CURRICULUM

OF

SOIL SCIENCE

BS/MS/PhD

(Revised 2014)

HIGHER EDUCATION COMMISSION
ISLAMABAD
CURRICULUM DIVISION, HEC

Prof. Dr. Mukhtar Ahmed  
Mr. Fida Hussain  
Mr. Rizwan Shoukat  
Mr. Abid Wahab  
Mr. Riaz-ul-Haque  
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Director General (Acad)  
Deputy Director (Curr)  
Assistant Director (Curr)  
Assistant Director (Curr)  

Composed by: Mr. Tanveer Ali, HEC
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PREFACE

The curriculum, with varying definitions, is a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives and learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Knowledge in all academic disciplines is expanding and even new disciplines are also emerging, it is imperative that curriculum are developed and revised regularly.

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 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 nominated by their organizations.

In order to impart education at par with quality 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  STAGE-II  STAGE-III  STAGE-IV

CURRI. UNDER CONSIDERATION  CURRI. IN DRAFT STAGE  FINAL STAGE  FOLLOW UP STUDY

COLLECTION OF REC  APPRAISAL OF 1ST DRAFT BY EXP. OF COL./UNIV  PREP. OF FINAL CURRI.  QUESTIONNAIRE

CONS. OF CRC.  FINALIZATION OF DRAFT BY CRC  INCORPORATION OF REC. OF V.C.C.  COMMENTS

PREP. OF DRAFT BY CRC  APPROVAL OF CURRI. BY V.C.C.  PRINTING OF CURRI.  REVIEW

IMPLE. OF CURRI.  BACK TO STAGE-I

ORIENTATION COURSES

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Soil Science was held during June 11 to 13, 2014 at HEC Regional Centre, Quetta to finalize the draft of Soil Science for BSc/MSc (Hons) & PhD that prepared in its preliminary meeting held on October 28-30, 2013 at HEJ, University of Karachi. The following members attended the meeting:

Sr. #  Name & Address

1. Prof. Dr. Mohammad Saleem Akhtar,  Convener
   Professor / Chairman,
   Department of Soil Science & SWC,
   PMAS Arid Agriculture University,
   Rawalpindi Shamshabad, Murree Road,
   Rawalpindi.
   msakhtar@uaar.edu.pk

2. Dr. Muhammad Jamil Khan,  Member/Secretary
   Professor / Chairman,
   Department of Soil & Environmental
   Science, Gomal University, D. I. Khan.
   shahmir3rd@yahoo.com jamil@gu.edu.pk

3. Dr. Zahir Shah,  Member
   Professor & Chairman,
   Department of Soil & Environmental
   Sciences, The University of Agriculture,
   Peshawar.
   zahirshah@aup.edu.pk

4. Dr. Muhammad Yaseen,  Member
   Associate Professor,
   Institute of Soil & Environmental
   Sciences,
   University of Agriculture Faisalabad,
   Faisalabad.
   dryaseenuaf@yahoo.com

5. Dr. Inayatullah Rajpar,  Member
   Professor & Chairman,
   Department of Soil Science,
6. Dr. Bushra Khan, Member
   Assistant Professor,
   Department of Environmental Sciences,
   University of Peshawar,
   Peshawar.
bushraasu@yahoo.com

7. Dr. Ghulam Sarwar, Member
   Assistant Professor, HoD
   Department of Soil & Environmental Sciences, University College of Agriculture,
   University of Sargodha, Sargodha.
   ghulamsarwar@uos.edu.pk

8. Mr. Zubair Rehman, Member
   Assistant Professor/HoD,
   Department of Soil Science,
   Balochistan Agriculture College,
   Baleli, Quetta.
zubair795@yahoo.com

9. Dr. Farhat Ullah Khan, Member
   Lecturer,
   Department of Agricultural Sciences,
   Allama Iqbal Open University,
   Islamabad.
   farhatkhan7@gmail.com

2. The following members, who attended the preliminary meeting, could not attend the final meeting due to other engagements:

<table>
<thead>
<tr>
<th>Sr. #</th>
<th>Name &amp; Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Moazzam Jamil, Member</td>
</tr>
<tr>
<td></td>
<td>Principal / Associate Professor,</td>
</tr>
<tr>
<td></td>
<td>University College of Agriculture &amp; Environmental Sciences,</td>
</tr>
<tr>
<td></td>
<td>The Islamia University of Bahawalpur, Bahawalpur.</td>
</tr>
<tr>
<td></td>
<td>E-mail:</td>
</tr>
<tr>
<td>2.</td>
<td>Mr. Abdul Khaliq, Member</td>
</tr>
<tr>
<td></td>
<td>Chairman,</td>
</tr>
<tr>
<td></td>
<td>Department of Soil &amp; Environmental Science, Faculty of Agriculture,</td>
</tr>
<tr>
<td></td>
<td>University of Azad Jammu &amp; Kashmir, Rawalakot, Poonch.</td>
</tr>
<tr>
<td></td>
<td>E-mail:</td>
</tr>
</tbody>
</table>
3. Prof. Dr. Muhammad Abid, Member
   Chairman, Department of Soil Science, Faculty of Agricultural Sciences & Technology B. Z. University, Multan.
   E-mail:

3. The meeting started with recitation of Verses from the Holy Quran by Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC. After brief introduction of participants, Mr. Habibullah Nasir, Deputy Director RC Quetta, HEC inaugurated the session and welcomed the participants on behalf of the Executive Director, HEC and thanked them for their participation in this important exercise.

4. Mr. Riaz-ul-Haque requested the Convener of the Committee to start Technical Session in accordance with the agenda. The house opted Dr. Muhammad Jamil Khan, Professor / Chairman, Department of Soil & Environmental Science, Gomal University, D. I. Khan as Co-Secretary of the committee.

5. The Committee after three day thorough deliberation and discussion finalized the draft curriculum of Soil Science for BSc/MSc (Hons) degrees including revisiting of recommended books. The Committee agreed that the recommendations will be published as Annexure in the final booklet of curriculum to be circulated by HEC for adoption/implementation to universities/degree awarding institutes of Pakistan.

6. Mr. Riaz-ul-Haque thanked the Convener and all members of the committee for their contribution with professional zeal. The committee appreciated Mr. Riaz-ul-Haque for facilitating the event and lauded the efforts by Mr. Habibullah Nasir, Deputy Director RC Quetta and other officials for providing local hospitality.

