conducted twice, i.e., before start of 3rd and 5th semester. It will have 3 credit hours (each time) for teaching / evaluation purpose; however, it will be reflected as non-credited course on the Transcript of 3rd and 5th semester.

Semester-III

SN	Course Code	Course Title	Credit Hours
1	ENGL2115	Technical Writing and Presentation Skills	3 (3+0)
2	EDUC3143	Educational Assessment	3 (3+0)
3*	BOTN2111	Cell Biology, Genetics and Evolution	4 (3+1)
	PHYS2111	Electricity and Magnetism-I	4 (3+1)
4*	ZOOL2111	Animal Diversity-I	4 (3+1)
	MATH2111	Calculus- III	3 (3+0)
5	CHEM2111	Environmental Chemistry	3 (3+0)
6	CHEM1112	Fundamentals of Physical Chemistry	4 (3+1)
7	EDUC2127	Short Term Teaching Practice-I	Non Credit
* Student may opt any one course			

Semester-IV

SN	Course Code	Course Title	Credit Hours

1	COMP1111	Introduction to Information Technology	3 (3+0)
2	STAT2111	Introduction to Statistics and Probability	3 (3+0)
3	EDUC2118	Curriculum Design and Instruction	3 (3+0)
4	CHEM2112	Analytical Chemistry	4 (3+1)
5	CHEM2113	Industrial Chemistry	3 (3+0)
6	CHEM2114	Introduction to Biochemistry	3 (3+0)

Six Credit Hours (Non-credited) Teaching Practice is mandatory to fulfill degree requirement. It will comprise of 3 weeks and it will be conducted twice, i.e., before start of 3rd and 5th semester. It will have 3 credit hours (each time) for teaching / evaluation purpose; however, it will be reflected as non-credited course on the Transcript of 3rd and 5th semester.

Semester-V

SN	Course Code	Course Title	Credit Hours
1	MATH3116	Mathematics for Chemist	2 (2+0)
2	CHEM3111	Chemistry of Transition Elements	4 (3+1)
3	CHEM3112	Stereochemistry and Reaction Mechanism	4 (3+1)
4	CHEM3113	Quantum Chemistry and Gas Phase Equilibrium	4 (3+1)
5	CHEM3114	Advanced Analytical Chemistry	4 (3+1)
6	EDUC3160	Short Term Teaching Practice II	Non Credit

Semester-VI

SN	Course Code	Course Title	Credit Hours
1	CHEM3115	Inorganic Material Chemistry	4 (3+1)
2	CHEM3116	Organic Reaction Mechanisms	4 (3+1)
3	CHEM3117	Advanced Physical Chemistry	4 (3+1)
4*	CHEM3118	Applied Chemistry	4 (3+1)
	CHEM3119	Biometabolism	4 (3+1)
	CHEM3120	Fuel Chemistry	4 (3+1)
* Student may opt any one course			

Semester-VII

Specialization in Inorganic Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4111	Inorganic Reaction Mechanism	4 (3+1)
2	CHEM4113	Pi-Acceptor Ligands and Polymers	3 (3+0)
3	CHEM4115	Inorganic Spectroscopy	3 (3+0)
4	CHEM4XXX	Elective- I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the field of specialization)	3 (3+0)
Specialization in Organic Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4112	Heterocyclic and Organometallics	4 (3+1)
2	CHEM4114	Reactive Intermediates	3 (3+0)
3	CHEM4116	Organic Spectroscopy	3 (3+0)
4	CHEM4XXX	Elective- I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the field of specialization)	3 (3+0)
Specialization in Analytical Chemistry			

SN	Course Code	Course Title	Credit Hours
1	CHEM4125	Atomic Spectrophotometry	4 (3+1)
2	CHEM4126	Electroanalytical Techniques	3 (3+0)
3	CHEM4127	Advanced Separation Techniques	3 (3+0)
4	CHEM4XXX	Elective - I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the field of specialization)	3 (3+0)
Specialization in Applied Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4131	Common Industries- I	4 (3+1)
2	CHEM4132	Agro Based Industries and Pollution Control	3 (3+0)
3	CHEM4133	Common Industries –II	3 (3+0)
4	CHEM4XXX	Elective - I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the field of specialization)	3 (3+0)
Specialization in Biochemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4137	Biomedical Chemistry	4 (3+1)
2	CHEM4138	Nucleic Acid and Protein Synthesis	3 (3+0)
3	CHEM4139	Physical Techniques in Biochemistry	3 (3+0)
4	CHEM4XXX	Elective - I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the field of specialization)	3 (3+0)
Specialization in Physical Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4143	Electrochemistry and Statistical Thermodynamics	4 (3+1)
2	CHEM4144	Polymer Chemistry	3 (3+0)
3	CHEM4145	Quantum Chemistry and Molecular Spectroscopy	3 (3+0)
4	CHEM4XXX	Elective - I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the area of specialization)	3 (3+0)
Specialization in Fuel Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4149	Chemistry of Coal Conversion	4 (3+1)
2	CHEM4150	Petroleum and Petrochemicals-I	3 (3+0)
3	CHEM4151	Characterization of Fossil Fuels	3 (3+0)
4	CHEM4XXX	Elective - I (other than the field of specialization)	3 (3+0)
5	CHEM4XXX	Elective - II (other than the area of specialization)	3 (3+0)

Semester-VIII

Specialization in Inorganic Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4118	Organometallics	3 (3+0)
2	CHEM4120	Symmetry and Magnetochemistry	3 (3+0)
3	CHEM4122	Radio and Nuclear Chemistry	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117/	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)

Specialization in Organic Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4119	Natural Products	3 (3+0)
2	CHEM4121	Organic Synthesis	3 (3+0)
3	CHEM4123	Medicinal Chemistry	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117/	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)
Specialization in Analytical Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4128	Luminescence Spectroscopy and Thermal Analysis	3 (3+0)
2	CHEM4129	Nuclear Analytical Techniques	3 (3+0)
3	CHEM4130	Food and Drug Analysis	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117/ CHEMXXXX	Thesis / Special Paper - II (other than the field of specialization)	6 (0+6) / 3 (3+0)
Specialization in Applied Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4134	Organic Based Industries	3 (3+0)
2	CHEM4135	Industrial Processes	3 (3+0)
3	CHEM4136	Metallurgy and Explosives	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117/	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)
Specialization in Biochemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4140	Microbiology and Immunology	3 (3+0)
2	CHEM4141	Bionanotechnology	3 (3+0)
3	CHEM4142	Nutritional Chemistry	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117/	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)
Specialization in Physical Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4146	Reaction Dynamics	3 (3+0)
2	CHEM4147	Radiation and Photochemistry	3 (3+0)

3	CHEM4148	Colloid and Surface Chemistry	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117 /	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)
Specialization in Fuel Chemistry			
SN	**Course Code**	**Course Title**	**Credit Hours**
1	CHEM4149	Coal Conversion Processes	3 (3+0)
2	CHEM4153	Petroleum and Petrochemicals-II	3 (3+0)
3	CHEM4154	Alternate Energy Resource	3 (3+0)
4	CHEMXXXX	Special Paper - I (other than the field of specialization)	3 (3+0)
5	CHEM4117 /	Thesis /	6 (0+6) /
	CHEMXXXX	Special Paper - II (other than the field of specialization)	3 (3+0)

Note:

- **Specialization:**

Students of semester VII & VIII may be divided into one or more group/s of specialization depending upon the Expertise, Faculty and Facilities available.

- **Elective Courses and Special Papers:**

Any of the Elective Course and Special Paper will be selected from Tables **(A – G)**, other than area of specialization.

- **Start and Evaluation of Thesis:**

The Thesis (Research work) will start in Semester VII but the evaluation of Thesis will be carried out at the end of Semester VIII after viva-voce of student.

- **Industrial/Study Tour:**

Visit to any industry/organization in semester VII and/or VIII to understand the objectives and contents of industries/organizations and also laboratory management which is a good application of practical knowledge.

Course Outlines

(Semester - I)

Course Title: **Functional English**

Course Code: **ENGL1114**

Credit Hours: **3 (3+0)**

Specific Objectives of the Course: To enhance language skills and develop critical thinking, To enable students to use English language for various functions

Course Outline: Identifying main idea from long extracts / speeches, Making requests and asking questions to receive specific information in different contexts, Understanding organizational clues in shorter texts**,** Use basic punctuation in appropriate way**,** Compare and contrast shorter texts**,** Identifying inferred and implicit meaning in a text, Use of phrasal verbs and idioms**,** Using correct grammar (e.g. subject-verb agreement, coherence and cohesion), Writing applications for leave, job etc. Writing official letters, letters to newspapers, Writing reports, emails, Reading and writing book reviews, resume writing

Recommended Readings:

- Ellen, K (2002).*Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top* (Latest Edition).
- Fisher, A (2001).*Critical Thinking.* CUP. (Latest Edition).
- Mandel, S (2000). *Effective Presentation Skills: A Practical Guide Better Speaking Communication for Business Success* (Canadian Edition v.1.0)
- Wren, P.C., Martin, H., & Rao, N.P (2000) *High School English Grammar and Composition*, S Chand& Company. (Latest Edition).

نصاب کوڈ :اِسلامیات ۱۱۱۱ **Course Code: ISLA1111**

عنوان نصاب:اِسلامیات **Course Title: Islamic Studies**

کریڈٹ آورز:(۲+۰)۲ **Credit Hours: 2 (2+0)**

شرائط: کوئی نہیں **Pre-Requisite: Nil**

نصاب کے مخصوص مقاصد:

طالب علم کو اسلام کی بنیادی تعلیمات سے روشناس کروانا، اِسلامی تعلیمات اور اِسلامی تہذیب سے متعلق ان کی تفہیم کو بڑھانا، عبادات اور روزمرہ زندگی کے معاملات کی اِصلاح، بنیادی عقائد کو سمجھنے اور اپنی زندگی اسلامی قدروں کے مطابق گزارنے کے حوالہ سے طالبِ علم کی صلاحیتوں کو بڑھانا۔

نصاب کے مندرجات

قرآنیات:

قرآن تمام بنی نوع اِنسان کے لئے عالمگیر دستور ہے۔ حِفاظتِ قرآن، جمع و تدوینِ قرآن، آیات سورہ بقرہ(۲۸۶۔۲۸۴)، آیات سورہ حجرات(۱۸۔۱)، آیات سورہ فرقان(۷۷۔۶۳)

مطالعہ حدیث:

قرآن کی تفہیم میں حدیث کی اہمیت، تدوینِ حدیث، حفاظتِ حدیث، حدیث کی اقسام، اربعین نووی(حدیث ۲۰۔۱)

اِیمانیات اور عقائد:

عقائدِ اِسلام، ارکانِ اِسلام اور ان کا فلسفہ

اِسلام کا معاشی نظام:

اِسلام میں زکوٰۃ کی اہمیت، صدقہ و خیرات کی تعریف، اِسلام میں کسبِ حلال کی اہمیت سورہ بقرہ کی آیات(۱۶۸،۱۸۸)اور اربعین نووی(حدیث:۶،۱۰) کی روشنی میں، اِسلام میں سود حرام اور غیر قانونی ہے۔ اِسلامی معاشرہ میں سود کی روک تھام اور انسداد کی ضرورت۔

اِسلامی طرزِ زندگی:

سادگی، تعیشات سے احتراز، جسمانی و روحانی پاکیزگی، تحمل و برداشت، مسلمانوں اور غیر مسلموں میں عفو و درگزر اور صبر (سورہ اعراف آیت ۱۹، سورہ العنکبوت آیت ۴۶، سورہ المزمل آیت ۱۰، الانعام آیت ۱۰۸، سورہ آل عمران ۶۷۔۶۴، سورہ المائدہ آیت ۸ اور سورہ الکافرون۔

انسانی حقوق:

نبی اکرم ﷺ کا آخری خطبہ (حجۃ الوداع)، مسلمان کی زندگی کی حرمت، اقلیتوں کے حقوق کی ضمانت، (سورہ اسرا: ۷۰، سورہ التین: ۴)، میدانِ جنگ کے مقتولین، زخمیوں، اور میدانِ جنگ کے اخلاقیات سے متعلق نبی اکرم ﷺ اور پہلے خلیفہ حضرت ابو بکر رضی اللہ عنہ کی قولی و عملی ہدایات، حلال جانوروں کے ذبح کی احتیاطی تدابیر اربعین نووی حدیث: ۱۷، جانوروں کے ساتھ ظالمانہ سلوک کی ممانعت، اِسلام ان کے حقوق کا محافظ ہے، اسلام۔۔۔امن و آشتی کا مذہب۔

برِ صغیر میں صوفیائے اِسلام:

حضرت علی ہجویریؒ، حضرت معین الدین چشتیؒ، حضرت فرید الدین مسعودؒ، حضرت مجدد الف ثانیؒ، صوفیاء بطور عملی مسلمان، صوفیاء بطور معلمین و مبلغینِ اِسلام، اِسلام کے نمائندگان کے طور پر صوفیاء کا کردار۔

مجوزہ کتب:

۱۔ حمید اللہ، محمد، اِسلام کا طلوع، (ایمرجنس آف اِسلام)، آئی آر آئی، اِسلام آباد۔

۲۔ حمید اللہ، محمد، اِسلام کیا ھے ؟، (انٹروڈکشن ٹو اِسلام)۔

۳۔ مودودی، ابو الاعلی، سید، تفہیمات، ادارہ تعمیرِ اِنسانیت، اردو بازار لاہور

۴۔ اِصلاحی امین احسن، تزکیہ نفس، ادارہ تعمیرِ اِنسانیت، اردو بازار لاہور

۵۔ خلیفہ عبد الحکیم، اسلامی نظریہ حیات، (اِسلامی آئیڈیالوجی)، ادارہ ثقافتِ اِسلامیہ، لاہور

۶۔ نیازی، لیاقت علی خان، اسلامی نظریہ حیات، سنگ میل پبلیکیشنز، لاہور

۷۔ محمد ضیاء الحق، انٹروڈکشن ٹو الشریعہ الاسلامیہ، علامہ اقبال اوپن یونیورسٹی، اِسلام آباد

۸۔ شبلی نعمانی، سیرۃ النبی ﷺ

۹۔ صفی الرحمٰن مبارکپوری، الرحیق المختوم، ادارہ دارالسلام، لاہور

۱۰۔ مودودی، ابو الاعلی، سید، سود، ادارہ اِسلامک پبلیکیشنز، لاہور

۱۱۔ سعیدی، غلام رسول، تبیان القرآن، ضیاء القرآن پبلشر، لاہور

۱۲۔ طاہر القادری، خونِ مسلم کی حرمت، منہاج القرآن پبلشر، لاہور

۱۳۔ طاہر القادری، میثاقِ مدینہ، منہاج القرآن پبلشر، لاہور

۱۴۔ طاہر القادری، مسلم ریاست میں غیر مسلموں کی حفاظت، منہاج القرآن پبلشر، لاہور

۱۵۔ محمود الطحان، اصطلاحات الحدیث، ادارہ اِسلامک پبلیکیشنز، لاہور

۱۶۔ غلام رسول سعیدی، تذکرۃ المحدثین، مکتبہ فرید بک سٹال، لاہور

۱۷۔ عبد الصمد الصارم، الازہری، تاریخ حفاظتِ حدیث، مکتبہ معین الادب، لاہور

۱۸۔ گیلانی، اسعد علی، اِنقلابِ نبوی ﷺ کی حکمت و خدوخال، ادارہ اِسلامک پبلیکیشنز، لاہور

۱۹۔ علی ہجویری، کشف المحجوب

۲۰۔ صوفیاء کے حالات، اِنسائیکلوپیڈیا اردو دائرہ معارفِ اِسلامیہ، پنجاب یونیورسٹی، لاہور

Course Title: **Ethics**

Course Code: **HUMN1111**

Credit Hours: **2(2+0)**

Course Objectives:

- This course will serve as an introduction to religious ethics in general and to personal ethics in particular.
- You will consider the positions of historical thinkers as well as contemporary philosophers.
- You will gain understanding of specific topics in character building.

Topics

1. What is Ethics?
2. Religious Ethics: A Comparative Study
3. Ethical Values
    i. Hinduism
    ii. Budhism
    iii. Zoroasterianism
    iv. Judaism
    v. Christianity and Islam
4. Ethics: Philosophical Perspective
    i. Ram Chander Ji
    ii. Mahatma Gandhi
    iii. Siddharta
    iv. Amanual Kant
    v. Saint Paul
    vi. Flourence Nightingale
    vii. Aurbindu Ghoos
    viii. Imam Ghazali
5. Mannerism
    i. Good Manners
    ii. Bad Manners
6. Ethics: Social Perspective
    i. Role of Family
    ii. Role of Community
    iii. Role of Educational Institutions
7. Defence Mechanism
    i. Conscience

a. Sin
b. Self Ego

ii. Law
a. Crime

iii. Character Building

8. Prejudice

9. Regionalism

10. Provincialism

Suggested Books

- Ethical Theory: An Anthology 5 th ed. Russ Shafer -Landau. Wiley-Blackwell. 2013
- The Fundamentals of Ethics 2nd ed. Russ Shafer-Landau. Oxford University Press. 2011.

Note: In addition to the above, any other text or book referred by Instructor can also be included.

Course Title: **Foundations of Education**

Course Code: **EDUC3111**

Credit Hours: **3(3+0)**

Course Description

This course enables the students to describe the elements and process of education. The students will be able to comprehend education in philosophical, psychological, sociological, and economic perspectives. The course will also enable them to discuss the views of educational thinkers. It will help students to discuss the educational initiatives from 2002 to date.

Course objectives

After completion of this course, the students will be able to:

- understand and analyze the elements and the process of education
- comprehend the process of education in philosophical, psychological, sociological, and economical perspectives
- discuss the philosophical thoughts of educational thinkers
- discuss the significant educational initiatives from 2002 to date

Course Contents

1 Concept, Types and Process of Education

- 1.1 Concept of Education – Meaning, Scope and Importance
- 1.2 Modes of Education – Informal, Formal and Non-formal
- 1.3 Elements of the Process of Education
  - 1.3.1 Aims and objectives
  - 1.3.2 Curriculum
  - 1.3.3 Pedagogy
  - 1.3.4 Evaluation

2 Philosophical Perspective of Education

- 2.1 What is philosophy? Explaining Educational Philosophy
- 2.2 Branches of Philosophy
  - 2.2.1 Ontology
  - 2.2.2 Epistemology

2.3.1 Axiology

2.3. Styles of Philosophy

3 Educational Philosophies (Assumptions, curriculum, role of teacher and student, classroom management, and evaluation)

3.1 Perennialism

3.2 Progressivism

3.3 Essentialism

3.4 Social Reconstructionism

4 Psychological Perspective

4.1 Educational Psychology: Concept and meaning

4.2 Role of Psychology in Learning

4.3 Role of Psychology in Teaching

5 Socio-economic Perspective

5.1 Educational Sociology: Concept and meaning

5.2 Sociological Roles in Education (conservative, critical and creative)

5.3 Social functions of Education

5.4 Education as investment

5.5 Education and economic development

6. Historical Perspective

6.1 Education in Primitive Societies

6.2 Pioneers in Education

6.3 Historical of Muslim Education

6.4 Development of Education in British Period

6.5 Educational movements in history

7. Significant Educational Policies and Initiatives

7.1 National Educational Policies

7.2 Education Sector Reform

7.3 Current education status

7.4 Vision 2025

Teaching and Learning Strategies

- In general, collaborative, and interactive approaches. Discussion/assignments/ presentations, projects using “learner-centered” methods.
- “Reflective Journals” on each session
- Maintaining course portfolios.

Suggested Readings

Ahmed, K. (1972). Principles of Islamic Education. Lahore: Islamic Publications Ltd.

Canestrari, A. (2009). Foundations of Education. New York: Sage Publications.

Goldblatt, P.F., & Smith, D. (2005). Cases for teacher development. New York: Sage Publications. Gutek, G. L. (2004). Philosophical and Ideological Voices in Education. Boston: Pearson.

Government of Pakistan, Ministry of Education (2002). Education Sector Reforms Action Plan. Islamabad

Government of Pakistan. (2009). National education policy 2009. Islamabad. Mangal,

S.K. (2012). Advanced Educational Psychology. PHI learning: New Delhi

Ornstein, A.C and Levine, D.U (1995). An Introduction to the Foundations of Education. Boston:

Houghton Mifflin Company.

Semel, S. F. (2010). Foundations of education: The essential texts. USA: Routledge

Course Title: **Diversity of Plants**

Course Code: **BOTN1111**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are to:

- Educate students about photosynthetic and non photosynthetic plants.
- Teach students about beneficial and harmful aspects of micro-organisms in everyday life.
- Make students to understand the role of Algae and Fungi in the improvements of environment.
- Enable students to know the phyletic lineage among plants.

Course Outline:

Comparative study of life form, structure, reproduction and economic significance of:

Viruses: RNA and DNA types with special reference to TMV.

Bacteria and Cyanobacteria: Nostoc, Anabaena, Oscillatoria with specific reference to biofertilizers, pathogenicity and industrial importance.

Algae: Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia.

Fungi: Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus, and their implication on crop production and industrial applications.

Lichens: Physcia.

Bryophytes: Riccia, Anthoceros, Funaria.

Pteridophytes: Psilopsida (Psilotum), Lycopsida (Selaginella), Sphenopsida (Equisetum), Pteropsida (Marsilea).

Gymnosperms: Cycas, Pinus, Ephedra.

Angiosperms: Monocot (Poaceae), Dicot (Solanaceae).

Practicals:

1. Culturing, maintenance, preservation and staining of microorganisms.
2. Study of morphology and reproductive structures of the types mentioned in theory.
3. Identification of various types mentioned from prepared slides and fresh collections.

