

**CURRICULUM  
OF  
SOIL SCIENCE  
BS/MS/PhD**

**(Revised 2014)**



**HIGHER EDUCATION COMMISSION  
ISLAMABAD**

## **CURRICULUM DIVISION, 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).

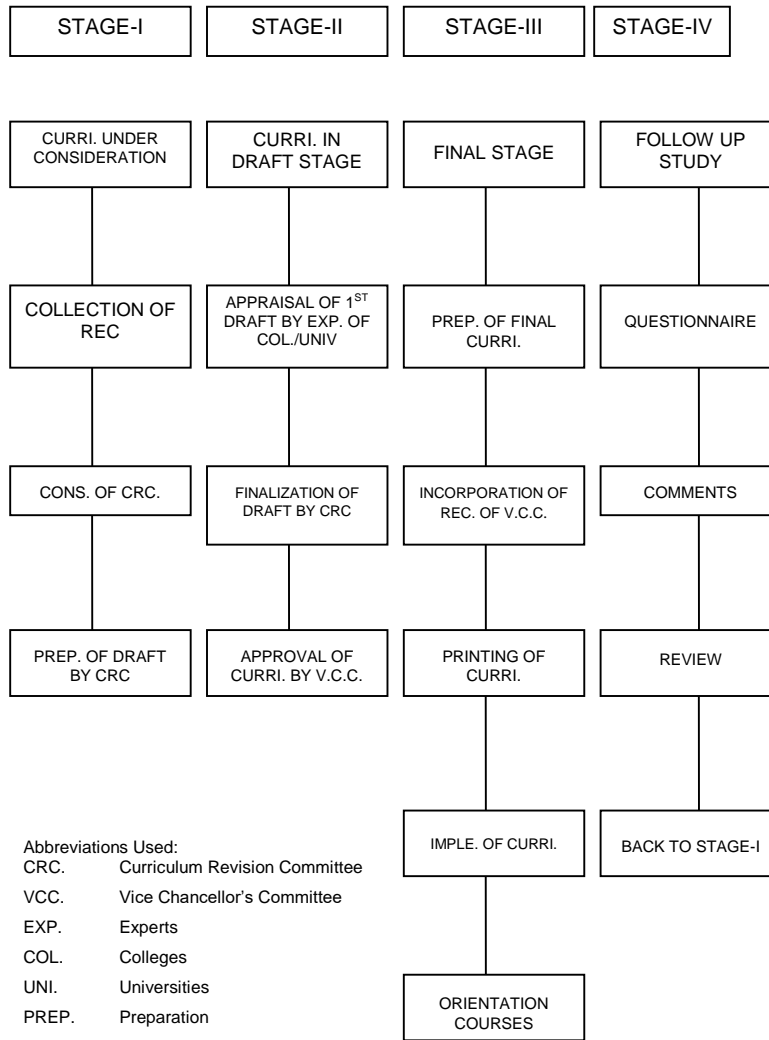
In compliance with the provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, 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](http://www.hec.gov.pk)).

**(Fida Hussain)**  
**Director General (Academics)**

## CURRICULUM DEVELOPMENT PROCESS



**MINUTES OF THE FINAL MEETING OF HEC NATIONAL  
CURRICULUM REVISION COMMITTEE FOR SOIL  
SCIENCE HELD AT HEC REGIONAL CENTRE, QUETTA  
FROM JUNE 11-13, 2014.**

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:

<b>Sr. #</b>	<b>Name &amp; Address</b>	
1.	Prof. Dr. Mohammad Saleem Akhtar, Professor / Chairman, Department of Soil Science & SWC, PMAS Arid Agriculture University, Rawalpindi Shamsabad, Murree Road, Rawalpindi. <a href="mailto:msakhtar@uaar.edu.pk">msakhtar@uaar.edu.pk</a>	Convener
2.	Dr. Muhammad Jamil Khan, Professor / Chairman, Department of Soil & Environmental Science, Gomal University, D. I. Khan. <a href="mailto:shahmir3rd@yahoo.com">shahmir3rd@yahoo.com</a> <a href="mailto:jamil@gu.edu.pk">jamil@gu.edu.pk</a>	Member/Secretary
3.	Dr. Zahir Shah, Professor & Chairman, Department of Soil & Environmental Sciences, The University of Agriculture, Peshawar. <a href="mailto:zahirshah@aup.edu.pk">zahirshah@aup.edu.pk</a>	Member
4.	Dr. Muhammad Yaseen, Associate Professor, Institute of Soil & Environmental Sciences, University of Agriculture Faisalabad, Faisalabad. <a href="mailto:dryaseenuaf@yahoo.com">dryaseenuaf@yahoo.com</a>	Member
5.	Dr. Inayatullah Rajpar, Professor & Chairman, Department of Soil Science,	Member

Sindh Agriculture University, Tandojam.  
[irajpar@yahoo.com](mailto:irajpar@yahoo.com)

