CURRICULUM

OF

BOTANY
BS (4-YEAR)

2008

HIGHER EDUCATION COMMISSION
ISLAMABAD
CURRICULUM DIVISION, HEC

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Prof. Dr. Riaz ul Haq Tariq  Member (Acad)
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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 Botany in a meeting held on May 6-7, 2008 at the HEC Regional Center, Lahore in continuation of its earlier meeting held on Nov 20-21, 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

PREPARATION OF DRAFT BY NCRC

IMPLEMENTATION OF CURRICULUM

REVIEW

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

A National Curriculum Revision Committee (NCRC) meeting in Botany was held from May 6-7, 2008 at HEC, Regional Centre, Lahore to finalize the draft curriculum in the light of generic framework/template developed by the conveners of NCRC in Basic, Social, Natural and Applied Sciences. The following attended the meeting.

1. Prof. Dr. Ihsan Ilahi
   Kohat University of Science & Technology
   Banu Road, Off Jarma,
   Kohat

2. Dr. Zaheer-ud-Din Khan
   Professor & Chairman
   Department of Botany,
   Government College University,
   Lahore

3. Dr. Muhammad Ashraf
   Professor of Botany & Dean
   Faculty of Sciences
   University of Agriculture,
   Faisalabad

4. Prof. Dr. Khan Rass Masood,
   Chairman,
   Department of Botany,
   University of the Punjab,
   Lahore

5. Prof. Basir Ahmed Arrain
   Professor
   Institute of Botany
   University of Sindh,
   Jamshoro
6. Prof. Dr. Ikram-ul-Haq, Member
   Professor
   Department of Botany,
   Government College University,
   Lahore

7. Prof. Dr. Saeed Malik, Member
   Professor
   Department of Botany
   BZ University, Multan

8. Prof. Dr. Mohammad Ashraf, Member
   Chairman
   Department of Plant Sciences,
   Quaid-i-Azam University
   Islamabad

9. Prof. Dr. Surayya Khatoon, Member
   Department of Botany
   University of Karachi, Karachi

10. Dr. G. Raza Bhatti, Member
    Professor
    Director, Herbarium & Botanical Garden
    Department of Botany
    Shah Abdul Latif University,
    Khairpur

11. Prof. Dr. Rashida Zafar, Member
    Department of Botany,
    Lahore College for Women University,
    Lahore

12. Dr. Bilquees Gul, Member
    Department of Botany
    University of Karachi
    Karachi

13. Dr. Ghulam Murtaza, Member
    Assistant Professor,
    Department of Botany
    University of Azad Jammu Kashmir
    Muzaffarabad

14. Prof. Dr. Farrukh Hussain, Member/
    Chairman
    Secretary
    Department of Botany
    University of Peshawar,
    Peshawar
The meeting started with the recitation from the Holy Quran by Mr. Tahir Ali Shah. Afterwards Fatiha was offered for Prof. Dr. K.M. Aslam (Member, NCRC in Botany), Prof. T.M. Khattak, Department of Botany, University of AJK, Muzaffarabad and Mr. Faisal A. Khan, IT Administrator, HEC Karachi. May God rest their souls in eternal peace.

As required the Committee developed the template for BS Botany 4 year programme on the provided performa. This included compulsory, general, foundation, major and elective courses to be adopted by both the public and private sector universities of the country. This Programme of 4 year BS comprised 130 credit hours spread over 8 semesters.

The rationale, goals and outcome of the course (on separate sheets) be included while the syllabus is printed. The Committee also made general recommendations for the consideration of the HEC authorities.

The meeting ended with a vote of thanks to HEC for organizing the meeting and extending hospitality during the meeting. May Allah bless all of us.

**Outcome of the Course**

The BS programme will enable to the students to be acquainted with the latest knowledge of the plant sciences. In the programme the knowledge of foundation courses as Diversity, Plant Anatomy, Biochemistry and Biostatistics etc. and the major courses as Physiology, Genetics, and Ecology etc. is incorporated. The four elective courses are left for specific requirement of the students of a university.

**Goal**

The goal of BS 4 year programme is to produce competent professionals in the field of Botany who will be capable to face the challenges of the changing world.

**Rationale**

The subject of plant sciences has undergone tremendous advances all over the world. It is imperative to update the existing national curriculum in Botany to bring it at par with the international standards.
# TEMPLATE FOR 4-YEAR BS DEGREE PROGRAM IN BOTANY

<table>
<thead>
<tr>
<th>SR.</th>
<th>CATEGORIES</th>
<th>NO. OF COURSES MIN– MAX</th>
<th>CREDIT HOURS MIN– MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>General Courses to be chosen from other departments</td>
<td>7 – 8</td>
<td>21 – 24</td>
</tr>
<tr>
<td>3.</td>
<td>Discipline Specific Foundation Courses</td>
<td>9 – 10</td>
<td>30 – 33</td>
</tr>
<tr>
<td>4.</td>
<td>Major Courses including research project / Internship</td>
<td>11 – 13</td>
<td>36 – 42</td>
</tr>
<tr>
<td>5.</td>
<td>Electives within the major</td>
<td>4 – 4</td>
<td>12 – 12</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40 – 44</strong></td>
<td><strong>124 – 136</strong></td>
</tr>
</tbody>
</table>

- Total numbers of Credit hours: 130
- Duration: 4 years
- Semester duration: 16-18 weeks
- Semesters: 8
- Course Load per Semester: 12-18 Cr hr
- Number of courses per semester: 4-6 (not more than 3 – Lab / Practical Courses per Semester)
LAYOUT FOR BS BOTANY (4 – YEAR PROGRAMME)

<table>
<thead>
<tr>
<th>Compulsory Requirements (the student has no choice)</th>
<th>General Courses to be Chosen From Other Departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 courses</td>
<td>7-8 courses</td>
</tr>
<tr>
<td>25 Credit hours</td>
<td>21-24 Cr. Hours</td>
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</table>

