CURRICULUM
OF
CHEMISTRY
BS (4-YEAR)

2008

HIGHER EDUCATION COMMISSION
ISLAMABAD
CURRICULUM DIVISION, HEC

Dr. Syed Sohail H. Naqvi        Executive Director
Prof. Dr. Riaz ul Haq Tariq       Member (Acad)
Miss. Ghayyur Fatima         Deputy Director (Curri)
Mr. M. Tahir Ali Shah        Assistant Director
Mr. Shafiullah Khan            Assistant Director
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PREFACE

Curriculum development is a highly organized and systematic process and involves a number of procedures. Many of these procedures include incorporating the results from international research studies and reforms made in other countries. These studies and reforms are then related to the particular subject and the position in Pakistan so that the proposed curriculum may have its roots in the socio-economics setup in which it is to be introduced. Hence, unlike a machine, it is not possible to accept any curriculum in its entirety. It has to be studied thoroughly and all aspects are to be critically examined before any component is recommended for adoption.

In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification No. D773/76-JEA (cur.), dated December 4th 1976, appointed the University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at the bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor’s Committee, the curriculum of a subject must be reviewed after every 3 years.

A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments.

For the purpose of curriculum revision various committees are constituted at the national level, comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations and respective accreditation councils. The National Curriculum Revision
Committee for chemistry in a meeting held on March 10-11, 2008, at the HEC Regional Center, Lahore, in continuation of its earlier meeting held on October 30-31, 2007, at HEC Regional Center, Karachi, revised the curriculum in light of the unified template. The final draft prepared by the National Curriculum Revision Special Committee, duly approved by the competent authority, is being circulated for implementation in the concerned institutions.

DR. RIAZ-UL-HAQ TARIQ
Member Academics

June 2008
CURRICULUM DEVELOPMENT

STAGE-I

STAGE-II

STAGE-III

STAGE-IV

CURRICULUM UNDER CONSIDERATION

COLLECTION OF EXP NOMINATION UNI, R&D, INDUSTRY & COUNCILS

APPRAISAL OF 1ST DRAFT BY EXP

PREPARATION OF FINAL CURRICULUM

QUESTIONNAIRE

CONS. OF NCRC.

FINALIZATION OF DRAFT BY NCRC

PRINTING OF CURRICULUM

COMMENTS

IMPLEMENTATION OF CURRICULUM

ORIENTATION COURSES BY LI, HEC

BACK TO STAGE-I

Abbreviations Used:

NCRC. National Curriculum Revision Committee
VCC. Vice-Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
LI Learning Innovation
R&D Research & Development Organization
HEC Higher Education Commission
INTRODUCTION

The Final meeting of National Curriculum Revision Committee (NCRC) in Chemistry was held at HEC Regional Centre Lahore on March 10-11, 2008. This Meeting was a follow up of the previous meeting held on October 30-31, 2007 at HEC Regional Centre, Karachi. The following attended the meetings.

1. Prof. Dr. Fahim Uddin
   Convener
   Adjunct Professor
   Department of Chemistry
   University of Karachi, Karachi

2. Prof. Dr. G. A. Miana
   Member
   Rector / Director R & D
   Riphah Institute of Pharmaceutical Sciences
   7th Avenue, G-7/4, Islamabad

3. Prof. Dr. Muhammad Shahid Ansari
   Member
   Department of Chemistry
   Quaid-i-Azam University, Islamabad

4. Prof. Dr. Sher Khan Sadozai
   Member
   Chairman
   Department of Chemistry
   Gomal University, D.I.Khan

5. Prof. Dr. Muhammad Kaleem Tahir
   Member
   Chairman
   Department of Chemistry
   Allama Iqbal Open University, Islamabad

6. Prof. Dr. Ubedullah M. Abbasi
   Member
   Director
   Dr. M. A. Kazi Institute of Chemistry
   University of Sindh, Jamshoro

7. Prof. Dr. Humayun Pervez
   Member
   Professor / Chairman
   Department of Chemistry
   Bahauddin Zakariya University, Multan

8. Prof. Dr. Muhammad Arfan
   Member
   Institute of Chemical Sciences
   University of Peshawar, Peshawar
<table>
<thead>
<tr>
<th>No.</th>
<th>Name and Title</th>
</tr>
</thead>
</table>
| 9.  | Prof. Dr. Abdullah Khan  
Chairman  
Department of Chemistry  
University of Balochistan  
Quetta | Member |
| 10. | Prof. Dr. Ahmed Saeed  
Department of Chemistry  
Gomal University  
D.I Khan | Member |
| 11. | Prof. Dr. Syed Ishrat Ali  
Chairman  
Department of Applied Chemistry  
University of Karachi  
Karachi | Member |
| 12. | Dr. Zafar Iqbal Zafar  
Department of Chemistry  
Bahauddin Zakariya University  
Multan | Member |
| 13. | Prof. Dr. Jamil Anwar  
Director  
Institute of Chemistry  
University of the Punjab, Lahore | Member |
| 14. | Prof. Dr. Muhammad Arif  
Department of Chemistry  
Bahauddin Zakariya University  
Multan | Member |
| 15. | Prof. Dr. Muhammad Aslam Shad  
Department of Chemistry  
Bahauddin Zakariya University  
Multan | Member |
| 16. | Prof. Dr. Abdul Shakoor Qureshi  
Dr. M.A. Kazi  
Institute of Chemistry  
University of Sindh  
Jamshoro | Member |
| 17. | Prof. Dr. Mohammad Saeed Iqbal  
Chairman  
Department of Chemistry  
G.C. University  
Lahore | Member/Secretary |
The meeting on 30th October 2007, started with recitation of a few verses from the Holy Quran by Mr. Shafiullah Khan, Assistant Director (Curriculum), HEC, Islamabad. The meeting was chaired by Prof. Dr. Riaz-ul-Haq Tariq, Member (Academics), HEC, Islamabad. The Member briefed the participants about the overall structure of template / framework of four year Bachelor Degree Program being developed by the Conveners of National Curriculum Revision Committees in Basic, Social, Natural and Applied Sciences in their meeting held on April 30, 2007 at HEC Islamabad under the supervision of the Executive Director, HEC. He emphasized the participants to revise / finalize the curriculum for BS (4 year) program in Chemistry in the light of the approved template. He pointed out to agree to some broad guidelines so as to suit the needs of the students, faculty and industry, and also to include the elements of creativity, independent learning and problem solving approach.

Then, the Chairman asked to select new Convener and Secretary for the current and forthcoming meeting (s). The participants selected Dr. Fahim Uddin, Professor & Chairman, Department of Chemistry, University of Karachi, Karachi as Convener and Prof. Dr. Mohammad Saeed Iqbal, Chairman, Department of Chemistry, G.C. University, Lahore as Secretary. The forum was handed-over to the Convener who conducted the subsequent proceedings on 30-31 October 2007 and 10-11 March 2008

The Agenda Items were discussed as Follows:

1. Development of Scheme of Studies for BS (4 year) programme in Chemistry. After thorough discussion the Scheme of Studies was discussed at length.

2. Constitution of sub-committees to prepare course of lines of various specializations.

3. To finalize the course outlines prepared by sub-committees.

    After thorough discussions the scheme of studies was discussed at length and approved as follows:

    The revised B.S four years scheme in line with the general guide lines for the Generic unified framework/ Templates for the programs was adjusted.

Code Key:

i) The code will start alphabets as follows.
CHEM: Chemistry Courses
GEN: General Courses
MATH: Mathematics Course
COMP: Computer Course
STAT: Statistics Course
BIO: Biology Course

ii) The letter code will be followed by three digits; the first digit will denote level of the course.

iii) For the Chemistry courses, second digit specifying the subject identity will be as follows:

- Analytical Chemistry 1
- Applied / Industrial Chemistry 2
- Biochemistry 3
- Environmental Chemistry 4
- Inorganic Chemistry 5
- Organic Chemistry 6
- Physical Chemistry 7
- Institutional Option 8

iv) The third digit may be used to indicate diversity within the specialty.

v) Codes for the special courses in 7th and 8th semester may be assigned in accordance with the above guidelines.

The salient features of this scheme are:

- Introduction of required weightage of social sciences.
- Independent life-long learning.
- Development of creative thinking.
After exhaustive discussion, the following layout of courses was finalized and approved in the light of guidelines provided by the HEC:

<table>
<thead>
<tr>
<th>Compulsory Requirements (The Student Has No Choice)</th>
<th>General Courses to Be Chosen from Other Dept.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>9 Courses</strong></td>
<td><strong>7- 8 Courses</strong></td>
</tr>
<tr>
<td><strong>25 Credit hours</strong></td>
<td><strong>21- 24 Credit hours</strong></td>
</tr>
<tr>
<td><strong>Subject</strong></td>
<td><strong>Subject</strong></td>
</tr>
<tr>
<td>1. ENGLISH I</td>
<td>1. GEN-100</td>
</tr>
<tr>
<td>2. ENGLISH II</td>
<td>2. GEN-101</td>
</tr>
<tr>
<td>3. ENGLISH III</td>
<td>3. GEN-201</td>
</tr>
<tr>
<td>4. ENGLISH IV/</td>
<td>4. GEN-301</td>
</tr>
<tr>
<td>UNIVERSITY OPTIONAL *</td>
<td></td>
</tr>
<tr>
<td>5. PAKISTAN STUDIES</td>
<td>5. GEN-302</td>
</tr>
<tr>
<td>6. ISLAMIC STUDIES /</td>
<td>6. GEN-400</td>
</tr>
<tr>
<td>ETHICS</td>
<td>7. GEN-401</td>
</tr>
<tr>
<td>7. MATHEMATICS-I</td>
<td></td>
</tr>
<tr>
<td>8. MATHEMATICS-II /</td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY OPTIONAL **</td>
<td></td>
</tr>
<tr>
<td>9. INTRODUCTION TO</td>
<td></td>
</tr>
<tr>
<td>COMPUTER</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong> 25</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discipline specific foundation courses</th>
<th>Major courses including research project/internship</th>
<th>Elective courses within the major</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>9-10 Courses</strong></td>
<td><strong>11-13 Courses</strong></td>
<td><strong>4 Courses</strong></td>
</tr>
<tr>
<td><strong>30-33 Credit hours</strong></td>
<td><strong>36 - 42 Credit hours</strong></td>
<td><strong>12 Credit hours</strong></td>
</tr>
<tr>
<td><strong>Subject</strong></td>
<td><strong>Subject</strong></td>
<td><strong>Subject</strong></td>
</tr>
<tr>
<td>CHEM-151</td>
<td>CHEM-251</td>
<td>ELECTIVE</td>
</tr>
<tr>
<td>CHEM-161</td>
<td>CHEM-261</td>
<td>COURSE – I</td>
</tr>
<tr>
<td>STAT-100</td>
<td>CHEM-271</td>
<td>ELECTIVE</td>
</tr>
<tr>
<td>CHEM-111</td>
<td>CHEM-211/231</td>
<td>COURSE – II</td>
</tr>
<tr>
<td>CHEM-131</td>
<td>CHEM-351</td>
<td>RESEARCH</td>
</tr>
<tr>
<td>CHEM-121</td>
<td>CHEM-361</td>
<td>PROJECT /</td>
</tr>
<tr>
<td>CHEM-171</td>
<td>CHEM-371</td>
<td>ADVANCED</td>
</tr>
<tr>
<td>CHEM-141</td>
<td>CHEM-311/331</td>
<td>PRACTICAL – I</td>
</tr>
<tr>
<td></td>
<td>CHEM-PAPER-I</td>
<td>/ POSITION</td>
</tr>
<tr>
<td></td>
<td>CHEM- PAPER-II</td>
<td>PAPER</td>
</tr>
<tr>
<td></td>
<td>CHEM- PAPER-III</td>
<td>RESEARCH</td>
</tr>
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<td></td>
<td>PRACTICAL.-I</td>
<td>PROJECT /</td>
</tr>
<tr>
<td></td>
<td>CHEM-PAPER-IV</td>
<td>ADVANCED</td>
</tr>
<tr>
<td></td>
<td>CHEM-PAPER-V</td>
<td>PRACTICAL – II</td>
</tr>
<tr>
<td></td>
<td>CHEM-PAPER-VI</td>
<td>/ POSITION</td>
</tr>
<tr>
<td></td>
<td>PRACTICAL-II</td>
<td>PAPER</td>
</tr>
<tr>
<td><strong>Total</strong> 23</td>
<td><strong>52</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>
THE FOLLOWING SCHEME OF STUDIES
WAS APPROVED BY THE COMMITTEE