- |    |  |        |
|----|--|--------|
| 6. | Dr. Bushra Khan,<br>Assistant Professor,<br>Department of Environmental Sciences,<br>University of Peshawar,<br>Peshawar.<br><a href="mailto:bushraasu@yahoo.com">bushraasu@yahoo.com</a>  | Member |
| 7. | Dr. Ghulam Sarwar,<br>Assistant Professor, HoD<br>Department of Soil & Environmental<br>Sciences, University College of<br>Agriculture,<br>University of Sargodha, Sargodha.<br><a href="mailto:ghulamsarwar@uos.edu.pk">ghulamsarwar@uos.edu.pk</a> | Member |
| 8. | Mr. Zubair Rehman,<br>Assistant Professor/HoD,<br>Department of Soil Science,<br>Balochistan Agriculture College,<br>Baleli, Quetta.<br><a href="mailto:zubair795@yahoo.com">zubair795@yahoo.com</a>   | Member |
| 9. | Dr. Farhat Ullah Khan,<br>Lecturer,<br>Department of Agricultural Sciences,<br>Allama Iqbal Open University,<br>Islamabad.<br><a href="mailto:farhatkhan7@gmail.com">farhatkhan7@gmail.com</a>   | Member |

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

**Sr. # Name & Address**

- |    |   |        |
|----|---|--------|
| 1. | Dr. Moazzam Jamil,<br>Principal / Associate Professor,<br>University College of Agriculture &<br>Environmental Sciences,<br>The Islamia University of Bahawalpur,<br>Bahawalpur.<br>E-mail: | Member |
| 2. | Mr. Abdul Khaliq<br>Chairman,<br>Department of Soil & Environmental<br>Science, Faculty of Agriculture,<br>University of Azad Jammu & Kashmir,<br>Rawalakot. Poonch.<br>E-mail:             | Member |

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

	<b>Credits Hours</b>
Mathematics / Biology (2 courses)	6 (3-0) (2-1)
Statistics 1 & 2	6 (3-0) (3-0)
Computers / IT	3 (2-1)
Pakistan Studies	2 (2-0)
Islamic Studies	2 (2-0)
Communication Skills	3 (3-0)
English	3 (3-0)
Basic Agriculture	3 (2-1)
	<b>Sub-Total 28</b>

### 2. Interdisciplinary Foundation Courses

Agronomy	3 (2-1)
Plant Breeding & Genetics	3 (2-1)
Entomology	3 (2-1)
Plant Pathology	3 (2-1)
Food Technology	3 (2-1)
Horticulture	3 (2-1)
Soil Science	3 (2-1)
Agriculture Economics	3 (2-1)
	<b>Sub-Total 24</b>

### 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	
	<b>Sub-Total 18-24</b>

<b>Sub-Total during the first four semesters</b>	<b>70-76</b>
<b>Semester 5, 6, 7 &amp; 8</b>	<b>56-60</b>
<b>Project / Internship</b>	<b>04</b>
<b>Grand Total</b>	<b>130-140</b>

- 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

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

**8<sup>th</sup> Semester**

SS-602	Soil - Water - Plant Relationship	3(3-0)
SS-604	Land Degradation and Management	3(3-0)
SS-606	Trace Elements in Agriculture	3(2-1)
SS-608	Internship/Research Project	4(0-4)
	<b>Total Credit Hours</b>	<b>16</b>
	<b>Sub Total</b>	<b>128</b>

## 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 under-graduate 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  $pH_s$  and  $EC_e$
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:

1. Bashir, E. and R. Bantel. 2001. Soil Science. National Book Foundation, Islamabad, Pakistan.
2. Brady, N.C. and R.R. Weil. 2007. The Nature and Properties of Soils. 14<sup>th</sup> Ed. Pearson Education, Upper Saddle River, NJ, USA.

3. Brady, N.C. and R.R. Weil. 2009. Elements of the Nature and Properties of Soils. 3<sup>rd</sup> Ed. Pearson Education, Upper Saddle River, NJ, USA.
4. Das, D.K. 2011. Introductory Soil Science. 3<sup>rd</sup> ed. Kalyani Publ. New Delhi-110002, India.
5. Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
6. Singer, M.J. and D.N. Munns. 2002. Soils- An Introduction. 5<sup>th</sup> Ed. Prentice-Hall, Inc., Upper Saddle River, NJ, USA.

## **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 tith
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:**

1. Brady, N.C. and R.R. Weil. 2009. Elements of the Nature and Properties of Soils. 3<sup>rd</sup> Ed. Pearson Education, Upper Saddle River, NJ, USA.
2. Hillel, D. 2004. Introduction to Environmental Soil Physics. Elsevier, San Diego, CA, USA.
3. Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
4. Jury, W. A. and R. Horton. 2004. Soil Physics. 6<sup>th</sup> Ed. John Wiley & Sons. Inc., NY, USA.

**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:**

1. Bohn, H.L., B.L. McNeal and G.A.O. Connor. 2001. Soil Chemistry. 3<sup>rd</sup>



Ed. John Wiley & Sons Inc., NY, USA.