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Cr. hr</th>
<th>Subjects</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ENGLISH I (Functional English)</td>
<td>3</td>
<td>1. Genera Course-I ***</td>
<td>3</td>
</tr>
<tr>
<td>2. ENGLISH II (Communication Skill)</td>
<td>3</td>
<td>2. Genera Course-II ***</td>
<td>3</td>
</tr>
<tr>
<td>4. ENGLISH VI*</td>
<td>3</td>
<td>4. Genera Course-IV ***</td>
<td>3</td>
</tr>
<tr>
<td>5. PAKISTAN STUDIES</td>
<td>2</td>
<td>5. Genera Course-V ***</td>
<td>5</td>
</tr>
<tr>
<td>6. ISLAMIC STUDIES / ETHICS</td>
<td>2</td>
<td>6. Genera Course-VI ***</td>
<td>3</td>
</tr>
<tr>
<td>7. MATHEMATICS I ** (Statistical Packages)</td>
<td>3</td>
<td>7. Genera Course-VII ***</td>
<td>3</td>
</tr>
<tr>
<td>8. MATHEMATICS II (Biostatistics)</td>
<td>3</td>
<td>8. Genera Course-VIII ***</td>
<td>3</td>
</tr>
<tr>
<td>9. INTRODUCTION TO COMPUTER</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Cr. hr</th>
<th>Subjects</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diversity of Plants</td>
<td>4</td>
<td>1. Phycology &amp; Bryology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10. Plant Physiology-II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>11. Genetics-II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12. Environmental Biology</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Cr. hr</th>
<th>Subjects</th>
<th>Cr. hr</th>
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</thead>
<tbody>
<tr>
<td>11</td>
<td>32</td>
<td>16</td>
<td>36</td>
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</tbody>
</table>
### Elective Courses within the major including research project/internship

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr. hr</th>
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</thead>
<tbody>
<tr>
<td>1. Elective-I / Research Project / Internship/ *Optional</td>
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</tr>
<tr>
<td>2. Elective-II University option</td>
<td>3</td>
</tr>
<tr>
<td>3. Elective-III Research Project / Internship/ *Optional</td>
<td>3</td>
</tr>
<tr>
<td>4. Elective-IV University Option</td>
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</tbody>
</table>

**4 courses**

**12 Credit Hours**

* University has the option to recommend any other course in lieu of English IV

** University may recommend any other course in lieu of Mathematics

*** To be chosen from list of General Courses
### SCHEME OF STUDIES FOR 4 YEAR INTEGRATED BS PROGRAMME

<table>
<thead>
<tr>
<th>Semester</th>
<th>Name of Subject</th>
<th>Theory</th>
<th>Lab</th>
<th>Cr. hr</th>
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<tr>
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<td>PAKISTAN STUDIES</td>
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<td>2</td>
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<tr>
<td></td>
<td>MATH/STAT-1 (Statistical Packages)**</td>
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<td>3</td>
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<td>GENERAL-I***</td>
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<tr>
<td></td>
<td>GENERAL-II***</td>
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<td>FOUNDATION-I Bot-301 Diversity of Plants</td>
<td>3</td>
<td>1</td>
<td>4</td>
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<td></td>
<td></td>
<td>1</td>
<td>18</td>
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<tr>
<td><strong>Second</strong></td>
<td><strong>ENGLISH-II (Communication Skills)</strong></td>
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<td>3</td>
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<tr>
<td></td>
<td>ISLAMIC STUDIES / ETHICS</td>
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<td>2</td>
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<td></td>
<td>ENGLISH IV UNIV. OPTIONAL*</td>
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<td>3</td>
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<tr>
<td></td>
<td>GENERAL-III***</td>
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<td>GENERAL-IV</td>
<td>3</td>
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<td></td>
<td>FOUNDATION-II Bot-302 Plant Systematics, Anatomy and Development</td>
<td>3</td>
<td>1</td>
<td>4</td>
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<td>17</td>
<td>1</td>
<td>18</td>
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<tr>
<td><strong>Third</strong></td>
<td><strong>ENGLISH-III (Technical Report Writing &amp; Presentation Skill)</strong></td>
<td>3</td>
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<td>INTRODUCTION TO COMPUTER</td>
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<td>GENERAL-V***</td>
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<td>FOUNDATION-III Bot-401 Cell Biology, Genetics and Evolution</td>
<td>3</td>
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<td><strong>Fourth</strong></td>
<td><strong>MATHEMATICS II (Bio Statistics)</strong></td>
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<td>GENERAL-VII***</td>
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<td>FOUNDATION-IV Bot-402 Plant Physiology and Ecology</td>
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<td>FOUNDATION-V Bot-403 Biodiversity and Conservation</td>
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<tr>
<td>Fifth</td>
<td>FOUNDATION-VI Bot-502 Bacteriology and Virology</td>
<td>3</td>
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<td>FOUNDATION-VII Bot-505 Diversity of Vascular Plants</td>
<td>3</td>
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<td>MAJOR-I Bot-503 Phycology and Bryology</td>
<td>3</td>
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<tr>
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<td>MAJOR-II Bot-504 Mycology and Plant Pathology</td>
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<td>MAJOR-III Bot-506 Plant Systematics</td>
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<td>FOUNDATION-VIII Bot-507 Plant Anatomy</td>
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<td>FOUNDATION-IX Bot-510 Plant Ecology-I</td>
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<td>MAJOR-IV Bot-508 Genetics-I</td>
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<td>MAJOR-V Bot-509 Plant Biochemistry-I</td>
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<td>MAJOR-VI Bot-511 Plant Physiology-I</td>
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<td>MAJOR-VII Bot-601 Molecular Biology</td>
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<tr>
<td>Seventh</td>
<td>MAJOR-VIII Bot-602 Plant Biochemistry-II</td>
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<tr>
<td></td>
<td>MAJOR-IX Bot-603 Plant Ecology-II</td>
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<tr>
<td></td>
<td>ELECTIVE-I, RESEARCH PROJECT/INTERNSHIP/*OPTIONAL PAPER</td>
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<td>MAJOR-X Bot-604 Plant Physiology-II</td>
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<td>15</td>
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<td>Eighth</td>
<td>MAJOR-XI Bot-606 Genetics-II</td>
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<td>MAJOR-XII Bot-607 Environmental Biology</td>
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<tr>
<td>Elective-III</td>
<td>0</td>
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</tr>
<tr>
<td>Research Prog / Internship/*Optional Paper</td>
<td>elective-IV</td>
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<td>Total</td>
<td>9</td>
<td>3</td>
<td>12</td>
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</tr>
</tbody>
</table>