Recommended Books:

1. Agrios, G.N. (2004). Plant Pathology. 8th Ed., Academic Press London.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. (1996). Introductory Mycology. 4th Ed., John Wiley and Sons Publishers.
3. Andrew, H.N. (1961). Studies in Paleobotany. John Willey and Sons.
4. Enger, E.D., Ross, F.C. & Baily, D.B. (2012). Concepts in Biology, 14th Edition, McGraw-Hill, New York.
5. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.
6. Ingrouille, M. (1992). Diversity and Evolution of Land Plants. Chapman and Hall.
7. Lee, R.E. (1999). Phycology. Cambridge University Press, UK.
8. Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP
9. Mauseth, J. D. (2003). Botany: An Introduction to Plant Biology. 3rd Ed., Jones and Bartlett Pub. UK.
10. Prescott, L.M., J.P. Harley and A.D. Klein. (2004). Microbiology, 3rd Ed., W.M.C. Brown Publishers.
11. Taylor, T.N. and E.D. Taylor. (2000). Biology and Evolution of Fossil Plants. Prentice Hall. New York.
12. Vashishta, B.R. (1991). Botany for degree students (all volumes). S. Chand and Company. Ltd., New Delhi.

Recommended Journals:

1. Pakistan Journal of Botany, American Journal of Botany, Canadian Journal of Botany, Annals of Botany, Botanical Journal of Linnean Society.

Course Title: **Mechanics-I**

Course Code: **PHYS1111**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are;

- To understand the different motions of objects on a macroscopic scale
- To develop simple mathematical formalisms to analyze such motions.

Course Outline:

Vectors: Vectors and scalars, components of vectors, addition of vectors, vector multiplication.

Particle dynamics: Effect of frictional and drag forces on motion, Frame of Reference (inertial and non-inertial), non-inertial frames and pseudo forces.

Kinetic Energy and Work: Work-energy theorem, conservative and non-conservative forces.

Center of Mass and Linear Momentum: center of mass, Newton's second law for a system of particles, linear momentum, two particle and many-particle systems, center of mass of solid objects, momentum changes in a system of variable mass. Collisions in the center-of-mass reference frame.

Gravitation: Newton's law of gravitation, gravitational effect of a spherical mass distribution, Kepler's laws of planetary motion.

List of Experiments:

1. The Harmonic Oscillation of Helical springs-parallel and series connection of spring
2. Measuring moments of inertia of different bodies; disc, hollow and solid cylinders.
3. Radius of gyration.
4. Value of g using compound pendulum
5. Determine the Surface tension of water by capillary rise method.

Recommended Books:

- M. W. Zemansky, Richard H. Dittman, (2011), Heat and Thermodynamics, 8th Edition, McGrawHill
- Resinck, Halliday & Walker (2008), Fundamental of Physics, 8th Edition New York: John Wiley and Sons.
- Resinck, Halliday & Krane (2002). Physics Vol. I & II, 5th Edition. New York: John Wiley and Sons.
- Hallidey, Resinck & Krane (2010). Fundamental of Physics, 9th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), University Physics, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso & Finn. (1999) Physics. USA: Addison-Wesley, Reading (MA).
- Raymond A. Serway, John W. Jewett Physics for Scientists and Engineers, 9th Edition.

Course Title: **Principles of Animal Life-I**

Course Code: **ZOOL1111**

Credit Hours: **4(3+1)**

Objectives:

After studying this course the students will be able to impart knowledge and understanding of:

- The concept and status of Zoology in life sciences.
- The common processes of life through its chemistry, biochemical and molecular processes.
- The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
- Biochemical mechanisms eventually generating energy for animal work.
- Animals and their relationship with their environment.

Course Outline:

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, vacuoles;**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.

Ecological Concepts: Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles, and limiting factors, populations and communities, human population growth, pollution, resource depletion and biodiversity.

Practicals:

1. Tests for different carbohydrates, proteins and lipids.

   Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).

   Note: *Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.*

3. Plasmolysis and deplasmolysis in blood.
4. Ecological notes on animals of a few model habitats.
5. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Recommended Books:

- Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th Edition (International), 2004. Singapore: McGraw Hill.
- Miller, S.A. and Harley, J.B. ZOOLOGY, 6th Edition (International), 2005. Singapore: McGraw Hill.
- Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 5th Edition (International), 2000. Singapore: McGraw Hill.
- Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES, 2001. New York: McGraw Hill.
- Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
- Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.
- Hickman, C.P. and Kats, H.L., LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

- Molles, M.C. ECOLOGY: CONCEPTS AND APPLICATIONS. 6th Edition. 2005. McGraw Hill, New York, USA.
- Odum, E. P. FUNDAMENTALS OF ECOLOGY. 3rd Edition. 1994. W.B. Saunders.Philadelphia.
- Slingby, D. and Cook, C., PRACTICAL ECOLOGY. 1986. McMillan Education Ltd. UK.
- Karp, G. and Marshal, W., CELL AND MOLECULAR BIOLOGY.2015. Wiley.

Course Title: **Calculus-I**

Course Code: **MATH1111**

Credit Hours: **3 (3+0)**

Objectives:
The main objectives of this course are to:

- Introduce and apply the $(\in -\boldsymbol{\delta})$-definition of limit for single variable functions.
- Derive basic rules for evaluating limits.
- Use the definition and rules for evaluating limits to discuss the continuity, characteristics, and differentiation of single variable functions.
- Discuss differentiation rules, important theorems in differential calculus, and extreme value problems of single variable functions.
- Use derivatives to analyze and graph algebraic and transcendental functions.

Course Outlines:

Preliminaries: Intervals, Inequalities, Functions, Graphs of Functions, Lines, Circles, Parabolas, Shifting and Scaling of Graphs.
Limits and Continuity: The $(\in -\boldsymbol{\delta})$-definition with examples, Derivation of basic limit rules, Evaluation of limits using the limit laws, One-Sided limits, Limits at infinity, infinite Limits and vertical Asymptotes, Continuity, Types of discontinuities, Continuous functions.
Differentiation: Secant and Tangent Lines, Rates of Change, Derivatives, Physical and Geometric Interpretation of Derivatives, Differentiable Functions, Techniques of Differentiation, Chain Rule, Implicit Differentiation, Linearization, Differentials
Applications of Derivatives: Extreme Values of Functions, Monotonic Functions and the First Derivative Test, Concavity, Rolle's Theorem, The Mean-Value Theorem, Curve Sketching: Graphs of Polynomials and Rational Functions, Applied Optimization Problems, Indeterminate Forms and l'Hôspital's Rule
Derivatives of Transcendental Functions: Logarithmic and Exponential Functions, Derivatives of Logarithmic and Exponential Functions, Graphs Involving Logarithmic and Exponential Functions, Inverse Functions, Derivatives of Hyperbolic and Inverse Hyperbolic Functions, Derivatives of Inverse Trigonometric Functions.
Recommended Books:

- Anton, H. (2012). *Calculus*. John Wiley and Sons.
- Stewart, J. (2002). *Calculus,* fifth edition, published by Brooks/Cole
- Thomas, G.B. and Finney, R.L. (1996) *Calculus and Analytic Geometry*
- Swokowski, E. W. (1979) *Calculus with Analytic Geometry*

Course Title: **Fundamentals of Inorganic Chemistry**

Course Code: **CHEM1111**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The key introductory concepts of chemical bonding.
- The acid-base chemistry&properties of p-block elements as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

Course Outlines:

Chemical Bonding: Types of chemical bonding, Ionic and covalent bonding, Coordinate covalent bonding and metallic 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 Boric acid, Double sulphate or alum, Carbides, Silicates, Nitric acid, Phosphoric acid, Sulfuric acid, Sodium thiosulphate and its use in photography, Inter-halogens, Pseudo-halogens, polyhalides, Uses of Nobel gasses and Clathrate compounds.

Practicals:

1. Lab safety and good laboratory practices, Knowledge about material safety data sheets (MSD), Disposal of chemical waste and first-aid practices.
2. The qualitative analysis of salt mixtures, Quantitative analysis, Acid-base titrations, Preparation and standardization of acid and alkali solutions.
3. The redox titrations, Preparation and standardization of potassium permanganate solution and its use for the determination of purity of

commercial potassium oxalate or oxalic acid.

4. The preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, Gravimetric analysis.
5. The determination of barium in a given sample, Determination of chloride in a given solution.

Recommended Books:

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

Course Outline (Semester - II)

Course Code: **ENGL1119**
Course Title: **Communication Skills**
Credit Hours: **3(3+0)**
Prerequisite(s): **None**

Specific Objectives of course: Enable the students to meet their real life communication needs; enable the learners solve problems and issues related to their career , define communication and describe communication as a process , identify the essential components of communication , enable them to excel in their academics.

Course Outline: Definition & types of communication (verbal & non-verbal), Components of communication, Barriers in Effective Communication, Listening Skills: Listening to individuals, Listening strategies in group discussion, Listening news reports, speeches etc and getting the gist. Speaking Skills: Presentations, Formal and informal Conversation, Interviews and strategies to make interview successful. Reading Skills: Skimming, Scanning, Intensive and Extensive Reading, Reading short stories, comics and excerpts. Writing Skills: Writing applications, official letters, resume; precis writing, Changing narration-converting a story into a news report etc,Writing report/story by looking at an image.
`

Recommended Books:

1) Ellen, K. 2002. Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top
2) Hargie, O. (ed.) Hand book of Communications Skills
3) Mandel, S. 2000. Effective Presentation Skills: A Practical Guide Better Speaking
4) Communication for Business Success (Canadian Edition) (v. 1.0).
5) Reading and Study Skills by John Langan
6) Study Skills by Riachard Yorky.
7) Barker, A (2003) Improve Your Communication Skills. London: Kogan Page
8) Bygate, M (2003).Speaking : NewYork. OUP

Course Title: **Pakistan Studies**

Course Code: **PAKS1111**

Credit Hours: **2 (2+0)**

Course Outline:

Specific Objectives of course: To familiarize the students with political and religious backdrop of the ideology of Pakistan and other related events concerning the post-partition history.

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.

Historical Perspective: Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah, factors leading to Muslim separatism, people and land, Muslim advent location and geo-physical features.

Government and Politics in Pakistan: Political and constitutional phases; 1947-58, 1958-71, 1971-77, 1977-88, 1988-99, 1999 onward.

Contemporary Pakistan: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

Recommended Books:

1) Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
2) Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
3) S. M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4) Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.
5) Wilcox, Wayne. *The Emergence of Bangladesh.,* Washington: American Enterprise, Institute of Public Policy Research, 1972.
6) Mehmood, Safdar. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7) Amin, Tahir. *Ethno - National Movement in Pakistan,* Islamabad:

Institute of Policy Studies, Islamabad.

8) Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd, 1980.
9) Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10) Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11) Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12) Aziz, K. K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13) Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14) Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research.

Course Title: **General Methods of Teaching**

Course Code: **EDUC1112**

Credit Hours: **3(3+0)**

Course Description

The course will help students to develop teaching competencies and skills. The students will be able to choose and apply appropriate methods of teaching according to their content areas.

Course objectives

At the completion of the course the student will be able to:

- Describe the importance of the efficient teaching methodology in the overall teaching learning process.
- Appreciate the characteristics of various methods of teachings.
- Select a suitable method or strategy to make his/her teaching effective in local context.
- Apply various teaching methods and strategies during teaching of their subjects.

Course Contents

1 The Concept and Principles of Teaching

- 1.1 Concept of teaching
- 1.2 Features of teaching
- 1.3 Planning for teaching
- 1.4 Principles of teaching

2 Teaching Methods/ Strategies and their selection

- 2.1 Concept of methods, strategies, tactics, and techniques
- 2.2 Criteria for selection of a method/ strategy
- 2.3 Selection of Method / technique

3 Methods of Teaching

- 3.1 Lecture Method
- 3.2 Text Book Reading

3.3 Discussion Method

3.4 Team Teaching

3.5 Demonstration Method

3.6 Project Method

3.7 Activity Method

3.8 Story telling

3.9 Problem Solving Method

3.10 Illustration Method

3.11 Drill Method

3.12 Socratic Method

3.13 Simulated Teaching

3.14 Programmed learning

3.15 Micro teaching

4 Lesson Planning

4.1 Introduction to Lesson Planning

4.2 Steps of Lesson Planning

4.3 Types of Lesson Planning

4.4 Evaluation of Lesson Planning

5. Planning Instruction In the relevant Content Area

5.1 Instructional objectives in Behavioral Terms (Blooms Taxonomy)

5.2 Learn to teach different topics in their relevant content area.

Teaching Learning Strategies

- Lecture method followed by discussion and question answer method
- Cooperative learning
- Students are required to prepare and maintain course portfolio

- Assignments and presentations / quizzes based on the content of the course outline and project
- using “do-it-yourself” or “learner-centered” methods.

Suggested Readings

Westwood, P. (2008). What teachers need to know about teaching methods, Australia. Camberwell, Vic. ACER Press

Course Title: **Plant Systematics, Anatomy and Development**

Course Code: **BOTN1112**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are to educate students about:

- Various systems of classification, identification and nomenclature of higher plants.
- Morphological description of different species.
- Structures and functions of tissues and organs.
- Early development of plant body at embryonic level.

Course Outline:

Plant Systematics

Introduction to Plant Systematics: Aims, objectives and importance.

Classification: Brief history of various systems of classification with emphasis on Takhtajan.

Brief Introduction to Nomenclature: Importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN)' Vienna code.

Morphology:A detailed account of various morphological characters of root, stem, leaf, inflorescence, flower, placentation and fruit types.

Diagnostic Characters, Economic Importance and Distribution Pattern of the Families: Ranunculaceae, Brassicaceae (Cruciferae), Fabaceae (Leguminosae), Rosaceae, Euphorbiaceae, Cucurbitaceae, Lamiaceae (Labiatae), Apiaceae (Umbelliferae), Asteraceae (Compositae), Liliaceae (Sen. Lato).

Anatomy

Cell Wall: Structure and chemical composition.

Concept, Structure and Function of Various Tissues: Parenchyma, collenchyma, sclerenchyma;Epidermis (including stomata and trichomes);Xylem andphloem.

Meristem: Types;Stem and root apices.

Vascular Cambium

Structure and Development: Root, stem and leaf; Primary and secondary growth of dicot stem, periderm.

Characteristics of Wood: Diffuse porous and ring-porous;Sap and heart wood, soft and hard wood;Annual rings.

Development / Embryology

Early Development of Plant Body: Capsella bursa-pastoris.

Structure and Development: Anther, microsporogenesis, microgametophyte.

Structure: Ovule, megasporogenesis, megagametophyte.

Endosperm Formation

Parthenocarpy and Polyembryony

Practicals:

Plant Systematics

1. Identification of families given in syllabus with the help of keys. Technical description of common flowering plants belonging to families mentioned in theory syllabus.
2. Field trips shall be undertaken to study and collect local plants.
3. Students shall submit 40 fully identified herbarium specimens.

Anatomy

4. Study of stomata, epidermis.
5. Study of tissues of primary plant body.
1. 3-Dimensional plane of wood: study of xylem.
6. T.S of angiosperm stem and leaf.

Recommended Books:

- Eames, A.J. and L.H. Mac Daniels. (2002). *An Introduction to Plant Anatomy*. Tata and MacGraw Hill Publishing Company, Limited. New Delhi.
- Enger, E.D., Ross, F.C. & Baily, D.B. (2012). *Concepts in Biology*, 14thEdition, McGraw-Hill, New York.
- Esau, K. (1960). *Anatomy of Seed Plants*. John Wiley, New York.
- Fahn, A. (1990). *Plant Anatomy*. Pergamon Press, Oxford.
- Lawrence, G.H.M. (1951). *Taxonomy of Vascular Plants*. MacMillan and Co. New York.
- Maheshwari, P. (1971). *Embryology of Angiosperms*. McGraw Hill. New York.
- Mauseth, J.D. (1998). *An Introduction to Plant Biology*: Multimedia Enhanced. Jones and Bartlett Pub. UK.

- Moore, R.C., W.D. Clarke and D.S. Vodopich. (1998). *Botany*. McGraw Hill Company, USA.
- Naik, V.N. (2005). *Taxonomy of Angiosperms*. 20th Reprint. Tata and MacGraw Hill Publishing Company Limited, New Delhi.
- Panday, B.P. (2004). *A textbook of Botany (Angiosperms)*. S. Chand and Company, New Delhi.
- Pullaiah, T. (2007). *Taxonomy of Angiosperms*. 3rd Ed., Regency Publications, New Delhi.
- Raven, P.H., R.E. Evert and S.E. Eichhorn. (1999). *Biology of Plants*. W.H. Freeman and Company, Worth Publishers.
- Raymond, E. and S.E. Eichhorn. (2005). *Esau's Plant Anatomy*. *Meristems cells and tissues of the plant body*. 3rd Ed., John Wiley and Sons Inc.
- Stuessy, T.F. (1990). *Plant Taxonomy*. Columbia University Press, USA.

Course Title: **Mechanics-II**

Course Code: **PHYS1114**

Credit Hours: **4(3+1)**

Objectives:

The main objectives of this course are;

- To understand the different motions of objects on a macroscopic scale and
- To develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Course Outline:

Rotational Dynamics: Rotational variables, Rotation with constant angular momentum, relating linear and angular variables, Torque, Newton's second law for rotation. Work and rotational Kinetic energy, moment of inertia, moment of inertia of bodies of various shapes, parallel axis theorem, Rotational dynamics of rigid bodies.

Rolling, Torque, and Angular Momentum: Equation of motion and effects of application of torques, Forces and Kinetic energy of rolling, Angular momentum, Newton's Second Law in Angular Form, The Angular Momentum of a System of Particles, Conservation of angular momentum.

Fluid Dynamics: Density and pressure, Pascal's principle, Archimedes principle Equation of continuity, Bernoulli's Equation and applications.

Equilibrium and Elasticity: Equilibrium, The Requirements of Equilibrium, The Center of Gravity, Some Examples of Static Equilibrium, Elasticity, stress and strain.

Relativity: Inertial and non-inertial frames, postulates of special relativity, Galilean and Lorentz transformation, length contraction and time dilation, twin paradox, relativistic mass, Relativistic momentum and relativistic energy.

List of experiments:

1. Determining the modulus of rigidity of wire by static method (Using Barton's Equipment).
2. Determining the modulus of rigidity of material of a wire using dynamic Maxwell needle method.
3. Determine the modulus of rigidity by oscillating rod using dynamic method
4. Determine the vertical distance between two points by sextant.
5. Determine the density of a given solid using Archimedean principle.

Recommended Books:

- M. W. Zemansky, Richard H. Dittman, (2011), Heat and Thermodynamics, 8th Edition, McGrawHill

- Resinck, Halliday & Walker (2008), Fundamental of Physics, 8th Edition New York: John Wiley and Sons.
- Resinck, Halliday & Krane (2002). Physics Vol. I & II, 5th Edition. New York: John Wiley and Sons.
- Hallidey, Resinck & Krane (2010). Fundamental of Physics, 9th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), University Physics, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso & Finn. (1999) Physics. USA: Addison-Wesley, Reading (MA).
- Raymond A. Serway, John W. Jewett Physics for Scientists and Engineers, 9th Edition.

Course Title: **Principles of Animal Life-II**

Course Code: **ZOOL1112**

Credit Hours: **4 (3+1)**

Objectives:

The course will impart knowledge and understanding of:

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

Course Outline:

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.

Cellular Control: DNA: the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA technologies and their applications.

Animal Behavior: Behavior 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: Natural selection Lamarckism and 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.

Practicals:

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare the slide).

Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of *Drosophila*, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behavior (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behavior (documentary film be shown, honey bee, monkey group in a zoo).

Recommended Books:

- Pechenik, J.A. 2012. Biology of Invertebrates, 4th Edition
- (International), Singapore: McGraw Hill.
- Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
- Miller, S.A., Harley, J.B. 2002. Zoology, 5th Edition (International), Singapore: McGraw Hill.
- Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
- Campbell, N.A. 2002. Biology. 6th Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
- Kent, G.C., Miller, S. 2000. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
- Karp, G. and Marshal, W., CELL AND MOLECULAR BIOLOGY.2015.

Course Title: **Calculus-II**

Course Code: **MATH1112**

Credit Hour: **3 (3+0)**

Objectives:
The main objectives of this course are to:

- Provide basic knowledge of the fundamental concepts of definite and indefinite integration, i.e., Riemann Sums and the Fundamental Theorem of Calculus.
- Use various rules of integration.
- Provide knowledge of sequences and series including tests for their convergence.
- Introduce Power.
- Taylor and Maclaurin series, including test for convergence and methods of approximation of sums.

Course Outline:

Integration: The Indefinite Integral, Estimating with Finite Sums, Sigma Notation and Limits of Finite Sums, Areas as Limits, The Definite Integral, The Fundamental Theorem of Calculus
Techniques of Integration: Integration by Parts, Integration of Rational Functions by Partial Fractions, Integrating Powers of Sine and Cosine, Integrating Powers of Secant and Cosecant, Trigonometric substitutions, Improper Integrals, Evaluating Integral
Applications of Definite Integrals: Area between Two Curves, Volumes by Slicing; Discs and Washers, Volumes by cylindrical Shells, Length of a Plane Curve, Area of a Surface of Revolution.
Infinite Sequences and Series: Sequences, Monotone Sequences, Infinite Series, The Integral Test, Comparison Tests, The Ratio Test, The Root Test, Alternating series, Absolute and Conditional Convergence, Power Series, Taylor's and Maclaurin Expansions, Convergence of Taylor Series; Error Estimates, Applications of Power Series, Fourier Series.

Recommended Books:

- Anton, H. (2012). *Calculus*. John Wiley and Sons.
- Stewart, J. (2002). *Calculus*, fifth edition, published by Brooks/Cole
- Thomas G.B. and Finney R.L. (1996) *Calculus and Analytic Geometry*

Swokowski E. W. (1979) *Calculus with Analytic Geometry*

Course Title: **Fundamentals of Organic Chemistry**

Course Code: **CHEM1113**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge about:

- Basic concepts of Organic Chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reaction.
- Such information will be useful for qualitative analysis and synthesis of organic compounds.

Course Outlines:

Basic Concepts of Organic Chemistry: Bonding and hybridization localized and delocalized bonding, Resonance Effect, Inductive effect, Dipole moment, Resonance and its rules, Hyper conjugation, 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, Amines with focus on reaction mechanism andapplications, 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.