2. Essington, M.E. 2004. Soil and Water Chemistry: An Integrated Approach. CRC Press, Boca Raton, FL, USA.
3. Ghafoor, A., M. Qadir and G. Murtaza. 2004. Salt-Affected Soils: Principles of Management. Allied Book Center, Lahore, Pakistan.
4. Handbook 60
5. IWASRI manual
6. Molden, D. (ed.). 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan Colombo, IWMI, Sri Lanka.
7. Tanji, K.K. and N.G. Kiern. 2002. Agricultural Drainage Water Management in Arid and Semi-arid Areas. FAO Agri. Drainage Paper 61. Rome, Italy.

### **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:**

1. Bohn, H. L., D. L. McNeal and G. A. O'Connor. 2001. Soil Chemistry. 3<sup>rd</sup> Ed. John Wiley & Sons. Inc., NY, USA.

2. Essington, M.E. 2004. Soil and Water Chemistry: An Integrated Approach. CRC Press, Boca Raton, FL, USA.
3. Sparks, D.L. 2003. Environmental Soil Chemistry. 2<sup>nd</sup> Ed. Academic Press, Inc., San Diego, CA, USA.
4. Sposito, G. 2008. The Chemistry of Soils. 2<sup>nd</sup> Ed. Oxford University Press, NY, USA.
5. Tan, K.H. 2009. Environmental Soil Science. 3<sup>rd</sup> Ed. CRC Press, Greensboro, GA, USA.

### **SS-504 SOIL FERTILITY AND FERTILIZER USE**

**3(2-1)**

#### **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. Fertilizers 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:**

1. Ahmad, N. and M. Rashid. 2003. Fertilizer and Their Use in Pakistan: An Extension Guide. Planning Commission, National Fertilizer Development Centre, Islamabad, Pakistan.
2. Elsworth, L. and W.O. Relay (eds.). 2009. Fertilizers: Properties, Applications and Effects. Nova Science. Publ. Inc., NY, USA.
3. Havlin, J.L., S.L. Tisdale, W.L. Nelson and J.D. Beaton. 2013. Soil Fertility and Fertilizers: An Introduction to Nutrient Management. 8<sup>th</sup> ed. Pearson Education, Prentice Hall, Upper Saddle River, NJ, USA.
4. Mengel, K. and E.A. Kirkby. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. International Potash Inst., Bern, Switzerland.
5. Russell, E.J. 2011. The Fertility of the Soil. 1<sup>st</sup> Ed. Cambridge Univ. Press, UK.

**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:**

1. Carter, M.R. and E.G. Gregorid (eds.). 2008. Soil sampling and Methods of Analysis. 2<sup>nd</sup> Ed. Taylor & Fancis Group, Boca Raton, FL, USA.
2. Jones, J.B. Jr. 2001. Laboratory Guide for Conducting Soil Tests and Plant Analysis. CRC Press, Boca Raton, FL, USA.
3. Ryan, J., G. Estefan and A. Rashid. 2001. Soil and Plant Analysis. Laboratory Manual. International Centre for Agricultural Research in the Dry Areas. Aleppo, Syria.
4. Smith, K.A. and M.S. Cresser. 2003. Soil and Environmental Analysis: Modern Instrumental Techniques. CRC Press. Boca Raton, FL, USA.
5. Sparks, D. L. et al. (eds.). 1996. Methods of Soil Analysis. Part III. Chemical Methods. SSSA, ASA Series No.5, Madison, WI, USA.
6. Tandon, H.L.S. 2005. Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. Fertilizer Development and Consultation Organization, New Delhi, India.

**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:**

1. Burt, R. (ed.). 2004. Soil Survey Laboratory Methods Manual Soil Survey Investigations Report No. 42, Version 4.0. USDA, Washington, DC, USA.
2. Lagacherie, P., A. McBratney and M. Voltz. 2007. Digital Soil Mapping – An Introductory Perspective. Elsevier Publishers, Amsterdam, The Netherlands.
3. Soil Survey Division Staff. 2002. Soil Survey Manual. USDA, University Press of Pacific, Washington, DC, USA.

**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:**

1. Buol, S.W., M.P. Walker, R.J. Southard and P.A. McDaniel. 2003. Soil Genesis and Classification. 5<sup>th</sup> Ed. Iowa State University Press, Ames, IA, USA.
2. Rabenhorst, M. C. Bell, J. C. & Mc. Daniel (eds.). 1998. Quantifying Soil Hydromorphology. SSSA Special Publ. No. 54, Madison, WI, USA.
3. Schaetzl, R. and S. Anderson. 2005. Soils: Genesis and Geomorphology. Cambridge University Press, Cambridge, UK.
4. Soil Survey Staff. 2006. Keys to Soil Taxonomy. 10<sup>th</sup> Ed. USDA,

- Washington, DC, USA.
5. Wilding, L. P. 1994. Factors of Soil Formation. SSSA Special Publ. No. 33, Madison, WI, USA.

