CURRICULUM DIVISION, HEC

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. Mukhtar Ahmed</td>
<td>Executive Director</td>
</tr>
<tr>
<td>Mr. Fida Hussain</td>
<td>DG (Academics)</td>
</tr>
<tr>
<td>Mr. Rizwan Shaukat</td>
<td>Deputy Director (Curri)</td>
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<tr>
<td>Mr. Abid Wahab</td>
<td>Asst. Director (Curri)</td>
</tr>
<tr>
<td>Mr. Riaz-ul-Haque</td>
<td>Asst. Director (Curri)</td>
</tr>
</tbody>
</table>

Composed by: Mr. Zulfiqar Ali, HEC, Islamabad
# Table of Content

1. Introduction ........................................... 6
2. Outcome of the Course ................................. 9
3. Rationale .................................................. 9
4. Goal ......................................................... 9
5. Layout for BS Botany (4 – Year Programme) ........ 11
6. Scheme of Studies for BS ............................. 13
7. Detail of Courses for BS ............................... 15
8. Recommendations ................................... 55
9. Annexures ................................................. 56
10. Scheme of Studies for MS/MPhil Botany .......... 77
PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC (www.hec.gov.pk).

(Fida Hussain)
Director General (Academics)
CURRICULUM DEVELOPMENT PROCESS

STAGE-I
- CURRI. UNDER CONSIDERATION
  - COLLECTION OF REC
  - CONS. OF CRC.
  - PREP. OF DRAFT BY CRC

STAGE-II
- CURRI. IN DRAFT STAGE
  - APPRAISAL OF 1ST DRAFT BY EXP. OF COL./UNIV
  - FINALIZATION OF DRAFT BY CRC
  - APPROVAL OF CURRI. BY V.C.C.

STAGE-III
- FINAL STAGE
  - PREP. OF FINAL CURRI.
  - PRINTING OF CURRI.
  - IMPLE. OF CURRI.

STAGE-IV
- FOLLOW UP STUDY
  - QUESTIONNAIRE
  - COMMENTS
  - REVIEW

ABBREVIATIONS USED:
- CRC. Curriculum Revision Committee
- VCC. Vice Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations

ORIENTATION COURSES
BACK TO STAGE-I
Introduction

The final meeting of National Curriculum Revision Committee in the discipline of Botany was held at HEC Regional Centre Peshawar from February 11-13, 2013, to finalize draft curriculum of BS 4 years and MS/MPhil Programme prepared in its preliminary meeting held on Sept. 11-13, 2012. The following members attended the meeting:-

i. **Prof. Dr. Ghulam Sarwar Markhand**  
   Convener  
   Professor  
   Department of Botany  
   Shah Abdul Latif University, Khairpur.

ii. **Prof. Dr. Fauzia Yusuf Hafeez**  
    Secretary  
    Department of Bio Sciences  
    COMSATS Institute of Information Technology (CIIT)  
    Park Road, Chak Shahzad, Islamabad.

iii. **Dr. Farrukh Hussain**  
    Member  
    Chairman  
    Department of Botany,  
    Bacha Khan University, Charsadda.

iv. **Dr. Muhammad Javed Zaki**  
   Member  
   Professor  
   Department of Botany  
   University of Karachi, Karachi.

v. **Dr. Ghulam Murtaza**  
   Member  
   Professor  
   Department of Botany  
   University of Azad Jammu and Kashmir, Muzaffarabad.

vi. **Dr. Aamir Ali**  
    Member  
    Associate Professor  
    Department of Biological Sciences  
    University of Sargodha, Sargodha.

vii. **Dr. Sultan Mehmood**  
    Member  
    Associate Professor  
    Department of Botany  
    University of Science & Technology, Bannu.
viii. Dr. Muhammad Ibrar Shinwari  
Assistant Professor  
Department of Environmental Science,  
International Islamic University, H-10, Islamabad

ix. Dr. Muhammad Irshad  
Assistant Professor  
Department of Botany  
Abdul Wali Khan University, Mardan.

x. Dr. Nasrullah Khan  
Assistant Professor  
Department of Botany  
University of Malakand Chakdara, Dir (Lower).

xi. Dr. Muhammad Zafar  
Herbarium Botanist  
Department of Plant Sciences  
Quaid-i-Azam University, Islamabad

xii. Mr. Fida Hussain  
Lecturer  
Department of Weed Science  
Khyber Pakhtunkhwa Agricultural University, Peshawar.

