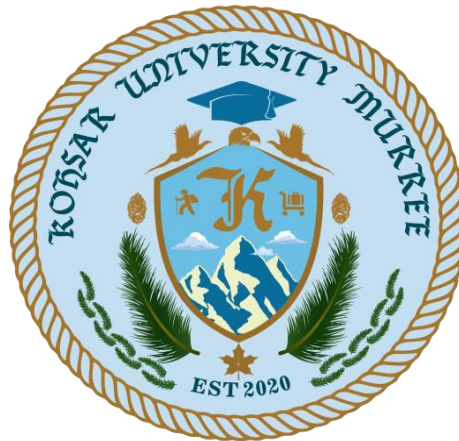


KOHSAR UNIVERSITY MURREE
ADMIN BLOCK, KASHMIR POINT, MURREE
Tel. No. 051-9269170-71



**Dossier for Launching the Program of
BS Environmental Sciences**

At

Department of Environmental Sciences

Faculty of Mountain Agriculture and Environmental Sciences

Kohsar University Murree

KOHSAR UNIVERSITY MURREE

Kohsar University Murree's Vision Statement

VISION

As a premier higher education institution, the Kohsar University, Murree (KUM) aspires to be a leading provider of high-quality education in a broad range of disciplines, particularly those that are relevant to the needs of mountainous areas, while also striving for national and international competitiveness.

Kohsar University Murree's Mission Statement

MISSION

As a public university, KUM's mission is to advance knowledge and improve the lives of impoverished people by providing access to outstanding higher education, entrepreneurship, and research opportunities to them. Apart from that, enhancing outreach participation of dynamic and brilliant young brains, particularly those from mountainous regions, is important. Kohsar University of Murree (KUM) will be known as a university that cultivates a diverse and inclusive community of internationally engaged, energetic, and skilled future leaders.

Department of Environmental Science
Faculty of Mountain, Agriculture and Environmental sciences
Kohsar University Murree

Subject: Curricula for Bachelor of Environmental Sciences

Kohsar University Murree proposes to launch Bachelor of Environmental Sciences (BS. Environmental Sciences) degree program under the Department of **Environmental Sciences**, Faculty of Mountain Agriculture and Environmental sciences in the fall semester of 2022 at the GPO Campus of Kohsar University Murree.

The Pre-Board of Studies (including external experts, primarily from public sector universities, identified and solicited for their valuable feedback and input) was held, during which the following curriculum under the supervision of the Registrar & Dean/Incharge Academics, Kohsar University Murree, along with the help of guidelines provided by Higher Education Commission (HEC).

Board of Studies ad Pre-Academic Council approved the following curricula for the (all-22 and Spring-23 semesters under the supervision of the Department of Environmental Sciences.

KOHSAR UNIVERSITY MURREE

Under Higher Education Commission (HEC) letter No. Registrar/QA/HEC/NOC/Gen/2016/239, dated May 13, 2016

- A. BS degree approved title: **BS. Environmental Sciences**
B. Department **Environmental Sciences**
C. Faculty **Mountain Agriculture and Environmental Sciences**

1. Provision in Act/Charter of the University to offer the said program

KOHSAR UNIVERSITY MURREE” Act 2020 (IX of 2020)

2. Brief Introduction

Environmental sciences is an interdisciplinary field that deals with an assemblage of Physical, chemical, Biological and social sciences under one umbrella. The discipline of Environmental sciences deals with the direct and indirect interaction of human beings with environmental issues that influence the environmental laws and policies. Many of the most complex challenges will be environmental forcing people to divert their attention towards this field. Meeting these challenges will require problem solving abilities based in natural, social and management sciences, and other disciplines. Environmental Science is the application of a combination of scientific disciplines to issues and questions regarding environmental and socio-economic problems. Environmental degradation, energy crisis, water scarcity, food security; mitigation and adaptation to climate change impacts are the major areas of concern in today’s world. The economy is moving towards **“Green or low Carbon Economy”** based on Carbon neutrality and valuation of ecosystem services. Its main focus is the protection and management of environment from the emerging pollutants nationally and globally through research and public awareness. The Environmental Sciences department at Kohsar University Murree (KUM) seeks to provide students with opportunity to engage in an intensive academic environment that includes multi-disciplinary, cutting-edge research, and an entrepreneurial ecosystem. KUM's

curriculum is carefully framed to suit the knowledge and skill sets required for the industry in the 21st century and beyond.

Students studying under the Department of Environmental Sciences, Faculty of Mountain, Agriculture and Environmental Sciences at KUM will not only be able to lay the groundwork for the resolution of environmental issues, but will also have the opportunity to collaborate with the Entrepreneurship center and the office of research, innovation, and collaboration to develop smart pest management and forecasting tools. Ur department will provide students with a broad range of skill and knowledge development opportunities, allowing them to be sought after by employers and stakeholders both within and outside of Pakistan, and to be prepared for any challenge in their future work environments.

Vision:

- ✚ The department of Environmental Sciences is determined to contribute to national needs on sustainable development through the following step:
- ✚ Quality education in core and applied domains of environmental Sciences
- ✚ Basic and applied research in environmental science and overlapping domains of knowledge
- ✚ Creating national demands of knowledgeable graduates who can contribute to national development

Mission:

- ✚ The department of Environmental Sciences will impart quality comprehensive education and will be determined to provide adequate expertise in meeting the challenges of emerging environmental hazards, ecosystem restoration, and conservation of natural resources along public awareness of environmental Sciences.

3. Objectives to offer Program

Objectives: Aims and objectives

The major aims and objectives of the Department of Environmental Sciences are

- ✚ To provide enduring solutions for environmental problems by using innovative green technologies.
- ✚ To develop collaboration with national and international environment supporting bodies for research and development revenues generation.
- ✚ To establish productive programs that develops an association between our expert faculty members and students for strengthen our department.
- ✚ To develop competence among students to face the ongoing environmental challenges (air, soil, water, overuse of natural resources, energy crises and climate change) with environment friendly scientific skills.

Student Learning Outcomes

Upon graduation, students would be capable to:

- ✚ Demonstrate a comprehensive understanding of environmental systems and issues using an interdisciplinary framework to incorporate ideas and concepts from biological and physical natural sciences
- ✚ Develop skills in data analysis and problem-solving of relevant environmental problems.
- ✚ Use a systems approach to conduct integrated, quantitative, and interdisciplinary analyses and modeling of environmental systems and issues.