The meeting ended with vote of thanks.
## Template for 4-Year BS/BSc (Hons) in Agricultural Disciplines

1. **Compulsory Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics / Biology (2 courses)</td>
<td>6</td>
<td>(3-0)</td>
</tr>
<tr>
<td>Statistics 1 &amp; 2</td>
<td>6</td>
<td>(3-0)</td>
</tr>
<tr>
<td>Computers / IT</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Pakistan Studies</td>
<td>2</td>
<td>(2-0)</td>
</tr>
<tr>
<td>Islamic Studies</td>
<td>2</td>
<td>(2-0)</td>
</tr>
<tr>
<td>Communication Skills</td>
<td>3</td>
<td>(3-0)</td>
</tr>
<tr>
<td>English</td>
<td>3</td>
<td>(3-0)</td>
</tr>
<tr>
<td>Basic Agriculture</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>28</strong></td>
<td></td>
</tr>
</tbody>
</table>

2. **Interdisciplinary Foundation Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agronomy</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Plant Breeding &amp; Genetics</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Entomology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Plant Pathology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Food Technology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Horticulture</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Soil Science</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Agriculture Economics</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>24</strong></td>
<td></td>
</tr>
</tbody>
</table>

3. **Supporting Courses**

6-8 courses (3 Cr. hr) amongst below:
- Agriculture Extension
- Forestry & Range Management
- Animal Science
- Marketing & Agri Business
- Rural Development
- Human Nutrition
- Agriculture Chemistry
- Agriculture Engineering
- Water Management
- Any other discipline recommended by the university

| Sub-Total**                                   | 18-24   |

**Sub-Total during the first four semesters**

<table>
<thead>
<tr>
<th>Section</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Semester 5, 6, 7 &amp; 8</td>
<td>56-60</td>
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<tr>
<td>Project / Internship</td>
<td>04</td>
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<tr>
<td>Grand Total</td>
<td>130-140</td>
</tr>
</tbody>
</table>
• 1 credit of theory = one contact hour per week for 16-18 weeks and 1 practical/Lab hour = 3 contact hours per week for 16-18 weeks.
• In case of non availability of department of supporting courses, courses from foundation courses can be opted.
CURRICULUM FOR SOIL SCIENCE
BS/BSc (HONS.) AGRICULTURE

Foundation Course

SS-301 Introduction to Soil Science 3(2-1)

Major Courses

SS-501 Physical Properties of Soil 3(2-1)
SS-502 Salt-Affected Soils and Water Quality 3(2-1)
SS-503 Chemical Properties of Soil 3(2-1)
SS-504 Soil Fertility and Fertilizer Use 3(2-1)
SS-505 Instrumentation and Laboratory Techniques 3(1-2)
SS-506 Soil Survey and Land Evaluation 3(2-1)
SS-507 Soil Genesis and Morphology 3(2-1)
SS-508 Soil and Water Conservation 3(2-1)
SS-601 Soil Microbiology 3(2-1)
SS-602 Soil-Water-Plant Relationship 3(3-0)
SS-603 Environmental Pollution and Management 3(3-0)
SS-604 Land Degradation and Management 3(3-0)
SS-605 Research Project and Scientific Writing 3(2-1)
SS-606 Trace Elements in Agriculture 3(2-1)
SS-607 Municipal and Agro Waste Management 3(3-0)
SS-608 Internship/ Research Project 4(0-4)
SS-609 Carbon Sequestration In Soil 3(2-1)

Total 52 (35-17)
### SEMESTER WISE BREAK UP

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5th Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-501</td>
<td>Physical Properties of Soil</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-503</td>
<td>Chemical Properties of Soil</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-505</td>
<td>Instrumentation and Laboratory Techniques</td>
<td>3(1-2)</td>
</tr>
<tr>
<td>SS-507</td>
<td>Soil Genesis and Morphology</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td>Elective – I</td>
<td>3(3-0)</td>
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<tr>
<td></td>
<td>Total Credit Hours</td>
<td>15</td>
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<tr>
<td><strong>6th Semester</strong></td>
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<td></td>
</tr>
<tr>
<td>SS-502</td>
<td>Salt-Affected Soils and Water Quality</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-504</td>
<td>Soil Fertility and Fertilizer Use</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-506</td>
<td>Soil Survey and Land Evaluation</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-508</td>
<td>Soil and Water Conservation</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td>Elective – II</td>
<td>3(3-0)</td>
</tr>
<tr>
<td></td>
<td>Total Credit Hours</td>
<td>15</td>
</tr>
<tr>
<td><strong>7th Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-601</td>
<td>Soil Microbiology</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-603</td>
<td>Environmental Pollution and Management</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>SS-605</td>
<td>Research Project and Scientific Writing</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-607</td>
<td>Municipal and Agro Waste Management</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>SS-609</td>
<td>Carbon Sequestration in Soil</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td>Elective – III</td>
<td>3(3-0)</td>
</tr>
<tr>
<td></td>
<td>Total Credit Hours</td>
<td>18</td>
</tr>
</tbody>
</table>
### 8th Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-602</td>
<td>Soil - Water - Plant Relationship</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>SS-604</td>
<td>Land Degradation and Management</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>SS-606</td>
<td>Trace Elements in Agriculture</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SS-608</td>
<td>Internship/Research Project</td>
<td>4(0-4)</td>
</tr>
</tbody>
</table>

**Total Credit Hours** 16

**Sub Total** 128
DETAIL OF COURSES

Foundation Course

SS-301 INTRODUCTION TO SOIL SCIENCE 3(2-1)

Objective and Learning Outcome
This course introduces the concepts of soil science for agriculture students at undergraduate level. The students will be able to understand soil properties and their relationship with crop production and environment.