BS (4-YEAR) PROGRAM IN CHEMISTRY
SCHEME OF STUDIES

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit hours</th>
<th>Semester - I</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG-100 English-I (Functional)</td>
<td>3</td>
<td>Theory</td>
</tr>
<tr>
<td>GEN-100 General-I</td>
<td>3</td>
<td>Practical</td>
</tr>
<tr>
<td>GEN-101 General-II</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MATH-100 Mathematics-I</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>COMP-100 Computer and Its Applications in Chemistry</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CHEM-151 Inorganic Chemistry</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG-200 English-II (Functional)</td>
</tr>
<tr>
<td>GEN-200 Islamic Studies / Ethics</td>
</tr>
<tr>
<td>GEN-201 General-III</td>
</tr>
<tr>
<td>MATH-200 Mathematics-II/Functional Biology/University Optional</td>
</tr>
<tr>
<td>STAT-100 Statistics</td>
</tr>
<tr>
<td>CHEM-161 Organic Chemistry</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester - III</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG-300 English-III (Report Writing)</td>
</tr>
<tr>
<td>GEN-300 Pakistan Studies</td>
</tr>
<tr>
<td>GEN-301 General-IV</td>
</tr>
<tr>
<td>GEN-302 General-V</td>
</tr>
<tr>
<td>CHEM-141 Environmental Chemistry</td>
</tr>
<tr>
<td>CHEM-171 Physical Chemistry</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester - IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG-400 English-IV / University Optional</td>
</tr>
<tr>
<td>GEN-400 General-V</td>
</tr>
<tr>
<td>GEN-401 General-V</td>
</tr>
<tr>
<td>CHEM-111 Analytical Chemistry</td>
</tr>
<tr>
<td>CHEM-121 Industrial Chemistry</td>
</tr>
<tr>
<td>CHEM-131 Biochemistry</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Course Title</td>
</tr>
<tr>
<td>------------------------------------</td>
</tr>
<tr>
<td><strong>Semester - V</strong></td>
</tr>
<tr>
<td>CHEM-251  Inorganic Chemistry</td>
</tr>
<tr>
<td>CHEM-261  Organic Chemistry</td>
</tr>
<tr>
<td>CHEM-271  Physical Chemistry</td>
</tr>
<tr>
<td>CHEM-211  Analytical-/</td>
</tr>
<tr>
<td>CHEM-231  Bio-Chemistry</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Semester - VI</strong></td>
</tr>
<tr>
<td>CHEM-351  Inorganic Chemistry</td>
</tr>
<tr>
<td>CHEM-361  Organic Chemistry</td>
</tr>
<tr>
<td>CHEM-371  Physical Chemistry</td>
</tr>
<tr>
<td>CHEM-311  Analytical-/</td>
</tr>
<tr>
<td>CHEM-331  Bio-Chemistry</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Semester - VII:</strong></td>
</tr>
<tr>
<td>Specialization (Inorganic/</td>
</tr>
<tr>
<td>Organic/Physical/Applied/</td>
</tr>
<tr>
<td>Analytical/Bio-Chemistry</td>
</tr>
<tr>
<td><strong>Paper-I</strong></td>
</tr>
<tr>
<td><strong>Paper-II</strong></td>
</tr>
<tr>
<td><strong>Paper-III</strong></td>
</tr>
<tr>
<td><strong>Practical-I</strong></td>
</tr>
<tr>
<td><strong>Elective Course-I (other than the field of specialization)</strong></td>
</tr>
<tr>
<td><strong>Research Project / Advanced Practical / Position Paper (literature survey)</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Semester - VIII:</strong></td>
</tr>
<tr>
<td>Specialization (Inorganic/</td>
</tr>
<tr>
<td>Organic/Physical/Applied/</td>
</tr>
<tr>
<td>Analytical-/Bio-Chemistry</td>
</tr>
<tr>
<td><strong>Paper - IV</strong></td>
</tr>
<tr>
<td><strong>Paper - V</strong></td>
</tr>
<tr>
<td><strong>Paper - VI</strong></td>
</tr>
<tr>
<td><strong>Practical - II</strong></td>
</tr>
<tr>
<td><strong>Elective Course - II (other than the field of specialization)</strong></td>
</tr>
<tr>
<td><strong>Research Project / Advanced Practical / Position Paper (write-up)</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

**Total Credit Hours: 131**
The list of general courses was also reviewed and approved as follows:

**List of General Courses:**
(Proposed in NCRC special meeting in Chemistry)

1. Social Psychology
2. Community Development
3. Environmental Sciences
4. Principles of management
5. Logic and Reasoning
6. Teaching and Learning
7. Social Issues of Pakistan
8. Entrepreneurship
10. Basic Financial Management
11. History of Human Civilization
12. History of Science

OR

Any other, including supportive science courses other than chemistry, depending upon the expertise available

2. **Constitution of Sub-Committees to Prepare Course Outlines of Various Specializations:**

Various sub-committees were constituted to prepare course outlines of various specializations. The sub-committees constituted are as under:

<table>
<thead>
<tr>
<th>Inorganic Chemistry</th>
<th>Physical Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prof. Dr. M Arif Chairman</td>
<td>1. Prof. Dr. Fahim Uddin Chairman</td>
</tr>
<tr>
<td>Department of Chemistry</td>
<td>Department of Chemistry</td>
</tr>
<tr>
<td>Bahauddin Zakaria University, Multan</td>
<td>University of Karachi Karachi</td>
</tr>
<tr>
<td>2. Prof. Dr. Sher Khan Sadozai Chairman</td>
<td>Prof. Dr. M. Shahid Ansari Department of Chemistry</td>
</tr>
<tr>
<td>Department of Chemistry</td>
<td>Quaid-i-Azam University</td>
</tr>
<tr>
<td>Gomal University</td>
<td>Islamabad</td>
</tr>
<tr>
<td>D. I. Khan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Name</td>
</tr>
<tr>
<td>---</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>Prof. Dr. Humayun Pervez</td>
</tr>
<tr>
<td>2</td>
<td>Prof. Dr. Muhammad Arfan</td>
</tr>
<tr>
<td>3</td>
<td>Prof. Dr. G. A. Miana</td>
</tr>
<tr>
<td>4</td>
<td>Prof. Dr. Habib-ur-Rehman</td>
</tr>
<tr>
<td>5</td>
<td>Prof. Dr. Rehana Ifzal</td>
</tr>
</tbody>
</table>

**Organic Chemistry**

1. Prof. Dr. Muhammad Mazhar  
   Chairman  
   Department of Chemistry  
   Quaid-i-Azam University  
   Islamabad

3. Prof. Dr. Ghulam Hussain  
   Dean  
   Faculty of Sciences & Tech., University of Sargodha, Sargodha

4. Prof. Dr. Abdullah Khan  
   Department of Chemistry  
   University of Balochistan  
   Quetta.

5. Prof. Dr. Saeed-ur-Rehman  
   Department of Chemistry  
   University of Peshawar, Peshawar

6. Dr. Habib-ur-Rehman  
   Institute of Chemical Sciences  
   University of Peshawar  
   Peshawar

**Biochemistry**

1. Prof. Dr. M. Kalim Tahir  
   Chairman  
   Department of Chemistry  
   Allama Iqbal Open University, Islamabad

2. Prof. Dr. Ahmed Saeed  
   Department of Chemistry  
   Gomal University  
   D.I. Khan

3. Prof. Dr. Munir Ahmed Sheikh  
   Department of Chemistry  
   University of Agriculture  
   Faisalabad

4. Prof. Dr. Saeed Ahmed Nagra  
   Dept. of Chemistry  
   University of the Punjab  
   Lahore

5. Prof. Dr. M. M. Yasinzai  
   Director  
   Institute of Biochemistry  
   Univ. of Balochistan  
   Quetta
It was decided that the Convener will coordinate with the sub-committees with the help of HEC to prepare the course outlines which will be presented to the NCRC meetings to be held at an appropriate time and date in Islamabad for approval of these courses. It was further decided that the course outlines of the following subjects will be prepared by

**Analytical/Environmental Chemistry**
1. Prof. Dr. M. Saeed Iqbal
   Chairman, Department of Chemistry
   GC University, Lahore

2. Prof. Dr. Ubedullah M. Abbasi
   Director, Dr. M. A. Kazi Institute of Chemistry
   University of Sindh, Jamshoro

3. Prof. Dr. Jamil Anwar
   Director, Institute of Chemistry
   University of the Punjab, Lahore

**Applied Chemistry**
1. Prof. Dr. Syed Ishrat Ali
   Chairman, Deptt. of Applied Chemistry
   University of Karachi, Karachi