D. Entry requirement of Program

BS. Environmental Sciences

The candidates holding F.Sc. Pre-Medical/Pre-Engineering with 45% marks

* **Note:** Due to the probability of a dominant covid-19 situation, a hybrid teaching (Zoom, google classroom, LMS, Kahoot) style and interactive education strategies will be used to instruct and assess the students via university online google classrooms/ zoom/LMS in case of lockdown period of COVID-19 pandemic.

E. Scope regarding market, social and employment perspective of program

Scope & career prospects

Being an interdisciplinary field Environmental sciences has established the following career opportunities.

Research and development (R&D)

Research and development is best environmental opportunity for pollution monitoring, disaster management mitigation, low cost waste treatment, water quality analysis, climate change studies solid waste and energy crisis management.

Industrial Linkages

Industries are the backbone of economy, therefore primary focus of our department is on the development of a strong relationship between academia and industry to direct the industries for adopting green technologies for waste disposal and pollution control.

Environmental impact assessment (EIA) Consultancy

Environment consultancies are the best opportunities for environmentalists that give quality analysis provide expert assessment and advisory services for their clients on matters

There are number of national such as Pakistan Program For Collaborative Research (PPCR), GCF, LCF, TTSF, ICRG pertaining to the management of environmental issues.

National and International funding agencies

NRPU, TDF and international agencies like UNEP, IUCN, TSBF, and World Bank providing collaborative environment-related projects.

- ✚ Environmental Science degree provide excellent employment areas like
- ✚ Ministry of Environment (MoE)
- ✚ Ministry of Climate Change (MCC)
- ✚ Environmental Protection Agency (EPA)
- ✚ Environmental Protection Department (EPD)
- ✚ Water and Sanitation Agency (WASA)

- ✚ Nature Conservation Organizations (NCOs)
- ✚ Various international agencies such as UNEP, IUCN, TSBF, and World Bank
- ✚ Research and Development (R&D)
- ✚ Water Authority and Urban Planning
- ✚ Environmental Monitoring Organizations
- ✚ Biodiversity Conservation Department
- ✚ Environmental consultancies
- ✚ Solid Waste Management and Treatment
- ✚ Sanitation and Health Department
- ✚ Air pollution management wing
- ✚ NGOs working on environmental resources and environmental issues
- ✚ Industries (Food processing, Refineries, Distilleries and Fertilizer plants etc.)
- ✚ Colleagues, Universities and Research centers
- ✚ Print and electronic media (Environmental journalist)
- ✚ Agriculture, and Biotechnology
- ✚ Environmental Microbiology Department
- ✚ Soil sciences lab
- ✚ Environmental Nano sciences and materials
- ✚ Soil and ecosystem ecology
- ✚ Environmental engineering lab

F. Course content of Program

The Scheme of Studies and course contents are given below:

G. Duration of the program

1. **Minimum duration of Program: 4 years 8 Semesters (BS. Environmental Sciences)**

H. Exact title of program that will appear on the degree

BS. Environmental Sciences

I. Approval of the University statutory body to start/launch new program (To be provided by the Register Office)

Subsequent to the approval by Academic Council, the curricula of the programme will be presented to the Syndicate, for the approval.

J. Affiliation Letter of University (if applicable)

N/A

K. NOC of Professional Councils (To be provided by the Departments, if so desired)

N/A

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
KOH SAR UNIVERSITY MURREE
KASHMIR POINT MURREE**

1st BOS MEETING AGENDA

Agenda Item 1	<p>Establishment of Department of Environmental Sciences The HoD (Environmental Sciences) request to launch Department of Environmental Sciences at Kohsar University Murree. The Head of Department must have the PhD degree in Environmental Sciences from HEC recognized Institutes.</p>
Agenda Item 2	<p>Approval of the Vision and Mission of the Environmental Sciences Department of at Kohsar University Murree by Fall-2022 We aim to commence the approval of vision and mission of the department of Environmental Sciences by our experts. Annex 1. Relevant document is attached</p>
Agenda Item 3	<p>Request for the approval to launch a 4-year BS-Agriculture and BS-Environmental Sciences program by the Department of Environmental Sciences at Kohsar University Murree by Fall-2022 We aim to commence BS Agriculture and BS Environmental Sciences program at Kohsar University Murree (KUM). It will provide trained and skilled human workforce which will ultimately contribute for ecosystem conservation, restoration and sustainable development of agriculture and environmental sector.</p>
Agenda Item 4	<p>Approval for the scheme of study for BS Agriculture and BS Environmental Sciences The department of Environmental sciences request for the approval of following courses for Fall-2022 intake. Annex 2. Relevant document is attached</p>
Agenda Item 5	<p>Eligibility criteria for BS Agriculture and BS Environmental Sciences program for Fall-2022 onwards Students seeking admissions in Fall-2022 and onwards must have HSSC (Pre-Medical/Pre-Engineering/Pre-Agriculture) degree with minimum 45% aggregate. Annex 3. Relevant document is attached</p>
Agenda Item 6	Any other agenda with the permission of the Chairperson

**DR. SHAHIDA SHAHEEN
HEAD OF DEPARTMENT**

DEPARTMENT OF ENVIRONMENTAL SCIENCES
FACULTY OF MOUNTAIN AGRICULTURE AND ENVIRONMENTAL SCIENCES
BS ENVIRONMENTAL SCIENCES & AGRICULTURE
SESSION 2022-26

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BOS MEMBERS

Faculty Members

1. Dr. Shahida Shaheen (Lecturer/ HoD, Environmental Sciences)
2. Dr. Sumaira Maqsood (Lecturer, Environmental Sciences)
3. Dr. M. Mohiuddin (IPFP, Environmental Sciences)
4. Dr. M. Qasim (IPFP, Environmental Sciences)
5. Dr. Khadija Javed (IPFP, Environmental Sciences)
6. Dr. Asim Abbasi (IPFP, Environmental Sciences)
7. Dr. Summer Sohail (IPFP, Environmental Sciences)