Practicals:

1. Qualitative analysis of compounds with different functional groups.
2. Synthesis of organic compounds using as a tool for understanding techniques like Reflux, Distillation, Filtration, Recrystallization and yield calculation.
3. 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.

Recommended Books:

- Brown, W; Poon, T. Introduction to Organic Chemistry. John-Wiley & Sons, 2005; 3rd Ed.
- John, E.M. Organic Chemistry. Brooks/Cole Publishing Co: USA, 2012; 8th Ed.
- Robert, T.M; Robert, N.B. Organic Chemistry. Prentice Hall: New Jersey, 1992; 6th Ed.
- Younus, M.A. Textbook of Organic Chemistry. Ilmi Kitab Khana, Urdu Bazar: Lahore, 2006.
- Sykes, P.A. Guide Book to Mechanism in Organic Chemistry.Pearson Education Limited: England, 1986; 6th Ed.
- Vogel, A.I. A Text Book of Practical Organic Chemistry, Longman, London (1968).
- Mann, F.G and Saunders B.C. Practical Organic Chemistry, Longman, London (1978).
- Shriner, R.L., Curtin, D.Y. Fuson, R.C. and Morrill, T.C. The Systematic Identification of Organic Compounds, Wiley, NY (1997).
- Rehman, A. Experimental Organic Chemistry, The Caravan Book House, Lahore (2006)

Course Outline (Semester - III)

Course Title: **Technical Writing and Presentation Skills**

Course Code: **ENGL2115**

Credit Hours: **3 (3+0)**

Objectives:

The main objective of this course is to:

• Enhance language skills and develop critical thinking

Course Outline:

Presentation skills: Elements of an effective speech, Getting ready for presentation **(**organizing data), During the Presentation. (gaining attention, presenting data, working with visuals etc.), After the presentation (revision, question answer session, feedback),

Presentation ethics

Essay writing: Descriptive, narrative, discursive, argumentative, Parts of essay

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).

Report Writing: Types of Reports, Formats

Note: Extensive reading is required for vocabulary building

Application writing: Leave, complaint and job applications

Letter Writing: Formal letter, Cover letters, Business letters, sales letters, Inquiry letters Office Correspondence: memorandum, minutes of meeting, electronic mails

Recommended books:

•Technical Writing and Presentation Skills

• Essay Writing and Academic Writing

• Writing.Advanced by Ron White.Oxford Supplementary Skills. Third Impression 1992.ISBN 0194354073 (particularly suitable for discursive,descriptive, argumentative and report writing).

• College Writing Skills by John Langan.McGraw-Hill Higher Education. 2004.

• Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R.MandelLSt.-Martin's Press

• 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).

Report writing: What is a report? Formal Report writing,Characteristics of an effective report, Long and short reports

Writing summaries, articles and reviews

Recommended Readings:

- Aaron, J. 2003.The Compact Reader. New York: Bedford
- Axelrod, R. B and Cooper, C.R. 2002. Reading Critical Writing Well: A Reader and Guide
- Barnet, S. and Bedau, H. 2004. Critical Thinking, Reading and Writing: A Brief Guide to Writing. 6th Edition.
- Behrens & Rosen. 2007. Reading and Writing Across the Curriculum.
- Gardner, P. S. 2005. New Directions: Reading Writing and Critical Thinking
- George, D. and Trimbur, J. 2006. Reading Culture: Context for Critical Reading and Writing. 6th Edition
- Goatly, A. 2000. Critical Reading and Writing: An Introductory Course. London: Taylor & Francis
- Grellet, F., Writing for Advanced Learners of English. CUP
- Jordan, K. M. and Plakans, L. 2003. Reading and Writing for Academic Success
- Jordon, R. R. 1999.Academic Writing Course.CUP.
- Smith, L. C. 2003. Issues for Today: An Effective Reading Skills Text.
- Withrow J., Effective Writing. CUP

Course Title: **Educational Assessment**

Course Code: **EDUC3143**

Credit Hours: **3(3+0)**

Course Description

This course provides knowledge and skills required for assessment of students learning. Throughout the course, the students will learn different concepts of educational assessment, and its various forms and types. The course will provide hands on experiences in development of valid and reliable tests items and application of theory and principles of assessment in real life situation.

Course Objectives

After completion of this course, the students will be able to:

- understand different concepts used in educational assessment
- differentiate between the various forms of assessment
- understand classification of the types of assessment and their usability
- design and construct assessment that measure a variety of learning outcomes
- apply principles of assessment in planning a classroom assessment
- apply strategies to construct valid and reliable test items
- recognize both the potentialities and the limitations of the various types of tests & assessment procedures used in the schools
- interpret assessment results effectively

Course Contents

1 Introduction to Educational Assessment

1.1 Introducing the Concepts: Test, Measurement, Assessment & Evaluation

1.2 Instructional Process and & Role of Assessment

1.3 Assessment *of* and Assessment *for* Learning

1.4 Principles of Assessment

1.5 Classification of Assessment on the basis of

1.5.1 Nature of Assessment

1.5.2 Purpose of Assessment

1.5.3 Forms of Assessment

1.5.4 Methods of Interpreting Results

1.5.5 Teacher made vs standardized test

2 Planning Classroom Assessment

2.1 Instructional Aims, Goals and Objectives

2.2 General vs Specific Learning Outcomes

2.3 Taxonomy of Education Objectives

2.4 Developing Assessment Framework

2.4.1 Developing test specifications

2.4.2 Selecting appropriate type of test items

3 Types of Achievement Test: Subjective Vs Objective

3.1 Constructing Objective Test Items

3.1.1 Characteristics

3.1.2 Different Types

3.1.3 Rules to construct

3.1.4 Scoring

3.1.5 Advantages and Limitations

3.2 Constructing Subjective Test Items

3.2.1 Characteristics

3.2.2 Different Types

3.2.3 Rules to construct

3.2.4 Developing scoring Rubrics and Scoring

3.2.5 Advantages and Limitations

4 Test Administration

4.1 Constructing Test Instructions

4.2 Responsibilities Before Starting Test

4.2.1 Checking Testing Conditions

4.2.2 Test Instructions

4.3 Responsibilities During Test

4.3.1 Physical environment

Teaching Learning Strategies

- Lecture method followed by discussion and question answer method
- Cooperative learning
- Students are required to prepare and maintain course portfolio
- Assignments and presentations / quizzes based on the content of the course outline and project using "do-it-yourself" or "learner-centered" methods.
- Development of test items
- Development of a test with instructions
- Development of table of specification
- Development of table of rubrics
- Item analysis

Assignments

- Test instruction
- Multiple choice Questions
- Short Questions/Answer
- Long Questions/Answer
- Table of specification
- Item analysis
- Development of Progress Report

Suggested Readings

Ebel, Robert (2004). *Essentials of Educational Measurement*. India: Prentice hall.

Freeman, Richard, (2004). *Planning and Implementing Assessment*. New York: Rout ledge Flamer.

Linn, R. L. (2008). *Measurement and assessment in teaching*. Pearson Education India.

Taylor, C. S. (2013). *Validity and validation*. Oxford University Press.

Torrance, H. (Ed.). (2012). *Educational assessment and evaluation: Major themes in education*. Routledge.

Mohan, R. (2016). *Measurement, Evaluation and Assessment in Education*. PHI Learning Pvt. Ltd.

Additional Readings

Nitko, A. (2001) *Educational Assessment Of Students*. 3rd Edition. Merrill Prentice-Hall.

Popham, W. J. (2001) *Classroom Assessment*: What Teachers Need To Know. (3rd Edition). Boston: Allyn And Bacon, ISBN 0205333044.

Course Title: **Cell Biology, Genetics and Evolution**

Course Code: **BOTN2111**

Credit Hours: **4 (3+1)**

Specific objectives of course:

- Structure and functions of cell.
- Nature of genetic material and hereditary process.
- Familiarization with evolutionary processes.

Course Outline:

Cell biology

Biomolecules: Structures and functions of bio-molecules (carbohydrates, lipids, proteins, nucleic acids).

Cell: Physicochemical nature of plasma membrane and cytoplasm.

Ultrastructure of Plant Cell with a Brief Description and Functions: Cell wall, endoplasmic reticulum, plastids, mitochondria, ribosomes, dictyosomes, vacuole, micro bodies, glyoxysomes and peroxisomes.

Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis.

Reproduction: In somatic and embryogenic cell, mitosis and meiosis; Cell cycle.

Genetics

Introduction: Scope and brief history of genetics; Mendelian inheritance - Laws of segregation and independent assortment; Backcross; Testcross; Dominance and incomplete dominance.

Molecular Genetics: DNA replication; Nature of gene; Geneticcode; Transcription, translation, protein synthesis; Regulation of gene expression (e.g. *lac* operon).

Principles of Genetic Engineering / Biotechnology: Basic genetic engineering techniques.

Chromosomal Aberrations: Changes in the number of chromosomes; Aneuploidy and euploidy; Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

Evolution: Introduction and theories.

Practicals:

Cell Biology

1. Study of cell structure using compound microscope and elucidation of ultra structure from electron microphotographs.

2. Measurement of cell size.
3. Study of mitosis and meiosis by smear / squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

Genetics

6. Genetical problems related to transmission and distribution of genetic material.
7. Identification of DNA in plant material. Carmine / orcein staining.

Recommended Books:

- Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2010). Essential Cell Biology. Third addition, Garland Science, Taylor & Francis Group, New York and London.
- Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. & Walter, P. (2015). Molecular Biology of the Cell. 6thEdition, Garland Science, Taylor & Francis Group, New York and US.
- Carroll, S.B., J.K Grenier, and S.D. Welnerbee. (2001). *From DNA to Diversity*: *Molecular Genetics and the Evolution of Animal Design*. Blackwell Science.
- Dyonsager, V.R. (1986). *Cytology and Genetics*. Tata and McGraw Hill Publication Company Limited, New Delhi.
- Enger, E.D., Ross, F.C. & Baily, D.B. (2012). Concepts in Biology, 14thEdition, McGraw-Hill, New York.
- Hoelzel, A.R. (2001). *Conservation Genetics*. Kluwer Academic Publishers.
- Ingrouille, M.J. and B. Eddie. (2006). *Plant Diversity and Evolution*. Cambridge University Press.
- Lewin, R. (1997). *Principles of Human Evolution*. Blackwell Science.
- Lodish, H. (2001). *Molecular Cell Biology*. W.H. Freeman and Company.
- Reece, J. B., Urry, L. A., Cain, M. L. 1., Wasserman, S. A., Minorsky, P. V., Jackson, R., & Campbell, N. A. (2014). Campbell biology (Tenth addition). New York, NY : Pearson Education
- Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. & Jackson., R.B. (2009). Biology, Ninth addition, Benjamin Cummings Pearson, USA.
- Sinha, U. and S. Sinha. (1988). *Cytogenesis, Plant Breeding and Evolution*. Vini Educational Books, New Delhi.
- Strickberger, M.V. (1988). *Genetics*. MacMillan Press Limited, London.
- Strickberger, M.W. (2000). *Evolution.* Jones and Bartlet Publishers, Canada.

Course Title: **Electricity and Magnetism-I**

Course Code: **PHYS2111**

Credit Hours: **4(3+1)**

Objectives:

The main objectives of this course are

- To understand the Physics of Electromagnetism
- To develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Course Outlines:

Electric field: Electric field due to a point charge, Electric dipole, Line of charge and a charged disk, A point charge in an electric field, Electric field of continuous charge distributions, Dipole in an electric field

Gauss' Law: Electric Flux, Gauss' Law, Applications of Gauss' law.

Electric Potential: Equipotential Surfaces, Calculating the potential from the field, Potential due to a charged particle, Group of charged particles, Electric dipole and continuous charge distribution, Calculating the field from the potential, Electric potential energy of a system of charged particles, Potential of charged isolated conductor.

Capacitance: Capacitors in parallel and in series, Energy stored in an electric field, Capacitor with a dielectric,Dielectrics and Gauss' Law.

Circuits: Calculating the Current in a Single-Loop Circuit, Multi-loop Circuits, The Ammeter and the Voltmeter, RC Circuits.

Magnetic Fields: The Hall Effect, A circulating charged particle, Magnetic force on a current-carrying wire, Torque on a current loop, themagnetic dipole moment, Biot-Savart law, Amperes law.

Practicals:

- Measurement of resistance using a Neon flash bulb and condenser.
- Conversion of a Galvanometer into Voltmeter.
- Conversion of a Galvanometer into Ammeter.
- Measurement of self-inductance/mutual inductance.
- To measure the time constant of an RC circuit using graphical method

Recommended Books:

- M. W. Zemansky, Richard H. Dittman, (2011), Heat and Thermodynamics, 8th Edition, McGrawHill
- Resinck, Halliday & Walker (2008), Fundamental of Physics, 8th Edition New York: John Wiley and Sons.
- Resinck, Halliday & Krane (2002). Physics Vol. I & II, 5th Edition. New York: John Wiley and Sons.
- Hallidey, Resinck & Krane (2010). Fundamental of Physics, 9th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), University Physics, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso & Finn. (1999) Physics. USA: Addison-Wesley, Reading (MA).
- Raymond A. Serway, John W. Jewett Physics for Scientists and Engineers, 9th Edition.

Course Title: **Animal Diversity-I**

Course Code: **ZOOL2111**

Credit Hours: **4 (3+1)**

Objectives:

The course is designed to provide students with:

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

Course Outline:

Introduction: Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom with evolutionary perspective.

Animal-Like Protests: The Protozoa; 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: 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, and further phylogenetic considerations

Triploblastics and Acoelomate Body Plan: Phylum Platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; maintenance functions; reproduction, further phylogenetic considerations.

Pseudocoelomate Body Plan: Aschelminths: general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of Phylum Nematoda.

Molluscan Success: 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 bivalves; further phylogenetic considerations.

Annelida: The Metameric Body Form: relationship to other animals, metamerism and tagmatization; External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development in oligochaetes; further phylogenetic considerations.

Arthropods: Blueprint for Success: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations; phylogeny and adaptive diversification.

Echinoderms: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroids, further phylogenetic considerations.

Practicals:

1. Study of *Euglena, Amoeba, Entamoeba, Plasmodium,Trypanosoma, Paramecium* as representative of animal likeprotists. (Prepared slides).
2. Study of sponges and their various body forms.
3. Study of principal repesentative classes of phylum Coelenterata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, phylum Nematoda.
6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda.
9. Brief notes on medical/economic importance of the following:

   Plasmodium, Entamoebahistolitica, Leishmania, Liverfluke,Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following:

    Obelia, Daphnia, Cestode, Parapodia of *Nereis.*

Recommended Books:

- Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
- Miller, S.A. and Harley, J.B. ZOOLOGY, 7th Edition (International), 2007. Singapore: McGraw Hill.
- Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
- Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
- Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
- Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Course Title: **Calculus-III**

Course Code: **MATH2111**

Credit Hours: **3 (3+0)**

Objectives:

The main objectives of this course are to:

- Perform operations with vectors in two and three-dimensional spaces
- Differentiate and integrate vector-valued functions and apply calculus to motion problems in two and three-dimensional spaces.
- Determine the limits, derivatives, gradients, and integrals of multivariate functions.
- Solve problems in multiple integration using rectangular, cylindrical, and spherical coordinate systems.
- Work with Green's, Divergence, and Stoke's theorems.

Course Outline:

Multiple Integrals: Double Integrals, Double Integrals over Non-Rectangular Regions, Double Integrals in Polar Coordinates, Surface Area, Triple Integrals, Centroid, Triple Integrals in Cylindrical and Spherical Coordinates, Change of Variables in Multiple Integrals

Vector Field: Introduction to Vector Valued Functions, Curl, Divergence, Binormal, Torsion, Curvature.

Integration in Vector Fields: Line Integrals, Vector Fields, Green's theorem, Parameterized surfaces, Stokes' Theorem, The Divergence Theorem

Partial Derivatives: Functions of Two or More Variables, Limits and Continuity, Partial Derivatives, Differentiability and Chain Rule for Two Variables, Differentiability of Three Variables, Directional Derivatives of Three Variables, Gradients for Functions of Three, Maxima and Minima of Functions of Two Variables.

Recommended Books:

- Anton, H. (2012). *Calculus*. John Wiley and Sons.
- Stewart, J. (2002). *Calculus,* fifth edition, published by Brooks/Cole
- Thomas G.B. and Finney R.L. (1996) *Calculus and Analytic Geometry*
- Swokowski E. W. (1979) *Calculus with Analytic Geometry*

Course Title: **Environmental Chemistry**

Course Code: **CHEM2111**

Credit Hours: **3(3+0)**

Objectives:

The students will be able to acquire:

- The 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 Outlines:

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, Heavymetals 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:

- Baird, C; Cann, M. Environmental Chemistry. W.H. Freeman& Company,

2012; 5th ed.

- Dara, S.S; Mihsra, D.D. A Text Book of Environmental Chemistry and Pollution Control. S. Chand & Co, 2004;9th Ed.
- Singhi, R; Singh, V. Green Chemistry for Environmental Remediation. John-Wiley & Sons, 2011.

Course Title: **Fundamentals of Physical Chemistry**

Course Code: **CHEM1112**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge:

- To understand the fundamental principles and laws of thermodynamics and chemical equilibria.
- To investigate the physical properties of ideal/non-ideal binary solutions.
- About the rates of reactions and perform related calculations.

Course Outlines:

Gaseous State: Equation of states, Ideal and real gases, Virial equation and the vander Waal's equation for real gases, Critical phenomena and critical constants,

Chemical Thermodynamics: Four laws of thermodynamics and their applications, Thermo chemistry, 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, Le-Chatelier's principle. Effect of temperature and pressure on the equilibrium constants/compositions, Van't Hoff equation,

Liquid State: Physical properties of liquids, Surface tension, Viscosity, Refractive index, Dipole momentand their applications, Brief account of interactions among the molecules in liquids

Solution Chemistry:, 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, Half-lives of reactions,

Experimental techniques for rate determination and methods for determination of order of reaction,Arrhenius equation.

Practicals:

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

Recommended Books:

- Atkins, P; Paula,J.D. Atkin's Physical Chemistry. Oxford University Press, 2010;9thEd.
- Shoemaker, D. Experiments in Physical Chemistry.McGraw Hill, 2003; 8thEd.
- Silbey, R; Alberty, R; Bawendi, M. Physical Chemistry.2005,4thEd.
- Glasstone, S. Textbook of Physical Chemistry. Macmillan London, 1960.
- James, A.M; Prichard, F.E. Practical Physical Chemistry. Longman Group Limited: New York, 1974;3rdEd.
- Chaudhary, S.U. Ilmi Textbook of Physical Chemistry, Ilmi Kitab Khana: Lahore, 2013;2ndEd.
- Atkins, P; Jones, L. Chemical Principles: The Quest for Insight. W.H. Freeman: New York, 2010;5thEd.

Course Outline (Semester - IV)

Course Title: **Introduction to Information Technology**

Course Code: **COMP1111**

Credit Hours: **3 (3+0)**

Specific objectives of course:

The main objectives of this course are to:

- Understand the fundamentals of Information Technology
- Learn about upcoming technologies in different disciplines
- Understand word processing, spreadsheet, databases and presentation softwares.
- Get the knowledge about networking and internet.
- Get the knowledge about computer risks and safety, system failure and backup.

Course Outline:

Computers and Networks: Introduction to Computers, History of Computers, Classification of Computers, Advantages and Disadvantages of using Computers, Network types, LAN, MAN and WAN, Internet, email, World-Wide Web, E-Commerce, Video Conferencing, Computer-based Training, Distance learning

Computer Hardware: System unit, Central Processing Unit (CPU), Memory, Storage, Input Devices, Output Devices and Communication Devices.

Computer Software: System Software, Application Software which includes Microsoft Word, Excel, Access, PowerPoint, Outlook.

Number System: Binary, Decimal, Octal, hexadecimal, Conversion

Computer Security, Safety, Ethics and Privacy: Computer Security Risks, Cyber Crimes, Ethics and Society

Discipline related Software: Discipline related software of each department for instance (InPage, CorelDRAW, WinText etc.)

Recommended Books:

- Intro to Computers, Peter Norton, latest edition.
- Discovering Computers Complete, latest edition. Shelly Cashman series.
- Exploring Computers Complete latest edition by Floyd Fuller, Brian Larson.
- Steve Lambert and M Dow Lambert, Microsoft® Office Access(TM) Step by Step (Step By Step (Microsoft)), 2007.

- Computer Fundamentals by P.K. Sinha 6th Edition
- Computer Science: An Overview (11th Edition) By J. Glenn Brookshear
- Microsoft Office 2010: Ultimate Tips and Tricks by Matt Smith.

Note: in addition to the above, any other text or book referred by Instructor may also be included.

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Course Title: **Introduction to Statistics and Probability**

Course Code: **STAT2111**

Credit Hours: **3(3+0)**

Objectives:

The main objectives of this course are to:

- Understand the statistical models graphically and mathematically.
- Realize the handling of data and to manipulate the data as per the requirements.
- Understand measures of central tendency and dispersion, i.e., mean, median, mode, variance and standard deviation etc.
- Understand the concept of basic probability and probability distribution.

Course Outline:

Preliminaries: Frequency Distribution, Histogram, Pie-Chart, Multiple Bar Graph, Cumulative Frequency Curve and Polygon, Mean, Mode, Median, Variance and Standard Deviation, Quartiles, Deciles, Percentiles, Coefficient of Variation, Scatter Plots, Correlation Coefficient, Methods of Least Squares, Regression Line, Curve Fitting

Probability: Sample Space, Event, Mutually Exclusive Events, Exhaustive Events, Equally Likely Events, Axioms of Probability, Tree Diagram, Law of Complement, Law of Addition, Conditional Probability, Law of Multiplication, Dependent and Independent Events, Bayes' Formula, Repeated Independent Trials, Binomial, and normal distributions

Recommended Books:

- Lipschutz, L. *Introduction to Probability and Statistics.* McGraw-Hill
- Freund, J. E. *Mathematical Statistics,* Prentice-Hall
- Gupta, S.C. and Kapoor, V. K. (1983). *Fundamentals of Mathematical Statistics*, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
- Hogg, R. V. and Craig R. G. (1989). *Introduction to Mathematical Statistics*, Edition 4. MacMillan Publishing Co., New York.