* University has the option to recommend any other course in lieu of English IV

** University may recommend any other course in lieu of Mathematics I

*** To be chosen from list of General Courses

Note: - Optional and elective papers to be framed by respective Board of Studies.
DETAIL OF COURSES
FOR BS (4 YEAR IN BOTANY)

1st Year
1st Semester

Title of the Course: Bot-301 Diversity of Plants
Credit Hours: 4(3+1)
Prerequisites: Inter / A levels with Biology

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

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

a) Viruses (RNA and DNA types) with special reference to TMV;

b) Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance;

c) Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)

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

e) Lichens (Physcia)

f) Bryophytes
   i. Riccia
   ii. Anthoceros
   iii. Funaria

g) Pteridophytes.
   i. Fossils and fossilization
   ii. Psilopsida (Psilotum)
iii. Lycopsida (Selaginella)
iv. Sphenopsida (Equisetum)
v. Pteropsida (Marsilea)
vi. Seed Habit

h) Gymnosperms
i. Cycas
ii. Pinus
iii. Ephedra

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

Recommended Books:

2\textsuperscript{nd} Semester

Title of the Course: Bot – 302 Plant Systematics, Anatomy and Envelopment

Credit Hours: 4(3+1)

Prerequisites: Bot – 301

Specific objectives of course: To understand 1- various systems of classification, identification and nomenclature of higher plants, 2- Structures and functions of tissues and organs at embryonic level.

Course outline:

a) Plant systematics

1. Introduction to Plant Systematics: aims, objectives and importance.

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


4. Morphology: a detailed account of various, orphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.

5. Diagnostic characters, economic importance and distribution pattern of the following families:

i. Ranunculaceae
ii. Brassicaceae (Cruciferae)
iii. Fabaceae (Leguminosae)
iv. Rosaceae
v. Euphorbiaceae
vi. Cucurbitaceae
vii. Solanaceae
viii. Lamiaceae (Labiatae)
ix. Apiceae (Umbelliferae)
x. Asteraceae (Compositae)
xii. Liliaceae (Sen. Lato)
xii. Poaceae (Gramineae)
b) **Anatomy**

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:
   i. Parenchyma
   ii. Collenchyma
   iii. Sclerenchyma
   iv. Epidermis (including stomata and trichomes)
   v. Xylem
   vi. Phloem
3. Meristem: types, stem and root apices
4. Vascular cambium
5. Structure and development of root, stem and leaf.
   - Primary and secondary growth of dicot stem, periderm

c) **Development / Embryology**

Early development of plant body:

1. Capsella bursa-pastoris
2. Structure and development of Anther Microsporogenesis
   - Microgametophyte
3. Structure of Ovule Megasporogenesis
   - Megagametophyte
4. Endosperm formation
5. Parthenocarpy
6. Polyembryony

**Lab Outline:**

**Anatomy**

1. Study of stomata, epidermis,
2. Tissues of primary body of plant
3. Study of xylem 3-dimensional plane of wood.
4. T.S of angiosperm stem and leaf.

**Taxonomy**

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

**Recommended Books:**


**Journals / Periodicals:** Pakistan Journal Of Botany, Taxon, Phyton.

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**2nd Year 3rd Semester**

**Title of the course:** BOT-401 Cell Biology, Genetics and Evolution

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

**Prerequisites:** BOT- 301 & 302
Specific objectives of course: To understand 1- structure and functions of cell, 2-nature of genetic material and hereditary process 3- familiarization with evolutionary processes.

Course outline:

a) Cell biology

1. Structures and Functions of Bio-molecules
   i. Carbohydrates
   ii. Lipids
   iii. Proteins
   iv. Nucleic Acids


3. Ultrastructure of plant cell with a brief description and functions of the following organelles
   i. Cell wall
   ii. Endoplasmic reticulum
   iii. Plastids
   vi. Mitochondria
   v. Ribosomes
   vi. Dictyosomes
   vii. Vacuole
   viii. Microbodies (Glyoxysomes and Peroxisomes)

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

5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle


b) Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.

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2. Sex linked inheritance, sex linkage in Drosophila and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex linked characters, sex determination.

3. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.

4. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. lac operon).

5. Transmission of genetic material in Bacteria: Conjugation and gene recombination in E.coli, transduction and transformation.


8. Introduction to germplasm conservation

c) Evolution

The nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Lab Outline:

Cell Biology

1. Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.
Genetics

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

Recommended Books:


4th Semester

Title of the course: Bot-501 Biostatistics

Credit hours: 3(2+1)

Prerequisites:

Specific objectives of course:

Course outline:

1. Introduction objectives and scope:
   i. Definition
ii. Characteristics
iii. Importance and limitations
iv. Population and samples

2. Frequency distribution:
i. Variable types
ii. Formation of frequency table from raw data
iii. Summation, notation and statistical inference
iv. Data transformation.

3. Measures of central tendencies and dispersion:
i. Arithmetic mean
ii. Median
iii. Mode
iv. Range
v. Variance
vi. Standard deviation
vii. Standard error of the mean
viii. Mean deviation.

4. Organizing and describing data (Standard distributions):
i. Random sampling and the binomial distribution
ii. Probability, Types of Probabilities, Random variables, Combining probabilities, Probability distributions, Binomial distributions.
iii. Poisson and normal distributions, properties and applications.