## **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:**

1. Bhushan, L.S., I.P. Abrol, and M.S.R.M. Rao. 1998. Soil and Water Conservation: Challenges and Opportunities. Vol. 1 & 2 A. A. Balkema, Rotterdam, The Netherlands.
2. Ehlers, W. and G. Michael. 2003. Water Dynamics in Plant Production. CAB Publishing, Cambridge, UK.
3. Fangmeier, D.D., W.J. Elliot and S.R. Workman. 2006. Soil and Water Conservation Engineering. 5<sup>th</sup> Ed. Thomson Delmar Learning, NY, USA.
4. Morgan, R.P.C. 2005. Soil Erosion and Conservation. 3rd Ed. Longman Group Ltd., Essex, UK.
5. Unger, P.W. 2006. Soil and Water Conservation Handbook: Policies, Practices, Conditions and Terms. Haworth Food and Agriculture Products Press, NY, USA.

**SS-601 SOIL MICROBIOLOGY****3(2-1)****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 CO<sub>2</sub>
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:**

1. Barton, L.L. and D.E. Northup. 2011. Microbial Ecology. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
2. González, M.B.R. and J. González-López. 2014. Beneficial Plant-microbial Interactions- Ecology and Applications. CRC Press, Taylor & Francis, Boca Raton, FL.
3. Paul, E.A. (ed.). 2007. Soil Microbiology, Ecology and Biochemistry. 3<sup>rd</sup> Ed. Elsevier, Oxford, UK.
4. Pommerville, J.C. 2014. Fundamentals of Microbiology. 10th Ed. Jones & Bartlett learning, Burlington, MA, USA.
5. Sylvia, D.M., J.J. Fuhrmann, P.G. Hartel and D.V. Zuberer. 2005. Principles and Applications of Soil Microbiology. Prentice Hall International, NJ, USA.

**SS-602 SOIL-WATER-PLANT RELATIONSHIP****3(3-0)****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**

1. Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
2. Jury, W.A. and R. Horton. 2004. Soil Physics. 6<sup>th</sup> Ed. John Wiley & Sons, Inc., Hoboken, NJ, USA.
3. Kirkham, M.B. 2005. Principles of Soil and Plant Water Relations. 1<sup>st</sup> Ed. Elsevier Academic Press, San Diego, CA, USA.
4. Kramer, P.J. and J.S. Boyer. 1995. Water Relations of Plants and Soils. Academic Press, San Diego, CA, USA.
5. Rending, V.V. and H.M. Taylor. 1989. Principles of Soil-Plant Inter Relationships. McGraw-Hill Publishing Co., NY. USA.

**SS-603 ENVIRONMENTAL POLLUTION AND MANAGEMENT****3(3-0)****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



and plant uptake

5. Degradation of pollutants: chemical, biological and light
6. Factors affecting movement of pollutants in soil
7. Impact of pollutants on soil, plant, animal and human health
8. Water pollution: drinking and irrigation; BOD, COD and eutrophication
9. Atmospheric pollutants; greenhouse gases
10. Strategies for pollution control
11. Management and control: control measure at source, soil and water treatment, public awareness
12. Legislation and socio-economic issues of environmental pollution

#### **Recommended Books:**

1. Ashfaq, M. and M.A. Saleem. 2010. Environmental Pollution and Agriculture. Pak Book Empire, Lahore.
2. Asthana, D.K. and M. Asthana. 2003. Environment Problems & Solutions. S. Chand & Co. Ltd. New Delhi, India.
3. Clinic, C., M. Ignazio and G.M. Lodovica. 2008. Sustainable Development and Environmental Management: Experiences and Case Studies. 1<sup>st</sup> Ed. Springer Publishers, Dordrecht, The Netherlands.
4. Cunningham, W.P., M.A. Cunningham and B.W. Saigo. 2007. Environmental Science: A global Concern. 9<sup>th</sup> Ed. McGraw-Hill, NY, USA.
5. Harrison, R.M. (ed.). 2001. Pollution: Causes, Effects and Control. 4<sup>th</sup> Ed. The Royal Society of Chemistry, Cambridge, UK.
6. Pakistan Environmental Protection Act, 1997. Govt. of Pakistan.
7. Raven, B., L.R. Berg and D.M. Hassenzahl. 2008. Environment. 6<sup>th</sup> Ed. John Wiley & Sons, NY, USA.

### **SS-604 LAND DEGRADATION AND MANAGEMENT**

**3(3-0)**

#### **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:**

1. Chisholm, A. and R. Dumsday. 2009. Land Degradation: Problems and Policies. Cambridge University Press, London, UK.
2. Johnson, D.L. and L.A. Leiois. 2007. Land Degradation: Creation and Destruction. 2<sup>nd</sup> Ed. Rowman & Littlefield Publishers, Inc. USA.
3. Pessarakali, M. (ed.). 2010. Handbook of Plant and Crop Stress. 3<sup>rd</sup> Ed. Marcel and Dekker Inc., NY, USA.
4. Wong, M.H., J.W.C. Wong and A.J.M. Baker. 1999. Remediation and management of degraded lands. CRC Press, Boca Raton, FL, USA.