2. Prof. Dr. Fazeelat Tahira
   Chairperson, Deptt. of Chemistry
   Univ. of Engg. & Technology, Lahore

3. Prof. Dr. Bakhtiar Muhammad
   Chairman, Deptt. of Chemistry
   Hazara University, Mansehra

4. Dr. Zafar Iqbal Zafar
   Director, Institute of Chemical Sciences
   Bahauddin Zakariya University, Multan

5. Dr. Yousuf Iqbal
   Institute of Chemical Science
   University of Peshawar, Peshawar

6. Dr. Aziz Ahmed Chaudhry
   Department of Chemistry
   AJK University, Muzaffarabad

7. Prof. Dr. Rehana Rashid
   Department of Chemistry
   University of Balochistan, Quetta

8. Prof. Dr. M. Aslam Shad
   Dept. of Chemistry
   Bahauddin Zakariya University, Multan

9. Prof. Dr. Ubedullah M. Abbasi
   Director, Dr. M. A. Kazi Institute of Chemistry
   University of Sindh, Jamshoro

10. Prof. Dr. Jamil Anwar
    Chairman, Department of Chemistry
    GC University, Lahore

11. Prof. Dr. Rasul Jan
    Director, Institute of Chemical Sciences, University of Peshawar, Peshawar

12. Dr. Ikhtiar Khan
    Institute of Chemical Sciences
    University of Peshawar, Peshawar

13. Dr. Yousuf Iqbal
    Institute of Chemical Science
    University of Peshawar, Peshawar

14. Dr. Aziz Ahmed Chaudhry
    Department of Chemistry
    AJK University, Muzaffarabad

15. Prof. Dr. M. Aslam Shad
    Dept. of Chemistry
    Bahauddin Zakariya University, Multan

16. Prof. Dr. Ubedullah M. Abbasi
    Director, Dr. M. A. Kazi Institute of Chemistry
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35. Dr. Aziz Ahmed Chaudhry
    Department of Chemistry
    AJK University, Muzaffarabad
holding separate meetings of the sub-committees constituted for that purpose. However, the following members will coordinate with these committees to assist in preparation of these courses.

Mathematics: Prof. Dr. Fahim Uddin  
Biology: Prof. Dr. M. Kalim Tahir  
Statistics: Prof. Dr. M. Saeed Iqbal  
English: Prof. Dr. Humayun Pervez

The course outlines of the general subjects will be got prepared and provided by the relevant committees under the directions of HEC.

3. Before the Start of the formal Proceedings on 10-11 March 2008, Fateha was offered for the Departed Soul of Prof. Dr. Rashid Iqbal, former Chairman, Department of Chemistry, Quaid-e-Azam University, Islamabad

The course outlines prepared by the sub-committees were reviewed, finalized and approved by the NCR Special Committee. The Heads of the sub-committees were advised to send the course contents to the respective members and to incorporate the minor changes as proposed by the members. Each Heads of subcommittee shall submit the final modules of the course contents to the Convener NCRC latest by March 30, 2008 for onward transmission to the HEC.

Final Version is detailed below:

MISSION STATEMENT

1. The common purpose is to achieve the highest possible standards of scholarship, teaching and research in chemistry and allied subjects.

2. The objectives of this curriculum are:

   i) To encourage intellectual development and scholarship in and through chemistry;

   ii) To impart a sound knowledge of chemistry to students and to help them to use this knowledge creatively and analytically;

   iii) To develop in students an awareness of the applications of chemistry including its practical, social and economic
aspects such as health, agriculture, industry and defense.

iv) To develop and improve students’ practical, written and oral communication, information retrieval, computer and problem solving skills.

v) To encourage students to become effective independent learners.

vi) To develop the curriculum which is need based and its continuous developments shall be made considering the changing global and national requirements.

vii) To develop in students the ability to work in groups so as to acquire respect for human values.

viii) To encourage students to broaden their knowledge, to develop their own capabilities and self confidence, to respect learning and to participate in continuing education.

DETAILS OF COURSE
BS 1st Year
Semester-I

Title of the Course: Inorganic Chemistry Code: CHEM-151
Credit Hours: 03 Marks: 100

The program is aimed that the student should learn:

1. The Development of periodic law and properties of elements in a systematic way.

2. The principal of chemical bonding

3. Chemistry of acid and bases

4. Chemistry of p-block Elements

1. **The Periodic Law and Periodicity**
   Development of Periodic Table; Classification of elements based on s, p, d and f orbitals, group trends and periodic properties in s, p, d and f block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electronagetivities and redox potential.

2. **Principles of Chemical Bonding**
   Types of chemical bonding; ionic bonding; the localized bond approach: VB theory, hybridization and resonance; the
delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

3. **Acids and Bases**
   Concepts of acids and bases including SHAB concept, 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.

4. **Chemistry of p-block Elements**
   Chemistry and structure of p-block elements; main emphasis on the chemistry and structure of noble gases and their compounds, chemistry and structure of interhalogens, pseudohalogenes and polyhalides. Prediction of shapes of molecules using VSEPR model and hybridization.

**PRACTICAL (CHEM-151) (1-Cr. Hr.)**

1. **Laboratory Ethics and safety measures**
   Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations

2. **Qualitative analysis**
   Analysis of four ions (two anions and two cations) from mixture of salts

3. **Quantitative analysis**
   Laboratory work illustrating topics covered in the lecture of CHEM-151

**Recommended Books**


BS 1st Year
Semester-II

Title of the Course: Organic Chemistry Code: CHEM-161
Credit Hours: 03 Marks: 100

Introduction to Organic Chemistry
Organic chemistry-the chemistry of carbon compounds; the nature of organic chemistry-a historical perspective.

Chemical Bonding and Properties of Organic Molecules
Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shape of organic molecules; dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases.

Classes and Nomenclature of Organic Compounds
Classification of organic compounds; development of systematic nomenclature of organic compounds; IUPAC nomenclature of hydrocarbons and heteroatom functional groups.

Functional Group Chemistry
A brief introduction to the chemistry of hydrocarbons, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, amines, and carboxylic acids and their derivatives.

Recommended Literature
(Latest available editions of the following books)

**Supplementary Literature**

(Latest available editions of the following books)
Title of the Course: Environmental Chemistry
Credit Hours: 02
Marks: 100

Objectives of the Course:
From this course, the students should be able to:

- Understand the fundamental principles of environmental chemistry.
- Apply these principles in pollution related subjects.
- Demonstrate the understanding of environmental chemistry principles via experimental exercises in the laboratory.

Course Outlines:

**Atmospheric Chemiser**
The air around us, atmospheric temperature and pressure profile, Temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, radioactivity, atmospheric aerosols, Acid rain – major sources, mechanism, control measures and effects on buildings and vegetation, Global warming – major green house gases, mechanism, control measures and global impact, The stratospheric ozone – the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

**Water Pollution and Water Treatment** – sources of water pollution - industrial sources and agricultural sources, heavy metals contamination of water, Eutrophification, 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.

**Soil Pollution** – soil and mineral resources, general principles of metal extraction, Heavy metals contamination of soil, toxicity of heavy metals, bio-accumulation of heavy metals, Organic matter in soil, Macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.
Green Revolution – pest control, pesticides, toxicity of pesticides, integrated pests management.


Renewable Energy – nuclear energy, solar energy, geothermal and tidal energy.

Recommended Text Books
Latest editions of the following books:
5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.

Recommended Reference Books
Latest editions of the following books:

Recommended Journals/Periodicals Journals Related to:
1. Atmospheric Chemistry.
2. Air Pollution.
3. Water Pollution.
4. Soil Pollution/Soil sciences.
5. Environmental Technology.

Recommended World Web:

Web Sites related to:
2. Ozone depletion.
3. Acid Rain
4. Environmental Pollution
5. Energy Conservation

BS 2nd Year
Semester-III

Title of the Course: Physical Chemistry  Code: CHEM-171
Credit Hours: 03  Marks: 100

Physical States of Matter
Ideal and real gases, equations of state, critical phenomenon and critical constants. Molecules in motion: collision diameter and mean free path. Physical properties of liquids: surface tension, viscosity, refractive index etc. and their applications. Brief account of interactions among the molecules in liquids. Packing of atoms in solids. Unit cells and crystal systems. Method of crystal structure analysis. Brief account of polymers and composite materials with special emphasis on superconductors, semi-conductors etc. Introduction to plasma.

Chemical Thermodynamics

Chemical Kinetics

Solution Chemistry
Surface Chemistry

Electrochemistry

Practicals (Chem-171) (1-Cr. Hr.)
- Determination of viscosity and parachor values of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method.
- Determination of heat of neutralization of an acid with a base.
- Kinetic study of acid catalyzed hydrolysis of ethyl acetate.
- Determination of partition coefficient of a substance between two immiscible liquids.

Books Recommended (Theory)
Books Recommended (Practicals)

BS 2nd Year
Semester-IV
Title of the Course: Analytical Chemistry Code: CHEM-111
Credit Hours: 02 Marks: 100

Course Goals
- This course will introduce you to the vocabulary and concepts used in basic Analytical Chemistry.
- You will learn the details of steps involved in the preparation and analysis of a sample, the chemical basis and various techniques of analysis.
- You will also learn and use statistical methods to determine the precision and accuracy of experimental results.
- Graded assignments, quizzes, class tests and a final exam will test your understanding of the material dealing with these goals.
- To develop skills needed to solve analytical problems in a quantitative manner, particularly with the aid of the spreadsheet tools.
- Teaching laboratory skills that will give students confidence in their ability to obtain high-quality analytical data.

Course Description
- Introduction to Analytical Chemistry
- Measuring Apparatus
- Expression of Quantities and Concentrations
- Basic Approach to Equilibrium
- Errors in Chemical Analyses and Quality of Results
- Chemicals and reagents
- Use and handling of standards
- Sampling
- Errors
- Precision, Accuracy, Signal-to-noise ratio, Limits of detection and...
• Statistical Evaluation of Data
• Quality Control and Quality Assurance

BS 2nd Year
Semester-IV

Title of the Course: Industrial Chemistry Code: CHEM-121
Credit Hours: 02 Marks: 100

Fundamentals of Chemical Industry
Basic principles and parameters for industrial plant location; Elementary treatment of general unit operations commonly used in industries such as size reduction; evaporation, filtration, distillation, crystallization and drying; Chemical unit processes like carbonation, sulfitation, defecation, nitrilation, etc. in chemical process industries.

Basic and Heavy Chemical Industries
Raw materials and chemicals; Flow sheet diagrams and commercial production of sulphuric acid, nitric acid, hydrochloric acid, oxalic acid, formic acid, caustic soda and washing soda; Applications of these chemicals in chemical industries.