5. Basic experimental design:
i. Concept and design
ii. Principles of experiments
iii. Observational studies
iv. Planning of experiments
v. Replication and randomization
vi. Field plot technique
vii. Layout and analysis of completely randomized design
viii. Randomized complete block design
ix. Latin square
x. Factorial design
xi. Treatment comparison
6. Tests of significance:
   i.   T-test: (Basic idea, confidence limits of means, significant difference of means.
   ii.  Chi square test: Basic idea, testing goodness of fit to a ratio, testing association (contingency table).
   iv.  LSD test, Duncan’s New Multiple Range test (for comparison of individual means). Bonferroni test.

7. Introduction to comparing many means:
   Unit organization, Basic one way ANOVA, Types of sums of squares, How ANOVA works, The ANOVA Table. Two-way ANOVA- Factorial designs: (two-way actorial analysis, calculating and analyzing the two-way ANOVA, Linear combination, multiple comparisons.

8. Correlation and Regression.

**Lab outline:**

1. Data collection, arrangement of data in frequency table, calculating frequency, cumulative frequency and preparation of Ogive.
2. Calculating different measure of central tendency such as arithmetic means, harmonic mean, geometric mean, median and mode.
3. Calculation of mean from grouped and ungrouped data.
4. Calculation of variance and standard deviation from grouped and ungrouped data.
5. Calculating dispersion, relative dispersion, standard deviation, standard error, standard score and co-efficient variation by hand and machine method.
7. Chi square test.
8. Analysis of variance - one factor design.
9. Multiple Analyses Of Variance.
10. Determination of correlation by constructing different types of graphs such as scatter diagram, linear positive correlation, linear perfect negative correlation, no correlation and curvilinear correlation (second degree polynomial, third degree polynomial).
11. Linear Regression and multiple regression models.
Recommended Books:


Title of the course: BOT-402 Plant Physiology And Ecology

Credit hours: 4(3+1)

Prerequisites: Bot-301, 302, 401

Specific objectives of course:

1- To provide comprehensive knowledge of functioning of organs, organelles and biomolecules,
2- to enable the students to assess the effects of various environmental factors on plant growth and development.

Course outline:

a) Plant Physiology


5. Growth: Definition; role of auxins, gibberellins, cytokinins, abscisic acid and ethylene in controlling growth. Introduction to plant tissue culture.

6. Photoperiodism: Definition, historical background, Classification of plants based on photoperiodic response, Role of phytochromes, and hormones and metabolites in photoperiodism.

7. Dormancy: Definition and causes of seed and bud dormancy; methods of breaking seed dormancy. Physiological processes during seed germination.


b) Ecology

1. Introduction, aims and applications of ecology.

2. Soil: Physical and Chemical properties of soil (soil formation, texture, pH, EC, organism and organic matter etc) and their relationships to plants.


5. Wind: Wind as an ecological factor and its importance.


7. Community Ecology
   i. Ecological characteristics of plant community
   ii. Methods of sampling vegetation (Quadrat and line intercept)
   iii. Succession.
   iv. Major vegetation types of the local area.

8. Ecosystem Ecology
   i. Definition, types and components of ecosystem.
   ii. Food chain and Food web.
   iii. Biogeochemical cycles, definition, types with emphasis on Nitrogen & Hydrological cycles.

   i. Causes, effects and control of water logging and salinity with respect to Pakistan
   ii. Soil erosion: types, causes and effects (wind and water)
   iii. Brief concept of pollution types and effects (air, sediments and water pollution)
   iv. Brief introduction to biodiversity and conservation with emphasis on Pakistan.

Lab Outline:

a) Plant Physiology

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.
5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/ by cobalt chloride paper method.

6. Chemical tests for the following cell constituents:
   i. Starch
   ii. Cellulose
   iii. Lignin
   iv. Proteins

7. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.

8. Estimation of oxygen utilized by a respiring plant by Winkler's method.

9. Extraction of amylase from germinating wheat seeds and study of its effect on starch breakdown.

10. Measurement of carbon dioxide evolution during respiration of germinating seeds by the titration method.


12. Effect of light and temperature on seed germination.

b) Ecology

1. Determination of physical and Chemical characteristics of soil.

2. Measurements of various population variables


4. Field trips to ecologically diverse habitats.

5. Measurements of wind velocity.

Recommended Books:


Journals / Periodicals: Plant Physiology, Journal of Ecology

Title of the Course: Bot-403 Biodiversity and Conservation

Credit Hours: 4(3+1)

Prerequisites: Bot-301, 302, 401, 402

Specific objectives of course: To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems.
Course outline:
1. Definition of biodiversity as defined in the convention of biological diversity (CBD).
2. Introduction of species on each other for their survival.
3. Extent of known and estimated biodiversity of earth.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of living resources).
6. Sustainable and unsustainable use of ecosystem resources, consequences of unsustainable use, ecosystem degradation, extinct species, desertification and deforestation.
7. Biodiversity Hot spots of the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar.
9. IUCN categorised protected areas in Pakistan.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Lab outline:
1. Inventory of plant biodiversity in various habitats.
2. Field survey for baseline studies and Impact Assessment.
3. Identification of wild plant species used by local communities in different ecosystems.

Recommended Books:
4. IUCN. 1994. IUCN Red List Categories. As Approved by the IUCN Council. IUCN.
8. Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.

Journals /Periodicals
- Systematics and Biodiversity
- Biological Conservation.