Following members could not attend the meeting due to their official/personal engagements.

i. Prof. Dr. Muhammad Ashraf,  
Professor & Dean,  
Department of Botany,  
University of Agriculture, Faisalabad.

ii. Dr. Atta Mohammad,  
Associate Professor,  
Department of Botany,  
University of Balochistan, Quetta.

iii. Dr. Hassan Sher,  
Associate Professor,  
Centre of Botany and Biodiversity Conservation,  
University of Swat, Swat.

iv. Mr. Ikramullah Khan,  
Assistant Professor,  
Department of Weed Science,  
Khyber Pakhtunkhwa Agricultural University, Peshawar.
2. The meeting started with recitation of Holy Verses from the Holy Quran by Dr. Sultan Mehmood, Associate Professor, University of Science and Technology, Bannu. **Mr. Zaheer Ahmad Awan, Director** Regional Centre, Peshawar HEC on behalf of the Chairman and the Executive Director, HEC welcomed the participants and thanked all the members of the committee for sparing precious time for this national cause. He further added that their efforts will go long way in developing workable, useful and comprehensive degree Programmes in Botany. He briefed the participants about the aims and objectives of the meeting with a particular focus on revising the course outlines of BS 4 years and also developing the course outlines of MS Programme in Botany, so as to make it compatible with international standards and demands as well as ensuring the uniformity of academic standards within the country.

3. The members of the Committee unanimously selected Dr. Ghulam Sarwar Markhand, Professor, Department of Botany, Shah Abdul Latif University, Khairpur and Prof. Dr. Fauzia Yusuf Hafeez, Professor, Department of Biosciences, COMSATS Institute of Information Technology, Islamabad as Convener and Secretary of the NCRC, respectively. The Director Regional Centre Peshawar then requested the Convener of the committee to conduct proceedings of all technical sessions of meeting for three days. The Convener thanked the participants for his selection and started proceedings of the meeting in accordance with the agenda. The Committee, during the proceedings of the meeting, considered the inputs given by the members of the Committee, and incorporated their suggestions where necessary in the final curriculum.

4. After thorough discussion and having three days deliberations, the committee achieved the following objectives:-

   i. *Finalized the draft Curriculum of Botany for BS and MS Programme, so as to bring it at par with international standards.*

   ii. *Incorporated latest reading and writing material against each course.*

   iii. *Made recommendations for promotion and development of the discipline of Botany.*

   iv. *Approved the Final Curriculum of Botany four BS and MS Programme.*
5. The Convener of the NCRC thanked the members for their inputs in revising the final draft curriculum of Botany by keeping in view the requirement of the country and to make it more practical, competitive and effective.

6. Mr. Riaz-ul-Haque, Assistant Director Curriculum HEC thanked the Convener, the Secretary and all the members of the committee for sparing precious time and for their quality contribution towards preparation of the final draft curriculum in the discipline of Botany.

7. The committee highly appreciated the efforts made by the officials of HEC Regional Centre, Peshawar and Assistant Director, Curriculum for making proper arrangements to facilitate the members of committee.

8. The meeting ended with the vote of thanks to and from the chair.

**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 contents of various foundation courses has been reviewed, modified and updated such as; Biodiversity and conservation, Plant Anatomy, Genetics, Biochemistry, Biostatistics etc. and the major courses as Physiology, Genetics, Ecology, Ethnobotany, cell biology etc. is incorporated. The technical and typing errors have been removed. The four elective courses are left for specific requirement of the students of a University.