Glass Industry
Raw materials and manufacture of glass; Chemistry involved in the production of glass; Types of glass; Glassy state phenomena and annealing of glass; Photochromic and photographic lasses; Production of safety glasses.

Ceramics Industry
Raw material used for ceramics; Chemistry involved in the production of ceramics articles and wares; Types and classification of ceramic products; Manufacture of ceramics products.

Cement Industry
Raw materials used for cement production; Chemistry involved in the production of cement; Manufacture of cement by wet and dry processes; Types of cement and composition of clinker. Chemical phenomena and chemistry involved in the hardening and setting of cement.
Water Treatment, Steam Production and Scale Removal

Sources of water; Hardness of water; Water treatment and conditioning for municipal and industrial purposes. Steam production and its utilization for power and energy generation; Boiler water treatment; Chemistry involved in the formation of scale; Prevention of scale formation.

BS 2nd Year
Semester-IV

Title of the Course: Bio-chemistry Code: CHEM-131
Credit Hours: 02 Marks: 100

Title of the Course: Basic Chemistry and Functions of Biomolecules

Prerequisites: Basic courses of Organic Chemistry and Biology

Objective of the Course: This course provides fundamental concepts in biochemistry, which focuses upon the major macromolecules and chemical properties of living systems. Primary topics include the structures, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

Course Outline:

Introduction to Biochemistry

Brief introduction, to the scope and history of Biochemistry. Molecular logic of the living organism. Cell structures and their functions. Origin and nature of biomolecules

Carbohydrates

Definition and classification, Chemistry, physical and chemical properties of various classes of carbohydrates. Biological functions of starch, glycogen, cellulose and cell wall polysaccharides, acid mucopolysaccharides and proteoglycans.

Lipids

Definition and classification of lipids. Chemistry and biological importance of fatty acids, waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols and prostaglandins.

Significance of liquids in biological membranes and transport mechanism
Proteins

Nucleic Acids

Recommended Text Books

BS 3rd Year
Semester-V

Title of the Course: Inorganic Chemistry Code: CHEM-251
Credit Hours: 03 Marks: 100

Objective of the Program
After completing this program students will be able to learn the following:

1. The historical development of transition element chemistry
2. The importance and applications of the transition elements
3. To learn about coordination chemistry and various theories developed to explain the structure and properties of these complexes
4. Reactions in non aqueous solvents.
1. **Coordination Compounds**  
   Historical background of coordination compounds, geometry of complexes having coordination number 2 to 9, nomenclature, theories of coordination compounds; Werner’s theory, valence bond theory, crystal field and; molecular orbital theory; Jahn-Teller theorem; magnetic properties; spectrochemical series, isomerism and stereochemistry, stability constants, techniques for studying complexes, applications of coordination compounds.

2. **Non Aqueous Solvents**  
   Classification of solvents, types of reactions in solvents, effect of physical and chemical properties of solvent, detailed study of liq. NH₃, liq. H₂SO₄, liq HF, and liq. SO₂, BrF₃ and reaction in molten salts system.

**PRACTICAL (CHEM-251) (1-Cr. Hr.)**

- Semi-micro analysis and Separation of anions in a mixture by paper chromatography
- Preparation of at least four coordination compounds in a pure state
- Complexometric titrations

**Recommended Books**

BS 3rd Year
Semester-V

Title of the Course: Organic Chemistry   Code: CHEM-261
Credit Hours: 03   Marks: 100

Isomerism
Introduction; classification of isomerism; optical isomerism: optical activity, chirality and optical activity, symmetry elements and optical inactivity, relative and absolute configuration, R, S notation, method of determining configuration, racemic mixtures and their resolution, asymmetric synthesis, optical activity in biphenyls, allenes and spiro compounds, stereospecific and stereoselective reactions; geometrical isomerism: determination of configuration of geometrical isomers, Z, E convention and cis trans isomerism in cyclic systems; conformational isomerism: conformational analysis of mono-substituted cyclohexanes, di-substituted cyclohexanes and decalin systems.

Introductory Organic Spectroscopy
Introduction to IR, UV, 1H-NMR and Mass spectrometric methods, and their usage for structure elucidation of some simple organic compounds.

Aliphatic Substitution Reactions

Aliphatic Nucleophilic Substitution Reactions: Mechanisms—study of SN2, SN1, SNi, SN2′, SN1′, SNi′ mechanisms; neighbouring group participation—intramolecular displacement by neighbouring oxygen, nitrogen, sulphur and halogen; structure and reactivity—effects of the substrate structure, entering group, leaving group and reaction medium on the mechanisms and rates of substitution reactions.

Aliphatic Electrophilic Substitution Reactions: Mechanisms—study of SE1, SE2 (front), SE2 (back) and SEi mechanisms; structure and reactivity—effects of substrate, leaving group and medium on the rates of these reactions.

Elimination Reactions

Eliminations Proceeding by Polar Mechanisms: Study of E1, E1cB and E2 mechanisms; orientation: Saytzeff and Hofmann rules; structure and reactivity—the effects of substrate structure, attacking base, leaving group and the reaction medium on the rates and mechanisms of elimination reactions; competition between elimination and substitution reactions.
Eliminations Proceeding by Non-polar Mechanisms: Pyrolytic eliminations—study of Ei and free-radical mechanisms; orientation in pyrolytic eliminations.

Recommended Literature
(Latest available editions of the following books)

Supplementary Literature
(Latest available editions of the following books)

PRACTICAL (CHEM-261) (1 Cr. Hr.)
Laboratory work illustrating topics covered in the lecture of Chem-261

BS 3\(^{rd}\) Year
Semester-V

Title of the Course: Physical Chemistry    Code: CHEM-271
Credit Hours: 03  Marks: 100
Kinetic Theory of Gases


Chemical Thermodynamics


Chemical Kinetics


Quantum Chemistry

Limitation of classical mechanics, Wave and particle nature of matter, de Broglie’s equation, Heisenberg’s uncertainty principle. Schroedinger wave equation and its solution for particle in 1-dimentional and 3-dimentional boxes. Concept of quantization of energy, introduction to spectroscopy of molecules, spectra of hydrogen and hydrogen like atoms.

PRACTICALS (CHEM-271) (1Cr. Hr.)

- Equilibrium constant of the KI + I₂ = KI₃ reaction
- Kinetics of saponification of ethyl acetate
- Acid catalyzed hydrolysis of sucrose
- Study of the adsorption isotherms of acetic acid-charcoal system
- Study of the charge transfer complex formation between iodine and benzene
- Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate
- Determination of partial molar volumes
- Characterization of the given compound by UV-Vis spectroscopy
Books Recommended (Theory)


Books Recommended (Practicals)


BS 3rd Year
Semester-V

Title of the Course: Analytical Chemistry Code: CHEM-211
Credit Hours: 03 Marks: 100
Principles and Application of Chemical Equilibrium Systems in Quantitative Analysis

- Gravimetric Methods of Analysis
- Stoichiometric Reactions
- Acids, Bases and Buffers
- Acid-Base Titrations
- Complexometric Titrations
- Redox Titrations
- Non-aqueous Titrations
- Karl-Fischer Titrations

**PRACTICAL (CHEM-211) (1-Cr. Hr.)**

- Calibration of volume measuring glassware
- Calibration of electronic analytical balance
- Calibration of conductivity meter and potentiometer
- Two experiments demonstrating the use of gravimetry in quantitative analysis
- Two experiments based on acid-base titrations
- Two experiments based on complexometric titrations
- Two experiments based on redox titrations
- Two experiments based on non-aqueous titrations
- Two experiments based on Karl-Fischer titrations

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BS 3rd Year  
Semester-V

Title of the Course: Bio-Chemistry  
Code: CHEM-231  
Credit Hours: 03  
Marks: 100

Title of the Course: Bioenergetics and Metabolism of Biomolecules

Objective of the Course:
This course provides fundamental concepts about the energy production and the mechanisms of the major macromolecules metabolism. Regulation and inhibition of the metabolic pathways are also addressed. This course will also integrate knowledge of bioenergetics and the metabolic pathways of amino acids, proteins, carbohydrates, nucleic acids and lipids to solve biological problems.
**Course Outline:**

**Intermediary Metabolism And Bioenergetics**


**Metabolism of Carbohydrates**


**Metabolism of Lipids**


**Metabolism of Proteins**


**Metabolism of Neucleic Acids**

Biosynthesis and Catabolism of purines and Pyrimidines and their regulation. Synthesis of Catabolism, of Nucleosides DNA Polymerases and other enzymes involves in metabolism.

**Recommended Text Books**


PRACTICALS
(CHEM-231) (1-Cr. Hr.)

Prerequisite: Chem.: 131
Qualitative and Quantitative analysis of carbohydrates, lipids and proteins

Recommended Books

BS 3rd Year
Semester-VI

Title of the Course: Inorganic Chemistry Code: CHEM-351
Credit Hours: 03 Marks: 100

Objective of the Program
After completing this program students will be able to learn the following:

1. Chemistry of Lanthanides, their purification and properties.
2. Chemistry of actinide and their characteristics.
3. Chemistry of metal carbonyls their synthesis structure and properties.

Chemistry of f-Block Elements
(i) Lanthanides: Electronic structure and position in the periodic table, Lanthanide’s contraction, oxidation states, spectral and magnetic properties, general characteristics, occurrence, extraction and general principles of separation, complexes and uses.
(ii) Actinides: Electronic structure and position in the periodic table, oxidation states, general characteristics, half life and decay law.
Acceptor Complexes
Mononuclear and polynuclear metal carbonyls: the eighteen electron rule as applied to metal carbonyls; rationalization of molecular structure; evaluation of structures based on spectroscopic evidences; chemistry of metal carbonyls and their derivatives (nitrosyls, halides and hydrides

PRACTICAL

(CHEM-351) (1 Cr. Hr.)

- Semi-micro analysis and Separation of cations in a mixture by paper chromatography
- Redox Titration
- Estimation of at least two halides by adsorption indicator
- Gravimetric estimation of Ba$^{2+}$ and C$_2$O$_4^{2-}$ ions

Recommended Books

Addition Reactions

_Electrophilic and Nucleophilic Addition to C=C_: Their mechanisms, orientation and stereochemistry; electrophilic addition of halogens and hydrogen halides to C=C; electrophilic addition to conjugated dienes; nucleophilic addition to C=C and C=C-C=O linkage.

_Nucleophilic Addition to C=O_: Structure and reactivity of carbonyl group; simple addition reactions i.e. addition of water, alcohol, hydrogen cyanide and bisulphite; addition/elimination reactions: addition of derivates of ammonia; stereoselectivity in carbonyl addition reactions.