Course Contents
1. Definition of earth, geology and soil science; Disciplines of soil science.
2. Factors and processes of soil formation
3. Soil forming rocks and minerals and types of parent material
4. Soil profile description
5. Physical, chemical and biological properties of soil
6. Soil classification and land use capability classes
7. Soil organic matter: Sources, composition and decomposition
8. Soil Fertility: Essential plant nutrients, organic and inorganic sources
9. Salt-affected and waterlogged soils
10. Soil and water conservation
11. Soil and water pollution

Practical
1. Soil sampling and handling
2. Preparation of saturated soil paste and measurement of pH and EC
3. Determination of soil water contents
4. Determination of bulk density and total porosity
5. Soil texture: feel and hydrometer methods
6. Irrigation water analysis and interpretation
7. Identification and calculation of nutrient percentage from fertilizer
8. Determination of soil organic matter

Recommended Books:

Major Courses

SS-501 PHYSICAL PROPERTIES OF SOIL 3(2-1)

Objective and Learning Outcome

Physical properties of soil and their role in water and nutrient holding and soil conditions in relation to plant growth will be covered. The students should be able to measure and interpret the soil physical properties and their significance in crop growth.

Course Contents

1. Soil physical condition and plant growth
2. Soil texture, specific surface area and importance
3. Soil structure: development and description
4. Soil crusting and surface sealing with role in seedling emergence
5. Particle and bulk density: description and significance
6. Total porosity and pore-size distribution and root development
7. Soil air composition and aeration
8. Soil temperature and its management
9. Soil color: causes and significance
10. Soil consistency and strength and interpretation for soil mechanics
11. Soil water and water potential and plant available water.
12. Water and solute movement through soil
13. Soil compaction: causes and remedies
14. Soil tillage systems and tilth
15. Soil physical environment and root architecture

Practical

1. Textural analysis: sieve, hydrometer, pipette and feel methods
2. Determination of bulk and particle density
3. Total soil porosity estimation
4. Aggregate stability estimation
5. Measurement of soil water contents
6. Measurement of soil temperature
7. Soil color and its interpretation
8. Determination of soil strength/soil penetrometer resistance

Recommended Books:

SS-502 SALT-AFFECTED SOILS AND WATER QUALITY 3(2-1)

Objective and Learning Outcome
Extent of salt-affected soils, sources and type of salinity, water quality and management are discussed. The students will be able to diagnose type of salinity, apply suitable reclamation techniques and recommend sustainable management for crop production.

Course contents
1. Salt-affected soils, classification, properties and extent
2. Salination and sodication: Gapon and pHc equations
3. Systems of characterization of salt-affected soils
4. Chemistry of soil solution
5. Root zone salinity
6. Reclamation and management of salt-affected soils
7. Irrigation water: Criteria and classification
8. Groundwater: Characteristics and resources
9. Salinity build up and prediction
10. Waterlogged soils: Causes, impact and management
11. Bio-saline Agriculture

Practical
1. Field visits and sampling of salt-affected soils and irrigation water
2. Saturated soil extract analysis, SAR calculation and ESP prediction
3. Irrigation analysis, classification and interpretation
4. Gypsum requirement of soil and brackish irrigation water
5. Demonstration of Ex-situ soil reclamation techniques

Recommended Books:
SS-503 CHEMICAL PROPERTIES OF SOIL 3(2-1)

Objective and Learning Outcome

Chemical properties of soil with their role in nutrient availability, chemical processes and soil condition for plant growth are discussed. The students should be able to measure and interpret the chemical properties and their role for plant growth and pollutant behavior.

Course Contents

1. Soil colloids: Inorganic and organic
2. Layer silicate clays, tectosilicates and sesquioxides
3. Charge characteristics of colloids: sources and significance
4. Ion exchange and Zero point of charge
5. Diffuse double layer theory
6. Soil pH and buffering capacity
7. Base saturation percentage
8. Exchange equations (Langmuir, Freundlich and Gapon)
9. Sorption and desorption in soils

Practical

1. pH with and without different electrolytes, and soil to water ratios
2. Soluble and extractable cations in soil
3. Cation exchange capacity of three different textured soils
4. Base saturation percentage
5. Estimation of gypsum requirement

Recommended Books:


SS-504 SOIL FERTILITY AND FERTILIZER USE

Objective and Learning Outcome

Plant nutrients availability, replenishment and retention as well as use and behavior of fertilizer in soil are discussed. The students should be able to diagnose nutrient deficiency and toxicity symptoms and requirement of fertilizers for optimum plant growth.

Course Contents

1. Crop growth, factors affecting and growth expressions
2. Essential plant nutrients: functions, deficiency and toxicity
3. Movement of nutrients to roots, acquisition and uptake
4. Nitrogen gains and losses in soil
5. Nitrogen fertilizers and their fate in soil
6. Phosphorus forms and P-fertilizers behavior in soil
7. Potassium forms, amount and exchange equilibrium in soil
8. Calcium, magnesium and sulfur forms and amount in soil
9. Crop responses; factor affecting and residual effects
10. Integrated plant nutrient management
11. Nutrients behavior in submerged soil
12. Nutrient role in human and plant health
13. Micro Nutrients role and deficiency symptoms

Practical

1. Fertlizers identification and composition
2. Fertilizer requirement calculation
3. Fertilizer analyses (urea, CAN, DAP and SOP)
4. Determination of available P and K in soil
5. Plant analysis for N, P and K sufficiency and uptake
6. Field visits for identification of nutrients deficiency and toxicity symptoms
7. Visit to fertilizer factories, soil fertility institutes and demonstration trials
Recommended Books:


SS-505  INSTRUMENTATION AND LABORATORY TECHNIQUES  3(1-2)

Objective and Learning Outcome

Principles and use of common laboratory equipment and analytical techniques for soil and plant analysis are discussed. The students will be able to use laboratory instruments, and collect, handle, and analyze soil and plant samples.

Course Contents

1. Quality assurance
2. Safety measures in laboratory
3. Storage and disposal of chemicals
4. S.I. and derived S.I. units
5. Extraction, digestion and dry ashing
6. Introduction to principle and operation of specialized equipment:
   6.1 Conductivitymetry,
   6.2 potentiometry,
   6.3 spectrophotometry,
   6.4 Emission and absorption spectroscopy

Practical

1. Soil and plant sampling and preparation
2. Preparation of standard solutions
3. Introduction to soil analytical techniques for nitrate, P, K, and micronutrients
4. Interpretation analytical results
Recommended Books:


SS-506 SOIL SURVEY AND LAND EVALUATION 3(2-1)

Objective and Learning Outcome

Techniques used for survey and characterization of soil and their suitability for various uses are discussed. The students will be able to interpret the soil maps and delineate mapping units in the field and be able to use the concept of soil suitability and land use capability classes.