**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.

**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.
## TEMPLATE FOR 4-YEAR BS DEGREE PROGRAMME

<table>
<thead>
<tr>
<th>SR.</th>
<th>CATEGORIES</th>
<th>NO. OF COURSES MIN– MAX</th>
<th>CREDIT HOURS MIN– MAX</th>
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<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: 124-136
- 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>
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<tr>
<td>25 Credit hours</td>
<td>21-24 Cr. Hours</td>
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<table>
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<tr>
<th>Subjects</th>
<th>Cr. Hr</th>
<th>Subjects</th>
<th>Cr. Hr</th>
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</thead>
<tbody>
<tr>
<td>1. ENGLISH I (Functional English)</td>
<td>3</td>
<td>1. General Course-I ***</td>
<td>3</td>
</tr>
<tr>
<td>2. ENGLISH II (Communication Skill)</td>
<td>3</td>
<td>2. General Course-II ***</td>
<td>3</td>
</tr>
<tr>
<td>3. ENGLISH III (Technical Report Writing &amp; presentation skills)</td>
<td>3</td>
<td>3. General Course-III ***</td>
<td>3</td>
</tr>
<tr>
<td>4. ENGLISH VI*</td>
<td>3</td>
<td>4. General Course-IV ***</td>
<td>3</td>
</tr>
<tr>
<td>5. PAKISTAN STUDIES</td>
<td>2</td>
<td>5. General Course-V ***</td>
<td>3</td>
</tr>
<tr>
<td>6. ISLAMIC STUDIES / ETHICS</td>
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<td>6. General Course-VI ***</td>
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<tr>
<td>7. MATHEMATICS</td>
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<td>7. General Course-VII ***</td>
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<tr>
<td>8. BIOSTATISTICS</td>
<td>3</td>
<td>8. General Course-VIII ***</td>
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<tr>
<td>9. INTRODUCTION TO COMPUTER</td>
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**Total:** 25 Cr. Hr

### Discipline Specific Foundation Courses

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<th>Subjects</th>
<th>Cr. Hr</th>
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<td>1. Phycology &amp; Bryology</td>
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<tr>
<td></td>
<td></td>
<td>10. Plant Physiology-II</td>
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<tr>
<td></td>
<td></td>
<td>11. Genetics II</td>
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<tr>
<td></td>
<td></td>
<td>12. Environmental Biology</td>
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**Total:** 32 Cr. Hr

### Major courses

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<th>Cr. Hr</th>
<th>Subjects</th>
<th>Cr. Hr</th>
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</thead>
<tbody>
<tr>
<td>1. Phycology &amp; Bryology</td>
<td>3</td>
<td>11. Genetics II</td>
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<tr>
<td>3. Plant Systematics</td>
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<tr>
<td>4. Genetics-I</td>
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<td>5. Plant Biochemistry-I</td>
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<td>6. Plant Ecology-I</td>
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<tr>
<td>7. Molecular Biology</td>
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<td>9. Plant Ecology-II</td>
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<td>10. Plant Physiology-II</td>
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**Total:** 36 Cr. Hr
**Elective Courses within the major including research project/internship**

<table>
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<th>4 courses</th>
<th>12 Credit Hours</th>
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<td><strong>Subject</strong></td>
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<td>2. Elective-II University Option</td>
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<td>3. Elective-III Research Project / Internship/ *Optional</td>
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<td>4. Elective-IV University Option</td>
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* 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
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<th>Name of Subject</th>
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<th>Lab</th>
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<td>FOUNDATION-II Bot-302 Plant Systematics, Anatomy and Development/ Embryology</td>
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<td>8 7 15</td>
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* University has the option to recommend any other course in lieu of English IV
** 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)

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. Psilopsida (Psilotum)
   ii. Lycopsida (Selaginella)
   iii. Sphenopsida (Equisetum)
   iv. Pteropsida (Marsilea)

h) Gymnosperms
   i. Cycas
   ii. Pinus
   iii. Ephedra
i) Angiosperms
   i. Monocot (Poaceae)
   ii. Dicot (Solanaceae)

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:

Journals / Periodicals:

1st Year
2nd Semester

Title of the Course: Bot-302 Plant Systematics, Anatomy and Development/Embryology
Credit Hours: 4 (3+1)

Specific Objectives of course:
To understand: 1. various systems of classification, identification and nomenclature of Angiosperms, 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 morphological 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. Lamiaceae (Labiatae)
viii. Apiaceae (Umbelliferae)
ix. Asteraceae (Compositae)
x. Liliaceae (Sen. Lato)

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. Phloem Epidermis (including stomata and trichomes)
v. Xylem
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
6. Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.

c) Development/Embryology
1. Early development of plant body:
2. Capsella bursa-pastoris
3. Structure and development of Anther Microsporogenesis, Microgametophyte
4. Structure of Ovule Megasporogenesis Megagametophyte
5. Endosperm formation
6. Parthenocarpy
7. Polyembryony

Lab Outline:
Plant Systematics
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.
3. Field trips shall be undertaken to study and collect local plants.
4. Students shall submit 40 fully identified herbarium specimens.