Organometallic Compounds

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

Chemistry of Enolate Ions and Enols

Acidity of carbonyl compounds; enolization of carbonyl compounds; α-halogenation of carbonyl compounds; aldol-addition and aldol-condensation; condensation reactions involving ester enolate ions; alkylation of ester enolate ions.

Aromatic Substitution Reactions

_Electrophilic Substitution Reactions_: Mechanisms of substitution; orientation and reactivity; electrophilic substitution reactions i.e. nitration, halogenation, sulphonation, Friedel-Craft’s reaction, diazocoupling, formylation and carboxylation.

_Nucleophilic Substitution Reactions_: Mechanisms - study of S_NAr, SN1 and benzene mechanisms; structure and reactivity - the effects of substrate structure, leaving group and the attacking nucleophile on the rates of substitution reactions.

Recommended Literature

(Latest available editions of the following books)

Supplementary Literature
(Latest available editions of the following books)

PRACTICAL(CHEM-361) (1 Cr. Hr.)

Laboratory work illustrating topics covered in the lecture of Chem-361

BS 3rd Year
Semester-VI

Title of the Course: Physical Chemistry  Code: CHEM-371
Credit Hours: 03  Marks: 100

Electrochemistry
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, nuclear spins.

Group Theory

Photochemistry

PRACTICALS
(CHEM-371) (1 CR. HR.)

- Spectroscopic determination of Cu % in the given sample.
- Conductometric determination of Cu (II)- EDTA mole ratio in the complex.
- To determine the effectiveness of an extraction of I₂ solution by using Solvent Extraction method.
- Determination of molecular weight of a polymer by viscosity method.
- Determination of percentage composition of KMnO₄/ K₂Cr₂O₇ in a given solution by spectrophotometry.
- Evaluation of pKₐ value of an indicator by spectrometric method.
- Conductometric determination of hydrolysis constant (K₇) of conjugate base of a weak acid.

Recommended Books (Theory)

**Recommended Books (Practical)**


**BS 3rd Year**  
**Semester-VI**

Title of the Course: Analytical Chemistry    Code: CHEM-311
Credit Hours: 03     Marks: 100

**Separation Techniques**
- Introduction to Analytical Separations: Masking, Precipitation and Filtration,
- Solvent Extraction
- Chromatography
- Electrophoresis

**Thermal Analysis**
- Thermogravimetry
- Differential Thermal Analysis
- Differential Scanning Calorimetry
- Thermo-Mechanical Analysis
PRACTICAL
(CHEM-311) (1-Cr. Hr.)
Ten experiments based on theory topics as per facilities available

BS 3rd Year
Semester-VI

Title of the Course: Bio-Chemistry Code: CHEM-331
Credit Hours: 03 Marks: 100

Title of the Course: Biocatalysts and Acid-Base Regulation

Objective of the Course:
Course will emphasize the all aspects of the biochemistry of enzymes. Importance of coenzyme and cofactors of the enzymes will also be covered. This course will also emphasize on the acid-base regulation in human body.

Course Outline:

Enzymes
Chemical nature, nomenclature and classification of enzymes, Cofactors, Substrate specificity, enzyme-substrate interactions and nature of active site, Mechanism of enzyme action with specific reference to chymotrypsin and ribonuclease, Kinetics of single substrate reactions, Effect of different factor on enzyme activity, Bisubstrate reactions, Quantitative assays of enzyme activity, Enzyme Inhibition, Regulatory enzymes; Allostric enzymes, Multienzyme system, Zymogens, and Isozymes, Enzymatic control of metabolic pathways, Immobilized enzymes; synthesis, properties and uses.

Acid – Base and Electrolyte Chemistry
Intracellular and Extracellular Electrolytes, Body fluids as electrolyte solutions, pH, Henderson-Hasselbalch Equation and Buffers, Acids and bases, Actual and titratable acidities, Equilibrium reactions of acids, bases and protons, Buffer action, Effect of other ions on acid-base equilibria, Amino acids, peptides and proteins as acids and bases, Acid and base production in human metabolism, Regulation of Acid-Base Balance; Control of acidity and physiologic buffer action, Buffer capacity, Buffers of body fluids, Respiratory regulation of acid-base balance, Haemoglobin as an acid-base system, Renal control of Acid-
base balance, Acid-Base disorders; Acidosis, Alkalosis, Effect of acid-base disturbances on electrolytes, Homeostasis, Variation of Na⁺, K⁺, and Cl⁻ in acid-base disturbances.

**Recommended Text Books**


**PRACTICALS**

**(CHEM-331) (1-Cr. Hr.)**

Laboratory work illustrating topics covered in the lecture of Chem. 331. Determination of pH, Preparation of buffers, Enzyme catalysis, Progress curve for enzyme catalyzed reactions, Determination of $K_m$ values, To study the effect of different factors on the rate of enzyme catalyzed reactions.

**Recommended Books**


**BS 4th Year**  
**Semester-VII**

Title of the Course: Inorganic Chemistry  
Paper: I  
Credit Hours: 03  
Marks: 100

**Objective of the Program**

After completing this program students will be able to learn the following:
1. Periodic Anomalies and Bonding in Electron deficient Compounds
2. Kinetics and Reaction Mechanism of Inorganic Reactions
3. Electron Transfer Reaction

**Periodic Anomalies and Bonding in Electron deficient Compounds**

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

**Kinetics and Reaction Mechanism of Inorganic Reactions**

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

**Electron Transfer Reactions**

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

**Recommended Books**


BS 4th Year
Semester-VII

Title of the Course: Inorganic Chemistry PAPER: II
Credit Hours: 03 Marks: 100

Objective of the Program

After completing this program students will be able to learn and had a sound knowledge of the following:

1. Organic Reagents used in Inorganic Analysis, their selectivity, specificity etc.
2. Polymer Chemistry

Organic Reagents Used in Inorganic Analysis

Types of reagent, specificity and sensitivity of the reagents, methods of application with specific examples, complexometric and gravimetric methods involving various reagents, chelates and chelate-effect.
Polymer Chemistry

Molecular species: Introduction, homoatomic and heteroatomic inorganic polymers, chains and cages of Boron, Silicon, Nitrogen, Phosphorous and Sulphur; their synthesis, reactivity and applications, metal clusters.
Polyionic species: Isopyl and heteropoly anions of transition metals, Silicates, borates, condensed phosphates, zeolites.

Recommended Books

4. Emelues and Sharpe., “Modern Aspects of Inorganic Chemistry”.

BS 4th Year
Semester-VII

Title of the Course : Inorganic Chemistry PAPER: III
Credit Hours : 03 Marks: 100

Objective of the Program

After completing this program students will be able to learn and able to interpret simple spectra.

1. Nuclear Magnetic Resonance Spectroscopy.
2. Ultra violet spectroscopy
3. Infrared spectroscopy
4. Mass Spectrometry
5. Thermal Analysis
Instrumental Methods of Analysis

Physical methods in Inorganic Chemistry, TGA & DTA, NMR, IR, UV Spectroscopy, Mass Spectroscopy; Basic principles, Instrumentation and Applications

Recommended Books


BS 4th Year
Semester-VII

Title of the Course: Inorganic Chemistry PAPER: I (PRACTICAL)
Credit Hours: 01 Marks: 100

- Use of some organic reagents for the estimation of various elements
- Preparation of at least six compounds/organometallic compounds in a pure state and determination of their state of purity
- The experiments may be set making use of conductivity meter and potentiometer depending upon the availability.
Recommended Books


BS 4th Year
Semester-VII

Title of the Course: Chemistry PAPER: I
Credit Hours: 03 Marks: 100

Oxidation and Reduction

**Oxidation:** Introduction; reactions involving elimination of hydrogen, cleavage of C-C bond, replacement of hydrogen by oxygen and addition of oxygen to the substrate; oxidative coupling.

**Reduction:** Introduction; reactions involving replacement of oxygen by hydrogen, removal of oxygen from the substrate and reduction with cleavage; reductive coupling.

**Protective Groups**
Use of hydroxyl-, amino-, carboxyl- and carbonyl- protecting groups in organic synthesis.

**Pericyclic Reactions**
Principles; cycloadditions; electrocyclic reactions; cheletrophic reactions; sigmatropic rearrangements; the ene-reaction and related reactions.

Recommended Literature

(Latest available editions of the following books)

Supplementary Literature

(Latest available editions of the following books)

BS 4th Year
Semester-VII

Title of the Course: Organic Chemistry PAPER: I
Credit Hours: 03 Marks: 100

Molecular Rearrangements
Types of rearrangements; general mechanisms of nucleophilic, free radical and electrophilic rearrangements; reactions: 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.

Free Radicals
Introduction; radical generation; radical detection; radical shape and stabilization; radical reactions: addition reactions - addition of halogens, hydrogen halides, halomethanes, other carbon radicals and S-H
compounds; substitution reactions-halogenation, oxidation and substitution involving aryl radicals.

**Reactive Intermediates**
Carbenes, nitrenes, and arynes: Their generation, stability, reactions and synthetic applications.

**Recommended Literature**

(Latest available editions of the following books)

**Supplementary Literature**

(Latest available editions of the following books)
Organic Spectroscopy
A brief review of introductory organic spectroscopy.

$^1$H-NMR and $^{13}$C-NMR
Chemical shift; factors affecting chemical shift; spin relaxation; spin-spin coupling; coupling constants; factors affecting coupling constants; 2-D NMR.

Mass Spectrometry
Introduction; mass spectrometers; ionization and ion sources: electron impact and chemical ionization; field ionization; field desorption; fast atom bombardment; plasma desorption, thermospray and electrospray mass spectra; fragmentation pattern of common functional groups. Combined usage of IR, UV, NMR and Mass spectrometric methods for structure elucidation of organic compounds having medium complexity.

Aromatic Heterocycles
Introduction; nomenclature; structure and aromaticity; basicity and acidity of the nitrogen heterocycles; chemistry of furan, pyrrole and thiophene; synthesis of indoles and isoindoles; chemistry of pyridine, quinoline and isoquinoline; occurrence of heterocyclic compounds.

Recommended Literature
(Latest available editions of the following books)

Supplementary Literature

(Latest available editions of the following books)

BS 4th Year
Semester-VII

Title of the Course: Organic Chemistry PAPER: I (PRACTICAL)
Credit Hours: 01 Marks: 100

Laboratory work illustrating topics covered in the lecture of papers I, II & III.