**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:**

1. Blaxter, L., C. Hughes and M. Tight. 2006. How to Research. 3<sup>rd</sup> Ed. Open University Press McGraw-Hill, Berkshire, UK.
2. Ghafoor, A. 2007. Manual for Synopsis and Thesis Preparation. Univ. Agri., Faisalabad, Pakistan (ISBN 969-8237-7-0). 109 p.
3. Ghafoor, A., G. Murtaza and S.I. Hussain. 2006. Fundamental of scientific communications and presentations. Allied Book Centre, Urdu Bazaar, Lahore. (ISBN 969-547-01-7). 190 p.
4. Harrad, S., L. Batty, M. Diamond and G. Arhonditsis. 2008. Students Projects in Environmental Science. John Wiley & Sons Ltd. West Sussex, England.
5. Katz, M.J. 2009. From Research to Manuscript – A Guide to Scientific Writing. 2<sup>nd</sup> Ed. Springer-Verlag, Frankfurt, Germany.
6. Luellen, R.W. 2001. Fine-tuning your writing. Wise Owl Publishing Company, Madison, WI, USA.

**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.
8. National Environmental Quality Standards (NEQS) in soil and water.

### **Practical**

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

### **Recommended Books:**

1. Adriano, D.C. 2001. Trace elements in the Terrestrial Environment: Biogeochemistry, Bioavailability and Risks of Metals. Springer – Verlag New York, USA.
2. Bell, R.W. and B. Dell. 2008. Micronutrients for Sustainable Food, Feed, Fiber and Bio-energy Production. International Fertilizer Industry Association (IFA), Paris, France.
3. Kabata – Pendias, A. and H. Pendias. 2001. Trace Elements in Soils and Plants. 3<sup>rd</sup> Ed. CRC Press, Inc. Boca Raton, FL, USA.
4. Mortvedt, J.J., F.R. Cox, L.M. Shuman and R.M. Welch. 1991. Micronutrients in Agriculture. 2<sup>nd</sup> Ed. Soil Sci. Soc. Am. Inc., Madison, WI, USA.

## **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:**

1. Cheremisiyoff, N.P. 2002 Handbook of Solid Waste Management and Waste Minimization Technologies. Elsevier Science, Burlington, MA, USA.
2. Dhamija, U. 2006. Sustainable Solid Waste Management: Issues, Policies, and Structures. Academic Foundation, New Delhi, India.
3. Ghafoor, A. 2010. Environmental Pollution: Types, sources and management. Allied Book Centre, Lahore.

4. Pepper, I.L., C.P. Gerba and M.L. Brusseau (eds.). 2006. Environmental and Pollution Science. 2<sup>nd</sup> Ed. Elsevier / Academic Press, San Diego, CA, USA.
5. Pichtel, J. 2005. Waste Management Practices: Municipal, Hazardous and Industrial. CRC Press, Taylor and Francis Group, Boca Raton, FL, USA.
6. Tchobanoglous, G., H. Theisen and S. Vigil. 1993. Integrated Solid Waste Management. Irwin McGraw-Hill. USA.

**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 CO<sub>2</sub> emission in soil under different land use
3. Biochar preparation and characterization

**Recommended Books:**

1. Hartemink, A. E. and K. McSweeney (Ed.). 2014. Soil Carbon: Progress in Soil Science. Springer International Publishing, Switzerland.
2. Lal, R., M. Suleimenov, B.A. Stewart, D.O. Hansen and P. Doraiswamy. 2007. Climate Change and Terrestrial Carbon Sequestration in Central Asia, Taylor and Francis, the Netherlands.
3. Piccolo, A. (Ed.). 2012. Carbon Sequestration in Agricultural Soils. Springer-Verlag Berlin Heidelberg, Germany.
4. Verheijen, F. G. A., S. Jeffery, A.C. Bastos, M. van der Velde and I. Diafas. 2010. Biochar application to Soils: A critical scientific Review of Effects on Soil Properties, Processes and Functions. Official publications, European Communities, Luxembourg.

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

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

**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 spectrophotometry
  - 5.6 Electro Ultra Filtration
  - 5.7 Neutron moisture probe/time domain reflectometry (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:

1. DeLevie, R. 1997. Quantitative Chemical Analysis. McGraw-Hill Co. Inc. New York, USA.
2. Harris, D.C. 2006. Quantitative Chemical Analysis. 7<sup>th</sup> Ed. W. H. Freeman & Co. NY, USA.
3. Pansu, M. and J. Gautheyrou. 2006. Handbook of Soil Analysis. Avenue de Marinville 6 94100 St. Maur des Fossés France. ISBN-10 3-540-31210-2 Springer.
4. Smith, A. K. and M.S. Cresser. 2004. Soil and Environmental Analysis:



Modern Instrumental Techniques. 3<sup>rd</sup> Ed., Marcel & Dekker, Inc., USA.