Anatomy and Embryology
1. Study of stomata and 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.
5. Anatomy of germinating seeds
6. Study of pollens
Recommended Books:

Journals / Periodicals:
Pakistan Journal of Botany, Taxon, Phyton.
2nd Year
3rd Semester

Title of the course: Bot-401  Cell Biology, Genetics and Evolution
Credit hours: 4 (3+1)

Specific objectives of course: To understand:
1. Structure and function of cell.
2. Nature of genetic material and hereditary process
3. Familiarization with evolutionary processes.

Course outline:

a) Cell Biology
1. Structure and Function of Bio-molecules
   i. Carbohydrates
   ii. Lipids
   iii. Proteins
   iv. Nucleic Acids
2. Cell: Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell.
3. Brief description of following cell organelles
   i. Cell wall
   ii. Cell membrane
   iii. Nucleus
   iv. Endoplasmic reticulum
   v. Plastids
   vi. Mitochondria
      vii. Ribosomes
   viii. Dictyosomes
   ix. Vacuoles
4. Reproduction in somatic and embryogenic cell, mitosis, meiosis and 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.
2. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. lac operon).

c) Evolution: Introduction and theories.
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 chromosomes in plant material. Carmine/orcein staining.
3. Determination of blood groups.

Recommended Books:

Journals/Periodicals:
Theoretical & Applied Genetics, the Cell, Heredity.
2\textsuperscript{nd} Year  
4\textsuperscript{th} Semester 

Title of the course: Bot-402 Plant Physiology and Ecology  
Credit hours: 4 (3+1) 

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: 

\textbf{a) Plant Physiology} 

3. Photosynthesis: Introduction, Oxygeenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C\textsubscript{3} and C\textsubscript{4} plants. Factors affecting this process, Products of photosynthesis.  

\textbf{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. Major vegetation types of the local area.

8. Ecosystem Ecology
   i. Definition, types and components of ecosystem.
   ii. Food chain and Food web.

9. Applied Ecology: Causes, effects and control of water logging and salinity with respect to 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/cobalt chloride paper method.
6. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
7. Estimation of oxygen utilized by a respiring plant by Winkler's method.

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.
7. Effect of light and temperature on seed germination.

Recommended Books:
Title of the Course: Bot-403  
Biodiversity and Conservation 
Credit Hours: 4 (3+1) 

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

**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:**
5. Provincial conservation strategies

**Journals /Periodicals**
Systematics and Biodiversity, Biological Conservation.
Title of the course: Bot-404 Biostatistics
Credit hours: 3 (2+1)

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 of 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 factorial 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.
6. Problems concerning probability, binomial distribution, T-test
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.
12. MS Excel, MSTAT or relevant statistical software packages.

Recommended Books:
3\textsuperscript{rd} Year  
5\textsuperscript{th} Semester  

Title of the Course:  Bot-501  Bacteriology and Virology 
Credit Hours:  3 (2+1) 

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.  

b) 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.  
6. Symptoms and control of major bacterial diseases in Pakistan  

c) Plant microbe interaction  

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:**

8. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds), 2009 MPG Books Group, Bodmin, UK.

**Journals/Periodicals:**


**Title of the Course:** Bot- 502 Phycology and Bryology

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

**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:**

**Journals / Periodicals:**
Title of the Course: Bot-503 Mycology and Plant Pathology
Credit Hours: 3 (2+1)

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, dieback, red rot of sugarcane 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:

Journals / Periodicals:

Title of the Course: Bot-504 Diversity of Vascular Plants
Credit Hours: 3 (2+1)

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.
3. Study of pollen morphology

**Recommended Books:**


**Journals / Periodicals:**

Title of the Course: Bot-505     Plant Systematics
Credit Hours: 3 (2+1)

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 Genecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories such as ecophene, 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. Capparidaceae
   8. Caryophyllaceae
   9. Chenopodiaceae
10. Convolvulaceae
11. Cucurbitaceae
12. Cyperaceae
13. Euphorbiaceae
14. Fabaceae (Leguminosae)
15. Lamiaceae (Labiatae)
16. Liliaceae
17. Magnoliaceae
18. Malvaceae
19. Myrtaceae
20. Orchidaceae
21. Papaveraceae
22. Poaceae (Gramineae)
23. Ranunculaceae
24. Rosaceae
25. Salicaceae
26. Scrophulariaceae
27. Solanaceae