(ADVANCED PRACTICAL-I IN LIEU OF RESEARCH PROJECT AND POSITION PAPER) (2 CR., LABORATORY)

BS 4th Year
Semester-VII

Title of the Course: Physical Chemistry PAPER: I
Credit Hours: 03 Marks: 100

Statistical Thermodynamics


Electrochemistry


**Electrode Kinetics**


**Books Recommended**

Title of the Course: Physical Chemistry  
PAPER: II  
Credit Hours: 03  
Marks: 100

**Polymer Chemistry**  

**Recommended Books**

Quantum Chemistry

Molecular Spectroscopy

Recommended Books
Specific experiments may be set making use of the following instruments depending upon their availability. Special experiments may also be designed for which a specimen list of instruments is given below. For the innovative designing of experiments the Journal of Chemical Education may be consulted.

**Instruments:**

- PH-meter
- Conductivity meter
- Dipole meters
- Electrogravimetric apparatus
- UV/Visible spectrometer
- Infrared spectrophotometer
- Atomic absorption spectrophotometer
- Stopped flow spectrometers
- Gas Chromatography
- HPLC
- Light Scattering Instruments

**Practical – I**

- Determination of partial molar quantities.
- Determination of free energy changes, standard free energies.
- Verification of Kohlrausch law.
- Study of temperature dependence of electrode potentials.
- Determination of heat of solution, ionic reactions and other experiments from thermochemistry.
- Determination of molecular weight of a polymer by viscosity method.
- Precipitation value of electrolytes.
- Measurement of IR spectra of simple compound and their interpretation.
- Determination of dipole moment of an organic liquid.
- Determination of percentage composition of KMnO$_4$-K$_2$Cr$_2$O$_7$ in given solution by spectrometry.
- Evaluation of pKa value an indicator by spectrometric method.
- Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques.

**Recommended Books**


BS 4th Year
Semester-VII

Title of the Course: Applied Chemistry          PAPER: I
Credit Hours: 03            Marks: 100

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, gelatine and adhesives; Preparation of hides; Methods of tanning, Vegetable and chrome tanning processing of leather; Production of glue and gelatine.

BS 4th Year
Semester-VII

Title of the Course: Applied Chemistry          PAPER: II
Credit Hours: 03            Marks: 100

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 super phosphate (TSP), Nitrophos (NP), Diammonium phosphate (DAP), Calcium ammonium nitrate (CAN), Ammonium nitrate (AN), Ammonium sulphate (AS), Zinc sulphate (ZS) and Complex fertilizers.

**Agrochemical Industry**
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 Environmental Protection**
Sources of air, water and soil pollution; Industrial waste and its control for environmental protection; Modern trends for waste treatment; Industrial gases and pollution control methods; Role and production of free radicals and atmospheric chemistry.

**BS 4th Year**
**Semester-VII**

Title of the Course: Applied Chemistry  
PAPER: III  
Credit Hours: 03  
Marks: 100

**Oils, Fats, Waxes and Vegetable Ghee Industry**
Oils, Fats and Waxes; Extraction of oils such as soybean 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; Interesterification 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 brightners and surfactants; Cleansing action of soaps; Effect of acidic species and hard water on soap; Production of transparent soap.

**Surface Coating Industry**
Raw materials for paints and pigments; Classification and properties of surface-coating constituents; Classification and manufacture of pigments; Production of paints, varnishes, distempers, enamals and lacquers; Chemistry involved in the drying phenomena of paints; Drying oils for paint and classification of drying oils.
Title of the Course: Applied Chemistry             PAPER: I (PRACTICAL)
Credit Hours:    01                                 Marks: 100

Water analysis; Analysis of oil and fats; Testing and analysis of vegetable ghee; Synthesis of soap and its analysis; Analysis of bleaching powder; Fertilizer analysis and testing of raw materials such as phosphate rock and ores; Various other practicals may be added in accordance with the available facilities.

Title of the Course: Analytical Chemistry PAPER: I
Credit Hours: 03 Marks: 100

**Spectroscopic Methods of Analysis**
- Making Measurements with Light
- Instruments for Measuring Absorption
- Calculations Involving Absorption
- Atomic Spectroscopy

Title of the Course: Analytical Chemistry PAPER: II
Credit Hours: 03 Marks: 100

**Electrochemical Methods**
- Oxidation-Reduction Reactions, Electrochemical Cells, Electrode Potentials
- Calculating Potentials of Electrochemical Cells and Applications
- Ion-selective Electrodes
- Polarography
- Voltametry
BS 4th Year
Semester-VII

Title of the Course: Analytical Chemistry PAPER: III
Credit Hours: 03 Marks: 100

Nuclear Techniques

- Radioactivity
- Neutron Activation Analysis
- Nuclear Quadrupole Resonance
- Isotope Dilution Method
- Isotope Ratio Mass Spectrometry
- Mössbauer Spectroscopy
- Radio-Immuno Assay
- X-Ray Technique

BS 4th Year
Semester-VII

Title of the Course: Analytical Chemistry PAPER: (PRACTICAL)
Credit Hours: 01 Marks: 100

- Calibration of a uv-visible spectrophotometer as per requirements of British Pharmacopoeia
- Experimental determination of limits of detection and quantitation by use of spectrophotometry
- Experimental determination of precision, accuracy and specificity
- Two experiments for quantitative determination of analytes of interest by spectrophotometry
- Two experiments for quantitative determination of analytes of interest by atomic spectrometry
- Three experiments based on electrochemical techniques

Books Recommended (Theory)

Books Recommended (Practicals)
1. British Pharmacopoeia
2. United States Pharmacopoeia
3. Laboratory Manual of Analytical Chemistry by C. Reilly; Allyn and Bacon, London
4. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N. Y.
5. Most of the experiments prescribed can be found on various websites.

BS 4th Year
Semester-VII

Title of the Course: Bio-Chemistry
Credit Hours: 03 Marks: 100

Title of the Course: General Biochemistry Related to Biomedical Sciences

Prerequisites: Course I and concept of basic human physiology

Objective of the Course: This course provides fundamental concepts biochemical and molecular aspects of endocrinology and chemistry of blood and other extracellular fluids. Emphasis is on relation of the above topics to medicine.

Course Outline:

Endocrinology
Blood and Other Body Fluids.

Recommended Text Books:

BS 4th Year
Semester-VII
Title of the Course: Bio-Chemistry PAPER: II
Credit Hours: 03 Marks: 100

Title of the Course: Physical Techniques in Biochemistry

Course Outlines
Extraction, Fractionation and Purification of macromolecules
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**

**Electrofocusing**
Preparative and Analytical electrofocusing.

**Centrifugation**

**Tracer techniques**
Detection and measurement of radioactivity. Application of radioisotopes in biological system.

**U.V. and Visible Spectroscopy**
Basic principles. Instrumentation and applications.

**ELISA Techniques**

**Books Recommended**
1. The tools of Biochemistry by Cooper
2. Principles and techniques of practical Biochemistry by William Edward and Arnold
3. Qualitative problems in Biochemistry by Dawas
4. A biologist's Physical chemistry by J.Gareth Morris

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**BS 4th Year**
**Semester-VII**

Title of the Course: Bio-Chemistry  
Credit Hours: 03  
Marks: 100

Title of the Course: Molecular Biology
Course Outline:
DNA; the primary genetic material. Structure, Replication in prokaryotes and comparison with eukaryotes. DNA sequencing. Chemical synthesis of polynucleotides. DNA repair and recombination.


Recommended Books
3. Lewin B. Gene VII. Oxford University Press
5. T. A. Brown. Genomes 3rd Edition Taylor &Francis

BS 4th Year
Semester-VII

Title of the Course: Bio-Chemistry PAPER:I (PRACTICAL)
Credit Hours: 01 Marks: 100

Laboratory work illustrating topics covered in the lecture of papers I, II, & III.

Advanced Practical-I in lieu of Research Project and Position Paper. (2 Cr. Hr.)

BS 4th Year
Semester-VIII

Title of the Course: Inorganic Chemistry PAPER: IV
Credit Hours: 03 Marks: 100
**Objective of the Program**
After completing this program students will be able to learn and have knowledge of the following:

1. Chemistry of Organometallics with especially with reference to their types and bonding.
2. Reactivity of Organometallic Compounds in Homogenous Catalytic

**Chemistry of Organometallics**
History and introduction to organometallic compounds, types of bonding. Transition metals; single, double and triple bonds to carbon (compound types, acyls, alkylidene complexes and alkylidyne complexes), delocalized hydrocarbon systems (alkenes, olefins, allyl and butadienes), alkyne complexes, cyclic $\pi$-complexes (five- and six- member rings).

**Organometallic Compounds in Homogenous Catalytic Reactions**
Homogenous catalytic hydrogenation, dimerization, oligomerization, polymerization, oxidation, hydrosilation, hydroformylation of olefins. Catalytic polymerization of acetylenes, insertion reactions, use of organometallic compounds in organic synthesis.

**Recommended Books**

BS 4th Year
Semester-VIII

Title of the Course: Inorganic Chemistry  PAPER: V
Credit Hours: 03 Marks: 100

Objective of the Program
After completing this program students will be able to learn the following:

1. Magneto Chemistry
2. Oxidative Addition and Reductive Elimination

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

Oxidative Addition and Reductive Elimination
Oxidative Addition: one electron oxidative addition, addition of oxygen, addition of bimetallic species, hydrogen addition, HX addition, organic halides, Reductive Elimination Reactions.

Recommended Books
BS 4\textsuperscript{th} Year  
Semester-VIII

Title of the Course: Inorganic Chemistry  
PAPER: VI
Credit Hours: 03  
Marks: 100

Objective of the Program  
After completing this program students will be able to learn the following:

1. The chemistry of radio isotopes, their reactions and applications.
2. Nuclear reactions

Nuclear Chemistry  
Introduction, theory of disintegrations, positive ray analysis, mass spectrograph, Astam mass spectrograph, Dempster mass spectrograph, Jordan double focusing mass spectrograph, Bain bridge mass spectrograph, structure of the nucleus, half life nuclear binding energy, artificial disintegration. Fission and Fusion reactions, Accelerators of charged particles, applications of Radio Isotopes

Recommended Books
1. Fried Landler, Kennedy and Miller, “Nuclear and Radiochemistry”, John Willey and Sons, Inc. 2\textsuperscript{nd} edition, 1964.

BS 4\textsuperscript{th} Year  
Semester-VIII

Title of the Course: Inorganic Chemistry  
PAPER:II (PRACTICAL)
Credit Hours: 01  
Marks: 100
• Spectroscopic determination of some metal ions.
• Recording and characterization of at least five organometallic compounds by IR and UV spectrophotometer to the subject of availability of facilities.
• Estimation of different metals in food, tap water and brass etc. by Atomic Absorption Spectrometer/ flame photometer / UV / Visible spectrophotometer, subject to the availability of facilities.