Experts Panel for BOS of Environmental Sciences and Agriculture

BOS ENVIRONMENTAL SCIENCES

1. **Prof. Dr. Qaisar Mahmood (Tamgha-i-Imtiaz 2011)**
Department of Environmental Sciences COMSATS University Abbottabad Campus,
University Road, Tobe Camp, Abbottabad, Pakistan
0092-312-5128479
0097334236957
drqaisar@cuiatd.edu.pk
2. **Prof. Dr. Sheikh Saeed Ahmed**
Department of Environmental Sciences Fatima Jinnah Women University of Rawalpindi
0092-3215167726
sheikh.saeed@gmail.com
3. **Dr. Muhammad Adrees**
Associate Professor Department of Environmental Sciences Government
College University, Faisalabad Pakistan
+92419201566
03237586555
madrees647@hotmail.com
madrees@gcuf.edu.pk
4. **Dr. Saamia Saif**
Director/Principal Environmental Consultant Environmental
Consultancies and Options (ECO)
+923244664355
saamia@eco-intl.org

BOS AGRICULTURE

1. Prof. Dr. Tariq Mahmood VC

University of Narowal Department of Agriculture and Environmental Sciences
Narowal, Pakistan
+92-322-5316115
qiratm@yahoo.com

2. Prof. Dr. Azeem Khalid

Institute of Soil and Environmental Sciences, Department of Environmental Sciences
PMAS- Arid Agriculture University, Rawalpindi, Pakistan
+92-301-6005958
azeem@uaar.edu.pk

3. Prof. Dr. Muhammad Anjum Aqueel

Professor and Chairperson, Department of Entomology
Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, Pakistan
+92-321-6558783
anjum.aqueel@iub.edu.pk

4. Mr. Sajid Iqbal

DG, Punjab, Directorate of Agri. Tourism Punjab, Agri. Tourism Development Corporation of Pakistan.
Chief Agri. Scientist, Climate Smart change and Agricultural Transformation green circle Pakistan
National Agri. Expert, National Productivity Organization Pakistan, Asian Productivity Organization Japan
0344-4442001
sajidsandhu@gmail.com

ELIGIBILITY CRITERIA FOR ADMISSION IN BS-ENVIRONMENTAL SCIENCES

A candidate seeking admission to the course for the BS Environmental Sciences degree must have passed F.Sc / Pre Medical / Pre Engineering or equivalent degree by IBCC in aggregate with 45% marks in annual examination.

DEGREE REQUIREMENT

A student admitted to BS Environmental Sciences program will be required to complete minimum 124 credit hours of course work along with the 6 credit hours of internship or research report. The Students must have 12 years of education in required subjects with 45 % marks

ASSESSMENT CRITERIA

University's semester and examination rules & regulations shall be followed for assessment & evaluation.

FRAMEWORK FOR BS ENVIRONMENTAL SCIENCES (4 YEAR PROGRAMME)

Minimum numbers of Credit hours	131
Duration	4 Years
Semester duration	16-18 Weeks
Semesters	08
Course Load per Semester	Maximum of 18 CH
Number of courses per semester	7

ELIGIBILITY CRITERIA FOR ADMISSION IN B.SC. (HONS.) AGRICULTURE

A candidate seeking admission to the course for the B.Sc. (Hons.) Agriculture degree must have passed F.Sc / Pre Medical / Pre Engineering/Pre Agriculture or equivalent degree by IBCC in aggregate with 45% marks in annual examination.

DEGREE REQUIREMENT

A student admitted to B.Sc. (Hons.) Agriculture program will be required to complete minimum 124 credit hours of course work along with the 6 credit hours of internship or research report. The Students must have 12 years of education in required subjects with 45 % marks

ASSESSMENT CRITERIA

University's semester and examination rules & regulations shall be followed for assessment & evaluation.

FRAMEWORK FOR B.SC. (HONS.) AGRICULTURE (4 YEAR PROGRAMME)

Minimum numbers of Credit hours	131
Duration	4 Years
Semester duration	16-18 Weeks
Semesters	08
Course Load per Semester	Maximum of 18 CH
Number of courses per semester	7

Minutes of the 1st Meeting of Board of Studies (BOS), Faculty of Mountain Agriculture and Environmental Sciences, Kohsar University, Murree

Opening

The meeting of first board of studies (BOS) of Department of Environmental Sciences, Faculty of Mountain Agriculture and Environmental Sciences was held in the Seminar Room, Admin Block Kohsar University Murree on June 10, 2022 at 10:00 AM. The meeting was chaired by Dr. Shahida Shaheen (HoD) Department of Environmental Sciences.

The following members attended the meeting.

1. Dr. Shahida Shaheen (HoD, Environmental Sciences, Kohsar University Murree)
2. Dr. Sumaira Maqsood (Lecturer, Environmental Sciences, Kohsar University Murree)
3. Dr. M. Mohiuddin (IPFP, Environmental Sciences, Kohsar University Murree)
4. Dr. M. Qasim (IPFP, Environmental Sciences, Kohsar University Murree)
5. Dr. Khadija Javed (IPFP, Environmental Sciences, Kohsar University Murree)
6. Dr. Asim Abbasi (IPFP, Environmental Sciences, Kohsar University Murree)

Expert Panel Agriculture

1. Prof. Dr. Tariq Mahmood (VC, University of Narowal) (Online)
2. Prof. Dr. Azeem Khalid (PMAS-Arid Agriculture University, Rawalpindi)
3. Prof. Dr. M. Anjum Aqueel (The Islamia University, Bahawalpur)
4. Mr. Sajid Iqbal (DG, Punjab, Directorate of Agri. Tourism Punjab)

Expert Panel Environmental Sciences

1. Prof. Dr. Qaisar Mahmood (Tamgha-i-Imtiaz, Comsats University, Abbottabad Campus) (online)
2. Prof. Dr. Sheikh Saeed Ahmed (Fatima Jinnah Women University, Rawalpindi)
3. Dr. Muhammad Adrees (Government College University, Faisalabad)
4. Dr. Saamia Saif (Director/Principal Environmental Consultant, Environmental Consultancies and Options (ECO) (Online)

The meeting was started with the recitation of Holy Quran. After that, Dr. Shahida Shaheen (HoD, ES) presented the vision and mission of University and Department along with possible career opportunities.

Suggestions: It was suggested to include word “basic and applied knowledge” in mission statement. Similarly, a few changes have been suggested in Career Opportunities relating to Agriculture and Environmental Science programs.

Approval Status: All the members approved the recommended suggestions.

After that, the participants of the meeting thoroughly discussed all the items of the Agenda and accordingly following suggestions were recommended.