Course Title: **Curriculum Design and Instruction**

Course Code: **EDUC2118**

Credit Hours: **3(3+0)**

Course Description

This course is intended to orient the prospective teachers about the principle, process and procedure of curriculum design and development. The participants will be informed about various foundations on which the curriculum is based, defining, and delineating the objectives, selection of content, its scope and outcomes, teaching strategies, curriculum evaluation, design of instructional materials. This course will also include description of instructional process to achieve the goals of curriculum. Students will be provided exposure to various curriculum development models. The course will be delivered within the context of existing curriculum and the bodies and procedures adopted for curriculum development process in Pakistan.

Learning Outcomes

At the end of the course, the students will be able to:

- understand the concept of curriculum
- aware about the process of curriculum development in Pakistan
- examine the components of curriculum development
- differentiate between different types of curriculum
- write curriculum objectives in behavioral terms
- state the critical issues, problems, and trends in curriculum
- Define and understand the process of instruction
- Understand the importance of instruction for implementation of curriculum

Course Outline

1. Introduction to Curriculum and Instruction
    1.1. The definition of Curriculum
    1.2. Various forms of Curriculum

1.3. Elements of Curriculum: Objectives, Content selection, Curriculum implementation, evaluation of curriculum.

1.4. Needs assessment for curriculum

1.5. How Curriculum defers from:

1.5.1. Syllabus

1.5.2. Course of Study

1.5.3. Educational Programme

1.5.4. Teaching

1.5.5. Instruction

1.5.6. Level of Curriculum

1.6. Foundations of Curriculum

1.7 Concept and process of Instruction

1.8 Relationship Between Curriculum and Instruction

2. Curriculum: Aims, Goals and Objectives

2.1. Distinction between aims, goals & objectives

2.2. Taxonomies of educational objectives

2.2.1. Cognitive domain

2.2.2. Affective domain

2.2.3. Psychomotor domain

2.3. Solo Taxonomy of educational objectives

3. Models of Curriculum

3.1. Tyler Model

3.2. Wheeler Model

3.3. Dynamic Model

4. Designs of Curriculum

4.1. Subject-centered Designs

4.2. Learner-Centered Designs

4.3. Teacher-Centered Designs

4.4. Integrated Curriculum Designs

5. Curriculum Development in Pakistan

5.1. Curriculum development processes at elementary and secondary level

5.2. Curriculum Reforms and policies

5.3. Role of teacher in curriculum development process at various levels

5.4. Problems and issues in curriculum development

6. Selecting and Implementing Strategies for Instruction

6.1. Styles of Teaching and Learning

6.2. Selection of Teaching Methods

6.3 Organization and implementation of instruction

7. Curriculum Change and Evaluation

7.1. Curriculum Change

7.2. Curriculum Evaluation

Recommended Books

Farooq, R.A. (1993). Education system in Pakistan. Islamabad: Asia Society for the Promotion of Innovation and Reforms in Education.

HarperCollins Murray P. (1993). Curriculum Development & Design, (5th ed),

Sharma R.C (2002). Modern Methods of Curriculum Organization. New Delhi:

Adeoye, E. A. (2007). Curriculum development: Theory and practice. Lagos: National Open University of Nigeria.

Bharvad, A. J. (2010). Curriculum evaluation, International Research Journal, 1, 72–74. McKimm, J. (2007). Curriculum design and development.

O'Neill, G (2010). Programme design: Overview of curriculum models.

Course Title: **Analytical Chemistry**

Course Code: **CHEM2112**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge about:

- The sampling and their handling and preparation and results calculation and data reporting.
- The classical techniques of analytical chemistry and quality control and quality assurance.

Course Outlines:

Chemometrics: Basic concepts,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: 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, Periodicaltrainings, ISO standards.

Classical Analytical Methods: Complexometric titration and Gravimetric analysis.

Clinical Chemistry: Composition of blood, Collection and preservation of samples, Clinical analysis, Common determinations, Immunoassay.

Environmental Sampling and Analysis: Getting a meaningful environmental sample, General considerations,sample collection, Sampling devices, Air sample analysis, Soil sample analysis, Water sample analysis.

Practicals:

1. Calibration of volumetric glassware, Electronic and analytical equipment.
2. Determination of hardness of water using EDTA.
3. Determination of chloride in tap water sample.
4. Estimation of copper using iodometry.
5. Determination of barium in barium nitrate by gravimetric analysis
6. Determination of nickel in a given steel sample.

7. Determination of bicarbonates in a clinical sample using back-titration.
8. Determination of cations in a mixture by complexometric titration.
9. Studying the effect of common ions on solubility of sparingly soluble salts (*e.g.* AgCl/$PbSO_4$).

Recommended Books:

- Skoog, D.A; West, P.M; Holler, F.J; Crouch, S.R.Fundamentals ofAnalytical Chemistry. Brooks Cole Publishing Company, 2013; $9^{th\ Ed}$.
- Christian, G.D. Analytical Chemistry. John-Wiley & Sons: NewYork, 2006; 6^{th}Ed.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman and Company: New York, 2011; 8^{th}Ed.

Course Title: **Industrial Chemistry**

Course Code: **CHEM2113**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The fundamentals of chemical industry, raw materials, manufacturing and industrial processes.

Course Outlines:

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.

Industrial Tour: Visit to any industry to understand the objectives and contents of said industries which is also a good application of practical knowledge.

Practicals:

1. Determine the total acidity by mass of HNO_3, HCl and H_2SO_4.
2. Determination of oxalic acid content.
3. Determination of the initial and final setting time of the hydraulic cement by Vicat needle apparatus.
4. Determine the tensile strength of cement.
5. Design an apparatus to cook food with energy from the sun.
6. Synthesis of fluorescein and indophenol blue dyes.
7. Dyeing of cotton using aniline black dye.
8. Preparation of Novalac (linear polymer) from *ortho*-hydroxy,benzyl alcohol.
9. Preparation of urea-formaldehyde resin, polystyrene and nylon 6-6.
10. Preparation of soap from animal fat.
11. Preparation of sodium lauryl sulphate detergent.

Recommended Books:

- Kent, J.A. Riegel's Handbook of Industrial Chemistry. KluwerAcademic/ Plenum Publishers, 2003; 10^{th}Ed.
- Vermani, O.P; Narula, A.K. Applied Chemistry; Theory and Practice. New

Age International Pvt. Ltd. Publishers, 2008.

- Hede, P.D; Bier. S.P. Inorganic and Applied Chemistry. Ventuspublishing app, 2007.
- Sharma, J; Ndi. Applied Industrial Chemistry.Arise publishers & Distributors, 2012.
- Heaton, A. An introduction to Industrial Chemistry. Chapman & Hall, 1996; 3rd Ed.

Course Title: **Introduction to Biochemistry**

Course Code: **CHEM2114**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The fundamental concepts of biochemistry.
- The structures, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

Course Outlines:

Introduction to Biochemistry: Brief introduction to the scope and history of biochemistry, Molecular logic of the living organism, Cell structures and their functions, Origin and nature of bio molecules

Acid–Base and Electrolyte Chemistry: Intracellular and extracellular electrolytes, Body fluids as electrolyte solutions, pH, Henderson-Hasselbalch equation and buffers, Amino acids, Peptides and proteins, Buffer capacity, Buffers of body fluids, Hemoglobin as an acid-base system, Renal control of acid-base, Balance, Acid-base disorders, Acidosis, Alkalosis. Hemoglobin and homeostasis, Variation of Na^+, K^+, Cl^-in acid-base disturbances.

Carbohydrates: Definition and classification, Chemistry, Physical and chemical properties of various classes of carbohydrates, Biological functions of starch, Glycogen, Cellulose, Cell wall polysaccharides, Acid mucopolysaccharides and proteoglycans.

Lipids: Definition and classification of lipids, Chemistry and biological importance of fatty acids, Waxes, Glycerides, Phospholipids, Sphingolipids, Glycolipids, Sterols and prostaglandins. Significance of lipids in biological membranes and transport mechanism

Proteins: Chemistry and classification of amino acids, Physical and chemical properties of amino acids, Biological significance of amino acids, Peptides, Proteins, Classification, Properties and biological significance, Primary, Secondary,Tertiary and quaternary structure of proteins, Denaturation of proteins.

Nucleic Acids: Chemical composition of nucleic acids, Structure and biological significance of nucleic acids, Chemical synthesis of oligonucleotides, Nucleic acids

hydrolysis, Isolation and separation of nucleic acids, Introduction to recombinant DNA technology.

Practicals:

1. Qualitative and quantitative analysis of carbohydrates, Lipids and proteins.
2. Laboratory work illustrating topics covered in the lectures.
3. Determination of pH, Preparation of buffers.
4. Determination of values of enzyme catalysis, Progress curve for enzyme catalyzed reactions.
5. To study the effect of different factors on the rate of enzyme catalyzed reactions.

Recommended Books:

- Alkire, R.C; Kolb, D.M; Lipkowski, J. Biselectro Chemistry.Wiley-VCH Verlag GmbH & Co, 2001;vol 13; 13thEd.
- Nelson, D.L. Lehninger's Principles of Biochemistry. Macmillan Higher Education, 2008;6thEd.
- Voet, D; Voet, J.D. Biochemistry. John-Wiley & Sons: Canada, 2011;4thEd.
- Murray, R.M; Harper, H.A. Harper's Biochemistry. Appleton & Lange, 2000;25thEd.
- Zubay, G.L. Biochemistry. W.M.C. Brown Publishers, 1998, Digitized 2008;4thEd.
- Guyton, A.C; Hall, J.E; Guyton & Hall Textbook of Medical Physiology.Saunders Elsevier, 2011;12thEd.
- Harvey, R.A; Ferrier, D.R; Karandish, S. Lippincott's illustrated Reviews: Biochemistry. Biochemistry Map (Med maps) Bundle.Lippincott Williams & Wilkins, 2010;5thEd.

Course Outline (Semester - V)

Course Title: **Mathematics for Chemist**

Course Code: **MATH3116**

Credit Hours: **2(2+0)**

Objectives:

The students will acquire knowledge about:

- The essential tools of calculus.
- The application of these concepts and the techniques in their respective disciplines.

Course Outlines:

Preliminaries: Real numbers and the real line,Functions and their graphs: Polynomial functions, Rational functions, Trigonometric functions, Transcendental functions. Slope of a line, Equation of a line, Solution of equations involving absolute values, Inequalities, Limits and Continuity, Limit of a function, Left hand and right hand limits, Continuity, Continuous functions.

Differentiation: Derivatives and its applications, Differentiation of polynomial, Rational and transcendental functions, Extreme values of functions.

Integration: Integration and indefinite integrals, Integration by substitution, Integration by parts, Change of variables in indefinite integrals, Least-squares line.

Recommended Books:

- Thomas. Calculus. Addison Wesley publishing company, 2005;11th Ed.
- Anton, H; Bevens, I; Davis, S. Calculus. John Wiley & Sons, 2005; 8th Ed.
- Hughes-Hallett; Gleason; McCallum. Calculus Single and Multivariable. John Wiley & Sons, 2002;3rd Ed.
- Frank, A; Elliott, M. Calculus. Schaum's Outline Series.1999;4th Ed.
- Swokowski, E. W. Calculus and Analytic Geometry. P. W. S. Publishers:Boston, 1983.
- John, H. Mathews. Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, 1992; 2nd Ed.

Course Title: **Chemistry of Transition Elements**

Course Code: **CHEM3111**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The physical and chemical properties of d& f-block elements on the basis of their electronic configurations.
- The structures of coordination compounds through development of understanding of VBT, CFT and MOT.

Course Outlines:

Chemistry of d-Block Elements and Coordination Complexes:

Back ground of coordination chemistry, General chemical and physical properties of transition elements, Comparison of the elements of first transition series (3d) with those of second (4d) and third (5d) series,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), Sidgwick‘s electronic interpretation of coordination,Effective atomic number (EAN), Jahn-Teller theorem, Magnetic properties, Spectral properties, Isomerism, Stereochemistry, Stability constants of coordination complexes.

Chemistry of f-Block Elements:

Lanthanides, General characteristics, Occurrence, Extraction and general principles of separation, Electronic structure and position in the periodic table, Lanthanides contraction, Oxidation states, Spectral and magnetic properties and uses.

Actinides, General characteristics, Electronic structure, Oxidation state and position in the periodic table, Synthesis of trans uranium elements, Comparison of d and f block elements, Half-life and decay law.

Practicals:

1. Preparations of following Inorganic Complexes:
    a) Tetraamminecopper (II) sulphate
    b) Potassiumtri oxalate chromate (III)
    c) Potassiumtri oxalate aluminate (III)
    d) Cis-potassium di oxalate diaquachromate (III).

2. Determination of zinc and cadmium by complexometric titration.
3. Chromatographic separations of transition metals.
4. Separation of Ni^{2+}& Co^{2+}, Ni^{2+}& $Cu^{2+}$and Cu^{2+}& Fe^{2+} ions in a mixture by paper chromatography.
5. Spectrophotometric determination of iron, manganese and nickel.

Recommended Books:

- Cotton, F.A, Wilkinson, G., Murillo, C.A., Bochmann, M. Advanced Inorganic Chemistry. Wiley-Interscience, 1999; 6thEd.
- Housecraft, C., Sharpe, A. G. Inorganic Chemistry. Prentice Hall, 2012; 4thEd.
- Miessler, G.L., Tarr, D.A. Inorganic Chemistry. Pearson-Prentice Hall International, 2010; 4thEd.

Course Title: **Stereochemistry and Reaction Mechanism**

Course Code: **CHEM3112**

Credit Hours: **4 (3+1)**

Objectives:

The students will gain knowledge about:

- The stereochemical behavior of organic molecules.
- An ability to propose mechanism of simple reactions.

Course Outlines:

Stereochemistry: Types of stereoisomers, RS and EZ notation for stereoisoners, Optical isomerism in biphenyl, allene and spiro compounds, Concept of racimization and resolution of racemic mixture, Stereoselectivity and stereospecificity of organic reactions, Felkin Ahn Model, Conformational isomerism of Cyclobutane, Cyclopentane, Cyclohexane, Mono-substituted, Di-substituted Cyclohexanes and condensed rings

Organic Reactions and Mechanism: Stereochemical aspects of aliphaticaddition, substitution and elimination reactions, Concept of energy profile, Transition state and intermediate.

Practicals:

1. Experiments using polarimeter such as to determine optical activity of a sugar solution and to determine sugar concentration by polarimeter
2. Isomerization of maleic acid.
3. Experiments involving aliphatic addition, Elimination and substitution reactions, Synthesis of cyclohexene from cyclohexanol, Addition reaction to cyclohexene.
4. Synthesis of a chalcone explaining the concept of condensation and dehydration.
5. *N*-Alkylation of phthalimide.

Recommended Books:

- Robert, T.M; Robert, N.B. Organic Chemistry.Prentice Hall:New Jersey, 1992; 6thEd.
- John, E.M. Organic Chemistry. Brooks/Cole Publishing Co: USA, 2012; 8thEd.
- Younas, M.A. Textbook of Organic Chemistry. Ilmi Kitab Khana, Urdu

Bazar: Lahore, 2006.

- Morris, D.G. Stereochemistry (Basic Concepts in Chemistry). Wiley-RSC, 2002.
- Mislow, K. Introduction to Stereochemistry. Dover Publications, 2003.
- David, M. Stereochemistry (Tutorial Chemistry Texts). Royal Society of Chemistry, 2002.
- Furniss, B.S; Hannaford, A.J; Smith, P.W.G; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry.Longman: UK, 1989; 5thEd.
- Mohan, J. Organic Analytical Chemistry, Theory and Practice. Alpha Science International, 2003; 1stEd.
- Seiler, J.P. Good Laboratory Practice: The Why and the How. Springer, 2005; 2ndEd.
- Brown, W.H; Fotte, C.S; Iverson, B.L; Anslyn, E.V. Organic Chemistry. Brooks/Cole Cengage Learning, 2012; 6thEd.
- Solomon's, T.W.G; Fryhle, C.B. Organic Chemistry.John-Wiley & Sons, 2011; 10thEd.
- Pavia, D.L; Kriz, G.S; Lampman, G.M;Engel, R.G.A Microscale Approach to Organic Laboratory Techniques. Brooks/Cole Cengage Learning, 2013; 5thEd.
- Eames, J; Peach, J. M. Stereochemistry at a Glance. Blackwell Science, 2003.
- Eliel, E.L; Wilen, S.H; Doyle, M.P. Basic Organic Chemistry. John-Wiley & Sons, 2001.
- Eliel, E.L; Wilen, S.H. Stereochemistry of Organic Compounds. John-Wiley & Sons, 1994.

Course Title: **Quantum Chemistry and Gas Phase Equilibrium**

Course Code: **CHEM3113**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The principles and theoretical background of quantum chemistry, kinetics theory of gases and phase equilibrium.
- Various aspects of quantum mechanics, gas kinetic behavior and thermodynamics and phase equilibrium.

Course Outlines:

Quantum Chemistry: Black body radiation, Photoelectric effect, Line spectra of elements, Bohratomic model, Wave and particle nature of matter, De Broglie's equation,Young's double slit experiment, Heisenberg's uncertainty principle, Wavefunctions and Born interpretation of wavefunctions, Probability density, Eigenfunctions and Eigenvalues, Hamiltonian operator, Schrodinger wave equation, Wavefunctions for hydrogen-like atomic orbitals, Radial distribution functions, Shielding and penetration, Effective nuclear charge, Orbital energies, Periodic trends in the properties of the elements in the periodic table.

Kinetic Theory of Gases: Probability density for molecular speeds of gas molecules, Maxwell distribution of molecular speeds, Average speeds, Pressure of an ideal gas, Calculation 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.

Phase Equilibrium: Gibbs phase rule, Phase diagrams of one component and two component systems, Gibbs energy and the phase diagram of a substance, Clausius-Clapeyron equation, Vapor-liquid equilibrium of binary liquid mixtures, Binary phase diagrams and lever rule.

Practicals:

1. The determination of equilibrium constant of the $KI + I_2 = KI_3$ reaction.
2. The determination of kinetics of saponification of ethyl acetate.
3. The determination of acid catalyzed hydrolysis of sucrose.
4. The determination of partial molar volumes.
5. The study of the adsorption isotherms of acetic acid-charcoal system.

6. The study of the charge transfer complex formation between iodine and benzene.
7. The determination of activation energy for the acid catalyzed hydrolysis of ethylacetate.

Recommended Books:

- Silbey, R.J; Alberty, R.A; Bawendi, M.G. Physical Chemistry. John-Wiley & Sons, 2005; 4thEd.
- McQuarrie, D.A; Simon, J.D. Physical Chemistry-A MolecularApproach.University Science Books, 1997; 1stEd.
- Atkins, P; Paula, J.D. Atkin's Physical Chemistry, Oxford University Press, 2010; 9thEd.
- Moore. W.J. Physical Chemistry.Longman Publisher, 1972; 4thEd.
- Keeler. J; Wothers, P. Chemical Structure and Reactivity: AnIntegrated Approach, Oxford University Press, 2008; 1stEd.
- Helpern, A.M. Experimental Physical Chemistry: A Laboratory Textbook. Prentice Hall, 1997; 2ndEd.
- Garland, C.W; Nibler, J.W; Shoemaker, D. Experiments inPhysical Chemistry. McGraw-Hill, 2003; 8thEd.
- Born, M. Atomic Physics. Blackie & Son Ltd, 1969; 8thEd.
- Atkins, P; Jones, L. Chemical Principles: The Quest for Insight. W.H. Freeman: New York, 2010; 5thEd.
- James, A.M; Prichard, F.E. Practical Physical Chemistry. Longman Group Limited: New York, 1974;3rdEd.

Course Title: **Advanced Analytical Chemistry**

Course Code: **CHEM3114**

Credit Hours: **4(3+1)**

Objectives:

The students will be able to:

- Understand the basics principles, instrumental aspects and applications of separation andspectrophotometric analytical methods.

Course Outlines:

Separation Methods: Principle of solvent extraction, Solvent extraction of metals, Analytical separations, Multiple batch extraction, Counter current distribution, Solid-phase extraction, Principles of chromatography, Classification of chromatographic techniques, Overview of paper, Thin layer, Column, Ion exchange chromatography and electrophoresis.

Analytical Spectrophotometry: Properties of light and its interaction with matter, Relation between frequency, Velocity and wave number, Lambert-Beer's law and its limitations, Single beam and double beam spectrophotometers, Monochromators, Detectors, Photomultiplier tube, Photodiode array, Charged coupled device, FT-IR spectroscopy, Signal/ Noise ratio.

Practicals:

1. Separation of phenol from given organic mixture using solvent extraction.
2. Separation of given mixture of cations using paper chromatography.
3. Analysis of the composition of a mixture of nitro anilines by TLC.
4. Separation of sugars using paper chromatography.
5. Separation of amino acids using paper/thin layer chromatography.
6. Deionization and softening of water using ion exchange chromatography.
7. Determination of λ max of $KMnO_4$ solutions and verification by Beer-Lambert's Law.
8. Determination of λmax $K_2Cr_2O_7$ solutions and verification of Beer-Lambert's law.
9. Determination of stoichiometry of a metal complex by visible spectrometry.
10. Determination of aspirin and caffeine in a proprietary analgesic by doublebeam UV-Vis spectrometer.
11. Quantification of iron in a given sample by using single

beamspectrophotometer.