5. Spark, D.L. (ed.) 1996. Methods of Soil Analysis. Part.3. Chemical Methods. SSSA, ASA Series No.5. Madison, WI, USA.

## **SS-702 SOIL CHEMISTRY**

**3(2-1)**

### **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:**

1. Bohn, H.L., B.L. McNeal and G.A.O. Connor. 2001. Soil Chemistry. 3<sup>rd</sup> Ed. John Wiley & Sons Inc., NY, USA.
2. Essington, M. E. 2004. Soil and Water Chemistry. CRC Press, Boca Raton, FL, USA.

3. McBride, M. 1994. Environmental Chemistry of soils. 406 pp. ISBN0-19-507011-9. Oxford University Press.
4. Sparks, D.L. 2003. Environmental Soil Chemistry. 2<sup>nd</sup> Ed. Academic Press, San Diego, CA, USA.
5. Sposito, G. 2008. The Chemistry of Soils. 2<sup>nd</sup> Ed. Oxford University Press, NY, USA.
6. Srinivas, P. 2010. Soil Chemistry. Oxford Book Company, New Delhi, India.
7. Tan, K.H. 2009. Environmental Soil Science. 3<sup>rd</sup> Ed. CRC Press, Greenwatch Georgia, USA.

### **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:**

1. Ahmad, N. and M. Rashid. 2003. Fertilizers and their use in Pakistan: An extension guide. Planning Commission, NFDC, Islamabad, Pakistan.

2. Barker A.V. and D.J. Pilbeam. 2007. Handbook of Plant Nutrition. CRC Press, Boca Raton, FL, USA.
3. Bhatti, A.U. 2005. Spatial Variability & its Management in Agriculture. Higher Education Commission, Islamabad, Pakistan.
4. Elsworth, L. and W.O. Relay (eds.). 2009. Fertilizers: Properties, Applications and Effects. Nova Science. Publ. Inc., NY, USA.
5. Havlin, J.L., S.L.Tisdale, W.L. Nelson and J.D. Beaton. 2013. Soil Fertility and Fertilizers: An Introduction to Nutrient Management. 8<sup>th</sup> ed. Pearson Education, Prentice Hall, Upper Saddle River, NJ, USA.
6. Mengel, K. and E.A. Kirkby. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. International Potash Inst., Bern, Switzerland.
7. Russell, E.J. 2011. The Fertility of the Soil. 1<sup>st</sup> Ed. Cambridge Univ. Press, UK.

### **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
11. Bio-fertilizers: present and future prospects

#### **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<sub>2</sub> fixation measurement techniques

**Recommended Books:**

1. Barton, L.L. and D.E. Northup. 2011. Microbial Ecology. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
2. González, M.B.R. and J. González-López. 2014. Beneficial Plant-microbial Interactions- Ecology and Applications. CRC Press, Taylor & Francis, Boca Raton, FL.
3. Khan, M.S., A. Zaidi, and J. Musarrat (eds.). 2009. Microbial Strategies for Crop Improvement. Springer, NY, USA.
4. Maier, R.M., I.L. Pepper and C.P. Gerba. 2009. Environmental Microbiology. 2<sup>nd</sup> Ed. Academic Press Inc., San Diego, CA, USA.
5. Paul, E.A. (ed.). 2007. Soil Microbiology, Ecology and Biochemistry. 3<sup>rd</sup> Ed. Elsevier, Oxford, UK.
6. Pommerville, J.C. 2014. Fundamentals of Microbiology. 10th Ed. Jones & Bartlett learning, Burlington, MA, USA.
7. Sylvia, D.M., J.J. Fuhrmann, P.G. Hartel, and D.V. Zuberer. 2005. Principles and Applications of Soil Microbiology. Prentice Hall International, NJ, USA.

**SS-705 SOIL CLASSIFICATION**

**3(2-1)**

**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:**

1. Buol, S.W., R.J. Southard, R.C. Graham and P.A. McDaniel. 2011. Soil Genesis and Classifications. 6<sup>th</sup> Ed. John Wiley & Sons, Inc. NY, USA
2. Eswaran, H. et al. 2003. Soil Classification: A Global Desk Reference. CRC Press. Boca Raton, FL, USA.
3. FAO. 1998. World Reference Base for Soil Resources. FAO, Rome, Italy
4. Soil Survey Division Staff. 2005. Soil Survey Manual. USDA, Washington DC, USA.
5. Soil Survey Staff. 2010. Keys to Soil Taxonomy. 11<sup>th</sup> Ed. USDA, Washington DC, USA.
6. USDA. 1998. Soil Taxonomy. Krieger Publishing Co., Washington DC, USA.