3rd Year
5th Semester

Title of the Course: BOT-502 Bacteriology and Virology
Credit Hours: 3(2+1)
Prerequisites: Bot. 301, 302, 401, 402, 501

Specific objectives of course: To understand the morphology, structure and economic importance of Viruses and Bacteria

Course outline:

a) Viruses
1. General features of viruses, viral architecture, classification, dissemination and replication of single and double – stranded DNA/RNA viruses.
2. Plant viral taxonomy.
3. Virus biology and virus transmission.
5. Symptomatology of virus-infected plants: (External and Internal symptoms).
6. Metabolism of virus-infected plants.
7. Resistance to viral infection.
a) **Bacteria**

1. History, characteristics and classification.
2. Evolutionary tendencies in Monera (Bacteria, actinomycetes and cyanobacteria)
3. Morphology, genetic recombination, locomotion and reproduction in bacteria
4. Bacterial metabolism (respiration, fermentation, photosynthesis and nitrogen fixation)
5. Importance of bacteria with special reference to application in various modern sciences specially agriculture, biotechnology and genetic engineering.

**Lab outline:**

a) **Viruses**

Observation of symptoms of some viral infected plant specimens.

b) **Bacteria, Actinomycetes and Cyanobacteria**

1. Methods of sterilization of glassware and media etc.
2. Preparation of nutrient medium and inoculation.
3. Preparation of slides for the study of various forms, capsule/slime layer, spores, flagella and Gram-staining.
5. Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh collections and prepared slides.

**Recommended Books:**


Title of the Course: Bot- 50 Phycology And Bryology

Credit Hours: 3(2+1)

Prerequisites: Bot. 301, 302, 401, 402, 501

Specific objectives of course: To understand the classification, morphology and economic importance of Algae and Bryophytes

Course Outline:

a) Phycology
   Introduction, general account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

b) Bryology:
   Introduction and general account of bryophytes, classification, theories of origin and evolution. Brief study of the classes: Hepaticopsida, Anthoceropsida and Bryopsida.

Lab Outline:

a) Phycology:
   i. Collection of fresh water and marine algae.
   ii. Identification of benthic and planktonic algae
   iii. Section cutting of thalloid algae
   iv. Preparation of temporary slides
   v. Use of camera lucida/micrographs.

b) Bryology
   Study of the following genera:
   Pellia, Porella, Anthoceros and Polytrichum.
Recommended Books:


Title of the Course: Bot-504 Mycology and Plant Pathology
Credit Hours: 3(2+1)
Prerequisites: Bot. 301, 302, 401, 402, 501

Specific Objectives of course: To introduce the students to Mycology and Diseases caused by Fungi.

Course Outline:
a) Mycology
1. Introduction: General characters of fungi, Thallus, cell structure and ultrastructure of fungi.
3. Fungal Systematics: Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of Myxomycota, Chytridiomycota, Zygomycota (Mucrales) Oomycota (Peronosporales), Ascomycota (Erysiphales, Pezizales), Basidiomycota (Agaricales, Polyporales, Uredinales, Ustilaginales) and Deuteromycetes.
4. Symbiotic relationships of fungi with other organisms (lichens and mycorrhiza) and their significance.
5. Importance of fungi in human affairs with special reference to Industry and Agriculture

b) Pathology
1. Introduction and classification of plant diseases.
2. Symptoms, causes and development of plant diseases
3. Loss assessment and disease control
4. Epidemiology and disease forecast
5. Important diseases of crop plants and fruit trees in Pakistan caused by fungi, e.g. damping off, mildews, rusts, smuts, shisham dieback etc.

Lab Outline:

a) Mycology
General characters and morphology of fungi. Study of unicellular and mycelial forms with septate and aseptate hyphae. Distinguishing characters of different phyla: study of suitable examples. Study of asexual and sexual reproductive structures in different groups of fungi. Study of some common examples of saprophytic, parasitic and air-borne fungi belonging to different phyla.

b) Pathology
Identification of major plant pathogens under lab and field conditions, cultural studies of some important plant pathogenic fungi, application of Koch's postulates for confirmation of pathogenicity. Demonstration of control measures through chemotherapeutants.

Recommended Books:


Title of the Course: Bot-505 Diversity of Vascular Plants
Credit Hours: 3(2+1)
Prerequisites: Bot. 301, 302, 401, 402, 501

Specific Objectives of course: To enable the students to understand and appreciate the biology and evolution of plant architecture

Course Outline:

a) Pteridophytes

Introduction, origin, history, features and a generalized life cycle. Methods of fossilization, types of fossils, geological time scale and importance of paleobotany. First vascular plant - Rhyniophyta e.g. Cooksonia

General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida (Psilotum), Lycopsida (Lycopodium, Selaginella), Sphenopsida (Equisetum), Pteropsida (Ophioglossum, Dryopteris and Azolla/Marsilea).

b) Origin and Evolution of seed habit.
c) **Gymnosperms:**

d) **Angiosperms:**
Origin, general characteristics, Importance, and life cycle of angiosperms

e) **Palynology:**
1. An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey and oil and gas exploration.
2. Basic information about the nomenclature, morphology and classification of living and fossil pollen and spores.

**Lab Outline:**
1. To study the morphological and reproductive features of available genera.
2. Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.

**Recommended Books:**


Title of the Course: Bot-506 Plant Systematics
Credit Hours: 3(2+1)

Prerequisites:

Specific Objectives of course: To know floral composition/ system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.

Course Outline:

1. Introduction: Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve; the earliest fossil records of angiosperms.

2. Concept of Species: What is a species? Taxonomic species, Biological species, Micro and macro species, Species aggregate., Infra specific categories.


4. Variation: Types of variation, Continuous and discontinuous variation, Clinal variation.

5. Systematics and Geneecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories such as ecophage, ecotype, ecospecies, coenospecies and comparium.

7. Nomenclature: Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names.

8. Classification: Why classification is necessary? Importance of predictive value. Brief history, Different systems of classification with at least one example of each (Linnaeus, Bentham and Hooker, Engler and Prantl, Bessey, Cronquist, Takhtajan, and Dahlgren.


10. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:

1. Apiaceae (Umbelliferae)
2. Arecaceae (Palmae)
3. Asclepiadaceae
4. Asteraceae (Compositae)
5. Boraginaceae
6. Brassicaceae (Cruciferae)
7. Cannaceae
8. Capparidaceae
9. Caryophyllaceae
10. Casuarinaceae
11. Chenopodiaceae
12. Convolvulaceae
13. Cucurbitaceae
14. Cyperaceae
15. Euphorbiaceae
16. Fabaceae (Leguminosae)
17. Juncaceae
18. Lamiaceae (Labiatae)
19. Liliaceae
20. Magnoliaceae
21. Malvaceae
22. Myrtaceae
23. Orchidaceae
24. Papaveraceae
25. Poaceae (Gramineae)
26. Ranunculaceae
27. Rosaceae
28. Salicaceae
29. Scrophulariaceae
30. Solanaceae
31. Trochodendraceae
32. Winteraceae

Lab Outline:
1. Technical description of plants of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan
2. Preparation of indented and bracketed types of keys
3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.
4. Study of variation pattern in different taxa.
5. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination
6. Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Books:

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Journals / Periodicals: Pakistan Journal Botany, Flora of Pakistan, Taxon, Botanical Journal of the Linnean Society

6th Semester

Title of the course: Bot-507 Anatomy of Vascular Plants
Credit hours: 3(2+1)
Prerequisites: Bot. 301, 302, 401, 402, 501
Specific objectives of course: To provide the students understanding about anatomical features of vascular plants
Course Outline:

1. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts:
   - Flower
   - Seed
   - Fruit
9. Economic aspects of applied plant anatomy
10. Anatomical adaptations
11. Molecular markers in tree species used for wood identification.

Lab Outline:

1. Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures.
2. Study of abnormal/unusual secondary growth.
3. Peel and ground sectioning and maceration of fossil material.
4. Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.
Recommended Books:


Journals / Periodicals: Pakistan Journal of Botany

Title of the Course: Bot-508 Genetics-I

Credit Hours: 3(2+1)

Prerequisites: Bot. 301, 302, 401, 402, 501

Specific Objectives of course: To understand the nature and function of genetic material

Course Outline:

1. Extensions of Mendelian Analysis: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity.
2. Linkage I: Basic Eukaryotic Chromosome Mapping: The discovery of linkage, recombination, linkage symbolism, linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans.


5. Recombination in Bacteria and their Viruses: Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the E.coli chromosome, bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.


8. DNA Function: Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.

9. The Extranuclear Genome: Variegation in leaves of higher plants, plastidic inheritance in fungi, extranuclear genes in chlamydomonas, mitochondrial genes in yeast, extragenomic plasmids in eukaryotes.


Lab Outline:

1. **Numerical problems**
   a) Arrangement of genetic material:
      i. Linkage and recombination.
      ii. Gene mapping in diploid.
      iii. Recombination in Fungi.
      iv. Recombination in bacteria.
      v. Recombination in viruses.
   b) Population Genetics:
      i. Gene frequencies and equilibrium.
      ii. Changes in gene frequencies.

2. **Blood group and Rh-factor**

3. **Drosophila**
   i. Culture technique
   ii. Salivary gland chromosome

4. **Fungal genetics**
   Sacchomyces culture techniques and study.

5. **Studies on variation in maize ear size and colour variation**

6. **Bacterial Genetics.**
   i. Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
   ii. Transformation.
   ii. Conjugation.

**Recommended Books:**

Journals / Periodicals: J. Genetics, Theoretical and Applied Genetics, Cytologia, Chromosoma, Genome

Title of the Course: Bot-509 Plant Biochemistry-I

Credit Hours: 3(2+1)

Prerequisites: F.Sc. Biology/ Chemistry

Specific Objectives of course: To elucidate the structure and role of primary metabolites in plants

Course Outline:

Carbohydrates: Occurrence and classification. A general account of ribose, deoxyribose, xylulose, xylose, D-glucose, D-galactose, D-mannose, cellobiose, sucrose, maltose, trehalose, pentosans, fructosans, starch, cellulose, hemicellulose, amino sugars, derived acids and alcohols, glycosides, mucilages, pectins and lignins.

Lipids: Occurrence, classification. Structure and chemical properties of fatty acids, triglycerides, phospholipids, glycolipids, sulpholipids, waxes and sterols.

**Nucleic Acids:** General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA. Types and functions of RNA. Chemical synthesis of oligonucleotides and DNA sequencing. DNA restriction enzymes. Properties of DNA polymerase I, II and III.


**Lab Outline:**
2. To determine the Rf value of monosaccharides on a paper Chromatogram.
3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/spectrophotometrically.
4. To determine the saponification number of fats.
5. To extract and estimate oil from plant material using soxhlet apparatus.
6. Analysis of various lipids by TLC methods.
7. To estimate soluble proteins by Biuret or Lowry or Dye-binding method.
8. To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
9. To determine the Rf value of amino acids on a paper chromatogram.
10. Extraction of Nucleic acids from plant material and their estimation by UV absorption or colour reactions.
11. To estimate the catalytic property of enzyme catalase or peroxidase extracted from a plant source.
12. To determine the PKa and isoelectric point of an amino acid.

**Recommended Books:**


Title of the Course: Bot-510 Plant Ecology I
Credit Hours: 3(2+1)
Prerequisites: Bot. 301, 302, 401, 402, 501
Specific Objectives of course: To understand the role and interaction of plants with their environment

Course Outline:
1. Introduction: history and recent developments in ecology
environment and plant ionic relations, Nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals (brief description), Salt and drought stress and osmoregulation. Soil erosion

3. Light and temperature: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,


7. Wind as an ecological factor.

8. Fire as an ecological factor.

Lab Outline:

1. Determination of physico-chemical properties of soil and water.
2. Measurements of light and temperature under different ecological conditions.
4. Measurement of CO₂ and O₂ concentration of air and water.
5. Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
6. Measurement of ions, stomatal conductance, osmotic potential, water potential, xylem pressure potential, leaf area and rate of CO₂ exchange in plants in relation to various environmental conditions.