Course Contents

1. Soil and landform
2. Kinds and levels of soil survey
3. Aerial photographs and their interpretation
4. Stereoscopic vision theory
5. Field traverse selection
6. Purposes, characteristics and identification of mapping units
7. Mapping legends, mapping and taxonomic units
8. Interpretation and use of soil survey reports
9. Land capability and suitability classification
10. Application of GIS, GPS and remote sensing in soil survey

Practical

1. Reading of topographic maps and calculation of slope percentage
2. Stereoscope: Types and uses
3. Interpretation of aerial photographs
4. Demonstration of GIS, GPS and remote sensing techniques
5. Field visits
Recommended Books:

SS-507 SOIL GENESIS AND MORPHOLOGY 3(2-1)

Objective and Learning Outcome
Factors and processes of soil formation, interpretative soil morphology and local pedogenic processes and introduction to USDA soil classification system are discussed. The students should be able to understand and describe morphological features and taxonomic relations of different soils.

Course Contents
1. Historical prospective of development of Soil Science discipline
2. Weathering of rocks and minerals; types of parent materials
3. Soil genesis and factors affecting it
4. Pedogenic processes
5. Soil morphology
6. Description of soil profiles, including special soil features
7. Soil taxonomy: categories and nomenclature
8. Soil orders in Pakistan: extent and their significance

Practical
1. Soil profile description of important soil series
2. Field trips
3. Identification of soil orders

Recommended Books:
4. Soil Survey Staff. 2006. Keys to Soil Taxonomy. 10th Ed. USDA,

SS-508 SOIL AND WATER CONSERVATION 3(2-1)

Objective and Learning Outcome

In this course, students will learn various ways and means of soil and water losses and how these losses can be decreased with various strategies of their conservation.

Course Contents

1. Soil erosion: description, types and impact on environment
2. Water and wind erosion: forms, causes and damages
3. Gravity erosion and landslides
4. Erosion prediction: modified Universal Soil Loss Equation; wind erosion equations
5. Erosion control and management: agronomic, engineering and bioengineering practices
6. Hydrological cycle and its components
7. Water conservation and management practices, and water harvesting techniques
8. Strategies for soil, water and environment conservation
9. Socio-economic issues of soil and water conservation

Practical

1. Measurement of slope gradient and discharge in water course
2. Calculation of runoff and soil losses
3. Visit to agro-meteorological / weather station
4. Visit of agronomical, engineering and bio-engineering practices used for soil and water conservation

Recommended Books:

Objective and Learning Outcome
Kinds and significance of microorganisms present in soil and their role in crop productivity and environmental quality are discussed. The students should be able to recognize different microbes, their functions in nutrient transformations under different conditions and their relationships with crops and environment.

Course Contents
1. Introduction and historical prospective of Soil Microbiology
2. Distribution, functions and classification of bacteria, archaea, actinomycetes, fungi, algae and fauna
3. Growth phases and environmental factors affecting soil microflora
4. Microbial ecology: soil organisms and their interactions
5. Soil organic matter decomposition; immobilization and mineralization of carbon; microbial fixation and release of CO₂
6. Microbial transformations of nutrients under aerobic and anaerobic soil conditions.
7. Microbial inoculants for N and P

Practical
1. Introduction to laboratory equipment
2. Media preparation
3. Measurement of microbial population and activity in soil
4. Algal culturing and their microscopy
5. Study of mineralization, nitrification and denitrification

Recommended Books:
Objective and Learning Outcome

Mechanisms of water and nutrient movement in soils and plants, and their relationships with plant growth are discussed. After completion of this course, the students will be able to understand water and nutrient movement in soil and plant and adaptation of plants to adverse soil water conditions.

Course Contents

1. Functions and properties of water
2. Components of soil and plant water potentials
3. Soil-plant-water relations
4. Movement of water and ions in soil and plant
5. Water absorption and root stem pressure
6. Water and mineral nutrient uptake
7. Photosynthesis and transpiration
8. Soil–plant–atmosphere continuum
9. Adaption of plants to adverse soil-water conditions

Recommended Books


Objective and Learning Outcome

The aim of this course is to teach students about soil, water and air pollution and impact on soil, plants and human health. The students should be able to know about the sources and causes of pollution and their remedies.

Course Contents

1. Introduction to soil, water and air pollution
2. Sources and causes of pollution
3. Types of pollutants: inorganic, organic and radioactive
4. Fate of pollutants: adsorption, precipitation, degradation, movement
Objective and Learning Outcome

Types of degraded lands and their effective utilization for crop production are highlighted. The students should be able to know causes of land degradation and their management for crop production.

Course Contents

1. Land resources and their uses in global and Pakistan perspective
2. Causes and types of degraded lands
3. Nutrient dynamics and management in degraded lands
4. Threats to national land use
5. Drought: low and erratic precipitation, lowering of water table; global warming and climate change
6. Water and wind erosion
7. Nutrient and organic matter depletion
8. Salinization of soil and water
9. Sea water intrusion
10. Soil physical degradation: Crusting and compaction
11. Water-logging
12. Land sliding

**Recommended Books:**


### SS-605 PREPARATION OF RESEARCH PROJECT AND SCIENTIFIC WRITING 3(2-1)

**Objective and Learning Outcome**

Problem oriented research plan, execution and documentation of research results are discussed. The students should be able to search literature, plan and execute research projects and publish research reports.

**Course Contents**

1. The purpose and kinds of research
2. General consideration and identification of the problem
3. Background reading and review of literature: objectives, sources, collection and citation
4. Preparation of research project: title, objectives, methodology, work plan and budget.
5. Scientific writing
   a. Aims, components and organizing the material
   b. Techniques of composition: table of contents, list of tables and figures, standard abbreviation
   c. Footnoting, documentation
   d. Referencing: alphabetical and chronological order
   e. Appendices and bibliography
6. Editing and evaluating the final draft.

**Practical**

1. Exercise of writing research proposal
2. Assigning different titles to the students
3. Exercise of collecting materials from different sources on assigned topics
4. Oral presentation

**Recommended Books:**


**SS-606 TRACE ELEMENTS IN AGRICULTURE 3(2-1)**

**Objective and Learning Outcome**

Sources and bio-geo-chemistry of trace elements, bioavailability and toxicity and environmental contamination issues are discussed. This course will equip the students with expertise about nutritional importance and environmental hazards of trace elements in agriculture.