**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

11. Environmental and economic impacts of salinity and waterlogging

**Recommended Books:**

1. Ghafoor, A., M. Qadir and G. Murtaza. 2004. Salt-Affected Soils: Principles of Management. Allied Book Centre, Urdu Bazar, Lahore, Pakistan.
2. Maliwal, G.L. and L.L. Somani. 2010. Nature, Properties and Management of Saline and Alkali Soils. Agrotech Publishing Academy, Udaipur, India.
3. Pessarakli, M. (ed.). 2010. Hand Book of Plant and Crop Stress. 3<sup>rd</sup> Ed. Marcel & Dekker Inc., NY, USA.
4. Pierzynski, G.M., J.T. Sims and G.F. Vance. 2000. Soils and Environmental Quality. CRC Press. Boca Raton, FL, USA.
5. Schjonning, P., S. Elmholt and B.T. Christensen. 2004. Managing Soil Quality Challenges in Modern Agriculture. CABI Publisher Cambridge, MA, USA.
6. Singh, N.T. 2005. Irrigation and Soil Salinity in the Indian Subcontinent: Past and Present. Lehigh University Press, Bethlehem, Israel.

**SS-707 SOIL PHYSICS**

**3(2-1)**

**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, Kostiaikov, 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:**

1. Hillel, D. 1998. Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.
2. Hillel, D. 2004. Introduction to Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.
3. Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
4. Jury, W.A. and R. Horton. 2004. Soil Physics. 5<sup>th</sup> Ed. John Wiley & Sons, Inc., NY, USA.
5. Marshall, T.J., J.W. Holmes and C.W. Rose. 1996. Soil Physics. 3<sup>rd</sup> Ed. Cambridge University Press, Cambridge, UK.

## **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/NH<sub>4</sub>
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:**

1. Akhtar, M.S. 2001. Soil mineralogy. In: Bashir, E. and R. Bantel (eds.). Soil Science. National Book Foundation, Islamabad, Pakistan.
2. Brindley, G.W. and G. Brown. 1984 Crystal Structures of Clay Minerals and their X-ray Identification. Mineralogical Soc. Monograph No.5. London, U.K.
3. Dixon, J.B. and S.B. Weed (eds.), 1989. Minerals in Soil Environment. 2<sup>nd</sup> Ed., SSSA. Madison, WI, USA.
4. Dixon, J.B. and D.G. Schulze. 2002. Soil Mineralogy with Environmental Applications. Soil Science Society of America, Madison, WI, USA.
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:**

1. Kirkham, M.B. 2005. Principles of Soil and Plant Water Relations. Elsevier Academic Press, San Diego, CA, USA.
2. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. 3<sup>rd</sup> Ed. Academic Press. Inc., Orlando, FL, USA.
3. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. Academic Press is an imprint of Elsevier 32 Jamestown Road, London NW1 7BY, UK 225 Wyman Street, Waltham, MA 02451, USA 525 B Street, Suite 1800, San Diego, CA 92101-4495, USA.
4. Mengel, K. and E.A. Kirkby. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Rendig, V.V. and H.M. Taylor. 1989. Principles of Soil-Plant Inter-relationships. McGraw-Hill Publishing Co., NY, USA.

**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:**

1. Conklin, Jr. A.R. 2005. Introduction to Soil Chemistry Analysis and Instrumentation. John Wiley & Sons, Inc., Hoboken, NY, USA.
2. Kumar, A. 2004. Environmental Contamination and Bio-reclamation. APH Publishing Corporation, New Delhi, India.
3. Schjonning, P., S. Elmholt and B.T. Christensen. 2004. Managing Soil Quality Challenges in Modern Agriculture. CABI Publisher Cambridge, MA, USA.
4. Sparks, D.L. 2003. Environmental Soil Chemistry. 2<sup>nd</sup> Ed. Academic Press, Inc., San Diego, CA, USA.

5. Sposito, G. 2008. The Chemistry of Soils. Oxford University Press, NY, USA.
6. Viessman, J.W. and M.J. Hammer. 2009. Water Supply and Pollution Control. 8<sup>th</sup> Ed. Prentice Hall NY, USA.

**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 microsities
  - 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:**

1. Barker A.V. and D.J. Pilbeam. 2007. Handbook of Plant Nutrition. CRC Press, Boca Raton, FL, USA.
2. Elsworth, L. and W.O. Relay (eds.). 2009. Fertilizers: Properties, Applications and Effects. Nova Science. Publ. Inc., NY, USA.
3. Havlin, J.L., J.D. Beaton, S.L. Tisdale and W.L. Nelson. 2005. Soil Fertility and Fertilizers. 7<sup>th</sup> Ed. Pearson Education, Singapore.
4. Marschner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press Inc., Orlando, FL, USA.
5. Mengel, K. and E.A. Kirkby. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. International Potash Inst., Bern, Switzerland.
6. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants Academic Press is an imprint of Elsevier 32 Jamestown Road, London NW1 7BY, UK 225 Wyman Street, Waltham, MA 02451, USA 525 B Street, Suite 1800, San Diego, CA 92101-4495, USA.