12. A study of characteristics infrared absorption frequencies.

Recommended Books:

- Skoog, D.A; West, P.M; Holler, F.J; Crouch, S.R. Fundamentals ofAnalytical Chemistry. Brooks Cole Publishing Company, 2013; 9thEd.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman andCompany: New York, 2011; 8thEd.
- Christian, G.D. Analytical Chemistry. John Wiley and Sons: NewYork, 2006; 6thEd.
- Kealey, D; Haines, P.J. BIOS Instant Notes in Analytical Chemistry. Bios Saence Publisher: Oxford& UK, 2002; 1stEd.
- Pavia, D.L; Lampman, G.M; Kriz, G.S; Vyvyan, J.A. Introductionto spectroscopy. Cengage Learning, 2008; 4thEd.
- Wall, P.E. Thin Layer Chromatography: A Modern Approach (RSCChromatography Monographs). Royal Society of Chemistry,2005; 1stEd.
- Deinstrop, E.H. Applied Thin Layer Chromatography. Wiley-VCH, 2006; 2ndEd.
- Kellener. R; Mermet. J.M; Otto, M; Valcarcel, M; Widmer, H.M. Analytical Chemistry: A Modern Approach to Analytical Science. Wiley VCH, 2004.
- Hollas, J. M. Modern Spectroscopy.John-Wiley & Sons, Ltd: England,2004; 4thEd.

Course Outline (Semester - VI)

Course Title: **Inorganic Material Chemistry**

Course Code: **CHEM3115**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge about:

- The various types of inorganic materials.
- The structure, synthesis, characterization and applications in various fields.

Course Outlines:

Introduction to inorganic materials: Introduction to nano materials, Crystalline and amorphous states, Bonding in solids, Crystal defects, Non-stoichiometric compounds, Binary solid solutions.

Properties of inorganic materials: Mechanical, Electrical, Magnetic, Dielectric, Optical, and chemical (corrosion) properties of advanced materials, Synthesis (sol-gel, hydrothermal techniques).

Designing and characterization: Doping and purification of silicone, Chemical and physical vapor deposition, XRF, XRD and sputtering.

Practicals:

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 $AgNO_3$ using fluorescein as indicator.b) Determination of % age purity of KBr, % composition of mixture of KI & KNO_3 using eoscein as indicator.
5. Spectrophotometric determination of cerium.
6. Separation of heavy metals using solvent extraction technique.

Recommended Books:

- Cotton, F.A; Wilkinson, G; Murillo, C.A; Bochmann, M. Advanced Inorganic Chemistry. Wiley-Interscience, 1999; 6^{th}Ed.
- Huheey, J.E; Keiter, E.A; Keiter, R.L. Inorganic Chemistry: Principles of Structure and Reactivity.Prentice Hall, 1997; 4^{th}Ed.

- Housecraft, C; Sharpe, A.G. Inorganic Chemistry. Prentice Hall, 2012; 4th Ed.
- Rodgers G.E. Descriptive Inorganic, Coordination and Solid StateChemistry.Brooks- Cole, 2012; 3rdEd.

Course Title: **Organic Reaction Mechanisms**

Course Code: **CHEM3116**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The aromatic substitution reactions, oxidation and reduction as well as pericyclicreactions.

Course Outlines:

Aromatic Substitution Reactions: Mechanisms of aromatic reactions including electrophilic nitration, suphonation, halogenation, alkylation, acylation and nucleophilic substitutions, Effect of substituents on orientation and reactivity.

Oxidation-reductions Reactions: Common oxidizing and reducing reagents, Reactions involving reduction of alkenes, alkynes, aromatic compounds and polar C-X σ bonds, Reactions involving epoxidation, dihydroxylation, oxidative cleavage of alkenes, alkynes and oxidation of polar C-X bonds.

Pericyclic Reactions: Introduction to pericyclic reactions, Frontier orbital theory, Mechanisms of electrocyclic, Cycloaddition and sigmatropic reactions

Practicals:

1. The experiments comprise ofaromatic substitution, oxidation/reduction reactions.
2. The nitration of nitrobenzene to meta-dinitrobenzene.
3. The reduction of meta-dinitrobenzene to meta-nitroaniline.
4. The sulphonation of aniline.
5. The oxidation of benzaldehyde.
6. The oxidation of cyclohexanol to cyclohexanone.
7. The preparation of benzoic acid and benzyl alcohol from benzaldehyde using Cannizzaro's reaction.

Recommended Books:

- Pavia, D.L; Kriz, G.S; Lampman, G.M; Engel, R.G.A Microscale Approach to Organic Laboratory Techniques. Brooks/Cole Laboratory Series, Learning, 2013; 5thEd.
- Furniss, B.S; Hannaford, A.J; Smith, P.W.G;Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry. Longman; UK, 1989; 5thEd.

- Mohan, J. Organic Analytical Chemistry: Theory and Practice. Alpha Science: New Delhi India, 2003; 1st Ed.
- Robert,T.M; Obert,N.B.Organic Chemistry. Prentice Hall: New Jersey, 1992; 6th Ed.
- Tse-Lok, H. Symmetry: A Basis for Synthesis Design. John-Wiley & Sons: New York, 1995.
- Pine, S.H. Organic Chemistry. Tata McGraw-Hill: India, 1987; 5th Ed.
- Sykes, P.A. Guide Book to Mechanism in Organic Chemistry. Pearson Education, 1986; 6th Ed.

Course Title: **Advanced Physical Chemistry**

Course Code: **CHEM3117**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The theoretical and instrumental as well as application related aspects of conductometry.
- The electrochemical techniques and surface chemistry.
- The nuclear binding energy, nuclear instabilities and decay mechanisms as well as the fission and fusion processes.

Course Outlines:

Conductometry: Ions in solution, Measurement of conductance and Kohlrausch's law, Mobility of ions and transport number, Conductometric titrations, Debye-Huckel 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 (Instrumentation & Applications), Reference and indicator electrodes, Voltammetry ((Instrumentation, Applications & types), Fuel cells, Corrosion and its prevention,Fuel cell and hydrogen economy

Surface Chemistry: Interfaces, Gibbs surface excess, 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.

Practicals:

1. Spectroscopic determination of Cu percentage in the given sample.
2. Electrochemical separation of copper or other metals from their salts.
3. Conductometric determination of Cu (II)-EDTA mole ratio in the complex.
4. To determine the effectiveness of an extraction of I_2 solution by using

solventextraction method.

5. Determination of molecular weight of a polymer by viscosity method.
6. Determination of percentage composition of $KMnO_4/K_2Cr_2O_7$ in a given solution by spectrophotometry.
7. Evaluation of pKa value of an indicator by spectrometric method.
8. Conductometric determination of hydrolysis constant (Kh) of conjugate base of a weak acid.

Recommended Books:

- Silbey, R.J; Alberty, R.A; Bawendi, M.G. Physical Chemistry. John-Wiley & Sons, 2005; 4thEd.
- Ball, D.W. Physical Chemistry. Brooks/Cole Company, 2003.
- Vertes, A;Nagy, S; Klencsar, Z. Handbook of Nuclear Chemistry.Basics of Nuclear Science, Springer, 2003; vol 1; 1stEd.
- Choppin, G; Liljenzin, J.O; Rydberg, J. Radiochemistry and NuclearChemistry. Butterworth- Heinemann, 2002; 3rdEd.
- Loveland, W; Morrisey, D.J; Seaborg, G.T. Modern NuclearChemistry. John-Wiley & Sons, 2006.
- Atkins, P; Paula, J.D. Atkin's Physical Chemistry. Oxford University Press, 2010; 9thEd.
- Somorjai, G.A; Li, Y. Introduction to Surface Chemistry andCatalysis.John-Wiley & Sons, 2010; 2ndEd.
- Laidler, K.J. Chemical Kinetics.Prentice Hall, 1987; 3rdEd.
- Atkins, P; Jones, L. Chemical Principles: The Quest for Insight. W.H. Freeman: New York, 2010; 5thEd.
- James, A.M; Prichard, F.E. Practical Physical Chemistry. Longman Group Limited: New York, 1974; 3rdEd.

Course Title: **Applied Chemistry**

Course Code: **CHEM3118**

Credit Hours: **4(3+1)**

Objectives:

The students will gain understanding about:

- The importance of water and its quality requirements for the industrial uses.
- The water treatment techniques and the composite materials.

Course Outlines:

Water Treatment, Steam Production and Scale Removal: Sources of water hardness, Water treatment and conditioning for municipal andindustrial purposes, Steam production and its utilization for power and energy generation, Boiler water treatment, Chemistry involved in the formation of scale and its prevention.

Distillation: Vapour liquid equilibrium, Methods of getting equilibrium data for binary systems, Construction of equilibrium diagram, Designing of distillation column, Reflux ratio and its importance.

Composite Materials: Introduction to composite material, Classification of composite on the basis ofreinforcement (Particle-Reinforced composite, Fibre-reinforced composite, Structural composites) and classification of composites on the basis of matrix phase (polymer-matrix composite, metal-matrix composite, ceramics-matrixcomposite, carbon-carbon composite, hybrid-composite, laminar composite, sandwich panels), Synthesis, Properties and applications of composite materials.

Practicals:

1. Measurement of water hardness with EDTA titrations.
2. Estimation of total solids in water.
3. Estimation of chloride in water.
4. Estimation of ferrous and ferric ions in drinking water by redox titration.
5. Extraction of capsicum oil (soxhlet extraction).
6. Extraction of clove oil from cloves.
7. Preparation of liquid detergents.
8. Study of the kinetics of dissolution of magnesium metal in dilute HCl.
9. Estimation of manganese in steel.
10. Estimation of ferric iron in cement.

Recommended Books:

- Erwin D.L. Industrial Chemical Process Design. McGraw-Hill, 2002.
- Chawla, K.K. Composite Materials: Science and Engineering.Springer, 2012; 3rd Ed.
- Methews, F.L; Rawlings, R.D. Composite Materials: Engineering andSciences. CRC Press, 2003.
- Deborah, D.L. Composite Materials: Science and Applications. Springer, 2010; 2nd Ed.
- Gay, D; Hoa, S.V. Composite Materials: Design and Applications.CRC Press, LLC, 2007; 2nd Ed.
- Kister, H. Distillation Operation.McGraw-Hill Professional, 1990; 1st Ed.
- Kister, H. Distillation Design.McGraw-Hill Professional, 1992; 1st Ed.
- Tchobanoglous, G; Burton, F.L; Stensel, H.D. WastewaterEngineering: Treatment and Reuse.McGraw-HillProfessional, 2003; 4th Ed.
- Callister, W.D. Materials Science and Engineering: An Introduction.John-Wiley & Sons, 2007; 7th Ed.
- Roussak, O.V; Gesser, H.D. Applied Chemistry: A Textbook forEngineers and Technologists.Springer, 2013; 2nd Ed.
- Mizrahi, J. Developing an Industrial Chemical Process: An IntegratedApproach. CRC Press, 2002.

Course Title: **Biometabolism**

Course Code: **CHEM3119**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The fundamental concepts of energy production and the mechanisms of major macromolecules (amino acids, proteins, carbohydrates, nucleic acids and lipids).
- The metabolism and regulation and inhibition of the metabolic pathways.

Course Outlines:

Intermediary Metabolism and Bioenergetics: Biological oxidation-reduction including respiratory carriers, Cell bioenergetics, Oxidative phosphorylation, Free energy change and redox system.

Enzymes: Enzyme-substrate interactions and nature of active site, Mechanism of enzyme action with specific reference to chymotrypsin and ribonuclease, Kinetics of single substrate reactions, Enzyme inhibition, Regulatory enzymes, Allosteric enzymes, Multienzyme system, Zymogens and isozymes, Enzymatic control of metabolic pathways, Immobilized enzymes, Synthesis, Propertiesand uses.

Metabolism of Carbohydrates: Digestion, Absorption and transport of sugars into cell, Glycolysis, Citric acid cycle, HMP pathway and its significance, Uronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Photosynthesis.

Metabolism of Lipids: Digestion of lipids, Absorption and transport of lipids and fatty Acids, Oxidation saturated and unsaturated, Odd chain and branched chain fatty acids, Biosynthesis of fatty acids and eicosanoids, Biosynthesis of triglycerides, Phosphides, Steroid and bitter acids, Biosynthesis and utilization of ketone bodies.

Metabolism of Proteins: Digestion of proteins, Absorption and transport of amino acids to the cell, Biochemical reaction of amino acids: Decarboxylation, Deamination, Transamination and transmethylation, Metabolism of essential amino acids, Metabolic disorders, Urea cycle, Creatine and uric acid synthesis, Inter-relationship between carbohydrate, Lipid and protein metabolism.

Metabolism of Nucleic Acids: Biosynthesis and catabolism of purines and pyrimidines and their regulation, Synthesis, Catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism.

Practicals:

1. Separation of proteins by electrophoresis.
2. Separation of nucleic acids by electrophoresis.
3. Column chromatographic separations of protein resolution.
4. Blood glucose estimation, RFT, LFT, Lipid profile, Cardiac markers, Bone markers, Pancreatic markers, Anemia profile, Trace elements, Urine CSF.
5. Immunochemical techniques.
6. Determination of type of inhibition.
7. Determination of Michaelis constant in the presence and absence of inhibitors.

Recommended Books:

- Voet, D; Voet, J.D. Biochemistry.John-Wiley & Sons: Canada, 2011;4thEd.
- Nelson, D.L; Cox, M.M. Lehninger's Principles of Biochemistry. Freeman, 2012; 6thEd.
- Murray, R;Bender, D; Botham, K.M; Kennely, P.J; Rodwall, V;Weil, P.A. Harper's Biochemistry, 2012; 29thed.
- Zubay, G.L. Biochemistry. W.M.C. BrownPublishers, 1998; 4thEd.
- Guyton, A.C; Hall, J.E. Guyton & Hall Text Book of MedicalPhysiology.Saunders Elsevier, 2011; 12thEd.
- Plummer, D.T. An Introduction to Practical Biochemistry. TATAMcGraw-Hill Publishing Company LTD, 2010; 3rdEd.
- Sawhney, S.K; Sing, R. Introductory Practical Biochemistry.Narosa Publishing House: New Delhi, 2005; 2ndEd.
- Robert, A. Copeland, Enzymes: A Practical Introduction to Structure, Mechanism and Data analysis. John-Wiley & Sons,2000;2ndEd.

Course Title: **Fuel Chemistry**

Course Code: **CHEM3120**

Credit Hours: **4(3+1)**

Objectives:

The students will be able to understand:

- The chemistry of fossil fuels like coal, petroleum and natural gas and their conversion processes to get useful chemical products.
- The alternative fuels to be used in case of non-availability of petroleum based oils.

Course Outlines:

Chemistry of Fossil Fuels: Classification of fossil fuels.Origin of coal, Petroleum and natural gas, Preliminary treatment of crude oil, Fractionation of crude oil, Properties of petroleum products i.e. CNG, LPG, Gasoline, Kerosene, Dieselfuels and lubricating oils. Coal storage and cleaning, Carbonization of coal: Low temperature and high temperature carbonization, Coking and non-coking coals, Separation of tar from coke oven gas, Hydrogen sulfide removal fromcoke oven gas.

Introduction to Alternate Sources of Energy: Biomass as energy resources, Biogas technology, Alcohols and its uses as alternative fuel, Hydrogen production, Storage, Handling and its uses as alternative fuel, Fuel cells and its application,Solar energy collector, Nuclear fuels,Fission and fusion, Nuclear reactors and introduction to Hydral energy.

Practicals:

1. Determination of moisture contents of coal mined in different parts of Pakistan.
2. Determination of ash contents of coal mined in different parts of Pakistan.
3. Determination of volatile matter of coal.
4. Determination of fixed carbon contents of coal.
5. Determination of hydrogen and nitrogen contents of the coal.
6. Determination of chlorine and oxygen in coal.
7. Determination of various forms of sulfur in coal.
8. Determination of specific and API gravity of petroleum fractions.
9. Estimation of carbon residue in petroleum products (Conradson method).
10. Determination of ash content in petroleum products.

11. Determination of sulfated ash in lube oil.
12. Estimation of water, sediments and oil in crude oil by centrifuge method.
13. Determination of cloud and pour point of lube-oil.
14. Estimation of asphalt in road samples.

Recommended Books:

- Gyngell, E.S. Applied Chemistry for Engineers. Edward Arnold Publisher: London, 1989.
- Harker, J.H; Backurst, J.R. Fuel and Energy. Academic Press:London and New York, 1988.
- Wilson, P.J; Wells, J.H. Coal Coke and Coal Chemicals. McGraw-HillBook Company: London, 1980.
- Hobson, G.D. Modern Petroleum Technology, Part-I. John Wily & Sons:Toronto, 1984.
- Goodger, E.M. Alternative Fuels (chemical energy resources). TheMacmillan press: London, 1980.
- Twidell, J; Weir, T. Renewable Energy Resources. Sopn: London& NewYork, 1986.
- Matar, S; Hatch, L.W. Chemistry of Petrochemical Processes.Gulf Publishing Company: USA, 2002; 2nd Ed.

Course Outline (Semester - VII)

Course Title: **Inorganic Reaction Mechanism**

Course Code: **CHEM4111**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge:

- The different mechanisms of inorganic reactions and their applications towards understanding different types of complexes.
- The various estimation of various metal cations in transition metal compounds.
- To have expertise about the determination of dissociation constant.

Course Outlines:

Inorganic Reaction Mechanism

Classification of reaction mechanisms, Rate laws, Steady state approximation, Inert and labile complexes, Substitution reactions in octahedral complexes and square planar complexes, Acid hydrolysis, Base hydrolysis, Steric effects of inert ligands, Nucleophilic reactivity, Trans-effect, Cis-effect, Racemization reactions. Mechanism of electron transfer reactions, Oxidation reduction reactions of metal ions, Outer and inner sphere mechanisms, Factors affecting rate of electron transfer reactions, Two electrons transfer reactions, Complementary or non-complementary electron transfer reactions, Oxidative addition, Addition of oxygen, Hydrogen, HX, Organic halides and bimetallic species, Reductive elimination reactions.

Practicals:

1. The resolution of cis-dichlorobis (ethylenediamine) chromium (III) chloride into its optical isomers.
2. The preparation and resolution of the tris (ethylenediamine) cobalt (III) ion into its optical antipodes.
3. Estimation of Al (III) and Fe (III) using 8-hydroxyquinoline.
4. Estimation of Ni (II) in the presence of Cu (II).
5. Determination of chloride in the presence of iodide and evaluation of Ksp of AgI and AgCl.
6. Determination of dissociation constant Ka for acetic acid.

7. Determination of Ni^{+2} ions by EDTA (back titration).
8. Determination of Ca^{+2} and Zn^{+2} ions by EDTA (masking titration).
9. Titration of strong acid and weak acid with a strong base.
10. Precipitation titration involving $AgNO_3$ and KCl.
11. The synthesis of various metal complexes and coordination polymers of transition.
12. Use of organic reagents for the estimation of various metal ions.
13. Synthesis of ferrocene and acetyl ferrocene.
14. Synthesis of triaryl phosphines
15. Reduction of anisole by lithium-birch-reduction.
16. Preparation of ferrocenyl oximes
17. Preparation of zinc-porphyrin complexes
18. Synthesis of zinc-phthalocyanine
19. Synthesis of coordination polymers of transition metals.

Recommended Books:

- Elschenbroich, C; Salzer, A. Organometallics. VCH Weinheim, 1992.
- Huheey, J.E; Keiter, E.A; Keiter, R.L. Inorganic Chemistry: Principles of Structure and Reactivity. Prentice Hall, 1997; 4thEd.
- Jolly, W.L. Modern Inorganic Chemistry. McGraw-Hill Company, 1991; 2nd Ed.
- Jordan, R.B. Reaction Mechanisms of Inorganic and Organometallics Systems. Oxford University Press: New York, 1998; 2ndEd.
- Lucas, C.R; Walsh, K.A. OrganometallicsChemistry of Molybdenum. Journal of Chemical Education, 1987; 64; 265-266.
- McNeese, T.J; Ezbiansky, K.A. Photochemical Preparation and Reactivity of cis- $Cr(CO)_4(CH_3CN)_2$. Journal of Chemical Education, 1996; 73; 548-550.
- Miessler, G.L; Spessard, G.O. Organometallic chemistry-A Course Designed for Sophomore Chemistry Students. Journal of Chemical Education, 1991; 68; 16-18.
- Sharma, S.K. Inorganic Reaction Mechanism. Discovery Publishing House, 2007.
- Shriver, D.F; Atkins, P.W. Inorganic Chemistry. Oxford University Press, 2001; 3rdEd.

Course Title: **Pi-Aceptor Ligands and Polymers**

Course Code: **CHEM4113**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The chemistry of metal carbonyls, nitrosyls and isocyanides.
- The different types of inorganic polymers.

Course Outlines:

pi-Acceptor Ligands: Introduction to pi-acceptor ligands, Effective Atomic Number (EAN) rule and chemistry of metal carbonyls, Nitrosyls, Isocyanides, Structure elucidation based on spectroscopic evidences, Applications and uses of metal carbonyls and their derivatives for catalysis and organic synthesis.

Inorganic Polymers: Introduction to homoatomic and heteroatomic inorganic polymers, Chains and cages of boron, silicon, nitrogen, phosphorous and sulphur, Synthesis and applications, Polyionic species, Isopoly and heteropoly, Anions of transition metals, Silicates, Borates, Condensed phosphates, Zeolites.

Recommended Books:

- Brady, J.E; Sense, F. Chemistry-The Study of Matter and Its Changes. Wiley Plus, 2009; 5thEd.
- Miessler, G.L;Tarr, D.A. Inorganic Chemistry. Prentice-Hall International, New Jersey: USA, 2010; 4thEd.
- Huheey, J.E; Keiter, E.A; Keiter, R.L. Inorganic Chemistry: Principles of Structure and Reactivity. Prentice Hall, 1997; 4thEd.
- Shriver, D.F; Atkins, P.W; Langford, C.H. Inorganic Chemistry. Oxford University Press, 1994; 2ndEd.
- Atkins, P; Jones, L. Chemicals Principles: The Quest for Insight, W.H. Freeman, 2010; 5thEd.
- Ravve, A. Principles of Polymer Chemistry. Plenum Publishers, 2000; 2ndEd.
- Crabtree, R.H. The Organometallic Chemistry of the Transition Metals. John-Wiley and Sons: New Jersey, 2011; 5thEd.
- Yamamoto, A. Organotransition Metal Chemistry. Prentice Hall, 1992.

Course Title: **Inorganic Spectroscopy**

Course Code: **CHEM4115**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire understanding about:

- The various types of transitions (d-d transition, charge transfer) occurring in transition metal compounds.
- To characterize the new compounds by application of electronic spectroscopy.