**Course Contents**

1. Biogenic and geo-genic sources of trace elements.
2. Trace elements in agriculture (Zn, Mn, Cu, Fe, Mo, Co, B, Cl): nutritional aspects, availability, deficiency, toxicity and interactions.
3. Micronutrients: forms in soils and factors affecting their availability
4. Trace elements pollutants (Ag, As, Cd, Co, Cr, Hg, Ni, Pb, Se and V) in terrestrial and atmospheric eco-systems and their effects on plants, animal and human health.
5. Use of trace elements as commercial fertilizers.
6. Critical limits and functions in plants and their mobility.
7. Trace elements status of Pakistan soils and their response to various crops.
Practical

1. Analytical tests for trace elements in soil and plant.
2. Deficiency and toxicity symptoms

Recommended Books:


SS-607 MUNICIPAL AND AGRO WASTE MANAGEMENT 3(3-0)

Objective and Learning Outcome

Knowledge regarding the types and extent of municipal and agro wastes generation and their transformation into useful products is given due consideration. The students should be able to utilize the knowledge attained for the conversion of waste material into useful products.

Course Contents

1. Municipal and agro based waste: sources, types and composition
2. Nature and management of waste water
3. Solid waste management and role of community
4. Methods and technologies in solid waste management
5. Utilization of municipal waste as organic fertilizer and soil conditioner
6. Production of energy from municipal waste
7. Ethical issues of municipal and agro based waste management
8. International waste management strategies

Recommended Books:


**SS-608 INTERNSHIP/RESEARCH PROJECT 4(0-4)**

It will include orientation regarding literature review and project planning, e.g., title, hypothesis, objectives, methodology, execution, report writing, presentation and evaluation. The mode of evaluation of the progress of work will be determined by the respective host institution.

In case of research projects, each student will conduct research under the supervision of respective supervisor and will write a report.

**SS-609 CARBON SEQUESTRATION IN SOIL 3(2-1)**

**Objective and Learning Outcome**

Soil as a carbon sink and implications of its release to the atmosphere, relation of soil management with carbon emission, and international carbon budget & trade will be taught in the course. The students will learn effective organic carbon sequestration techniques for reduced carbon emission.

**Course Contents**

Introduction to carbon sequestration
Description and historical perspective of carbon cycle
Estimates and rate of carbon emission and climate change
Partitioning and transformations of carbon in soil
Soil and crop management strategies for carbon sequestration in soil; Crop residue incorporation, composting, agronomic practices
Biochar production, application, challenges and opportunities
Land use patterns in relation to carbon emission
International carbon trading

**Practical**

1. Estimation of soil organic carbon
2. Measurement of CO₂ emission in soil under different land use
3. Biochar preparation and characterization
Recommended Books:


### SCHEME OF STUDIES for Soil Science MS/MSc (Hons.)/PhD Programs

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-701</td>
<td>Principles and Uses of Laboratory Equipment</td>
<td>3(0-3)</td>
</tr>
<tr>
<td>SS-702</td>
<td>Soil Chemistry</td>
<td>3(2-1)</td>
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<tr>
<td>SS-703</td>
<td>Soil Fertility and Plant Nutrition</td>
<td>3(2-1)</td>
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<tr>
<td>SS-704</td>
<td>Soil Microbiology and Biochemistry</td>
<td>3(2-1)</td>
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<tr>
<td>SS-705</td>
<td>Soil Tazonomy</td>
<td>3(2-1)</td>
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<tr>
<td>SS-706</td>
<td>Salt-Affected and Waterlogged Soils</td>
<td>3(3-0)</td>
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<tr>
<td>SS-707</td>
<td>Soil Physics</td>
<td>3(2-1)</td>
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<tr>
<td>SS-708</td>
<td>Soil Mineralogy</td>
<td>3(2-1)</td>
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<tr>
<td>SS-709</td>
<td>Soil - Plant Relationship</td>
<td>3(3-0)</td>
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<tr>
<td>SS-710</td>
<td>Advanced Soil Chemistry</td>
<td>3(3-0)</td>
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<tr>
<td>SS-711</td>
<td>Advanced Soil Fertility</td>
<td>3(3-0)</td>
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<tr>
<td>SS-712</td>
<td>Advanced Soil Microbiology</td>
<td>3(3-0)</td>
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<tr>
<td>SS-713</td>
<td>Advanced Soil Physics</td>
<td>3(3-0)</td>
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<tr>
<td>SS-719</td>
<td>Special Problem</td>
<td>1(1-0)</td>
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<tr>
<td>SS-720</td>
<td>Seminar</td>
<td>1(1-0)</td>
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**Note:**

1. Minimum credit hours for MSc (Hons.) degree are 35 for course work including minor subjects which shall not exceed one-third of the total.
2. For the award of degree for MSc (Hons.) Agriculture (Soil Science) thesis carries a weightage of 10 credit hours.
3. For the award of PhD degree minimum credit hours for course work are 18 including 6 in minor subjects.
DETAIL OF COURSES

SS-701 PRINCIPLES AND USES OF LABORATORY EQUIPMENT 3(0-3)

Objective and Learning Outcome

Principles, theory and operation of the advanced instruments used for soil and plant analyses are discussed. The students should be able to operate different laboratory instruments, control error, interpret the data and maintain quality of analyses.

Course Contents

1. Quality management, assurance and control measures
2. Analytical errors, analysis and control
3. Development of standard operating procedures
4. Use of basic laboratory equipment:
   4.1 Spectrophotometer: UV and visible range
   4.2 Flame photometer
   4.3 Atomic absorption spectrophotometer
   4.4 Ion meter: selective ion electrodes
   4.5 EM-38 and EC probe
5. Introduction, principles and usage of specialized equipment:
   5.1 Inductively coupled plasma meter and direct current plasma meter
   5.2 Chromatography: GC and HPLC
   5.3 Microscopy: Scanning and transmission
   5.4 X-ray diffractometry
   5.5 Mass spectrophotometery
   5.6 Electro Ultra Filtration
   5.7 Neutron moisture probe/time domain reflectrometery (TDR)
   5.8 Oxygen diffusion rate meter
   5.9 Thermocycler PCR (polymerase chain reaction)
   5.10 Gel electrophoresis apparatus
6. Elements of analytical report writing

Recommended Books:

Objective and Learning Outcome

Principles governing ion exchange, retention, chemical equilibria for precipitation & synthesis and chemical remediation processes in soil are discussed. The students should be able to predict release of ions and fate of chemicals in soil by using models.