**SS-712    ADVANCED SOIL MICROBIOLOGY****3(3-0)****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:**

1. Burns, R.G. and R.P. Dik. 2002. Enzymes in the Environment. Marcel Dekker, Inc. NY, USA.
2. Harrison, R.M. (ed.). 2001. Pollution: Causes, Effects and Control. 4<sup>th</sup> Ed. Royal Soc. of Chem., Cambridge, UK.
3. Hurst, C.J., R.L. Crawford, G.R. Knudsen, M.J. McInerney, and L.D. Stetzenbach. 2002. Manual of Environmental Microbiology. American Society for Microbiology, Washington DC, USA.
4. Maier, R.M., I.L. Pepper, and C.P. Gerba. 2009. Environmental Microbiology. 2<sup>nd</sup> Ed. Academic Press Inc., San Diego, CA, USA.
5. Paul, E.A. (ed.). 2007. Soil Microbiology, Ecology and Biochemistry. 3<sup>rd</sup> Ed. Elsevier, Oxford, UK.
6. Sylvia, D.M., J.J. Fuhrmann, P.G. Hartel, and D.V. Zuberer. 2005. Principles and Applications of Soil Microbiology. Prentice Hall International, NJ, USA.

**SS-713    ADVANCED SOIL PHYSICS****3(3-0)****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:**

1. Bhatti, A.U. 2005. Spatial Variability and its Management in Agriculture. Higher Education Commission, Islamabad, Pakistan.
2. Hillel, D. 1998. Environmental Soil Physics. Academic Press Inc., San Diego, CA, USA.
3. Hillel, D. 2004. Introduction to Environmental Soil Physics. Elsevier Academic Press. San Diego, CA, USA.
4. Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
5. Jury, W.A. and R. Horton. 2004. Soil Physics. 5<sup>th</sup> Ed. John Wiley & Sons, Inc., NY, USA.
6. Marshall, T.J., J.W. Holmes and C.W. Rose. 1996. Soil Physics. 3rd Ed., Cambridge University Press, Cambridge, UK.

## ANNEXURE - A

### 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
    1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
    2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

- b) Writing
  - 1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- c) Reading/Comprehension
  - 1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- 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
  - 1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
  2. Reading and Study Skills by John Langan
  3. Study Skills by Richard York.

### **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
1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
  3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
- 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 Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).



## ANNEXURE - B

### 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

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- 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:

1. Burki, Shahid Javed. *State & Society in Pakistan*, The MacMillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.

3. S. M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: Wm Dawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K. K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

**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 Khlaft-E-Rashida
2. Period of Umayyads
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,"
- 5 Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law"  
leaf Publication Islamabad, Pakistan.
- 6 Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research  
Institute, International Islamic University, Islamabad (1993)
- 7 Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes"  
Islamic Book Service (1982)
- 8 H. S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep &  
Deep  
Publications New Delhi (1989)
- 9 Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia"  
Allama  
Iqbal Open University, Islamabad (2001)

**Note: One course will be selected from the following six courses of Mathematics.**

**COMPULSORY MATHEMATICS  
COURSES FOR BS (4 YEAR)**

**(FOR STUDENTS NOT MAJORING IN  
MATHEMATICS)**

**1. MATHEMATICS I (ALGEBRA)**

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

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

**Course Outline:**

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

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression. *Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)
2. Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)  
**Credit Hours:** 3 + 0

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

### Course Outline:

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

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

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

### Recommended Books:

1. Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley, New York
2. Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)
3. Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
4. Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA

## 3. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)  
**Credit Hours:** 3 + 0

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

### Course Outline:

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

*Circle:* Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections:* Parabola, ellipse, hyperbola, the general-second-degree equation

**Recommended Books:**

1. Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

**4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES**

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

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**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**

*Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations:* Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.

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

**Recommended Books:**

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences*',

**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:**

*Preliminaries*: Real Numbers and the Real Line, *Functions and their graphs*: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity*: Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications*: Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals*: Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

**Recommended Books:**

1. Thomas, Calculus, 11<sup>th</sup> Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8<sup>th</sup> edition, John Willey & Sons, Inc. 2005.

3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3<sup>rd</sup> Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelsohn, Calculus, Schaum's Outline Series, 4<sup>th</sup> edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

## 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

- 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.

## Annexure - E

### Statistics-I

Credit 3 (2-1)

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
3. A. Concise Course in A. Level Statistic with world examples by J. Crashaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomas J. Keans

### Statistics-II

Credit 3 (2-1)

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 X<sup>2</sup> (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
3. Principles and Procedures of Statistics A Bio-material approach, 2<sup>nd</sup> Edition, 1980 by R. G. D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K. A. Gomez and A. A. Gomez

## ANNEXURE - F

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:

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill
2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6<sup>th</sup> Edition, McGraw-Hill

3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer
4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.



## 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:*

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

## 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:*

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**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:*

3. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
4. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

### **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 18<sup>th</sup> 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.