Course Outlines:

Electronic states of transition metal complexes, Russel-sander's coupling scheme, Derivation of term symbols for d1-d10 systems, D-d transitions, Connecting atomic states and molecular states, Correlation diagrams, Tanabe sugano diagrams, Calculation of 10Dq values, High-spin and low-spin molecules, John-teller effect, Applications of subgroups, Selection rules for electronic transitions in molecules, LMCT and MLCT transitions, Some examples involving different geometries.

Recommended Books:

- Yarwood, J; Bazin, P; Douthwaite, R. Spectroscopic Properties of Inorganic and Organometallic Compounds. The Royal Society of Chemistry: UK, 2011; Vol 42.
- Lever, A.B.P. Inorganic Electronic Spectroscopy. Elsevier: UK, 1984; 2ndEd.
- Brisdon, A.K. Inorganic Spectroscopic Methods. Oxford University Press: UK, 1998.

Course Title: **Heterocyclic and Organometallics**

Course Code: **CHEM4112**

Credit Hours: **4 (3+1)**

Objectives:

The students will acquire knowledge about:

- The C-hetro atom bond with emphasis on how it is formed and how it reacts.
- The importance and applications of compounds containing hetero atom.
- The spectroscopic techniques, their applications in qualitative and quantitative purposes.
- How to isolate natural molecules exhibiting antioxidant activities from plant sources.

Course Outlines:

Aromatic Heterocycles: Structure, Classification and nomenclature, Aromaticity, Basicity and acidity of the nitrogen heterocycles, Synthesis and reactions, Chemistry of furan, Pyrrole and thiophene, Pyridine.

Organometallic Compounds: Principles, Organomagnesium, Organolithium, Organocopper, Organocadmium, Organomercury and organozinc compounds: Their structure and reactivity, Methods of preparation and synthetic applications. Chemistry of organic compounds containing sulfur, Phosphorus, Boron and silicon: Synthesis, Reactions and application.

Practicals:

1. Experiments based on available spectroscopic techniques will be arranged, both of qualitative and quantitative nature.
2. One and two-step synthesis using available starting material is recommended.
3. Experiments based on isolation of natural products from plants are recommended.
4. Isolation of caffeine from tea, Isolation of nicotine from tobacco, Isolation of carvone from mint,Isolation of limonene from orange peels,Isolation of piperine from black pepper.
5. Experiments involving multi-step synthesis: The synthesis of methyl orange. Literature survey for laboratory work is to be carried out during the course of studies.

Recommended Books:

- Beckett, A.H; Stenlake, J.B. Practical Pharmaceutical Chemistry. Part II, Continuum International Publishing Group, 1988; 4thEd.
- Claydem, J; Greeves, N; Warren, S. Organic Chemistry. Oxford University Press, 2012; 2ndEd.
- Coxon, J.M; Norman, R.O.C. Principles of Organic Synthesis. CRC Press, 1993; 3rdEd.
- Crabtree, R.H. The Organometallic Chemistry of the Transition Metals. John-Wiley & Sons:New Jersey, 2009; 5thEd.
- Furniss, B.S; Hannaford, A.J; Smith, P.W.G; Tatchell, A.R. Vogel's Text Book of Practical Organic Chemistry. National Book Foundation: Islamabad, 2008; 5thEd.
- Joule, J.A; Mills, K. Heterocyclic Chemistry. John-Wiley & Sons: UK, 2010. 5thEd.
- Mann, F.G; Saunders, B.C. Practical Organic Chemistry. Longman: London, 1960; 4thEd.
- Mendham, J; Denney, R.C; Barnes, J.D; Thomas, M.J.K. Vogel's Text Book of Chemical Analysis. Prentice Hall, 2000.
- Mohan, J. Organic Analytical Chemistry: Theory and Practice. Alpha Science Int, 2003; 1stEd.
- Pavia, D.L; Kriz, G.S; Lampman, G.M; Engel, R.G. A Microscale Approach to Organic Laboratory Techniques. Brooks/Cole Laboratory Series, Cengage Learning, 2013; 5thEd.
- Williams, D.H; Flemming, I. Spectroscopic Methods in Organic Chemistry. McGraw-Hill Higher Education, 2008; 6thEd.

Course Title: **Reactive Intermediates**

Course Code: **CHEM4114**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The rearrangement reactions and their types including some name reactions.
- The different intermediates involved in organic reactions.
- The underlying concepts and synthetic applications.

Course Outlines:

Reactive Intermediates: Comparison between reactive intermdiates and reaction intermediates, Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes & arynes, their generation, Stability, Reactions and synthetic applications. Chemistry of enolates and enols: Acidity of carbonyl compounds, Enolization of carbonyl compounds

Rearrangement Reactions: Types of rearrangements, General mechanisms of nucleophilic, Free radical and electrophilic rearrangements, Hydrogen and/or carbon migration to electron-deficient carbon, Nitrogen and oxygen, Carbon migration to electron-rich carbon, Aromatic rearrangements, Inter and intra-molecular carbon migration from oxygen to carbon.

Recommended Books:

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

Course Title: **Organic Spectroscopy**

Course Code: **CHEM4116**

Credit Hours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The fundamental and instrumental aspects of different spectroscopic techniques.
- How to perform structural elucidation of organic compounds using spectral data.

Course Outlines:

UV-Visible: Basic concepts, Electronic transitions, Lambert-Beer's law, Factors influencing the lambda max (max) values, Instrumental aspects, Woodward rules for calculation of wavelength values.

IR spectroscopy: Basic concepts, Instrumental aspects, Absorption mechanisms, Functional group determination and factors affecting the absorption frequencies

^{1}H-NMR and ^{13}C-NMR: Instrumental aspects Chemical shift, Factors affecting chemical shift, Spin relaxation, Spin-spin coupling, Coupling constants, Nuclear overhauser effect, 2-D NMR, COSY and HETCOR.

Mass Spectrometry: Basic concepts, Instrumental aspects Mass spectrometers, Ionization techniques, Different fragmentation patterns and structure elucidation, Combined usage of IR, UV, NMR and mass spectrometric data for structure elucidation of organic compounds having medium complexity.

Recommended Books:

- Kemp, W. Organic Spectroscopy. W.H. Freeman & Company: New York, 1991; 3rd Ed.
- Younas, M. Organic Spectroscopy. Ilmi Kitab Khana, Urdu Bazar Lahore: Pakistan, 2006.
- Hollas, J.M. Modern Spectroscopy. John-Wiley & Sons, 2004; 4th Ed.
- Pavia, D.L; Lampman, G.M; Kriz, G.S; Vyvyan, J.R. Introduction to Spectroscopy. Brooks/Cole Cengage Learning, 2009; 4th Ed.
- Williams, D. and I. Fleming, *Spectroscopic Methods in Organic Chemistry*, McGraw-Hill, Newyork
- Silverstein, R. M., G. C. Bassler and T. C. Morrill, *Spectrometric*

Course Title: **Atomic Spectrophotometry**

Course Code: **CHEM4125**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The theoretical aspects &instrumentation of different atomic spectroscopic methods.
- The applications of these techniques in the field of chemical sciences.
- How to determine the various bio & organic molecules in edibles and living system samples.
- The separation techniques used for quantitative and qualitative analysis.

Course Outlines:

Atomic Absorption Spectrophotometry (AAS): Principle of AAS, Concentration dependence of absorption, Quantitative methodology, Instrumentation for atomic absorption spectrophotometry, Radiation sources, Atomizers, Flames, Graphite furnaces and electrochemical atomizers, Monochromators, Detectors, Handling background absorption, Interferences, Sample handling in AAS, Preparation of the sample, Use of organic solvents, Microwave, Digestion, Sample introduction methods, Applications of AAS.

Atomic Emission Spectrophotometry: Principle of atomic emission spectrometry, Atomic emission spectrometry usingdifferent plasma sources, Plasma and its characteristics, Inductively coupled plasma, Direct current plasma, Microwave induced plasma, Choice of argon as plasma gas, Instrumentation for ICP-MS.

Flame Photometry: Origin and classification of atomic spectroscopic methods, Position of the signal, Intensity of the signal, Spectral line width, Principle of flame photometry, Fate of the sample in the flame, Flame and its characteristics, Instrumentation for flame photometry, Merits and limitations.

Atomic Fluorescence Spectrometry; Principle, Instrumentation of atomic fluorescence, Applications.

Practicals:

1. Separation of hydrocarbons using GLC.
2. Separation of essential oils and fatty acids.

3. To determine pKa values for the given samples of weak acids by potentiometric method.
4. Quantitative determination of sodium hydroxide by potentiometric titration.
5. Preparation of buffer solutions of definite pH.
6. Electrogravimetric determination of copper in given samples.
7. Study of thermal decomposition of copper sulfate pentahydrate and calcium oxalatemonohydrate.

Recommended Books:

- Camilleri, P. Capillary Electrophoresis: Theory and Practice. CRC Press, 1998; 2nd Ed.
- Christian, G.D. Analytical Chemistry. John-Wiley: New York, 2006; 6th Ed.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman and Company: New York, 2011; 8th Ed.
- Sharma, B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House: India, 2005; 24th Ed.
- Skoog, D.A; West, P.M; Holler, F.J; Crouch, S.R. Fundamentals of Analytical Chemistry. Cengage Learning, 2013; 9th Ed.

Course Title: **Electroanalytical Techniques**

Course Code: **CHEM4126**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The theoretical and instrumental analytical techniques.
- The applications of different electro analytical techniques.

Course Outlines:

Potentiometry: Electrode potential, Nernst equation and its use for measuring half-cell potential, Different kinds of electrodes including glass and calomel electrodes, Working of potentiometer and its applications including pH measurements, Ion selective electrode systems, Ion exchange membrane electrode, Solid state membrane electrodes, Bio-membrane electrodes, Potentiometric titrations.

Coulometry and Electrogravimetry: Basic electrochemistry, Principle, Instrumentation of coulometry, Principle, Instrumentation of electrogravimetry, Consequences of electrogravimetry, Ohmic drop, Activation over potential, Concentration and gas polarization, Basic difference and merits/demerits of coulometry and electrogravimetry.

Voltammetry and Polarography: Basic principle, Voltammogram, Polarizable and non-polarizable electrodes, Solid electrodes, Scope and limitations, Cyclic voltammetry, Anodic stripping voltammetry. Voltammetric equation, Basic concept of polarography and interpretation of various polarographic curves, Measurement of decomposition potential, Diffusion and limiting currents, Derivation of Ilkovic equation, Logarithmic analysis of polarographic wave, Advantages and limitation of dropping mercury electrode.

Recommended Books:

- Christian, G.D. Analytical Chemistry. John-Wiley & Sons: New York, 2006; 6^{th}Ed.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman and Company: New York, 2009; 8^{th}Ed.
- Kealey, D; Haines, P.J. BIOS Instant Notes in Analytical Chemistry. Bios Scientific Publishers Limited, Oxford: UK, 2002.

- Skoog, D.A; West, D.M. Fundamentals of Analytical Chemistry. Hot Reinehart Inc: London, 2008; 8thEd.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman and Company: New York, 2011; 8thEd.

Course Title: **Advanced Separation Techniques**

Course Code: **CHEM4127**

CreditHours: **3(3+0)**

Objectives:

The students will acquire knowledge about:

- The principles and instrumentation of advanced chromatographic techniques namely GLC, HPLC and capillary electrophoresis.
- Their applications in different fields such as food,pharmaceuticals, petroleum, environmental and other industrial sectors.

Course Outlines:

GasChromatography: Principle, Sample preparation/derivatization, Separation process, Instrumentatioon, Types of GC and applications.

HPLC: General principle, Sample preparation, Separation process (normal phase andreverse phase separation), Instrumentation, Method development and applications, types of gas chromatography, Basic principle and Instrumentation.

Electrophoresis: Theory and types of electrophoresis,Theory of capalliary electrophoresis, Mobility, Electro-osmotic flow separation by CE, Instrumentation, Modes of operation, Applications.

Recommended Books:

- Skoog, D.A; West, P.M; Holler, F.J; Crouch, S.R. Fundamentalsof Analytical Chemistry. Cengage Learning, 2013; 9thEd.
- Christian, G.D. Analytical Chemistry. John-Wiley & Sons: New York, 2004; 6thEd.
- Sharma, B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House: India, 2005; 24thEd.
- Meyer, V.R.Practical High-Performance Liquid Chromatography. John-Wiley & Sons, 2010; 5thEd.

Course Title: **Common Industries-I**

Course Code: **CHEM4131**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The technicalities about sugar manufacturing industry, starch production industry and leather tanneries.
- The analysis of steel, barium, Iodine &chlorine in various samples.
- Preparation of various polymers and cosmetic essentials.
- The psychomotor skills and enable to acquire knowledge about various industrial preparations like fertilizers, pesticides and herbicides used in agriculture sector.

Course Outlines:

Sugar Industry: Scope of sugar industry, Manufacture of raw sugar from cane and beet, Refining of raw sugar, Methods of clarification of cane juice and chemistry involved in the clarification processes, Defecation Remelt Carbonation (DRC), Defecation Remelt Sulphitation (DRS), Defecation Remelt Phosphitation (DRP) and Double Carbonation Double Sulphitation (DCDS), Utilization of by-products of sugar industry.

Starch Industry: Scope of starch industry, Raw materials for starch production, Manufacture of starch from various raw materials such as corn, Rice, Wheat, Potatoes, Industrial applications of starch, Chemistry involved in the conversion of starch, Synthesis of d-glucose and dextrin from starch.

Leather Industry: Leather, Gelatin and adhesives, Preparation of hides, Methods of tanning, Vegetable and chrome tanning processing of leather, Production of glue and gelatin.

Practicals:

1. Determination of iodine value of the given oil.
2. Determination of acid value of the given oil.
3. To find out the percentage purity of fatty acid.
4. Preparation of gum sample.
5. Preparation of liquid detergent or liquid soap.
6. To determine the temporary and permanent hardness of a given water sample

by EDTA method.

7. To determine the alkalinity of given water sample.
8. Determination of magnesium and aluminum by EDTA titration.
9. Analysis of caustic soda and soda ash in mixtures.
10. Analysis of effluents from tanneries.
11. Preparation and Testing of Varnish and Enamel Paints, Adhesives, Emulsion, Paints.

Recommended Books:

- Covington, A.D. Tanning Chemistry: The Science of Leather. Royal Society of Chemistry, 2009.
- Kent, J.A. Riegel's Handbook of Industrial Chemistry. Kluwer Academic/ Plenum Publishers, 2003; 10thed.
- Mendham, J; Denney, R.C; Barnes, J.D; Thomas M.J.K. Vogel's Textbook of Quantitative chemical analysis. The School of Chemical and Life Sciences University of Greenwich: London, 6thEd.
- Pandey, O. P; Bajpai, D.N; Giri S. Practical Chemistry. S. Chand & Company limited, Ramnagar: New Delhi, 2013.
- Pandey, O.P; Bajpai, D.N; Giri, S. Practical chemistry. S. Chand & Company limited, Ramnagar: New Delhi, 2011.
- Rao, G.P; Mogarey, R.C; Solomn, S; Rewal, S.S; Li,Y. Sugar Cane: Production Management and Agro-Industrial Imperatives. IBDC Publisher, 2005.
- Riegel, E.R; Kent, J.A. Reigel's Handbook of industrial Chemistry. Van Nostrand Reinhold Co:New York, 1983; 6thEd.

Course Title: **Agro Based Industries and Pollution Control**

Course Code: **CHEM4132**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The various fertilizers, pesticides and herbicides used in agriculture sector.
- The environmental pollution caused by these industries and protective measures for environment.

Course Outlines:

Fertilizers: Importance of chemical fertilizers, Classification of chemical fertilizers, Manufacture and chemistry involved in the production of various fertilizers i.e. Urea, Single Super Phosphate (SSP), Triple Superphosphate (TSP), Nitrophos (NP), Diammonium Phosphate (DAP), Calcium Ammonium Nitrate (CAN), Ammonium Nitrate (AN), Ammonium Sulphate (AS), Zinc Sulphate (ZS), Complex fertilizers.

Agrochemicals: Classification of pesticides, Formulation and toxicity of pesticides, Future trends of pest control, Control of weeds, Household agrochemicals, Plant growth regulators and background chemistry, Hazards associated with the use of agrochemicals and environmental aspects.

Industrial Pollution and its Abatement: Sources of air, Water and soil pollution, Industrial waste control for the protection of environment, Modern trends of waste management.

Recommended Books:

- Lister, J; Ennis, B. The Science and Engineering of Granulation Processes. Kluwer Academic Publishers, 2004.
- Park, M. The Fertilizer Industry. Woodhead Publishing Limited, 2001.
- Anastas, P.T; Warmer, J.C. Green Chemistry: Theory and Practice. Oxford University Press, 2000.
- Kumar, A. Industrial Pollution: Problems and Solution. Daya Publishing House: India, 2006.

Course Title: **Common Industries-II**

Course Code: **CHEM4133**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The extraction, production and processing of oil, fats and waxes.
- The soap and detergent industries as well as surface coating industries.

Course Outlines:

Oils and Fats: Oils, Fats and waxes, Extraction of oils such as soya bean and cotton seed oils, Purification and refining of oils, Chemistry involved in the production of vegetable ghee, Selective hydrogenation of oil and fats during the manufacture of vegetable ghee, Inter-esterification of crude fats.

Soaps and Detergents: Raw materials for the manufacture of soap and detergents, Chemistry involved in the production of soap and detergents, Action of builders, Additives brighteners and surfactants, Cleansing action of soaps, Effect of acidic species and hard water on soap, Production of transparent soap.

Paints: Raw materials for paints and pigments, Classification and properties of surface-coating constituents, Classification and manufacture of pigments, Production of paints, Varnishes, Distempers, Enamels and lacquers, Chemistry involved in the drying phenomenon of paints, Drying oils for paint and classification of drying oils.

Recommended Books:

- Chattopadyay, P.K. Modern Technology of Soaps, Detergents and Toilries: with formulae and project profile. National Institute of Industrial Research: India, 2003; 2nd Ed.
- Bockisch, M. Fats and Oils Handbook. American oil Chemists and Society, 1998.
- Gunstone, F. Oils and Fats in Food Industry. Wiley Black Well, 2008.
- Gunstone, F. Vegetable Oil in Food Technology: Composition, Properties and Uses. John-Wiley & Sons, 2011.

Course Title: **Biomedical Chemistry**

Course Code: **CHEM4137**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The fundamental biochemical and molecular aspects of endocrinology and chemistry of blood and other extra cellular fluids.
- The estimation and characterization of biomolecules and application of modern techniques like SDS-PAGE.
- How to estimate sodium, potassium and different serum contents of blood.
- How to synthesize nanoparticles of different metals.

Course Outlines:

Endocrinology: General introduction, Chemical nature of hormones, Common characteristics, Mode of action of hormones, Hormones receptors, Chemistry, Biosynthesis, Metabolism and biological functions of pituitary, Adrenal, Thyroid, Parathyroid, Pancreatic and gonadal hormones, Hormones of GIT, Renal and pineal glands.

Blood and Other Body Fluids: General composition of blood, Function of blood plasma, Plasma protein, Composition and functions, Composition, Development and functions of red blood cells, White blood cells and platelets, Haemoglobin, Chemistry properties, Synthesis, Functions and derivatives, Degradation of haemoglobin, Respiration and gas transport, Blood coagulation and clotting of blood, Blood pressure, Blood groups, Composition of urine, Extracellular fluids like: Cerebrospinal fluid, Lymph, Sweat, Tears, Synovial and interstitial fluid.

Practicals:

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

Recommended Books:

- Boyer, R. Modern Experimental Biochemistry. Pearson Education, 2009; 3rdEd.

- Cameron, A.T; White, F.D.A Course in Practical Biochemistry. JA. Churchill, 2005.
- Devlin, T.M. Textbook of Biochemistry with Clinical Correlations. Wiley, 2010; 7th Ed.
- Frisell, W.R. Human Biochemistry. Macmillan Publication Company, 1982; 1st Ed.
- Gosling, J.P; Basso, L. Imunoassay: Laboratory Analysis and Clinical Application. CRC Press, 1994; 1st Ed.
- Hadley, M; Levine, J. E. Endocrinology. Pearson, 2006; 6th Ed.
- Hall, J.E. Guyton & Hall Textbook of Medical Physiology. Elesvier Health Sciences, 2011; 12th Ed.
- Nelson, D.L; Cox, M.M. Lehninger's Principles of Biochemistry, W. H. Freeman, 2012; 6th Ed.
- Orten, James, M; Neuhaus, O.W. Human Biochemistry. Mosby Incorporated, 1982; 10th Ed.
- Sawhney, S.K; Sing, R. Introductory Practical Biochemistry. Narosa publishing House: New Delhi, 2005; 2nd Ed.
- Shankara, Y.M.S. Laboratory Manual for Practical Biochemistry. Jaypnees Brothers Medical Publishers:India, 2008; 1st Ed.
- Voet, D; Voet, J.D. Biochemistry. John Wiley & Sons, 2011; 4th Ed.

Course Title: **Nucleic Acid and Protein Synthesis**

Course Code: **CHEM4138**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The structural and functional features of DNA and RNA.
- The role of DNA and RNA in protein synthesis.

Course Outlines:

Deoxyribo Nucleic Acid (DNA): The primary genetic material, Structure, Replication in prokaryotes and comparison with eukaryotes, DNA sequencing, Chemical synthesis of polynucleotides, DNA repair and recombination.

Protein Synthesis: Different types of RNA and their role in protein synthesis, Transcription and its regulation, Genetic code, Post transcriptional processing, Structure of transfer RNA, Protein synthesis inhibitors, Control of translation, Post translational modification, Plasmids, Bacteriophage and cosmids, *In vitro* mutagenesis, Deletion, Insertion and substitution, Recombinant DNA and genetic diseases.