Course Contents

1. Chemical equilibria in soil, water and solute interactions
2. Soil solution-solid interaction
3. Mineral dissolution: congruent and incongruent
4. Neo-formation of minerals in soil
5. Thermodynamics and applications in soil
6. Organic matter: composition and fractionation
7. Surface chemistry of soil matrix
8. Sorption and desorption models
9. Ion exchange: selectivity coefficients, equivalent fraction concept
   9.1 Hysteresis in ion exchange
   9.2 Anion exclusion
   9.3 Complementation effect
   9.4 Zeta potential
10. Reactions of metal chelates in soils
11. Chemical behavior of ions / elements in aerated and submerged soils
12. Buffering reactions in soil
13. Chemical remediation of contaminated soils and water

Practical

1. Determination of CEC and base saturation
2. Developing K vs Ca + Mg activity ratios in laboratory
3. Determination of phosphorous adsorption isotherm
4. Comparative fit (data from 3) to Freundlich and Langmuir models
5. Developing titration curves

Recommended Books:


SS-703 SOIL FERTILITY AND PLANT NUTRITION 3(2-1)

Objective and Learning Outcome
Nutrient pools and dynamics in soil, uptake and translocation within the plant, their deficiencies and toxicities, interactions and fate of fertilizers are discussed. The students should be able to identify nutritional disorders, calculate fertilizer requirement and use efficiency, and understand techniques for integrated nutrient management.

Course Contents
1. Basic soil-plant-relationship in plant nutrition
2. Plant nutrient behavior in soils
3. Nutrient behavior in submerged soils
4. Soil fertility evaluation: soil test calibration and plant analysis
4.1 External and internal nutrient requirements
5. Fertilizer management strategies: nutrient availability and fertilizer use efficiency
5.1 Fertigation and foliar fertilization
5.2 Integrated plant nutrient management (IPNM)
5.3 Variable rate fertilizer technology
6. Nutrient-water and other interactions
7. Specific effects of fertilizers: plant, human and animal health
8. Environmental implications of fertilizer use

Practical
1. Soil and plant analysis for NPK
2. Interpretation of soil and plant analysis results
3. Create and learn deficiency symptoms of nutrients

Recommended Books:

SS-704 SOIL MICROBIOLOGY AND BIOCHEMISTRY 3(2-1)

Objective and Learning Outcome

Microbial mediated transformation of elements in soil, bioremediation and biotechnological approaches are discussed. The students should be able to understand and apply microbiological approaches for crop production and to safeguard the environment.

Course Contents

1. Rhizosphere: plant-microbes and microbe-microbe interactions
2. Microbial cycling of elements: macro and micronutrients and heavy metals; agricultural and environmental significance
3. Biochemistry and biotechnology of BNF; application in agriculture and environment
4. Carbon nitrogen Phosphorus and sulfur cycles
5. Plant growth regulators, phytotoxins and siderophores: microbiology and biochemistry
6. Composting: microbiology and biotechnology; agricultural and environmental application
7. Microbial metabolism
8. Bioremediation of contaminated soils: biodegradation and detoxification
9. Use of stable isotopes in microbiological research
10. Metabolic and nucleic acid based analysis of soil microbial diversity

Practical

1. Isolation of bacteria, actinomycetes and fungi
2. Enrichment techniques
3. Organic matter decomposition rates and C:N ratio effect
4. Inoculation techniques
5. Biological N\textsubscript{2} fixation measurement techniques

**Recommended Books:**


**SS-705 SOIL CLASSIFICATION**

**Objective and Learning Outcome**

The course is aimed to develop relation among different soil categories and their importance for particular use. The students should be able to classify soils and devise strategic and efficient land use.

**Course Contents**

1. Concepts and importance
2. Introduction to soil taxonomy
3. Criteria of classification
4. Properties diagnostic to categories
5. Diagnostic horizons and other diagnostic properties
6. Soil moisture regimes: Classes and importance
7. Soil temperature regimes: Classes and importance
8. Categories and nomenclature
9. Keys to categories: Order, suborder, great group and sub group FAO and other systems of classification
10. Agro ecological zones and soils of Pakistan

**Practical**

1. Profile description representing important soil orders
2. Classify research farm soil to sub group level.
3. Designation of genetic horizons found in Pakistan.
4. Identification of taxonomic names: orders, suborders, great groups, subgroups, families and series

**Recommended Books:**

3. FAO. 1998. World Reference Base for Soil Resources. FAO, Rome, Italy

**SS-706 SALT-AFFECTED AND WATERLOGGED SOILS 3(3-0)**

**Objective and Learning Outcome**

Sources, processes, accumulation and implications of excess salts and water in soil and their mitigation options are discussed in this course. The students should be able to identify sources and diagnose causes of excess salts and water, effectiveness of reclamation options and preventive measures, and select salt tolerant crops for profitable crop production.

**Course Contents**

1. Salt-affected and waterlogged soils in Pakistan and global perspective
2. Genesis of saline and sodic soils
3. Classification systems of salt-affected soils
4. Effects of salinity and sodicity on soil characteristics
5. Derivation and applications of Gapon equation
6. Plant responses to saline and sodic conditions
7. Amelioration strategies and economic feasibility for salt-affected soils
8. Water requirements for reclamation
9. Concept of leaching fraction and its applications
10. Soil waterlogging
   10.1. Causes
   10.2. Soil and plant responses
   10.3. Amelioration strategies
Objective and Learning Outcome

Physical processes of water, air, heat and pollutants movement in soil and their management are taught. The students should be able to understand soil physical conditions for optimal plant growth.