Agenda Item 1:- Request for the approval to launch a 4-year BS-Agriculture and BS-

Environmental Sciences program by the Department of Environmental Sciences, Faculty of Mountain Agriculture and Environmental Sciences at Kohsar University Murree by Fall-2022

Suggestions: It was suggested by the expert panel that instead of starting two programs under one department, the competent authority should start two Departments i.e. Department of Environmental Sciences and Department of Agriculture under the Faculty of Mountain Agriculture and Environmental Sciences.

Moreover, they pointed that Degree programs cannot be accredited without Departmental accreditation. Two departments will also strengthen the Faculty. They also pointed the minimum requirement of permanent faculty for opening of a new Department and suggested induction of permanent faculty members for Department of Environmental Sciences and Department of Agriculture.

Approval Status:

Agenda Item 2:- Approval for the scheme of study for BS- Agriculture and BS-Environmental Sciences.

The SOS were thoroughly discussed and following recommendations were made.

Agriculture

A few suggestions have been given regarding courses, keeping in mind the significance of mountain agriculture.

Suggestions:

1. The expert panel suggested that degree title (BS- Agriculture) should be replaced with B.Sc. (Hons.) Agriculture.
2. It was also suggested that the course AGR-122 General Crop Production (2nd Semester) should be replaced with Conservation Agriculture or Crop Production for Mountain Agriculture.
3. Similarly, it was also suggested that the courses PBG-232 Introductory Genetics (3rd Semester) and PBG-245 Introductory Plant Breeding should be merged in a single course.
4. Suggestion was also given for incorporation of a course named Agri-tourism and Business Management and Entrepreneurship in first 4 semesters of B.Sc. (Hons.) Agriculture.
5. It was suggested that course FST-243 Introduction to Food Science and Technology should be replaced with Mountain Agriculture and Food Security.
6. It was also suggested that the course ENT-353 Insect Ecology should be replaced with Climate Change and Insect Ecology.

7. The expert panel also suggested that competent authority should start minimum two majors initially i.e. viz. Entomology, Horticulture and not more than three if the resources are available to meet the required needs Agronomy as third major can be added later to strengthen the Department of Agriculture.

Environmental Sciences

The expert panel and participants of the meeting thoroughly discussed all the items of the Agenda and accordingly following suggestions were recommended.

Suggestions:

1. The course ECO-111 Introductory Economics (Semester 3rd) should be replaced with Environmental Economics.
2. It was suggested that the content of Climate Change Policy of Pakistan and Mitigation strategies should be added in course content of ENV-224 Climatology
3. It was also suggested that the course title of ENV-355 Introduction to Soil Science should be rephrased with title “Introduction to Soil and Environment” and topics related to water logging and salinity should be included in course content
4. Suggestion was also given for incorporation of a course named Eco-tourism or Forest Ecology or Physical Geography and Climate Change instead of PSY-101 Introduction to Psychology
5. It was also suggested that title of course ENV-475 Occupational Safety, Health and Environment should be replaced with Occupational Health and Safety
6. It was also suggested that topics related to Strategical Environmental Assessment (SEA) should be incorporated in contents of course ENV-471 Environmental Impact Assessment

Approval Status:

Agenda Item 3:- Eligibility criteria for BS-Agriculture and BS Environmental-Sciences program for Fall-2022 onwards.

- Students seeking admissions in Fall-2022 and onwards must have HSSC (Pre-Medical/Pre-Engineering/Pre-Agriculture) degree with minimum 45% aggregate

Suggestions: A 3-year diploma holder in Agriculture are also eligible for seeking admission in B.Sc. (Hons.) Agriculture

Approval Status: All the members approved the agenda and recommended suggestions.

Agenda Item 4:- Approval for the nomenclature of BS Agriculture and BS Environmental Sciences Degree

Suggestions: The expert suggested that the Course codes should follow the scheme of other

Universities.

Approval Status: All the members approved the agenda and recommended suggestions.

Agenda Item 5:- Approval for the logo of the Department of Environmental Sciences Degree

Suggestions: It was suggested that the logo should be different for both Departments i.e. Environmental Sciences and Agriculture. The logo of Agriculture must contain a local plant in it while the presented logo of ES was approved.

Approval Status: All the members approved the agenda and recommended suggestions.

The meeting ended with vote of thanks from the chair.

Minutes recorded by:

Dr. Asim Abbasi and Dr. M. Mohiuddin

Minutes approved by:

**HoD
Environmental Sciences**

SCHEME OF STUDIES FOR (4-YEARS) BS DEGREE IN ENVIRONMENTAL SCIENCE

Sr. No	Course Code	Course Titles	Credit Hours
Semester-1			
1.	ENV-101	Introduction to Environmental Sciences	3(3,0)
2.	BIO-101/ MTH-106	Introduction to Biology/ Introduction to Mathematics	3(2,1) / 3(3,0)
3.	CHM-101	Fundamental Chemistry	3(2,1)
4.	ENG-101	English-I Reading and Writing Skills	3(3,0)
5.	GEN-101	Pakistan studies and Global Perspectives	2(2,0)
6.	ENV-102	Environmental Physics	3(2,1)
		Semester credit hours	17
Semester-2			
7.	ENV-103	Fundamentals of Earth Sciences	3(2,1)
8.	STA-101	Introduction to Elementary Statistics	3(3,0)
9.	ENV-104	Air and Noise Pollution	3(3,0)
10.	ENG-105	English-II Composition Writing	3(3,0)
11.	IST-101/ ETH-101	Islamic studies / Ethics and Moral Values	2(2,0)
12.	ENV-105	Ecology	3(2,1)
		Semester Credit Hours	17
Semester – 3			
13.	CSC-101	Introduction to ICT (Information and Communication Technology)	3(2,1)
14.	MIC-301	Introduction to Microbiology	3(2,1)
15.	ENV-201	Applied Ecology	3(2,1)
16.	ENV-202	Environmental Economics	3(3,0)
17.	ENV-203	Energy and Environment	3(3,0)
18.	ENV-204	Environmental Management Systems	3(2,1)
		Semester Credit Hours	18
Semester – 4			