Recommended Books:

- Watson, J.D; Baker, A.T; Bell, S.P; Gann, A; Levine, M; Losick, M.R. Molecular Biology of the Gene. Benjamin Cummings, 2013; 7thEd.
- Watson, J.D; Myers, R.M; Caudy A.A; Witkowski, J.A. Recombinant DNA: Genes and Genome. A Short Course. W. H. Freeman, 2006; 3rdEd.
- Krabs, J. Genes X. Jones and Bartlett Learning, 2011; 10thEd.
- Alberts, B. Molecular Biology of the Cell. Garland Science, 2008; 5thEd.
- Brown, T.A. Genomes 3. Garland Science Publishing, 2007; 3rdEd.

Course Title: **Physical Techniques in Biochemistry**

Course Code: **CHEM4139**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The fundamental biochemical techniques such as extraction, purification, fractionation and centrifugation.
- The characterization of different biomolecules.
- The application of these techniques for macromolecules separation.

Course Outlines:

Physical Techniques in Biochemistry: Extraction, Fractionation and purification of macrobiomolecules, Homogenization, Solubilization and concentration including ultrasonication, Lyophilization and ultradecantation, Purification based on differential solubility techniques, Ion-exchange chromatography, Gel chromatography, Affinity chromatography, Paper & thin layer chromatography and HPLC.

Electrophoresis: Paper and gel electrophoresis, Two-dimensional electrophoresis, Capillary electrophoresis, Electrofocusing: Preparative and analytical electrofocusing, Centrifugation:Principle, Preparative centrifugation, Application of density gradient anddifferential centrifugation, Ultracentrifugation sedimentation equilibrium andsedimentation velocity methods, Application of analytical centrifugation.

Tracer Techniques: Detection and measurement of radioactivity, Application of radioisotopes in biological system, UV and Visible Spectroscopy: Basic principles, Instrumentation and applications.Enzyme Linked Immune Sorbent Assay (ELISA):Basic principle, Instrumentation and applications.

Recommended Books:

- Cooper, T.C. The Tools of Biochemistry. John Wiley, 2007; 2nd Ed.
- Wilson, K; Golding, K.H. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, 1986; 3rd ed.
- Scopes, R.K. Protein Purification: Principles & Practice. Springer, 1994; 3rd Ed.

CourseTitle: **Electrochemistry and Statistical Thermodynamics**

Course Code: **CHEM4143**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The electrochemical processes, thermodynamic principles and mechanisms involved in aqueous salt solutions as well as colloidal solutions.
- The molecular level treatment of the thermodynamic functions/properties using partition functions and Boltzmann statistics.
- The practical grounds for the verification of fundamental principles of physical chemistry and applications of these principles.
- The advance techniques like XRD and cyclic voltammetry for characterization of materials and understandings of experimental methods of kinetics using different interface methods like spectroscopy and polarimetry.
- The effect of operational conditions on reactions and mechanism of surface reactions.

Course Outlines:

Electrochemistry: Electrical double layer, Interface, A look into the interface, OHP (Outer Helmholtz Plane) and IHP (Inner Helmholtz Plane), Contact adsorption, Gibbs surface excess, Potential differences across metal solution interfaces, Outer and surface potential differences, Galvanic potential difference, Electrochemical potential difference, Interfacial tension, Electro-capillary thermodynamics, Lippmann's equation, Helmholtz-perrin model, Gouy-Chapmann model, Stern model of electrical double layer, BDM (Bockris-Devanathan-Muller) model, Charge density, Differential capacitance, Shape of capacitance-charge curve, The capacitance hump. Electrochemical devices, Charge transfer processes in the absence and presence of electrical field, The over potential, Butler-Volmer's equation, The idea of equilibrium exchange current density, The symmetry factor, High field and low field approximation, Tafel's equation, Cyclic voltammetry and its applications, Electrochemical impedance spectroscopy.

Statistical Thermodynamics: Description of various systems, Concepts of states, Accessible states and distribution, Probability concepts, Maxwell-Boltzmann's statistics for the systems of independent particles, Partition functions, The relationship

of partition function to the various thermodynamic functions, Transitional, Vibrational and rotational partition functions and equilibrium constant, Statistical thermodynamics, Applications to equilibrium and chemical kinetics, Bose-Einstein's and Fermi-Dirac's statistics.

Practicals:

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.
7. Precipitation value of electrolytes.Measurement of IR spectra of simple compound and their interpretation.
8. Measurement of cyclic voltammogram of an organic compound and its interpretation.
9. Determination of dipole moment of an organic liquid.
10. Determination of percentage composition of KMnO4-K2Cr2O7 in given solution by spectrometry.
11. Evaluation of pKa value of an indicator by spectrometric method.
12. Synthesis of metal oxide nanoparticles and their characterization using IR andXRD techniques.

Recommended Books:

- Athawale, V.D; Mathur, P. Experimental Physical Chemistry. New Age International, 2001.
- Bockris J.O.M; Reddy, A.K.N. Modern Electrochemistry: Ionics. Plenum Press: London, 1998; Vol. I; 2nd Ed.
- Farrington, D. Experimental Physical Chemistry. BiblioBazaar, 2011.
- Garland, C.W; Shoemaker, D.P; Nibler, J.W. Experiments in Physical Chemistry. McGraw-Hills: New York, 2003; 8th Ed.
- Gasser, R.P.H. Entropy and Energy Level, Rev. ed. Oxford University Press: New York, 1986.

- Halpern, A; McBane, G. Experimental Physical Chemistry: A LaboratoryTextbook. W. H. Freeman, 2006; 3rdEd.
- Palmer, W.G. Experimental Physical Chemistry. Cambridge University Press, 2009; 2ndEd.
- Wayatt, P.A.H. The Molecular Basis of Entropy and Chemical Equilibrium. Royal Institute of Chemistry London: UK, 1971.

Course Title: **Polymer Chemistry**

Course Code: **CHEM4144**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The fundamental principles of polymerization, synthesis methods and reaction mechanisms & thermodynamic.
- The kinetic aspects of the polymerization, physical and mechanical properties of polymers.

Course Outlines:

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, Methods of determination, Viscosity, Osmometry, Light scattering method, Diffusion, Sedimentation, Optical rotation method, Structure of polymer chain, Introduction to chain isomerism.

Stereochemistry: Configurations, Conformations (not in Hiemenz), Amorphous state of polymers, In-depth examination of polymer conformation, Microstructure, Dynamics in the amorphous state, Polymer viscoelasticity, Stress relaxation, Mechanical models of polymer behavior, Time-temperature superposition.

Polymer Rheology: Crystalline state of polymers, Crystallization and kinetics, Crystalline structures, Experimental methods, Polymer solutions and blends.

Recommended Books:

- Sperling, L.H. Introduction to Physical Polymer Science. Wiley- Interscience, New York: USA, 2006; 4thEd.
- Odian, G. Principles of Polymerization. Wiley Interscience, 2004; 4thEd.
- Carraher, C.E. Carraher's, Polymer Chemistry. CRC Press, 2010; 8thEd.
- Ravve, A. Principles of Polymer Chemistry. Springer, 2012; 3rdEd.
- Stevens, M.P. Polymer Chemistry: An Introduction. Oxford University Press, 1998; 3rdEd.

Course Title: **Quantum Chemistry and Molecular Spectroscopy**

Course Code: **CHEM4145**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The quantum chemistry including Schrodinger wave equation and its applications.
- The behaviour and properties of different systems.
- The different molecular spectroscopic techniques.

Course Outlines:

Quantum Chemistry: Operators and their properties, Schrodinger 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, Huckel method for pi-electron approximation in aromatic compounds.

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

Recommended Books:

- Fayer, M.D. Elements of Quantum Mechanics. Oxford University Press: UK, 2001.
- Becker, E.D. High Resolution NMR; Theory & Chemical Application. Academic Press: New York, 2000; 3rd Ed.
- House, J.E. Fundamentals of Quantum Mechanics. Elsevier-Academic Press: New York, 2004; 2nd Ed.
- Kirsten, H.J.W.M. Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral. World Scientific Publishing, 2006; 1st Ed.

Course Title: **Chemistry of Coal Conversion**

Course Code: **CHEM4149**

Credit Hours: **4(3+1)**

Objectives:

The students should be able to understand:

- The environmentally friendly utilization of coal and how to extract maximum energy and convert coal in to a variety of highly demanding chemicals.
- How to use this feed stock in a number of Industries.
- The application of analytical techniques like potentiometric titration, calorimeter for the estimation of different elements (sulfur, chlorine) in petrochemicals.

Course Outlines:

Coal: Composition, Structure, Coalification and classification of coal, ASTM international and coal Standards. Use of coal in different industries like power generation, Steel and other metallurgical operations.Coal exploration, Mining and mining risk handling, Pretreatment and preparation of coals.Innovations in coal using industry.

Environmental Aspects: Pollution problems associated with coal combustion, Mining and flue gases.

Gasification: Thermodynamics, Kinetics and catalytic aspects of coal gasification, Fixed bed gasifier, Fluidized bed gasifier, Transport reactor, Liquid medium gasifier andunderground gasification.Gas upgrading by carbon monoxide shift, Gas purification, Methanation and dehydration, Properties and processing of gaseous fuels, Environmental consideration.

Practicals:

1. Determination of the electrical conductivity of aviation and distillate fuels, containing static dissipator additives.
2. Determination of the total base number of petroleum products by potentiometric titration.
3. Determination of total salt content in crude petroleum by conductivity method. Determination of the kinematic viscosity of asphalt (bitumen).
4. Determination of heat of combustion of liquid hydrocarbon fuels.
5. Determination of neutralization number of lubricating oils by potentiometric

titration. Determination of the calorific value of coal by bomb calorimeter.

6. Determination of total sulfur in coal by bomb calorimeter.
7. Determination of chlorine in coal by bomb calorimeter.
8. Determination of the distillation behavior of petroleum fractions.
9. Determination of sulfur in petroleum products by bomb calorimeter method. Determination of sulfur in petroleum products by lamp method.

Recommended Books:

- Speight, J.G. Handbook of Petroleum Analysis. Wiley-Interscience, 2002.
- Speight, J.G. Handbook of Coal Analysis. John Wiley and Sons: New Jersey, 2005.
- ASTM. Annual Book of ASTM Standards, American Society for Testing and Materials, West Consbohockm, PA: USA, 2000
- Hobson, G.D. Modern Petroleum Technology, Part 2. John Wiley and Sons: New York, 1984.
- Gates, B.C; Katzer, J.R; Schuit, G.C.A. Chemistry of Catalytic Processes. McGraw Hill Book Company: London, 1979.
- List, H.L. Petrochemical Technology. Printice-Hall Englewood Cliffs: New Jersey, 1986.
- Goodger, E.M. Hydrocarbon Fuels. Union Brothers Ltd: London, 1975.
- Speight, J.G. Handbook of Petroleum Analysis. Wiley-Interscience, 2002.
- Wen, C.Y; Stanley, E. Coal conversion Technology. Addison-Wesley: New York, 1979.
- Probstein, R.F; Hicks, R.E. Synthetic Fuels. McGraw Hill: New York, 1982.

Course Title: **Petroleum and Petrochemicals-I**

Course Code: **CHEM4150**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The modern refining operations for maximum recovery of petroleum products.
- How to use crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Outlines:

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

Petrochemicals: Ethylene production by thermal cracking from ethane,Propane and naphtha,Petrochemicals from oxidation processes, Production of petrochemicals from halogenation processes, Hydrogenation of benzene, Fats, and adiponitrite, Nitration of benzene and toluene, Sulphonation of benzene and toluene, Alkylation of aromatics.

Recommended Books:

- Hobson, G.D. Modern Petroleum Technology, Part 2. John Wiley and Sons: New York, 1984.
- Gates, B.C; Katzer, J.R; Schuit, G.C.A. Chemistry of Catalytic Processes. McGraw Hill Book Company: London, 1979.
- List, H.L. Petrochemical Technology. Printice-Hall Englewood Cliffs: New Jersey, 1986.
- Goodger, E.M. Hydrocarbon Fuels. Union Brothers Ltd: London, 1975.
- Maleev, V.L. Internal Combustion Engines. McGraw Hill Book Company: London, 1985.
- Hughes, J.R; Swindells, N.S. Storage and Handling of Petroleum Liquids. Charless Griffin and Company Ltd: London, 1987.
- Speight, J. G. Handbook of Petroleum Analysis. Wiley-Interscience, 2002.

Course Title: **Characterization of Fossil Fuels**

Course Code: **CHEM4151**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The physicochemical and instrumental analysis of fuels.
- Howto produce high quality fuel with good octane number.

Course Outlines:

Formation of Fossil Fuels: Diagenesis, Catagenesis,From keragen to fossil fuels, Algal and liptinitic kerogen, Humic kerogen.

Structure and Property RelationshipAmong Hydrocarbons: Intermolecular interactions, Volatility, Density and API gravity, Viscosity, Heat of combustion, The special effect of aromaticity.

Characterization of Fossil Fuels: Physicochemical: Determination and data interpretation using American Society for Testing and Materials(ASTM) of American Petroleum Institute(API) Gravity, Flash Point, Pour Point, Analine Point, Distillation behaviors, Octane Number.

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

Recommended Books:

- Ewing, G.W. Instrumental Methods of Chemical Analysis. McGraw Hill: London, 1985.
- Chrisition, G.D. Instrumental Analysis, Allyn and Bacon. Boston: London, 1986.
- Schobert, H. Chemistry of Fossil Fuels and Biofuels. Cambridge University Press: New York, 2013.

Course Outline (Semester - VIII)

Course Title: **Organometallics**

Course Code: **CHEM4118**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The chemistry of organometallics especially with reference to their types and bonding.
- The reactivity of organometallic compounds in homogeneous catalysis.

Course Outlines:

Fundamentals ofOrganometallics: Organometallic compounds, Types of bonding in organometallics, Single, Double and triple bonds to carbon (compound types, acyls, alkylidene complexes and alkylidyne complexes), Delocalized hydrocarbon systems (alkenes, olefins, allyl and butadienes).

Organometallic Complexes: Alkyne complexes, Cyclic p-complexes (five and six membered rings), Homogeneous catalytic hydrogenation, Dimerization, Oligomerization, Polymerization, Hydroformylation of olefins, Catalytic polymerization of acetylenes.Insertion reactions and uses of organometallic compounds in organic synthesis.

Recommended Books:

- Powell, P. Principles of Organometallics Chemistry. Springer, 1998; 2nd Ed.
- Yamamoto, A. Organotransition Metal Chemistry; Fundamental Concepts and Applications. John-Wiley & Sons, 1986; 1st Ed.
- Cotton, F.A; Wilkinson, G; Murillo, C.A; Bochmann M. Advanced Inorganic Chemistry. Wiley-Intersceince: New York, 1999; 6th Ed.
- Miessler, G.L; Fisher, P.J; Tar, D.A. Inorganic Chemistry. Prentice Hall, 2013; 5th Ed.
- Douglas, B; McDaniel, D; Alexander, J. Concepts and Models of Inorganic Chemistry. John-Wiley & Sons, 1994; 3rd Ed.

Course Title: **Symmetry and Magnetochemistry**

Course Code: **CHEM4120**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The magnetic properties from chemistry point of view.
- The magnetism and group theory.

Course Outlines:

Symmetry and Group Theory: Symmetry and group theory, Point groups, Multiplication tables, Group representation and development of character tables,Application of symmetry in vibrational spectroscopy for assigning point groups to linear and bent triatomic molecules.

Magnetochemistry: Theory of magnetism, Diamagnetism, Paramagnetism, Ferro, Ferri and antiferromagnetism, Magnetic susceptibility, Magnetic moments, Faraday's & Gouy's methods, Effect of temperature on magnetic properties of complexes, Electron spin resonance spectroscopy, Magnetic moment of lanthanides.

Recommended Books:

- Mackay, K.M; Mackay, R.A; Henderson, W. Introduction to Modern Inorganic Chemistry. CRC Press, 2002; 6thEd.
- Miessler, G.L; Fisher, P.J; Tar, D.A. Inorganic Chemistry. Prentice Hall, 2013; 5thEd.
- Purcell, K.F; Kotz, J.C. An Introduction to Inorganic Chemistry. W.B. Saunders, Company Holt-Saunders, 1980.
- Cotton, F.A; Wilkinson, G; Murillo, C.A; Bochmann, M. Advanced Inorganic Chemistry. Wiley-Intersceince: New York, 1999; 6thEd.
- Jolly, W.L. Modern Inorganic Chemistry. McGraw-Hill Company, 1991; 2ndEd.
- Carter, R.L. Molecular Symmetry and Group Theory. John-Wiley & Sons: New York, 1997; 1stEd.
- McWeeny, R. Symmetry: An Introduction to Group Theory and its Applications. Dover Publications, 2002.
- Vincet, A. Molecular Symmetry and Group Theory. John Wiley Ltd, 2001; 2ndEd.

Course Title: **Radio and Nuclear Chemistry**

Course Code: CHEM4122

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The radio and nuclear chemistry and nuclear reactions.
- The applications of nuclear and radiation chemistry in various field of life.

Course Outlines:

Radiation Chemistry: Kinetics of radioactive decay, Kinetics & mechanism of track etching, Tracers, Production and decay of excited states, Energy loss by gamma rays, Energy loss by electrons, Energy loss of other charge particles.

Radioactivity: Fundamentals and applied aspects of radioactivity and nuclear chemistry, Types and characteristics of nuclear radiation, Structure of nucleus, Half-life, Nuclear binding energy.

Applications of Radioactivity: Artificial radioactivity, Fission and fusion reactions, Acceleration of charged particles and applications of radioisotopes.

Recommended Books:

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

Course Title: **Natural Products**

Course Code: **CHEM4119**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The different types of natural products.
- The structure, synthesis and applications of natural products.

Course Outlines:

Alkaloids: Introduction, Classification, Isolation methods, Structure elucidation and discussion with particular reference to structure, synthesis and biosynthesis of typical alkaloids such as ephedrine, Nicotine, Atropine, Quinine, Papaverine and morphine.

Terpenoids: Introduction, Classification, Isolation techniques and discussion with particular reference to structure, synthesis and biosynthesis of typical terpenoids such as citral, α-terpineol, α-pinene, Camphor, Cadinene.

Steroids: Study of cholesterol and steroidal hormones with emphasis on their structure and biosynthesis.

Flavonoids: Introduction and classification of flavonoids, General biosynthetic pathway, Synthesis of flavone, Flavonol and cyaniding.

Recommended Books:

- Dewick, P.M. Medicinal Natural Products: A Biosynthetic Approach. Medicinal Natural Products, John-Wiley & Sons, 2009; 3rd Ed.
- Oyvind, M.A; Kenneth, R.M. Flavonoids: Chemistry, Biochemistry and Applications. CRC, Taylor & Francis: New York, 2010.
- Finar, I.L. Organic Chemistry. Stereochemistry and the Chemistry of Natural Products. Pearson Education Ltd: Delhi, 2008; Vol. 2; 5th Ed.
- Bhat, S.V; Nagasampagi, B.A; Sivakumar, M. Chemistry of Natural Products. Narosa Publishing House, 2005.
- Streitwieser, A., Heathcock, C. and Kosower, E.M. Introduction to Organic Chemistry, Macmillan, New York. (1998)
- Clayden, J., Greeves, N., Warren, S. and Wothers, P. Organic Chemistry.

Course Title: **Organic Synthesis**

Course Code: **CHEM4121**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The design protocols for synthesis of small to medium sized organic compounds.
- How to carry out retrosynthetic analysis.
- The purpose of alternative reactions to synthesize a compound.

Course Outlines:

Organic Synthesis: Principles and importance of organic synthesis, Introduction to reterosynthesis and disconnection approach, Synthesis of aromatic compounds; one and two group carbon C-X disconnections, Donor and acceptor synthons, C-C disconnections and 1,2-, 1,3-, 1,4-, 1,5- and 1,6- difunctionalized compounds, Synthesis of cyclic compounds (3-6 membered), Chemo, Regio and stereoselectivity.

Synthetic strategies: Functional group protection: Hydroxyl, Amino, Carbonyl, Carboxylic.

Solid phase synthesis: Basic principles, Preparation of small molecules,Preparation of oligomeric molecules,

Phase-transfer catalysis: Baisc concepts,Mechanism and rates in phase transfer catalyzed reactions, Phase transfer catalyzed alkylation, condensation, displacement, addition, elimination, oxidation, reduction, addition and elimination reactions

Recommended Books:

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

Course Title: **Medicinal Chemistry**

Course Code: **CHEM4123**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The nature, types and properties of drugs and medicines.
- The role of an organic chemist in drug designing and drug discovery.

Course Outlines:

Drug Design-A Rational Approach: Analogues and pro-drugs, Factors governing drug-design, Rational approach to drug design, Drug-design the method of variation, Drug design through disjunction, Drug design through conjunction, Drug design and development.

Molecular Modeling and Drug Design: Methodologies, Molecular modeling, Known receptor sites, 3D structure of macromolecular targets, Structure-based drug-design, Majorsteps in structure-based drug design, Ligand receptor recognition, Active site for a target, Predictive ADME.

Drugs and Drug Discovery: Chemistry of biomolecules, Introduction to drugs and drug discovery, Sources of therapeutic agents, Structure Activity Relationship (SAR), Drug-receptor interaction, Drug formulation and its methods, Different types of drugs, Chemistry and modes of action of some common drugs.

Recommended Books:

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

Course Title: **Luminescence Spectroscopy and Thermal Analysis**

Course Code: **CHEM4128**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The theoretical and instrumental aspects of luminescence spectroscopy.
- The thermal techniques of analysis in addition to learning about their applications.

Course Outlines:

Luminescence Spectrophotometry: Introduction, Origin of fluorescence and phosphorescence spectra, Jablonski diagram, Activation, Deactivation, Fluorescence spectrum, Fluorescent and phosphorescent species, Photoluminescence and structure, Factors affecting fluorescence and phosphorescence, Fluorescence quenching, Quantum yield, Instrumentation for fluorescence measurement, Sources, Wavelength selectors, Sampling, Detectors, Read out devices, Instrumentation for phosphorescence measurement, Sampling, Recording procedure, Applications of fluorescence and phosphorescence.

Thermal Methods of Analysis: Introduction, Instrumentation, Sources of errors, Interpretation of data, Factors affecting curve, Applications of TGA, DTA and DSC.