Recommended Books:


Title of the Course: Bot-511 Plant Physiology-I

Credit Hours: 3(2+1)

Prerequisites: F.Sc. Biology, Botany
Specific Objectives of course: To provide comprehensive knowledge on some vital functions and mechanisms of plants

Course Outline:


3. **Translocation of Food**: Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.


Lab Outline:

1. To determine the volume of CO₂ evolved during respiration by plant material.
2. To determine the amount of O₂ used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantification by spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
5. To categorize C₃ and C₄ plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colours and pH.

Recommended Books:


**Title of the Course:** Bot-512 Research Methodology

**Credit Hours:** 1(1+0)

**Prerequisites:**

**Specific objectives of course:** To enable the students to know the theoretical aspects of planning research, handling, presentation of data, writing and submission of research papers and thesis

**Course Outline:**

What is science, philosophy and theory, how to do science. Questions, hypothesis, their types, experimentation, validation, theories and laws. Research Methods (planning research, various methods, analyzing results, giving reports, etc.) research process including: formulating research questions; sampling (probability and nonprobability); measurement (surveys, scaling, qualitative, unobtrusive); research design (experimental and quasi-experimental); data analysis; and, writing the research paper, the major theoretical and philosophical underpinnings of research including: the idea of validity in research; reliability of measures; and ethics

**Recommended Books:**

Title of the Course: Bot-601 Molecular biology
Credit Hours: 3(2+1)
Prerequisites: Bot. 508, 509, 511
Specific Objectives of course: To disseminate the knowledge of molecular basis of life

Course Outline:

1. Nucleic Acids: DNA-circular and superhelical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA
6. Proteomics; structural and functional proteomics. Methods to study proteomics Metabolomics; methods to study metabolomics; importance and application of metabolomics.

Lab Outline:

Following techniques will be used for the isolation and analysis of different components:

1. Extraction of RNA, DNA and proteins
2. Electrophoreses: One and two dimensional
3. Purification of proteins, RNA and DNA.
4. Amplification using PCR.
5. Northern, Western and Southern Blotting.

Recommended Books:


Title of the Course: Bot-602 Plant Biochemistry-II

Credit Hours: 3(2+1)

Prerequisites: Bot. 509

Specific Objectives of course: To explicit the fundamentals of metabolic energy, Metabolism and Plant constituents.
Course Outline:


2. Metabolism:
   ii. Replication of DNA. Reverse transcription. Biosynthesis of DNA and RNA.


5. Vitamins: General properties and role in metabolism.

Lab Outline:

1. Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
2. Separation of nucleic acids by gel electrophoresis.
3. To estimate the amount of vitamin C in a plant organ (orange, apple juice).
4. To determine potential alkaloids in plants.
5. To estimate terpenoids in plants.

Recommended Books:


Title of the Course: Bot-603 Plant Ecology -II

Credit Hours: 3(2+1)

Prerequisites: Bot. 505 & 510
Specific Objectives of course: To provide comprehensive knowledge of population, community, ecosystem ecology and its relevance to mankind.

Course Outline:

A. Population Ecology
   1. Population structure and plant demography.: Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography
   2. Life history pattern and resource allocation : Density dependent and density independent factors, Resource allocation, Reproductive effort, Seed size vs seed weight, Population genetics, Evolution

B. Community Ecology: Historical development of community ecology, Community concepts and attributes, Methods of sampling of plant communities, Ecological succession, Community soil-relationship, Local Vegetation, Vegetation of Pakistan, Major formation types of the world


Lab Outline:

Determination of seed bank in various populations. Seed dispersal pattern of local populations. Demography and life history of local annual population. Study of community attributes. Sampling of vegetation including Quadrat, plotless, transect and Braun-Blanquart. Correlate soil properties with vegetation type. Field trip to study different communities located in different ecological regions of Pakistan. Slide show of the vegetation of Pakistan. Slide show of the major formations of the world. Soil physical and chemical properties

Recommended Books:

8. Hussain, S. Pakistan Manual of Plant Ecology,


Title of the Course: Bot-604 Plant Physiology-II
Credit Hours: 3(2+1)
Prerequisites: Bot. 402 & 511

Specific Objectives of course: To give it comprehensive and advance knowledge of growth regulators, mechanism of water uptake and role of essential nutrients in plant metabolism

Course Outline:
1. Plant Growth Regulators : Major natural hormones and their synthethic analogues. Bioassay, structure, biosynthesis, receptors, signal trasduction and mode of action, transport, physiological effects of Auxins , Gibberellins, Cytokinins, Abscisic
acid, Ethylene, Polyamines, Brassinosteroids, Jasmonates, and Salicylic acid.


**Lab Outline:**

1. To investigate the preferential absorption of ions by corn seedlings and potato slices.
2. To determine osmotic potential of massive tissue by freezing point depression method or by an osmometer.
3. To investigate water potential of a plant tissue by dye method and water potential apparatus.
6. Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.

**Recommended Books:**

Title of the Course: Bot-605   Biodiversity & Conservation
Credit Hours: 3(2+1)
Prerequisites: Bot. 505, 510, 603
Specific objectives of course: To understand the importance of biodiversity, threats and conservation measures

Course Outline:
1. Introduction and importance of biodiversity :Species diversity, Ecological diversity, Genetic diversity, Social diversity
2. i. Causes and depletion of biodiversity: Habitat loss, Habitat fragmentation, Over-exploitation, Climatic changes, Invasive species, Seawater intrusion
   ii. The value of species
   iii. How species become endangered?
   iv. Extinction of species, present rate. Theory of mass extinction
   v. Inventory and monitoring of biodiversity
   vi. Importance of red data book
   vii. In situ and ex situ conservation of plants
   viii. Implementation of laws (protection and conservation of various taxa.
   ix. Sustainable use of biodiversity (plant wealth)
   x. Protected areas of Pakistan
   xi. Criteria for determining different categories of protected areas
   xii. Baseline study

xiii. Impact assessment
xiv. Management plan for protected area
xv. IUCN categories for threatened species
xvi. Criteria for recognizing different categories of threatened species
xvii. Gene bank management and operation
xviii. Public awareness strategies.
ix. Population explosion
xx. Biodiversity action plan for Pakistan
xxi. Role of herbaria and botanical gardens in conservation.