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:

Journals / Periodicals:

3rd Year
6th Semester

**Title of the course**: Bot-506 Plant Anatomy

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

**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:
   a. Flower
   b. Seed
   c. 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:**
Title of the Course: Bot-507 Genetics-I
Credit Hours: 3 (2+1)

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.
4. 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.
5. The Structure of DNA: DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.
7. DNA Function: Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.
8. The Extranuclear Genome: Variegation in leaves of higher plants, cytoplasmic 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**
   Saccharomyces 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:**

Title of the Course: Bot-508  Plant Biochemistry-I
Credit Hours: 3 (2+1)

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

Course Outline:
Introduction to photosynthetic organisms, Bioenergetics and overview of photosynthesis, Photosynthesis: The Light Reaction Photosystems, ATP Synthesis, CO 2 Fixation, RuBisCo and enzyme kinetic, C-3 Cycle, C-4 Cycle, Regulation of photosynthesis
Introduction to carbohydrates: Occurrence and classification, Sugar structures, synthesis of polysaccharides, Carbon metabolism in the chloroplast, Starch synthesis Pentose phosphate pathway Carbon export Sucrose synthesis and transport in vascular plants, Cellulose synthesis and composition of primary cell walls
Introduction to lipids: Occurrence, classification. Structure and chemical properties of fatty acids, Fatty acid biosynthesis in plants, di and triglycerides, phospholipids, glycolipids, sulpholipids, waxes and sterols.


Introduction to Nucleic Acids: General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA. Types and functions of RNA. Nucleic Acid Metabolism.

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:


Journals / Periodicals:
Plant Physiology and Biochemistry, Annual Review of Biochemistry, Biochemistry Journal, Critical Review in Biochemistry and Molecular Biology
Title of the Course: Bot-509 Plant Ecology-I
Credit Hours: 3 (2+1)

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
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 CO$_2$ and O$_2$ 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 CO$_2$ exchange in plants in relation to various environmental conditions.

Recommended Books:

Journals / Periodicals:

Title of the Course: Bot-510 Plant Physiology-I
Credit Hours: 3 (2+1)

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 CO$_2$ evolved during respiration by plant material.
2. To determine the amount of O$_2$ 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 C$_3$ and C$_4$ plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colours and pH.

**Recommended Books:**
4th YEAR
7th Semester

Title of the Course: Bot-601 Molecular Biology
Credit Hours: 3 (2+1)

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, Central Dogma
3. Transcription: Enzymatic synthesis of RNA, transcriptional signals
Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.
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)

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:**


**Journals / Periodicals:**

Plant Physiology & Biochemistry, Annual Review of Biochemistry, Biochemistry Journal, Critical Review in Biochemistry and Molecular Biology

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

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

**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

C. **Ecosystem Ecology:**
   Ecological concepts of ecosystem, Boundaries of ecosystem. Compartmentalization and system concepts, Energy flow in ecosystem, Biogeochemical cycles: water carbon and nitrogen Case studies: any example

**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-Blanquut. 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:**
9. Hussain, S. Pakistan Manual of Plant Ecology,

**Journals/Periodicals:**
Title of the Course: ELECTIVE-I/RESEARCH PROJECT/ INTERNSHIP/OPTIONAL PAPER
Credit Hours: 3
Course Outline: To be adopted by the University as per expertise available

Title of the Course: ELECTIVE-II/RESEARCH PROJECT/ INTERNSHIP/OPTIONAL PAPER
Credit Hours: 3 (2+1)
Course Outline: To be adopted by the University as per expertise available

4th YEAR
8th Semester

Title of the Course: Bot-604 Plant Physiology-II
Credit Hours: 3 (2+1)

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:


4. Phytochromes: Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among...
species, cells and tissues and their role in biological processes. Phytochromes and gene expression.


7. Dormancy; definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination.

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 Genetics-II
Credit Hours: 3 (2+1)

Specific Objectives of Course:
To introduce students 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, 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.