General Considerations:Features common and traceability of thermal analysis methods, Heating and cooling curve analysis, Sources of errors, Characterization of the measured curves, Interpretation of data.

Recommended Books:

- Christian, G.D. Analytical Chemistry. John-Wiley & Sons: New York, 2006; 6thEd.
- Harris, D.C. Quantitative Chemical Analysis. W.H. Freeman and Company: New York, 2011; 8thEd.
- Lakowicz, J.R. Principles of Fluorescence Spectroscopy. Springer, 2006; 3rdEd.
- Gabbot, P. Principles & Applications of Thermal Analysis. Wiley-Blackwell, 2007.
- Skoog, D.A; West, D.M; Holler, F.J; Crouch, S.R. Fundamentals of Analytical Chemistry. Cengage Learning, 2004; 8thEd.

Course Title: **Nuclear Analytical Techniques**

Course Code: **CHEM4129**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The different nuclear analytical techniques.
- The theoretical, instrumental techniques and their applications.

Course Outlines:

Radiotracer: Radiotracertechniques, Choice of radiotracers, Factors affecting choice of radiotracers, Isotope dilution analysis (IDA), Principle and equation, Instrumentation.

Applications: Sub-stoichiometric Isotope Dilution Analysis (SIDA), Activation Analysis (AA), Principle of NAA, Neutron sources, Interferences, Sensitivity and detection limits, Classification, Instrumentation, Comparison of NAA and IDA with other methods, Radiometric Titrations (RT), Procedure, Advantages and limitations, Radio chromatography and radioimmunoassay.

Recommended Books:

- Friedlander, G; Kennedy, J.W; Macias, E.S; Miller. M.J. Nuclear and Radiochemistry. Wiley: New York, 1981; 3rd Ed.
- Arnikan, H.J. Essentials of Nuclear Chemistry. New Age International, 1995; 4th Ed.
- Harvey, B.G. Nuclear Physics and Chemistry. Prentice Hall, 1969; 2nd Ed.
- Naqvi, I.I; Farrukh, M.A. Radiotracers in Chemical Applications: Radiochemistry. VDM Verlog, 2010.

Course Title: **Food and Drug Analysis**

Course Code: **CHEM4130**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The sample preparation, derivations.
- The analysis of different types of foods, pharmaceuticals and forensic materials.

Course Outlines:

Food Products: Introduction to food analysis, Sampling of food, General methods of analysis,Analysis of milk, Butter, Wheat flour, Meat, Beverages, Tea, Coca, Honey and soft drinks.

Pharmaceuticals: Classification of drugs, Tests for analysis of different pharmaceuticals, Introduction to US and British pharmacopeia.

Forensics: History and scope of forensic science, Forensic ethics, Forensic toxicology, Classification and analysis of narcotics & dangerous drugs, Examination of crime scene evidences, Fingerprinting, Skeletal material to provide scientific opinion for legal.

Recommended Books:

- Skoog, D.A; West, D.M; Holler, F.J. Fundamentals of Analytical Chemistry. Saunders College Publishing, 1995; 7thEd.
- Christian, G.D. Analytical Chemistry. John-Wiley & Sons, 2004; 6thEd.
- Eckert, W.G. Introduction to Forensic Science. CRC Press, 1997; 2ndEd.
- Nielsen, S.S. Food Analysis. Springer, 2010; 4thEd.
- Watson, D.G. Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists. Elsevier, 2012.
- Stuart, H. Barbara. Forensic Analytical Techniques. John-Wiley & Sons, 2013; 1stEd.
- Jackson, A.R.W; Jackson, J.M. Forensic Science. Pearson Education, 2008; 2ndEd.

Course Title: **Organic Based Industries**

Course Code: **CHEM4134**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The structure, mechanism, properties and synthesis of various polymers.
- The technical know-how about perfumes and cosmetics and surface coating industries.

Course Outlines:

Paper and Pulp: Raw materials for pulp and paper industries, Classification of paper products, Chemistry involved in the processing of kraft pulp, Sulphite pulp and semi-chemical pulp, Manufacture of paper and regeneration of spent liquor.

Polymers: General classification and characterization of polymers, Mechanism and chemistry of polymerization, Thermoplastic and thermosetting polymerization, A brief outline for the production and applications of polymers: Polyethylene, Polystyrene, Polyurethanes, Polyesters and urea phenol formaldehyde resins, Production of drug delivery polymers.

Cosmetics and Perfumes: Chemistry and production of hair products and shampoos, Chemistry involved in hair curling and styling products, Hair tonics and depilatory products, Production of cold cream, Vanishing cream, Bleach cream and shaving creams, Tooth paste and face powders, Production of nail polish, Lipsticks and mascaras.

Recommended Books:

- Odian, G. Principles of Polymerization. John-Wiley & Sons, 2004; 4thEd.
- Roussak, D.V; Gesser, H.D. Applied Chemistry; A Textbook of Engineers and Technologists. Springer, 2013; 2ndEd.
- Bajpai, P. Environmentally Friendly Production of Pulp and Paper. John-Wiley & Sons, 2010.
- Schueller, R; Romanowski, P. Beginning Cosmetic Chemistry: Practical Knowledge for Cosmetic Industry. Allured Publishing Corporation, 2009; 3rdEd.

Course Title: **Industrial Processes**

Course Code: **CHEM4135**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The pharmaceutical industries and nuclear industry.
- The oil refinery and production of various petrochemicals.

Course Outlines:

Pharmaceuticals: Classification of pharmaceutical products and pharmaceutical processing, Manufacture of paracetamol and aspirin, Chemistry involved in the production and manufacture of various antibiotics such as streptomycin, Erythromycin, Penicillin.

Petroleum and Petrochemicals: Origin of petroleum, Constituents and classification of petroleum, Cracking and distillation of various fractions in distillation towers, Control of distillation tower in refinery, Manufacture of monomers such as acetylene, Ethylene, Propylene, Separation and purification of benzene, Toluene and xylene.

Recommended Books:

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

Course Title: **Metallurgy and Explosives**

Course Code: **CHEM4136**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The iron, steel and its alloys, the knowledge about corrosion and its preventions.
- The organic dyes industries, different lubricants used in industrial processes.

Course Outlines:

Iron, Steel and Alloys: Iron ores, Constituents and their classification, Manufacture of iron and steel, Types of iron and steel, Metal extractions and production of Alloys.

Explosives and Propellants: Raw materials, Manufacture of industrial explosives and propellants, Types of explosives and their safety measures, Chemistry involved in production of military explosives.

Nuclear Materials: Extraction of uranium from rocks, Importance of nuclear technology, Nuclear energy and its peaceful applications, Production of nuclear energy and control of nuclear reactors, Chemistry of fission and fusion reactions, Reprocessing of nuclear spent fuel, Industrial application of nuclear radiations.

Recommended Books:

- Akhawan, J. The Chemistry of Explosives. Royal Chemical Society, 2004; 2nd Ed.
- Campball, F.C. Elements of Metallurgy and Engineering Alloys. ASM. International, 2008.
- Davis, T.L. The Chemistry of Powder and Explosives. Angriff Press, 2012.
- Reddy, L.K. Principles of Engineering Metallurgy. New Age Publishers, 2009; 2nd Ed.
- Loveland, W; Morrissey, D.J; Seaborg, G.T. Modern Nuclear Chemistry, John-Wiley & Sons, 2006.
- Balsaral, V.M. Applied Chemistry. I.K. International House Pvt. Ltd: India, 2009.

Course Title: **Microbiology and Immunology**

Course Code: **CHEM4140**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The fundamentals of microbiology and immunology.
- The related associated disorders such as microbial borne infectious diseases, allergy, inflammation, and hypertension and their control.

Course Outlines:

Fundamentals of Microbiology: Prokaryotic cell structure and function, Prokaryotic growth and nutrition, Prokaryotic genetics.Virus and eukaryotic microorganisms, Bacteria, Fungi and parasites.Bacterial diseases: Airborne, Foodborne and waterborne. Industrial microbiology and biotechnology, Microorganism in industry, Alcoholic beverages, Important microbial products.

Immunology: Chemistry of immunoglobulins, Myeloma and hybridoma immunoglobulins, Immune system and its abnormalities, Allergy and inflammation, Complement system, Peripheral leucocytes and macrophages, Type 1 lgE-mediated hypersensitivity, Hypersensitivity autoimmune disorders, Immunodeficiency disorders.

Recommended Books:

- Nester, E; Nester, M; Anderson, D; Roberts, C. E. Microbiology: AHuman Perspective. McGraw-Hill, 2011; 7thEd.
- Duan, T; Melvold, R; Viselli, S; Waltenbaugh, C. Lippincott's Illustrated Reviews: Immunology. Lippincott William & Wilkins, 2012; 2ndEd.
- Harvey, R.A; Cornelissen, C.N; Fischer, B.D. Microbiology, Lippincott William & Wilkins, 2012; 3rdEd.
- Wiley, J.M; Sherwood, L.M; Woolnerton, C.J. Prescott's Microbiology. McGraw-Hill Education, 2011; 7thEd.
- Male, D; Brostoff, J; Roth, D.B; Roitt, I.M. Immunology, Elsevier, 2012; 8thEd.

Course Title: **Bionanotechnology**

Course Code: **CHEM4141**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The bionanotechnology in general and its potential applications in particular.
- The attributes of new materials like biosensors for medical applications.
- The structure and assembly of nanoparticles opens some exciting possibilities to construct artificial structures in applied nanotechnology, which will mimic the functions of the biological systems.

Course Outlines:

Introduction to Nanoparticles: Overview of nanoscale materials, Effect of length scale on properties, Thermodynamic features of nanoparticles.

Bionanotechnology: Introduction to bionanotechnology systems, Protein based nanostructures.

Nanobiosensors: Challenges and opportunities associated with biology on the nanoscale, Green nanoparticle production, Self-assembly and templating, Surface patterning and functionalization.

Characterization of Bionanomaterials:Techniques likes X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Brunauer, Emmett and Teller (BET), Adsorption method, Thermogravimetric Analysis (TGA), Atomic Absorption Spectroscopy (AAS), Ultraviolet-Visible Spectroscopy (UV-Vis) and Fourier Transform Infrared (FTIR) spectroscopy.

Recommended Books:

- Ratner, M.A; Ratner, D. Nanotechnology: A Gentle Introduction to the Next Big Idea. Prentice Hall Professional, upper saddle river: New Jersey, 2003.
- Goodsell, D.S. Bionanotechnology: Lessons from Nature. Wiley-Liss, Hoboken: New Jersey, 2004.
- Renugopalakrishnan, V; Lewis, R. V. Bionanotechnology: Proteins to Nano devices. Springer, 2006.
- Iqbal, S. Bionanosensors. Morgan &Claypool Publishers, California, 2008.
- Kotov, N.A. Nanoparticle Assemblies and Superstructures. CRC press, USA

2006.

- Dinh, T.V. Nanotechnology in Biology and Medicine: Methods, Devices and Application. CRC press: USA, 2007.
- Kumar, C. Nanomaterials for Biosensors. Wiley-VCH: Germany, 2007.

Course Title: **Nutritional Chemistry**

Course Code: **CHEM4142**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The dietary components.
- The energy needs based nutritional requirements of different age groups.
- The importance of minerals and vitamins.

Course Outlines:

Major Dietary Constituents: Nutritional importance of carbohydrates, Proteins and amino acids, Lipids, Dietary fiber.

Energy Needs: Assessment and requirement of energy in different age groups nutrition in growth and aging, Nutritional requirement during infancy and childhood, Diet, Nutrition and adolescence, Nutrition in the elderly minerals, Biochemical role of Calcium, Chromium, Copper, Iron, Iodine, Magnesium, Phosphorous, Selenium and zinc, Their dietary source daily requirements and deficiency diseases.

Vitamins: Role of vitamins as coenzymes structure, Physiological functions, Deficiency diseases and recommended dietary allowances of the following vitamins, Fat soluble vitamins: A, D, E, and K, Water soluble vitamins: Thiamine, Riboflavin, Niacin, Pantothenic acid, Folic acid, Biotin and ascorbic acid.

Recommended Books:

- Belitz, H.D; Grosch, W; Schieberle, P. Food Chemistry. Springer-Verlag Berlin: Germany, 2009; 4thEd.
- Spallholz, J.E; Boylan, L.M; Driskell, J.A. Nutrition: Chemistry & Biology. CRC Press Inc:USA, 1999; 2ndEd.
- Ross, A.C; Caballero, B; Cousins, R.J; Tucker, K.L; Ziegler, T.R. Modern Nutrition in Health and Disease. Lippincott Williams & Wilkins, 2012; 11thEd.
- Zempleni, J; Rucker, R.B; McCormick, D.B; Suttie, J.W. Handbook of Vitamins. CRC Press, 2007; 4th Ed.

Course Title: **Reaction Dynamics**

Course Code: **CHEM4146**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The kinetics of different bimolecular reactions.
- The dynamics, kinetic theories & the factors which influencereaction rates.

Course Outlines:

Reaction Dynamics: Correlation between physical properties and concentration, Kinetics of the complex reactions, Reversible, Parallel, Consecutive bimolecular reactions, Theory of absolute reaction rate, Lindemann's theory of unimolecular reactions, Bimolecular collision theory, Transition state theory, Comparison of collision and absolute reaction theories, Potential energy surfaces, Thermodynamic formulation of reaction rates, Calculation of entropy and enthalpy changes, Thermal decomposition of nitrogen pentaoxide.

Reactions in solutions: Influence of ionic strength on the reaction rate, Effect of dielectric constant of the medium on the rate of the reaction, Single sphere activated complex model, Double sphere activated complex model, Complex reactions, Chain reactions, Single chain carrier with second order breaking, One chain carrier with first order breaking, Two chain carrier with second order breaking, Experimental techniques for fast reactions.

Recommended Books:

- Espenson, J.H. Chemical Kinetics and Reaction Mechanism. McGraw-Hill: London, 2002; 2ndEd.
- Connors, K.A. Chemical Kinetics: The Study of Reaction Rates in Solution. VCH Publishers, 1990.
- Silbey, R.J; Alberty, R.A; Bawendi, M.G. Physical Chemistry. John-Wiley & Sons, 2005; 4thEd.
- Atkins, P; Paula, J.D. Atkin's Physical Chemistry. Oxford University Press, 2010; 9thEd.
- Houston, P.L. Chemical Kinetics and Reaction Dynamics. Dover Publications, 2006.

Course Title: **Radiation and photochemistry**

Course Code: **CHEM4147**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The mechanisms of radiation induced chemical changes in molecules, radiation dosimetery and applications of the radiation chemistry. The radioactive decays and how radio isotopes are produced.
- The principles of fluorescence, phosphorescence and other photochemical processes and their applications.

Course Outlines:

Radiation Chemistry: Development and advancement in radiation chemistry, Radiation dosimetry, Fricke dosimeter, Dosimetry in pulse radiolysis, Energy states in radiation chemistry, Excited states, Fragmentation, Pre-dissociation, Photochemical decay, Ions and electrons, Radiolysis of gases, Liquids, Solids, Frozen liquids and ions in radiation Chemistry, Recent application of radiation Chemistry.

Photochemistry: Principles of photochemistry, Laws of photochemistry, Einstein's law ofphotochemical equivalence, Rates of intramolecular processes, Chemical reactions and quantum yields with examples, Energy transfer in photochemical reaction, Quantum yield of emission process radiation and nonradiation process, Kinetics and quantum yields of radiative and nonradiative process (fluorescence, phosphorescence, inter-system crossing, internal conversion, quenching) and stern-volmer reactions, Photosensitized reactions.

Recommended Books:

- Spinks, J.W.T; Woods, R.J. An introduction to Radiation Chemistry. Wiley Inter Si. Pub: USA, 1990; 3rd Ed.
- Choppin, G;Liljenzin, J.O; Rydberg, J. Radiochemistry and Nuclear Chemistry. Butterworth-Heinemann, 2002; 3rd Ed.
- Mostafavi, M; Douki, T. Radiation Chemistry: From Basic to Applications in Material and Life Sciences. EDP Science, 2008.
- Dunkin, I. Photochemistry. RSC Publishing, 2007; Vol 36.

Course Title: **Colloid and Surface Chemistry**

Course Code: **CHEM4148**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The important physical and chemical aspects of nano and colloidal systems.
- The basics of thermodynamically and kinetically stabilized nanoparticles and colloidal solutions.
- The surfactant chemistry and characterization methods.

Course Outlines:

Colloidal Solutions: Catalyst preparation methods, Industrial catalysts, Emulsion, Surfactant, Nanoscale chemistry, Nanomaterials and their applications, Dimensional control in nanostructures, Macromolecular surface films, Charged films and Langmuir-Blodgett layers.

Characterization Methods and Applications: Solid surfaces, Surface structures, Clean surface structures, Gas solid interface, Thermodynamics of adsorption, Heterogeneous catalysis, Kinetic and mechanisms of catalyzed reactions, Adsorption at liquid surfaces, Chemisorption, Physiosorption and dynamics, Enzymatic catalysis, Organized molecular assemblies, Experimental probes for surface and adsorbent structures.

Scanning Probe Techniques: Low Energy Electron Diffraction (LEED), Electron spectroscopy, Surface analysis techniques.

Recommended Books:

- Hunter, R.J. Introduction to Modern Colloid Science. Oxford University Press: Oxford, 1994.
- Klabunde, K.J. Nanoscale Materials in Chemistry. John-Wiley & Sons, 2003.
- Kolunsiki, K.W. Surface Science: Foundations of Catalysis and Nanoscience. John-Wiley & Sons, 2012; 3rd Ed.
- Adamson, A.W; Gast, A.P. Physical chemistry of Surfaces. Wiley-Interscience, 1997; 6th Ed.
- Atkins, P: Paula, J. D. Atkin's Physical Chemistry. Oxford University Press, 2006; 8th ed.

Course Title: **Coal Conversion Processes**

Course Code: **CHEM4152**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The coal conversion processes like solvent extraction, hydrogenation.
- The importance of catalysis in these reactions, product up gradation and analysis and environmental problems relating to synthetic fuels obtained from coal.

Course Outlines:

Liquefaction of Coal: Historical developments of coal liquefaction, Earlier coal liquefaction processes; (a) Pott and Broch process (b) Bergius process. Solvent Extraction: Solvent extraction of coal, Some experiments on solvent extraction, Mechanism of solvent extraction, Types of solvent extraction, Solvent systems, Super critical gas extraction, Commercial processes of solvent extraction like SRC-I, SRC-II, EDS, Super critical gas extraction.

Direct Liquefaction: Direct liquefaction of coal through catalytic hydrogenation, Mechanism, catalyst systems, Catalyst poisoning, Catalytic role of coal minerals, Commercial processes of catalytic hydrogenation like H-coal & Synthoil process.

Indirect Liquefaction: Indirect liquefaction through Fischer Tropsch synthesis, Methanol synthesis and MTG (Methanol to Gasoline) processes. Effect of Parameters: Effect of coal properties, Catalyst and solvent on liquefaction behavior of coal, Effect of coal properties like rank, Maceral components and mineral matter on liquefaction, Effect of operating condition like temperature, Pressure, Residence time, Solvent, catalyst.

Processing of Coal Liquids: Purification of liquefaction products, Solidseparation, fractionation, Upgrading and characterization of coal derived liquids, Properties of coal derived liquids.

Liquefaction Reactor: Description of high pressure coal liquefaction reactor and auxiliary devices, Ebulated bed reactor, Fluidization.

Environmental Aspects: Environmental consideration, Aerial emissions, Water effluents, Solid waste disposal.

Recommended Books:

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

Course Title: **Petroleum and Petrochemicals-II**

Course Code: **CHEM4153**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The modern thermodynamics and combustion of hydrocarbons fuels.
- The safe storage and transportation of hydrocarbons fuels.

Course Outlines:

Thermochemistry and Combustion of Hydrocarbon Fuels: Basic thermodynamics principles, Standard enthalpy of formation, Standard enthalpy of reaction, Enthalpy of combustion products, Mechanism of combustion of gaseous and liquid hydrocarbon, Theory of flame propagation, Method of measuring flame speed, Fuel performances in reciprocating piston engines, Environmental pollution from hydrocarbon fuel utilization.

Storage and Handling of Hydrocarbon Fuels: Various types of storage tanks, Different methods of transportation of crude and refined petroleum products.Health hazards associated with petroleum handling, Volatility losses, Fire hazards and its prevention. Extinguishing of oil fire methods.

Recommended Books:

- Hobson, G.D. Modern Petroleum Technology. John Wiley and Sons: New York, 1984.
- Gates, B.C; Katzer, J.R; Schuit, G.C.A. Chemistry of Catalytic Processes. McGraw Hill Book Company: London, 1979.
- List, H.L. Petrochemical Technology. Printice-Hall Englewood Cliffs: New Jersey, 1986.
- Goodger, E.M. Hydrocarbon Fuels. Union Brothers Ltd: London, 1975.
- Maleev, V.L. Internal Combustion Engines. McGraw Hill Book Company: London, 1985.
- Hughes, J.R; Swindells, N.S. Storage and Handling of Petroleum Liquids. Charless Griffin and Company: London, 1987.

Course Title: **Alternate Energy Resource**

Course Code: **CHEM4154**

Credit Hours: **3(3+0)**

Objectives:

The students should be able to understand:

- The challenging sources of alternate sources of energy.
- The safe uses of natural resources.

Course Outlines:

Biomass Resources: Biomass conversion processes, Bio gas technology, Various traditional methods of alcohol production,Alcohols and its uses as alternative fuel.

Biofuels: Production of Bio-ethanol and biodiesel, Uses of bio ethanol assupplement with petroleum gasoline as E10 and E20, Hydrogen production, Storage, Handling and its uses as alternative fuel, Fuel Cells and its application,

Solar Energy: Photovoltaic power conversion & solar energy collectors.

Nuclear fuels: Nuclear fuels processing, Fission and fusion, Nuclear reactors.

Hydral Energy: Introduction to Hydral energy, Prospects of hydral powers in Pakistan.

Recommended Books:

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