19.	ENV-204	Environmental Microbiology	3(2,1)
20.	ENV-205	Environmental Toxicology	3(2,1)
21.	ENV-206	Climatology	3(3,0)
22.	ENV-207	Environmental Entrepreneurship	3(3,0)
23.	FOR- 303	Physical Geography and Climate Change	3(3,0)
24.	ENV-207	Environmental Sociology	3(3,0)
		Semester Credit Hours	18
Semester – 5			
25.	ENV-301	Water Resource Management	3(2,1)
26.	ENV-302	Environmental Pollution and Remediation	3(3,0)
27.	ENV-303	Environmental Profile of Pakistan	3(3,0)
28.	ENV-304	Research Methodology	3(3,0)
29.	ENV-305	Soil and Environment	3(2,1)
30.	ENV-306	ELECTIVE-I	3(3,0)
		Semester Credit Hours	18
Semester – 6			
31.	ENV-307	Solid Waste Management	3(3,0)
32.	ENV-308	Introduction to GIS and Remote Sensing	3(2,1)
33.	ENV-309	Analytics Techniques in Environmental Sciences	3(2,1)
34.	ENV-310	Conservation Biology	3(2,1)
35.	ENV-311	Environmental Monitoring	3(2,1)
36.	ENV-312	ELECTIVE-II	3(3,0)
		Semester Credit Hours	18
Semester – 7			
37.	ENV-401	Environmental Impact Assessment	3(2,1)
38.	ENV-402	Natural Resource Management	3(3,0)
39.	ENV-403	ELECTIVE-III	3(3,0)
40.	ENV-404	Occupational Health and Safety	3(3,0)
41.	ENV-499	Final year project/ Internship	3
		Semester Credit Hours	15
Semester 8			

42.	ENV-405	Environmental Laws and Policy	3(3,0)
43.	ENV-406	Public Health and Environment	3(3,0)
44.	ENV-407	Pollution Control Technologies	3(3,0)
45.	ENV-499	Final Year Project/Internship	3
		Semester Credit Hours	12

Elective Courses:

1. Environmental Biology
2. Urban Environmental Management
3. Disaster Risk Management
4. Hydrology
5. Agro-ecology
6. Ecotourism
7. Environmental Biotechnology
8. Anthropology
9. Wetland conservation and management
10. Environmental Biology

SEMESTER 1

COURSE 1:

ENV-101

Introduction to Environmental Sciences

3 (3-0)

Objectives:

The objective of this course is to provide orientation on the evolution and scope of this emerging discipline and to motivate them to think beyond basic sciences to decision sciences. After completing this course, the students are expected to learn the importance of Environmental Science in human life, its relationship with various segments of society and sectors of development. The students are also expected to become familiar with current national, regional and global challenges for sustainable development.

Basic principles: about convergence of ecology with economic and sociology to evolve as environmental science, its nature, history, scope and the contribution to society. Environmental aspects: physic-chemical, biological, socio-economic, socio-cultural, moral and ethical, and philosophical thinking.

Environmental problems: local, regional and global level. Environmental challenges:

Sustainability of resources for development: efficiency of energy and water resources, current and future trends in growth and resultant environmental pollution, poverty and resource depletion, development in industry, agriculture and urbanization.

Recommended Books:

1. Environmental Science: Earth as a Living Planet, Botkin, D.B & Keller, E.A. 9th Ed. John Wiley & Sons, 2013.
2. Environmental Science: systems and solutions, McKinney, M.L., Schoch, R.M. & Yonavjak, L. 5th Ed. Jones & Bartlett Publishers, 2003
3. Environmental Science for Environmental Management, O'riordan T, Routledge; 2014.
4. Environmental Science: Systems and Solutions. Michael L. McKinney, Schoch RM, Yonavjak L. Jones & Barlett Learning; 2019.

COURSE 2a:

BIO-101

Fundamental of Biology

3(2-1)

Objectives:

The objective of this course is to provide knowledge of the molecular basis of life to give a foundation for understanding the biochemical principles of structure and function of a living system as unity of life.

Course Outline:

Introduction: Definition and concept of life, chemical basis of structure and function of cell, chemical diversity of functional groups. Molecular basis of life: carbohydrates, lipids, proteins, phospholipids in membrane systems, polypeptides in protein diversity, and enzymes as molecular tools in chemical transformations nucleic acids the molecule of genetic information, replication and protein synthesis. Overview of structure and function of cell organelles and cell cycle.

Practical Work:

Identification of chemical nature of different animal and plant materials. Cytochemical

demonstration of DNA and RNA in Avian blood and Protozoa. Biochemical tests for carbohydrates, proteins and lipids. Protein digestion by enzyme pepsin. Study of mitosis in onion root tips. Study of meiosis in Grasshopper's testis.

Recommended Books:

1. Basic Biology; An Introduction, Purcell A, Basic Biology Limited; 2018.
2. Biology' Campbell, N. A. 8th Edition, The Benjamin / Cummings Publishing Company Inc. New York. USA,2008.
3. Concepts of biology, Fowler S, Roush R, Wise J, Stronck D., OpenStax College, Rice University; 2013.

COURSE 2b

MTH-106

Introduction to Mathematics

3(3-0)

Objectives:

The objective of this course is to impart knowledge, logic and skills to students necessary to explore, conjecture, reason logically, and use a variety of mathematical methods to solve problems, develop self-confidence and the ability to use quantitative and spatial information in problem solving and decision making, learn to enjoy and value mathematics, to think analytically, and to understand and appreciate the role of mathematics in everyday life, be prepared for the demands of both further education and the workplace.

Course Outline:

Sets, well known sets, operations on sets, Fundamental properties and operations of union and intersection, De Morgan's Law, Functions, types of functions, the graph of a function, Polynomial function, Algebra of polynomial function, Algebraic functions, Estimating using ratios, Arithmetic mean for grouped and ungrouped data, Matrices: types & algebra of matrices, Determinant of a square & transpose matrix, Inverse of a matrix, Determinant as a sum of products of elements, Characteristics of Binomial Theorem, Application of Binomial theorem, Limits of functions, Properties of limits of functions, Limit at infinity, Continuity of a function at a number, Limits and one sided limits, Properties of continuous functions, Continuity on an interval, Derivatives: Rates of change & slopes of tangent lines ,Slope of a tangent line to a graph, The derivative of a function Basic algebraic rules for differentiation, Rules for differentiating trigonometric functions, The chain rule, Implicit differentiation, Partial Derivates of functions of two variables, Indeterminate forms $0/0$, ∞/∞ , Increasing and decreasing functions, Monotone functions, critical numbers, relative extrema, First derivative test, Concavity Point of inflection and second derivative test, Absolute extrema, Indefinite Integration, Basic algebraic rules for integration, The method of substitution or change of variable, Definite integral, Basic properties of definite integral, Trapezoidal Rule, Simpson's Rule

Recommended Books:

1. Calculus with Analytic Geometry, 4th Ed, 2000, M.A Munem, D. J. Foulis. Worth Publishers, Inc.
2. Calculus with Analytic Geometry, 8th Ed, 2002, George B. Thomas, Jr. Ross L. Finney. Addison-Wesley Publishing Company.
3. Calculus with Analytic Geometry, 6th Ed, 2002, Dr. S.M. Yusaf, Prof Muhammad Amin. Ilmi Kitab Khana, LahorePakistan.
4. Mathematical Methods, 4th Ed, 2000, Dr. S.M. Yusaf, Dr. Abdul Majeed, Prof Muhammad Amin. Ilmi Kitab Khana, Lahore Pakistan.