Recommended books

BS 4th Year
Semester-VIII
Title of the Course: Organic Chemistry PAPER: IV
Credit Hours: 03 Marks: 100

Mechanisms and Methods of Determining Them
Review of kinds and mechanism of organic reactions; thermodynamic and kinetic requirements for reactions: kinetic and thermodynamic control; The Hammond postulate; microscopic reversibility; methods of determining mechanisms; identification of products; determination of the presence of an intermediate; the study of catalysis; crossover experiments; isotopic labeling; stereochemical and kinetic studies; solvent effect.

Lipids, Proteins, Carbohydrates and Nucleic Acids
Chemistry of lipids, proteins, carbohydrates, nucleic acids and their importance in living systems.

Drugs-Pharmaceutical Compounds
Introduction; classification; chemistry of analgesics and antipyretics, sulpha drugs/sulphonamides, antimalarials and antibiotics.
**Recommended Literature**

(Latest available editions of the following books)

**Supplementary Literature**

(Latest available editions of the following books)
Title of the Course: Organic Chemistry  
PAPER: V  
Credit Hours: 03  
Marks: 100

**Alkaloids**
Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of ephedrine, nicotine, atropine, quinine, papaverine and morphine.

**Terpenoids**
Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of citral, α-terpineol, α-pinene, camphor and α-cadinene.

**Steroids**
Introduction; nomenclature and stereochemistry of steroids; structure determination of cholesterol and bile acids; introduction to steroidal hormones with particular reference to adrenal cortical hormones.

**Recommended Literature**
(Latest available editions of the following books)

**Supplementary Literature**
(Latest available editions of the following books)
BS 4th Year
Semester-VIII

Title of the Course: Organic Chemistry
Credit Hours: 03
PAPER: VI
Marks: 100

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

Reterosynthesis
Introduction to reterosynthesis and disconnection approach; synthesis of aromatic compounds with 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.

Synthetic Polymers
Introduction to polymer chemistry; step growth polymerization; free radical polymerization; ionic polymerization; stereochemistry in polymers; polymerization using Ziegler-Natta catalyst; stereo-regulation and conformation polymers; molecular weight determination of polymers; structure-property relationship; reactions of synthetic polymers; degradation and stability with special emphasis on thermal and photo-degradation.

Recommended Literature
(Latest available editions of the following books)

Supplementary Literature

(Latest available editions of the following books)

BS 4th Year
Semester-VIII

Title of the Course: Organic Chemistry
PAPER:II (PRACTICAL)
Credit Hours: 01
Marks: 100

Laboratory work illustrating topics covered in the lecture of papers IV, V &VI.

(Advanced Practical-II in lieu of Research Project and Position Paper) (2 cr., laboratory)

Literature for Laboratory Work to be carried out during the Course of Studies

Recommended Literature

(Latest available editions of the following books)

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Supplementary Literature

(Latest available editions of the following books)
Title of the Course: Physical Chemistry          PAPER: IV
Credit Hours:            03            Marks: 100

**Chemical Kinetics**


**Recommended Books**

Radiation Chemistry

Photochemistry

BS 4th Year
Semester-VIII

Title of the Course: Physical Chemistry PAPER: VI
Credit Hours: 03 Marks: 100

Solid State Chemistry
**Surface Chemistry and Catalysis**

**Books Recommended**

**BS 4th Year**
**Semester-VIII**

**Title of the Course:** Physical Chemistry  
**PAPER:II (PRACTICAL)**

**Credit Hours:** 03  
**Marks:** 100

- Study of multistep reactions.
- Sugar analysis and inversion studies by polarimetry.
- Study of isotherms and experiments of surface chemistry.
- Kinetics of fading of phenolphthalein in alkaline solution.
- Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.
• Study of the salt effect on the rate constant of the reaction between similar charges of ions.
• Kinetics of autocatalytic reaction between permanganate and oxalate ions.
• Determination of energy of activation of the reaction between similar charges of ions.
• Kinetics of the reaction between methylorange and peroxodisulphate ions in presence of bromide ions.
• Stoichiometry of a complex in solution by Job’s method.

Recommended Books

BS 4th Year
Semester-VIII

Title of the Course: Applied Chemistry PAPER: IV
Credit Hours: 03 Marks: 100

Paper and Pulp Technology
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.

Industrial Polymerization and Polymers
General classification and characterization of polymers; Mechanism and chemistry of polymerization; Thermoplastic and thermosetting polymerization; A brief outline for the production and applications of polymers i.e. polyethylene, polystyrene, polyurethanes, polyesters and urea phenol formaldehyde resins; 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.

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

BS 4th Year
Semester-VIII

Title of the Course: Applied Chemistry
Credit Hours: 03
Marks: 100

Petroleum Refinery 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.

Pharmaceutical Industry
Classification of pharmaceutical products and pharmaceutical processing; Manufacture of paracetamol/disprol and aspirin; Chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Fermentation and Biotechnology
Micro-organisms, conditions for their growth and biochemical activity. Production of ethanol, acetic acid, citric acid, penicillin and amylase; Microbial growth rate and its modelling.

Nuclear Industry and Peaceful Applications
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.

**BS 4th Year**

**Semester-VIII**

**Title of the Course:** Applied Chemistry  
**PAPER:** VI

**Credit Hours:** 03  
**Marks:** 100

**Iron, Steel and Alloys Industries**
Iron ores, constituents and their classification; Manufacture of iron and steel; Types of iron and steel; Metal Extractions and production of Alloys.

**Corrosion and its Prevention**
Chemistry and causes of corrosion phenomena; Types and theories of corrosion; Corrosion prevention and inhibitors; Surfaces coating and Electroplating.

**Colour Chemistry**
Organic dyes, sources and classification of dyes; Chemistry and production of various organic dyes, Methods of dyeing, Finishing and dyeing of textiles.

**Coal cleaning and utilizations**
Origion and types of coal; Coal cleaning and its utilization; Coal combustion, carbonization and gasification; Production of various fuel gases from coal such as water gas, producer gas etc.

**BS 4th Year**

**Semester-VIII**

**Title of the Course:** Applied Chemistry  
**PAPER:** II (PRACTICAL)

**Credit Hours:** 01  
**Marks:** 100

Analysis of coal and petroleum fuels; Cement analysis and testing of raw materials; Milk analysis; Analysis of lime stone; Preparations of various cosmetics such as cold cream, shaving cream, nail polish, shoe polish.
etc. Various other of practicals may added in accordance with the available facilities.

**Recommended Books**

31. We Worral, Clays, (1968).

**BS 4th Year**

**Semester-VIII**

Title of the Course: Analytical Chemistry  
PAPER: IV  
Credit Hours: 03  
Marks: 100

**Hyphenated Techniques**

- Gas Chromatography-Mass Spectrometry (GC-MS)
- Liquid Chromatography-Mass Spectrometry (LC-MS)
- MS-MS
- LC-FTIR
- Inductively Coupled Plasma-Mass Spectrometry

**BS 4th Year**

**Semester-VIII**

Title of the Course: Analytical Chemistry  
PAPER: V  
Credit Hours: 03  
Marks: 100
Advanced Chromatography

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

BS 4th Year
Semester-VIII

Title of the Course: Analytical Chemistry PAPER : VI
Credit Hours: 03 Marks : 100

Special Topics
- Matrix-assisted Laser Desorption/Ionization-Time of Flight (MALDI-TOF) Mass Spectrometry
- Tanden Mass Spectrometry
- Ion Trap Mass Spectrometry
- Other topics of interest

BS 4th Year
Semester-VIII

Title of the Course: Analytical Chemistry PAPER:II (PRACTICAL)
Credit Hours: 01 Marks: 100

- Calibration and validation of an HPLC system as per requirements of British Pharmacopoeia or United States Pharmacopoeia
- Experimental determination of limits of detection, quantitation, precision, accuracy and specificity, resolution, column efficiency etc by use of HPLC
- Determinations demonstrating the use of other chromatographic techniques
ADVANCED PRACTICALS (2 Cr. Hr.)

Suitable number of advanced practicals may be prescribed by the departments keeping in view the facilities and expertise available.

Books Recommended (Theory)

Practicals
4. British Pharmacopoeia
5. United States Pharmacopoeia
7. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N. Y.
8. Most of the experiments prescribed can be found on various websites.

BS 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry PAPER: IV
Credit Hours: 03 Marks: 100

Title of the Course: Physiological Chemistry and Chemotherapy

Course Outline

Physiological chemistry:

Kidney: Structure and function of nephrons, Formation of urine, Filtration, Glomerular filtration rate, Action of the tubule, Reabsorption of Na, Cl and water, Loop of Henle.

Structure and function of muscle tissues, Nerve tissues and Connective tissues, Nerve conduction and sensory system.

Circulatory system.

Chemotherapy:
Structure and mode of action of antipyretics analgesic, antimalarial, supha-drugs, antibiotics with special reference to pencillin, sulphanilamides. Mechanism of drugs action and resistance.

Books Recommended
1. Principles of Biochemistry by White Hundler and Smith.
2. Biochemistry by Lehninger.
4. Text Book of Biochemistry by West Todd/Mason/Von Brugge.
5. Text Book of Biochemistry by Mazur/Harrow.

BS 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry PAPER: V
Credit Hours: 03 Marks: 100

Title of the Course: Microbiology and Immunology

Course Outline

Fundamentals of Microbiology: Prokaryotic cell structure and function, Prokaryotic growth and nutrition. Prokaryotic genetics.

Virus and Eukaryotic microorganisms: Virus. Bacteria, fungi and parasites

Bacterial Diseases: Airborne, Foodborne and waterborne bacterial diseases.

Industrial Microbiology and Biotechnology: Microorganisms in industry. Alcoholic beverages. Other important microbial products
Immunology:
Chemistry of immunoglobulins, myeloma and hybridoma immunoglobulins. Immune system and its abnormalities. Allergy and inflammation. Complement system, peripheral leucocytes and macrophages.

Immune Disorders
Type I IgE-Mediated Hypersensitivity, other types of hypersensitivity, Autoimmune disorders, Immunodeficiency disorders.

Recommended Books
2. Doan T., R.Melvold, S.Viselli and C. Waltenbaugh. Immunology: Lippincott Illustrated Reviews Lippincott Williams& Wilkins.

BS 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry PAPER: VI
Credit Hours: 03 Marks:100

Course Outline
Major Dietary Constituents
Nutritional importance of Carbohydrates, Proteins and Amino Acids, Lipids , and Dietary fiber
Energy Needs
Assessment and requirement of energy in different age groups.
Nutrition in Growth and Aging
Minerals
Biochemical role of Calcium, Chromium, Copper, Iron, Iodine, Magnesium, phosphorous, Selenium, and Zinc. Their dietary sources, 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


BS 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry PAPER: II
Credit Hours: 01 Marks:100

Laboratory work illustrating topics covered in the lecture of papers I, II, & III.