Course Contents

1. Soil physical properties and their inter-relationships
2. Nature and physical behavior of clay and clay minerals
3. Properties of water: Molecular, fluid and colligative
4. Soil water potential and its components
5. Measurement of water in soil
6. Water characteristics curves: Hysteresis
7. Saturated and unsaturated water flow
8. Infiltration models: Horton, Kostiakov, Green and Ampt, and Philip’s
   8.1 Flow in capillary tubes: Poiseuilles’ law
   8.2 Extended Darcy’s law and its application
   8.3 Richards equations for transient water flow
9. Free and artificial drainage: Drainage design equations
10. Heat flow in soil: Thermal properties; Factor affecting; heat flow equations
11. Transport of gases and water vapors through soil
12. Solute transport in soil; Solute conservation equation, convection-dispersion equation
   12.1. Miscible displacement and breakthrough curves
   12.2. Transport of inert, non-adsorbing and adsorbing chemicals in soil
   12.3. Volatile organic compounds transport in soil
13. Estimation of crop water requirement

Practical
1. Measurement of soil water, soil strength, particle density, soil water characteristic curves, infiltration rate and saturated hydraulic conductivity
2. Problem sets

Recommended Books:

SS-708 SOIL MINERALOGY 3(3-0)

Objective and Learning Outcome

Soil minerals’ structural properties, occurrence, identification and their role in nutrient chemistry, crop production, pollutant stabilization and engineering. The students should be able to understand and interpret mineral composition and its role in nutrient availability and structural stability.

Course Contents
1. Concept and significance
2. Chemical and structural classification of soil minerals
3. Carbonate, sulphate, sulphide and phosphate minerals
4. Oxides and hydroxide of Al, Fe and Mn
5. Phyllosilicate in soils: structure and morphological characteristics
6. Kaolinite, halloysite and serpentine minerals
7. Allophane and imogolite
8. Micas: structures, weathering and effect on K availability
9. Vermiculite: structure and properties in relation to K/NH₄
10. Smectites: structure and properties in relation to CEC
11. Chlorites and Inter-stratification in layer silicates
12. Tectosilicates: feldspar, quartz and zeolite
13. Clay mineral economy of Pakistan
14. Impacts of soil minerals composition on environment

Recommended Books:
5. Recent literature

SS-709 SOIL-PLANT RELATIONSHIP 3(3-0)

Objective and Learning Outcome

The course is designed to address the intricacies of soil and plant relations for crop production. The students should be able to understand hypoxia and salinity interactive effect on plant growth and importance of mycorrhizae, water and nutrient uptake and translocation to aerial parts.

Course Contents
1. Soil-plant-environment relationship
2. Plant root system: growth distribution, forms and factors affecting; Root hairs and CEC of roots; shoot-root relationship
3. Rhizosphere: root exudates and factors affecting; pH, redox potential and significance
4. Mycorrhizae: types and mechanisms for water and nutrient uptake
5. Uptake and transport of ions: movement in soil and plant
6. Mechanisms of ion transport across membranes: Ion release into xylem, xylem and phloem transport; factors affecting ion uptake
7. Water movement from soil to plant root and within plant
8. Water use efficiency and transpiration ratio
9. Water stress, hypoxia and plant growth
10. Mechanisms of salt tolerance; salinity-hypoxia interaction
11. Plant responses and adaptation to extreme environments
Recommended Books:


SS-710 ADVANCED SOIL CHEMISTRY 3(3-0)

Course Outline

1. Chemical thermodynamics of soils: Processes and variables
2. Chemical potentials: Metal oxides, hydroxides and silicates clays
3. Kinetics of soil chemical reactions
4. Precipitation and dissolution in soil environment
5. Surface electro-chemistry of colloids: Sorption of trace metal ions; Selectivity and pH
6. Inter-particles attraction: Solid-solid and solid-liquid interaction
7. Chemistry of submerged soils
8. Chemical transformations of selective elements in soils
9. Contamination of soils with organic and inorganic pollutants
10. Risk assessment of trace metals in soil and water
11. Integrated management of polluted environment
12. Sorption theory: Description and application for decontamination of soils and water
13. Recent developments in soil and environmental chemistry
14. Systems for waste water treatment: Physical, chemical and bio-chemical

Recommended Books:


SS-711 ADVANCED SOIL FERTILITY 3(3-0)

Course Outline

1. Growth expression: Mitscherlich and Quadratic equations
2. Plant responses to applied nitrogen: Mathematical description
   2.1 Stubble management and N availability
   2.2 Effect of forms of nitrogen on plant growth: Ammonia absorption, losses and toxicity
3. Phosphate phase equilibria in soils: Dissolution, precipitation, retention reaction at microsites
   3.1 Reaction products and changes in applied P
   3.2 Soil phosphate buffering capacity and availability
4. Potassium equilibria in soil: Quantity/intensity relationship and availability
5. Modeling nutrient uptake by plants
6. Modeling nutrient losses
7. Nutrition and plant disease interactions
8. Mineral nutrition of horticultural plants
9. Modern concept in soil fertility: Hydroponics, tunnel farming and roof top / pot culture
10. Formulation of fertilizer recommendations
11. Integrated plant nutrient management system
12. Soil variability and its control in field experiments

Recommended Books:

Course Outline

1. Recent trends and approaches in soil quality and crop growth improvement in soil and environmental microbiology
2. Microbiology of the terrestrial and aquatic environments
3. Organic pollutants: sources and types, biodegradation and bioremediation
4. Biotransformation of metal pollutants
5. Metabolic and nucleic acid based analysis of soil microbial diversity
   5.1 Extraction of bacterial DNA from soil
   5.2 Recombinant DNA techniques, PCR, probes and reporter genes used for monitoring soil microbes
6. Soil enzymes and their role

Recommended Books:


Course Outline

1. Water flow equations and their applications
2. Thermodynamic potentials and chemical potential of soil water
3. Use of models for artificial drainage
   3.1 Factors influencing drainage
4. Heat flow equations: Application and calculations
5. Application of gas flow equations
6. Pollutant transport in soil environment: Analytic solutions of the CDE model
7. Mobile-immobile water flow model for solute transport
8. Behavior assessment model for pesticide and hormones transport
9. Application of soil physics for remediation of hazardous wastes
10. Spatial variability analysis of soil properties and significance
11. Analysis of frequency distribution
12. Techniques for characterizing variability
13. Irrigation water scheduling; Water balance; Old and modern concepts of irrigation
14. Irrigation and water use efficiency
15. Calculation of evapo-transpiration by various methods

**Recommended Books:**

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

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

Comprehension
Answers to questions on a given text

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

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

Translation skills
Urdu to English

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

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books:
1. Functional English
   a) Grammar
b) Writing

c) Reading/Comprehension

d) Speaking

   English II (Communication Skills)

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

   Course Contents:

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

   Essay writing
   Introduction

   CV and job application

   Translation skills
   Urdu to English

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

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

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

   Note: documentaries to be shown for discussion and review

Recommended Books:

   Communication Skills

   a) Grammar

   b) Writing

c) Reading
2. Reading and Study Skills by John Langan

**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 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

Recommended Books:

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

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

Seerat of Holy Prophet (S.A.W) I
1. Life of Muhammad Bin Abdullah (Before Prophet Hood)
2. Life of Holy Prophet (S.A.W) in Makkah
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. Quran & 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 Khilaft-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. Hameedullah Muhammad, "Muslim Conduct of State"

3. Hameedullah Muhammad, "Introduction to Islam"

4. Mulana Muhammad Yousaf Islahi, "An Introduction to the Study of Islamic Law"
   leaf Publication Islamabad, Pakistan.

5. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law"
   leaf Publication Islamabad, Pakistan.


7. Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes"
   Islamic Book Service (1982)


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.


Recommended Books:

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:**


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:
1. Algebra

2. Statistics
   Introduction: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. Frequency distribution: Organisation of data, array, ungrouped and grouped data, types of
frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. Measures of central tendency: Mean medium and modes, quartiles, deciles and percentiles. Measures of dispersion: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

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:

6. MATHEMATICS FOR PHYSICS

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

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

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

Statistics-I

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

Practical:

a. Frequency Distribution  
b. Stem-and-Leaf diagram  
c. Various types of Graphs  
d. Mean, Geometric mean Harmonic Mean,  
e. Median, Quartiles Deviation, mean Deviation.  
f. Standard Deviation, Variance, Coefficient of variation,  
g. Skewness  and kenosis

Recommended Books:

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad

Statistics-II

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using
Z-test and t-test, Paired t-test, Test of association of attributes using X2 (chi-square) Testing hypothesis about variance.

Practical:

a. Sampling random sampling
b. Stratified random sampling.
c. Sampling distribution of mean
d. Testing of hypotheses regarding population mean
e. Testing of hypotheses about the difference between population means
f. Chi-square test
g. Testing of Correlation Coefficient
h. Fitting of simple linear regression
i. One-way ANOVA
j. Two-way ANOVA

Recommended Books:

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
Introduction to Information and Communication Technologies

Course Structure: Lectures: 2 Labs: 1  Credit Hours: 3
Pre-requisite: None  Semester: 1

Course Description:

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications. After completing this course, a student will be able to:
- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

Course Contents:

Basic Definitions & Concepts
Hardware: Computer Systems & Components
Storage Devices, Number Systems
Software: Operating Systems, Programming and Application Software
Introduction to Programming, Databases and Information Systems
Networks
Data Communication
The Internet, Browsers and Search Engines
The Internet: Email, Collaborative Computing and Social Networking
The Internet: E-Commerce
IT Security and other issues
Project Week
Review Week

Text Books/Reference Books:

ANNEXURE - G

Functional Biology-I Credit Hours 3+0

Biological Methods

Principles of Cellular Life
Chemical Basis
Structure and Function
Principles of Metabolism
Energy Acquisition
Principles of Inheritance
Mitosis and Meiosis
Chromosomes
Observable Inheritance Patterns
DNA Structure and Function
RNA and Proteins
Genes
Genetic Engineering and Biotechnology

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

Reading:

Functional Biology-II Credit Hours 3+0

Myths and Realities of Evolution

Microevolution
Speciation
Macroevolution

Level of Organization
Plants
Tissues
Nutrition and Transport
Reproduction
Growth and Development

Animals
Tissue, Organ System and Homeostasis
Information Flow and Neuron
Nervous System
Circulation and Immunity
Nutrition and Respiration
Reproduction and Development

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

Reading:

Note:
Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.
Functional Biology-II Credit Hours 3+0

Myths and Realities of Evolution

Microevolution
Speciation
Macroevolution

Level of Organization
Plants
Tissues
Nutrition and Transport
Reproduction
Growth and Development

Animals
Tissue, Organ System and Homeostasis
Information Flow and Neuron
Nervous System
Circulation and Immunity
Nutrition and Respiration
Reproduction and Development

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

Reading:


Note:

Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.
RECOMMENDATIONS

1. All the degree awarding institutions in Soil Science should follow the semester system as per HEC rules and regulations.

2. Uniform degree nomenclature should be followed in all degree awarding institutions.

3. In the cases where a course is taught / offered by more than one faculty, uniformity may be observed in teaching, paper setting and evaluation.

4. The committee felt serious shortage of faculty in some areas of the discipline of Soil Science particularly, soil physics, soil mineralogy, soil genesis, classification and survey. These areas need to be strengthened by providing fellowships to faculty members.

5. The committee felt shortage of local text books in Soil Science. It is suggested that the text book “Soil Science” published by National Book Foundation may be revised / updated and writing of new local books on different disciplines of Soil Science be encouraged.

6. It is felt that often practical are not as rigorously performed as needed due to lack of chemicals, glassware and equipment at under-graduate level. Similarly, lack of transport facilities hinders field trainings. HEC is suggested to devise mechanism to ensure availability of lab consumables and transport facilities to the students.

7. HoDs are advised to approach HEC for funds to strengthen their departments. HEC is stressed to entertain their fund requirements on priority bases.

8. In every institution, a central repair cell headed by an Electronic Engineer may be established for maintenance/repair of scientific equipment with HEC funding.

9. After the 18th amendment, the dissolution of Soil Survey department has ended the work on soil survey and classification and created hindrances in institutional co-ordination. It is therefore advised that provincial soil survey department may be re-established with manpower and infrastructure.

10. Short term teachers exchange program (STEP) may be re-vitalized.

11. The text book of Soil Science published by National Book Foundation, 1996 may be revised immediately

12. Faculty orientation for the courses where the required expertise is needed with respect to modification made in curricula may be arranged on regular basis.
13. Public private linkage program may be strengthened to update the student knowledge regarding current scenarios.

14. M.Sc and PhD Thesis and evaluation system, uniform policy by HEC for all institutions to avoid ambiguity.

15. Soil Science Department in several universities have adopted nomenclature as Soil and Environmental Sciences, for the reason some delegates strongly insisted that the course codes should carry the prefix “SES” instead of “SS”, and other vehemently opposed.