5. An Introduction to Mathematics, 2017, Alfred North Whitehead, Dover Publication, Inc, Mineola, Newyork.

COURSE 3

CHM-101

FUNDAMENTAL CHEMISTRY

3(2-1)

Objectives:

The main objective of this course is to provide a basic knowledge and understanding of chemistry and principles of chemical reactions as well as extend the fundamental knowledge of various pollutants and their interactions with environment. The course not only provides excellent practice in basic chemistry, but also allows the rigorous development of experimental schemes and analytical methods.

Course Outline:

Periodic Table, chemical bonding: ionic, covalent, coordinate covalent bond. Solution chemistry. Surface chemistry. Colloids chemistry. Thermodynamics and chemical kinetics. General chemistry of functional groups of organic compounds (alcohols, carbonyls, esters, carboxylic acids, amines). Aromatic compounds, ions, radicals. Photochemical reactions. Radioactivity. Weak Acids & Bases; Water Hardness; Redox Reactions, Chemical Kinetics; Radioactivity.

Practical Work:

Preparation of molar, molal, normal solutions and buffers. Osmosis and Diffusion. Measurement of pH, EC, DO and TDS in wastewater. Use of titrimetric and gravimetric analysis. Use of spectrophotometric techniques. Paper Chromatography (one and two dimensional), Thin layer chromatography, Column chromatography.

Recommended Books:

1. Chemistry for Environmental Engineering and Science, Clair Sawyer, Perry McCarty, Gene Parkin, McGraw-Hill 2009.
2. Principles of Environmental Chemistry, Girard, J.E., 1st Edition, Jones and Barlett, USA,2005.
3. An Introduction to Environmental Chemistry, Andrews, J.E., Brimblecombe, P., Jickells, T.D., Liss, P.S. and Reid, B.J.,2ndEdition. Blackwell Science, UK, 2004.
4. Fundamentals of Analytical Chemistry, Skoog, D.A., West, D.M. and Holler, F.J., 8thEdition. Thomson and Brooks, Canada, 2004.
5. Basic Concepts of Chemistry, Malone LJ, Dolter T. John Wiley & Sons; 2008.

COURSE 4

ENG-101

English1 (Reading and Writing Skills)

3(3-0)

Objective

The aim of this course is to groom the students linguistically in such a manner that they can operate independently on a reliable measure of communicative competence in the twin productive skills of speech and writing.

Theory:

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 Skills, Reading strategies, Critical Reading (SQ3R Method), Summarizing, Sequencing, Inferencing, Comparing and contrasting, Drawing conclusions, Self-questioning, Relating background knowledge, Distinguishing between fact and opinion, Finding the main idea, important facts, and supporting details, Comprehending text organization patterns, Investigating implied ideas in a text, Purpose and tone of the text, Presentation Skills ,Features of good presentations, Different types of presentations, Different patterns of introducing a presentation, Organizing arguments in a presentation, Tactics of maintaining interest of the audience, Concluding a presentation, Giving suggestions and recommendations while ending of a presentation, Dealing with the questions of audience, Listening to recorded presentations.

Recommended Books:

- Worthington, D. Fitch-Hauser, M. (2018). Listening: Processes, Functions, and Competency (2nd ed). Routledge.
- Siddons, S. (2008). The Complete Presentation Handbook. Kogan Page Ltd
- Hancock, M. (2012). English Pronunciation in Use (2nd ed). Cambridge
- Hughes, S., & Harwood, N. (2010). Materials to develop the speaking skill. English language teaching materials: Theory and practice, 207-224.

COURSE 5

GEN-101

Pakistan Studies and Global Perspectives (Compulsory)

2(2-0)

Objective

The course aims to develop vision among the students about historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.

Theory:

Two Nation Theory and Ideology of Pakistan, Historical background of creation of Pakistan, Two Nation Theory in its historical context, definition and interpretations, Quaid-e-Azam and his political ideas, Political Dynamics of Pakistan, Constitutional Development in Pakistan 1947-73, Salient features of Constitution of Pakistan 1973, Institutions of Pakistan: Political Parties, Bureaucracy, Army, Judiciary and Media, Problems of Pakistan as a federal state, Socio-Economic Issues of Pakistan, Economical Problem, Social and Demographic Issues. Diplomatic Dynamics of Pakistan, Determinants and objectives of Pakistan's Foreign Policy, Pakistan's relations with its neighboring countries, Pakistan and the Muslim World, Comprehensive review of foreign policy of Pakistan

Recommended Books:

- Ikram SM. 2008. Modern Muslim India and the Birth of Pakistan. Delhi.
- Qureshi IH. 2007. Struggle for Pakistan. University of Karachi.
- Khan H. 2009. Constitutional and Political History of Pakistan. Pak Book Lahore.
- Ali K. 2005. The Political Economy of Rural Development. Sang-e-Meel, Lahore.
- Afzal MR. 2008. Political Parties in Pakistan. Historical Research Society, Islamabad.

COURSE 6

ENV- 102

ENVIRONMENTAL PHYSICS

3(2-1)

Objectives:

The course will provide an introduction to the physical principles that underlie environmental issues and their relationship with different types of interactions with energy and matter.

Course Outline:

Introduction to environmental physics, Scientific notations and mathematical hints for basic concepts. Solar spectrum, interaction of light with matter, Ozone and UV light, Energy, Entropy, Energy conversion. Heat radiation and heat transfer, Nuclear energy, Transport of pollutants, Diffusion, Conversion of mass, Solids, Liquids and Gasses, Equations of fluid dynamics, Turbulence, Turbulent diffusion, Gaussian plumes in the air, Turbulent jets and plumes, Particle physics, Sound and Noise, Basic acoustics, Human perceptions and noise criteria, Reducing the transmission of sound, Active control of sound, Radioactivity and nuclear physics, Isotopes and radioactive decay, Electromagnetic radiation.