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)
   iii. Plant DNA
   iv. Protein

2 DNA Amplification by PCR

Recommended Books:

6. Ignacimuthu, S. 2005, Basic Bioinformatics, Narosa Publishing House, India,
8. Miglani, 2003, Advanced Genetics, Narosa Publishing House, India,
Title of the Course: Bot-606 Environmental Biology
Credit Hours: 3 (2+1)

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 and global warming: 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:**
10. Mohamamd Ashfaq and Mushtaq A. Saleem. Environmental Pollution and Agriculture.

**Journals/Periodicals:** Environmental Biology, Environment, Bioremediation

**Title of the Course:** ELECTIVE-III/RESEARCH PROJECT/INTERNSHIP/OPTIONAL PAPER  
**Credit Hours:** 3  
**Course Outline:** To be adopted by the University as per expertise available

**Title of the Course:** ELECTIVE-IV/RESEARCH PROJECT/INTERNSHIP/OPTIONAL PAPER  
**Credit Hours:** 3 (2+1)  
**Course Outline:** To be adopted by the University as per expertise available
GENERAL RECOMMENDATIONS

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 of Botany.
- It was unanimously adapted with restructuring and 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-year 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 year degree programme in Botany for public/private sector Universities. Therefore following recommendations were made:

1. HEC should provide sufficient funds to the universities to run such degree programme and to have updated research labs. Universities should organize training and workshops especially for affiliated college teachers. Affiliated colleges should also update their laboratories to meet the requirement of modern courses.

2. HEC should ensure that the institutions have at least eight teachers to start BS program (at least 2 teachers having MPhil Degree).

3. The Internship and Research projects should be encouraged (where applicable) to establish liaison between industry and academia but it should not be mandatory at this juncture.

4. The proper criteria and format for internship report should be adopted. Evaluation of internship report may be made by three most senior teachers of the department headed by Chairperson/HoD.

5. The credit hours (6) of research project may be included in the workload of concerned teacher.

6. The entrepreneurship in plant sciences and relevant area should be encouraged.

7. HEC should ensure the running of BS 4-year programme in all the public/private universities of the country.

8. Under special circumstances on the recommendations of respective academic body, student can have exit by having associate BS degree after successful completion of 2 years requirements.
COMPULSORY COURSES IN ENGLISH FOR BS
(4 YEAR) IN BASIC & SOCIAL SCIENCES

Functional English

Objectives: To 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
Communication Skills

Objectives:
To 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 and minutes of the meeting, use of library and internet recourses

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 Yorky.

## Semester III

**Technical Writing and Presentation Skills**

**Objectives:**
To enable the students to write a research paper / technical report in a succinct manner according to a specified format.

**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**

**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 northern 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).

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:

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

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

d) Presentation Skills
e) Reading
The Mercury Reader. A Custom Publication. Compiled by northern 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-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) 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,”
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)

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.


Recommended Books:
2. Boston (suggested text)
2. MATHEMATICS II (CALCULUS)

Credit Hours: \( \mathbf{3} + 0 \)

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:

\textit{Preliminaries}: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities. \textit{Limits and Continuity}: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

\textit{Derivatives and their Applications}: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

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

Recommended Books:

4. Thomas G. B, Finney A. R. \textit{Calculus} (11\textsuperscript{th} Edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Credit Hours: \( \mathbf{3} + 0 \)

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:

\textit{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.

\textit{Circle}: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

\textit{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:

modes, quartiles, deciles and percentiles. Measures of dispersion: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

**Recommended Books:**
4. Wilcox, R. R., ‘*Statistics for The Social Sciences*’,

5. **MATHEMATICS FOR CHEMISTRY**

**Credit Hours:** 3

**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**

**Credit Hours:** 3

**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:**

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 Mclaurin 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 Hours: 3 (3+0)

1. What is Statistics?

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, Historogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

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.

4. Measures of Dispersion

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

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.

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.

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
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

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

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**


**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.
Scheme of Studies
For MS/MPhil Botany

Duration: 2 Semesters Course Work and 1-2 year research thesis after course work

Courses: 24 Credits
Thesis: 06 Credits
Total: 30 Credits

List of Proposed Courses:
In addition University can offer other courses as per expertise available.

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<td>Methods in Plant Cell, Tissue and Organ Culture</td>
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