Advanced Practical-II in lieu of Research Project and Position Paper. (2 Cr. Hr.)

Recommended Text Books:

COMPULSORY COURSES IN ENGLISH FOR BS
(4 YEAR) IN BASIC & SOCIAL SCIENCES

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents

- Basics of Grammar
- Parts of speech and use of articles
- Sentence structure, active and passive voice
- Practice in unified sentence
- Analysis of phrase, clause and sentence structure
- Transitive and intransitive verbs
- Punctuation and spelling

Comprehension
Answers to questions on a given text

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

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

Translation skills
Urdu to English

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

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books:

1. Functional English
   a) Grammar

b) Writing

c) Reading/Comprehension

d) Speaking

English II (Communication Skills)

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing
Practice in writing a good, unified and coherent paragraph

Essay writing
Introduction

CV and job application
Translation skills
Urdu to English

Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills
Letter/memo writing, minutes of meetings, use of library and internet

Presentation skills
Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review
Recommended Books:

Communication Skills

a) Grammar

b) Writing

c) Reading
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard Yorkey.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing
Descriptive, narrative, discursive, argumentative

Academic writing
How to write a proposal for research paper/term paper
How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building
Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

b) Presentation Skills

c) Reading
   The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: 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).
Pakistan Studies (Compulsory)

Introduction/Objectives

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

Course Outline

1. Historical Perspective
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. Government and Politics in Pakistan
   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward

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

Books Recommended

Annexure “C”

ISLAMIC STUDIES
(Compulsory)

Objectives:
This course is aimed at:
1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies
1) Basic Concepts of Quran
2) History of Quran
3) Uloom-ul -Quran

Study of Selected Text of Holly Quran
1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Selected Text of Holly Quran
1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet  (S.A.W) I
1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah

97
3) Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II
   1) Life of Holy Prophet (S.A.W) in Madina
   2) Important Events of Life Holy Prophet in Madina
   3) Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah
   1) Basic Concepts of Hadith
   2) History of Hadith
   3) Kinds of Hadith
   4) Uloom –ul-Hadith
   5) Sunnah & Hadith
   6) Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction To Islamic Law & Jurisprudence
   1) Basic Concepts of Islamic Law & Jurisprudence
   2) History & Importance of Islamic Law & Jurisprudence
   3) Sources of Islamic Law & Jurisprudence
   4) Nature of Differences in Islamic Law
   5) Islam and Sectarianism

Islamic Culture & Civilization
   1) Basic Concepts of Islamic Culture & Civilization
   2) Historical Development of Islamic Culture & Civilization
   3) Characteristics of Islamic Culture & Civilization
   4) Islamic Culture & Civilization and Contemporary Issues

Islam & Science
   1) Basic Concepts of Islam & Science
   2) Contributions of Muslims in the Development of Science
   3) Quranic & Science

Islamic Economic System
   1) Basic Concepts of Islamic Economic System
   2) Means of Distribution of wealth in Islamic Economics
   3) Islamic Concept of Riba
   4) Islamic Ways of Trade & Commerce

Political System of Islam
   1) Basic Concepts of Islamic Political System
   2) Islamic Concept of Sovereignty

98
3) Basic Institutions of Govt. in Islam

Islamic History
1) Period of Khlaft-E-Rashida
2) Period of Ummayyads
3) Period of Abbasids

Social System of Islam
1) Basic Concepts Of Social System Of Islam
2) Elements Of Family
3) Ethical Values Of Islam

Reference Books:
1. Hameed ullah Muhammad, “Emergence of Islam”, IRI, Islamabad
2. Hameed ullah Muhammad, “Muslim Conduct of State”
3. Hameed ullah Muhammad, “Introduction to Islam”
4. Mulana Muhammad Yousaf Islahi,”
Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level
Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.
Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer’s rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.
Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.
Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.
Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books:
1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, Algebra 2 and Trigonometry, 1978, Houghton & Mifflin,
2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

Limits and Continuity: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:


Thomas GB, Finney AR, Calculus (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of
equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books:
Kaufmann JE, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

Title of subject: MATHEMATICS
Discipline: BS (Social Sciences).
Pre-requisites: SSC (Metric) level Mathematics
Credit Hours: 03 + 00
Minimum Contact Hours: 40
Assessment: written examination;
Effective: 2008 and onward

Aims: To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

Objectives: After completion of this course the student should be able to:
- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents:


Books Recommended:

5. **MATHEMATICS FOR CHEMISTRY**

**Credit Hours:** 3

**Prerequisites:** Mathematics at Secondary level

**Specific Objectives of Course:** To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**


**Recommended Books:**


6. **MATHEMATICS FOR PHYSICS**

**Contents**

1. Preliminary calculus.
   - Differentiation
     - Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz’ theorem; special points of a function; theorems of differentiation.
• Integration
  Integration from first principles; the inverse of differentiation;
  integration by inspection; sinusoidal function; logarithmic
  integration; integration using partial fractions; substitution
  method; integration by parts; reduction formulae; infinite and
  improper integrals; plane polar coordinates; integral
  inequalities; applications of integration.

2. Complex numbers and hyperbolic functions
• The need for complex numbers
• Manipulation of complex numbers
  Additions and subtraction; modulus and argument;
  multiplication; complex conjugate; division
• Polar representation of complex numbers
  Multiplication and division in polar form
• de Moivre’s theorem
  Trigonometrical identities; finding the nth roots of unity;
  solving polynomial equations
• Complex logarithms and complex powers
• Applications to differentiation and integration
• Hyperbolic functions
  Definitions; hyperbolic-trigonometric analogies; identities of
  hyperbolic functions; solving hyperbolic equations; inverses
  of hyperbolic functions; calculus of hyperbolic functions.

3. Series and limits
• Series
• Summation of series
  Arithmetic series; geometric series; arithmetico-geometric
  series; the difference method; series involving natural
  numbers; transformation of series
• Convergence of infinite series
  Absolute and conditional convergence; convergence of a
  series containing only real positive terms; alternating series
  test
• Operations with series
• Power series
  Convergence of power series; operations with power series
• Taylor series
Taylor’s theorem; approximation errors in Taylor series; standard Maclaurin series

Evaluation of limits

4. **Partial differentiation**
   - Definition of the partial derivative
   - The total differential and total derivative
   - Exact and inexact differentials
   - Useful theorems of partial differentiation
   - The chain rule
   - Change of variables
   - Taylor’s theorem for many-variable functions
   - Stationary values of many-variable functions
   - Stationary values under constraints

5. **Multiple integrals**
   - Double integrals
   - Triple integrals
   - Applications of multiple integrals
     - Areas and volumes; masses, centers of mass and centroids;
     - Pappus’ theorems; moments of inertia; mean values of functions
   - Change of variables in multiple integrals
   - Change of variables in double integrals;

6. **Vector algebra**
   - Scalars and vectors
   - Addition and subtraction of vectors
   - Multiplication by a scalar
   - Basis vectors and components
   - Magnitude of a vectors
   - Multiplication of vectors
     - Scalar product; vector product; scalar triple product; vector triple product
   - Equations of lines and planes
     - Equation of a line; equation of a plane
   - Using vectors to find distances
     - Point to line; point to plane; line to line; line to plane
   - Reciprocal vectors

7. **Matrices and vector spaces**
   - Vectors spaces
     - Basic vectors; the inner product; some useful inequalities
Matrices
The complex and Hermitian conjugates of a matrix
The determinant of a matrix
Properties of determinants
The inverse of a matrix
The rank of a matrix
Simultaneous linear equations
N simultaneous linear equations in N unknowns
Special square matrices
Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
Eigen vectors and eigen values of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
Determination of eigen values and eigen vectors degenerate eigen values

8. Vector calculus
Differentiation of vectors
Composite vector expressions; differential of a vector
Integration of vectors
Space curves
Vector functions of several arguments
Surfaces
Scalar and vector fields
Vector operators
Gradient of a scalar field; divergence of a vector field; curl of a vector field
Vector operator formulae
Vector operators acting on sums and products; combinations of grad, div and curl
Cylindrical and spherical polar coordinates Cylindrical polar coordinates; spherical polar coordinates
INTRODUCTION TO STATISTICS

Credit hrs: 3(3-0)

Unit 1. What is Statistics?

Unit 2. Presentation of Data
Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Historigram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

Unit 3. Measures of Central Tendency
Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

Unit 4. Measures of Dispersion

Unit 5. Probability and Probability Distributions
Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

Unit 6. Sampling and Sampling Distributions
Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.
Unit 7. **Hypothesis Testing**
Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

Unit 8. **Testing of Hypothesis - Single Population**
Introduction, Testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

Unit 9. **Testing of Hypotheses-Two or more Populations**
Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

Unit 10. **Testing of Hypothesis-Independence of Attributes**

Unit 11. **Regression and Correlation**
Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. \( r \) and \( R^2 \). Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

**Recommended Books**


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*Note: General Courses from other Departments*

Details of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.*
Annexure ‘F’

BS 2\textsuperscript{nd} Year (1st Semester)
Functional Biology
Credit Hours 3+0

\textbf{Biological Methods}

Principles of Cellular Life
- Chemical Basis
- Structure and Function
- Principles of Metabolism
- Energy Acquisition

Principles of Inheritance
- Mitosis and Meiosis
- Chromosomes
- Observable Inheritance Patterns
- DNA Structure and Function
- RNA and Proteins
- Genes
- Genetic Engineering and Biotechnology

Biodiversity
- Fundamental Concept of Biodiversity
- One or two examples of each of the following from commonly found organism
  - Prions
  - Viruses
  - Bacteria
  - Protists
  - Algae
  - Fungi
  - Plants
  - Crops
  - Animals
  - Invertebrates
  - Vertebrates

\textbf{Reading}


BS 2\textsuperscript{nd} Year (2\textsuperscript{nd} Semester)
Functional Biology

Credit Hours 3+0

Myths and Realities of Evolution
- Microevolution
- Speciation
- Macroevolution

Level of Organization
- Plants
  - Tissues
  - Nutrition and Transport
  - Reproduction
  - Growth and Development
- Animals
  - Tissue, Organ System and Homeostasis
  - Information Flow and Neuron
  - Nervous System
  - Circulation and Immunity
  - Nutrition and Respiration
  - Reproduction and Development

Ecology and Behavior
- Ecosystems
- Biosphere
- Social Interactions
- Community Interactions
- Human Impact on Biosphere
- Environment Conservation

Reading