Lab Work:

Study of the spectrum of light. Structure and function of spectrophotometer for absorption and transmission of light. Measurement and comparison of the light intensity at different locations and times using luxmeter. Measurement of noise level at different location to assess the noise pollution using sound level meter. Collection of particulate matter and its measurements by gravimetric methods. Field visit.

Recommended Books:

1. Introduction to Environmental Physics: planet Earth, Life and Climate, Hughes P, Mason NJ.. CRC Press; 2001.
2. Introductory Environmental Physics, Boeker, E. and Van Grondelle, R. John Wiley and Sons Inc. New York, 2nd Edition. USA, 2001.
3. Environmental Physics, Smith. C. Routledge, 1st Edition. Kentucky USA; 2001.
4. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Seinfeld, J.H. and Pandis, 2nd Edition. S.N. John Wiley and Sons Inc. USA, 2006.

SEMESTER 2

COURSE 7

ENV-103

Fundamentals of Earth Sciences

3(2-1)

Objectives:

This course aims to provide knowledge about the basic concepts of geology and geography. This will help the student to get the knowledge about different types of rocks and minerals, the processes of their formation, different earth processes like mountain buildings, earthquakes, weathering and erosion. The students will also be introduced to work with different type of maps and GPS system.

Course Outline:

Major components of Earth Systems: earth systems and their characteristics, Geologic Time and processes, Geology as an historical science, scientific methods and study of Earth's evolving systems.

Earth Systems: Processes and Interactions-Earth Solid System: components and processes, Rock cycle: Igneous rocks, Sedimentary rocks and Metamorphic rocks. The Hydrosphere–hydrologic cycle, Ocean circulations, the Biosphere–Biogeography, Energy relationships, biogeochemical cycles. Sedimentary rocks and fossils, processes of weathering, Biogenic sedimentary rocks, Chemical sedimentary rocks, Marine environments, Coral Reefs, Continental Shelves.

Terrestrial Environments: Forests, Deserts, Glaciers and Lakes. Time and Stratigraphy:

Introduction, Relative ages, Absolute ages, Evolution of Geologic time scale, why sea level is so important. Plate tectonics, structure of earth, hypothesis of continental drift, continental margins and plate boundaries types, features and behaviours, tectonic cycles.

The Dynamic Earth and Natural Hazards: Earth Quake and Volcanoes, Land instability, Weather Hazards, Fires and Coastal Hazards, Humans and the Environment: introduction to Holocene, sea level rise, Rapid climate change: at Millennial time scale, at Continental time scale and at Multidecadal time scales.

Practical and Field Work:

Study of earth relief features with the help of topographical models and thematic maps. Identification of samples of rocks and minerals. Use of Brunton compass and GPS. One study tour in the field.

Recommended Books:

1. Earth Evolving System: The History of Planet Earth by Ronald Martin, Jones & Bartlett Learning: LLC an Ascend Learning Company USA, 2013
2. Earth: An Introduction to Physical Geology, Tarbuck, E.J., Lutgens, F.K., and Tasa, D., 9th Edition, Prentice Hall; 2007
3. Historical geology: Evolution of Earth and Life Through Time, Wicander, R., and Monroe, J., 5th Edition, Brooks/Cole, 2007
4. Earth Science, Tarbuck, E. J., Lutgens, F. K., and Tasa, D., 11th Edition, Prentice Hall, 2005.

COURSE 8

STA-101

Introduction to Elementary Statistics 3(3-0)

Objective:

The objective of this course is to impart basic and applied knowledge about statistics for interpretation of results and decision-making.

Theory:

Sampling and its types, Probability and non-Probability Sampling, Simple random sampling, stratified random sampling, Systematic sampling, Sampling and non-sampling error, Sampling distribution of mean and difference between two means. Inference 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 χ^2 (chi-square), Testing hypothesis about variance. ANOVA and its assumptions, One-way ANOVA, Two-way ANOVA.

Recommended Books:

- Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal 2009.
- Faquir M. 2000. Statistical Methods and Data Analysis. KitabMarkaz, Aminpur Bazar, Faisalabad.
- Bio statistical Analysis. 4th ed. Pearson Education, Inc. and Dorling Kindersley Publishing Inc. (India), Zar JH. 2009.

COURSE 9

ENV- 105

AIR AND NOISE POLLUTION 3(3-0)

Objectives:

The course aims to introduce types of air, noise and electromagnetic waves. Causes and sources of air pollution, particulate matter, techniques of measurement of air pollutants and particulate matters, greenhouse gases, global warming, causes sources and effects, ozone depletion, acid rain. Air pollution prevention and control, strategies/methodology compliance of NEQS standards for air pollutants, nature of noise and electromagnetic waves. Propagation of electromagnetic waves and electromagnetic wave characterization, potential impacts of health impact of electromagnetic waves and noise pollution, noise measuring techniques and methodology etc. will be covered in this course.

Course Outline:

Air Pollution Essentials; The Risks of Air Pollution; Measurement and Monitoring of Air Pollution; The methodology of Air Pollution; The Regulatory Control of Air Pollution; The Engineering Control of Air Pollution; Introduction to Noise Pollution; Basic concepts of sound and noise; Noise and its effects; approaches to noise problems; Planning to control noise pollution; Noise reduction; Characteristics and impact of surface transportation noise; Traffic noise reduction; Aircraft noise reduction; Preventing airport noise; Control of noise pollution from diesel generator sets; Noise pollution in oil exploring and its control; noise pollution and its control in mining and product industries; Sound control technologies and instrumentation. Electromagnetic waves generated by cellular tower and its potential impact on humans and the environment.

Recommended Books:

1. Electromagnetic Surface Waves: A Modern Perspective (Elsevier Insights) by John Polo 2012.
2. Fundamentals of Air Pollution. Daniel Vallero. 4th Edition. ISBN10: 0-12- 373615-3 (2007).
3. Textbook of Noise Pollution and its Control. S.C. Bhatia. Atlantic Publishers and Distributors, (2007).

COURSE 10

ENG-105

English II-Composition Writing

3 (3-0)

Objectives:

The course aims at providing understanding of writer's goal of writing and to use that understanding and awareness for academic reading and writing.