Lab Outline:
1. Causes of local species extinction.
2. Field excursion.
3. Data collection.
4. Preparation of an inventory of the flora of a given region.
5. To carry on base line study of any designated category.

Recommended Books:


15. IUCN. 1994. IUCN Red List Categories. As Approved by the IUCN Council. IUCN.


17. Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.


Journals / Periodicals: Systematics and Biodiversity Biological Conservation.

Title of the Course: Bot-606 Genetics II

Credit Hours: 3(2+1)

Prerequisites: Bot. 302 & 508

Specific Objectives of course: To introduce students to recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics

Course Outline:

1. Recombinant DNA : Recombinant DNA Technology – Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, recombinant DNA and social responsibility, Site directed Mutagenesis, DNA sequencing.

2. Application of Recombinant DNA: Applications of recombinant DNA technology using prokaryotes, recombinant DNA
technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.

3. Control of Gene Expression: Discovery of the lac system: negative control, catabolite repression of the lac operon: positive control, transcription: gene regulation in eukaryotes - an overview.


5. Mechanisms of Genetic Change II: Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.


8. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects

9. Bioinformatics: Application of computational tests to the analysis of genome and their gene products

10. Bioethics: Moral, Religious and ethical concerns

Lab Outline:

Problems relating to the theory
1 Isolation and separation of DNA and protein on Gel electrophoresis.

   i. Bacterial chromosome
   ii. Plasmid DNA (minipreps)

66
2 DNA Amplification by PCR

**Recommended Books:**

7. Lwein, B. 2004, Gene VIII, Pearson Education Int..

**Journals / Periodicals:**  J. Genetics, Theoretical and Applied Genetics, Cytologia, Chromosoma, Genome

**8th Semester**

**Title of the Course:** Botany-607 Environmental Biology

**Credit Hours:** 3(2+1)

**Prerequisites:** Bot. 510 & 603
Specific Objectives of course: To provide updated knowledge of environmental problems and sustainable environmental management.

Course Outline:

1. Environment: Introduction, scope, pressure
2. Pollution: definition, classification and impact on habitats
   ii. Water pollution: Major sources of water pollution and its impact on vegetation. prevention, control remediation, eutrophication, thermal pollution.
   iv. Noise pollution.
   v. Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal
3. Forest: importance, deforestation, desertification and conservation
4. Ozone layer:
   i. Formation
   ii. Mechanism of depletion
   iii. Effects of ozone depletion
5. Greenhouse effect: causes, impacts.

9. Sustainable Environmental management.

10. Wetlands and sanctuaries protection: The pressures, problems and solutions.

11. Range management: Types of rangelands, potential threats, sustainable management.

Lab Outline:
1. Examination of industrial waste water and Municipal sewage and sludge for
   i. Total dissolved solids.
   ii. pH and EC.
   iii. BOD/COD.
   iv. Chlorides, carbonate, and Nitrates.

2. Examination of water samples forms different sites for the presence and diversity of organisms.

3. Effect of air pollutants on plants.

4. Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

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Journals/Periodicals: Environmental Biology, Environment, Bioremediation

Title of the Course: Botany Special Paper-II
Credit Hours: 4(3+1)
Prerequisites: Botany

Specific Objectives of course:

Course Outline: To be adopted by the university as per expertise
Lab Outline:

Recommended Books:

Journals / Periodicals:

Title of the Course: Bot-608 Special Paper-II
Credit Hours: 4(3+1)
Prerequisites:

Specific Objectives of course:
Course Outline: To be adopted by the university as per expertise

Lab Outline:

Recommended Books:

Journals / Periodicals:

RESEARCH 4(0+4)

Total credit hours: 133
GENERAL RECOMMENDATIONS (BOTANY)

After a comprehensive discussion by all the members of the committee constituted by HEC to adapt the curriculum (devised by HEC) following points were noted:

- This document contained information which was general for all the disciplines.
- It was unanimously adapted with minor modifications made.

While restructuring the scheme of study semester wise for BS 4 years programme in Botany, there were general feelings that we should accommodate for the phasing out of existing 2 year degree programme and phasing in the modern 4 years degree programme. Accordingly, courses were selected compatible to meet the current and future needs. Nevertheless emphasis was on the creation of a document that should be attractive and useful for the introduction of BS 4 years degree programme in Botany for public / private sector universities. Therefore following recommendations were made:

1. That HEC should write to Federal and Provincial Public Service Commissions for formal recognition of the BS 4 years degree programme and it must be considered equivalent to the existing M.Sc. (16 years schooling programme).

2. That HEC should provide sufficient funds to the colleges and the universities to initiate such new degree programmes. Universities and colleges offering these courses should organize training and workshops before initiating degree programme.

3. That HEC should ensure that the institutions have at least eight teachers (at least 2 teachers having M.Phil Degree).

4. That the Internship and Research projects should be encouraged but it should not be mandatory at this juncture as we do not have a culture of Internships and Research activities in the disciplines of Botany in our country.
ANNEXURE “A”

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/hits 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)
Recommended books:

Communication Skills

a) Grammar

b) Writing

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

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

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)

Seats 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
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
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) Hameedullah Muhammad, “Emergence of Islam”, IRI, Islamabad
2) Hameedullah Muhammad, “Muslim Conduct of State”
3) Hameedullah Muhammad, “Introduction to Islam”
4) Mulana Muhammad Yousaf Islahi,
6) Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
9) Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001)
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:
Dolciani MP, Wooton W, Beekenback EF, Sharron S, Algebra 2 and Trigonometry, 1978, Houghton & Mifflin,
Kaufmann JE, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston
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:**


### 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**


Recommended Books:
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:


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

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.