Course Description:

The course focuses on the basic strategies of composition and writing skills. Good writing skills not only help students obtain good grades but also optimize their chances to excel in professional life. The course includes modes of collecting information and arranging it in appropriate manner such as chronological order, cause and effect, compare and contrast, general to specific etc. It enables the students to write, edit, rewrite, redraft and proofread their own document for writing effective compositions. Because of the use of a significant amount of written communication on daily basis, sharp writing skills have always been valued highly in academic as well as professional spheres.

Course Objectives:

This course aims to:

- ✚ Assist students identify the audience, message, and the purpose of writing

- + Develop rhetorical knowledge and critical thinking
- + Enable them express themselves in a variety of writing styles
- + Help students write well organized academic texts including examination answers with Topic/thesis statement and supporting details.
- + Make students write argumentative essays and course assignments

Course outcome:

By the end of the course, students are expected to:

- + Use different mechanics of writing to produce various types of compositions
- + Effectively keeping in view the purpose and the audience
- + Demonstrate rhetorical knowledge
- + Demonstrate critical thinking in well-organized forms of academic texts

Course Contents:

Writing Process

- + Invention
- + Generating Ideas (collecting information in various forms such as mind maps, tables, lists, charts etc)
- + Identifying Audience, Purpose, and Message

Ordering Information

- + Chronology for a narrative
- + Stages of a process
- + From general to specific and vice versa
- + From most important to least important
- + Advantages and disadvantages
- + Comparison and contrast
- + Problem solution pattern

Drafting

- + Free Writing
- + Revising
- + Editing
- + Paraphrasing Cohesion and Coherence
- + Cohesive Devices
- + Paragraph unity
- + Summary and Precis Writing
- + Creative Writing
- + Essay Writing
- + Developing a thesis
- + Organizing an essay
- + Writing effective introduction and conclusion
- + Different types of essays
- + Use of various rhetorical modes including exposition, argumentation and analysis

Recommended Books:

2. McCarthy, M. & O'Dell, F. (2016). Academic Vocabulary in Use (2nded). Cambridge
3. Aristotle. (2007). On Rhetoric: A theory of civic discourse (2nded). New York: OUP.
4. Bailey, S. (2014). Academic Writing: A handbook for international students. Routledge.
5. Canagarajah, A. S. (2013). Critical Academic Writing and Multilingual Students. University of Michigan Press.

6. Goatly, A. (2000). *Critical Reading and Writing: An Introductory Course*. London: Taylor & Francis
7. Hacker, D. (1992). *A Writer's Reference*. 2nd ed. Boston: St. Martin's
8. Hamp-Lyons, L. & Heasley, B. (1987). *Study writing: A course in written*
9. *English for academic and professional purposes*. Cambridge: Cambridge University Press.
10. Howe, D. H, Kirkpatrick, T. A., & Kirkpatrick, D. L. (2004). *Oxford English for Undergraduates*. Karachi: Oxford University Press.

Recommended Books:

COURSE 11

IST-101

ISLAMIC STUDIES (Compulsory)

2 (2-0)

Objective:

This course is aimed to provide Basic information about Islamic Studies, understanding of the students, regarding Islamic Civilization, improve skill to perform prayers and other worships and understanding of issues related to faith and religious life.

Theory:

Introduction to Qur'anic Studies, Basic Concepts of Qur'an, History of Quran, Uloom-ul-Quran

مطالعہ قرآن (تعارف قرآن، سورۃ البقرہ، سورۃ الحجرات، سورۃ الفرقان، سورۃ المؤمنون، سورۃ الانعام، سورۃ الصف ترجمہ و تفسیر)

Introduction to Sunnah, Basic Concepts of Hadith, history of Hadith, kinds of Hadith, Uloom –ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah

Selected Study from Text of Hadith

معالغ حدیث (متن حدیث ترجمہ و تشریح)

النبی

سیرت

﴿مطالعہ سیرت کی ضرورت و اہمیت، تعمیر سیرت و شخصیت کا نبوی منہاج، اقامت دین، مینا قدمینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات﴾

Islamic Culture & Civilization, Basic Concepts of Islamic Culture & Civilization, historical Development of Islamic Culture & Civilization , Characteristics of Islamic Culture & Civilization, Islamic Culture & Civilization and Contemporary Issues

اسلامی تہذیب و تمدن (اسلامی تہذیب کے ارکان و بنیادیں، خصوصیات، اسلامی تہذیب کے فکری، علمی، معاشرتی اور سماجی اثرات، عصری تہذیبی کشمکش اور اسلامی تہذیب، تہذیبی تصادم کے اثرات و نتائج)

Recommended Books:

- Hameed ullah Muhammad, —Emergence of Islamll , IRI, Islamabad
- Hameed ullah Muhammad, —Muslim Conduct of State
- Hameed ullah Muhammad, = Introduction to Islam
- Dr. Muhammad Zia-ul-Haq, —Introduction to Al Sharia Al Islami Allama Iqbal Open University, Islamabad (2001)

Course Code: ETH-101

Course Title: ETHICS AND MORAL VALUES

Credit Hours: 3(3-0)

Objective:

This course not only aims to provide basic knowledge about ethical values to the students but also to enhance their skill for understanding of issues related to faith and religious life.

Theory:

Definition and scope of ethics: relation of ethics to psychology, metaphysics and relegation. A brief review of major theories of the moral standard: The standard as law, the standard as happiness, the standard as perfection. Promotion of Moral Values in society through family and various educational and cultural institutions; concept of good and evil; freedom and responsibility; various theories of punishment. Ethical teachings of world religions with special reference to Hinduism, Buddhism, Judaism and Islam. 100 ethical precepts from the Quran and the sayings of the Holy Prophet (PBUH). Islam's attitudes towards minorities.

Books Recommended:

- Mackenzie, J.A., A Manual of Ethics, Latest editions University Tutorial Press Ltd., London.
- Syed AbulAalaMaudoodi, Islamic Riyasat, Islamic Publications Ltd., 13-E, Shah Alam
- Dr. Mazhar U. Kazi, A Treasury of Hadith, 1991, Ferozeson (Pvt.) Ltd., Lahore

COURSE 12**ENV-105****ECOLOGY****3(3-0)****Objectives:**

To develop an understanding about ecology, its fundamental concepts, description of population, community, ecosystem and its types, biogeography and systems' ecology.

Course Outline:

Introduction and branches of ecology. Levels of ecological organization: species, population, community and ecosystem. Abiotic and biotic factors. Concepts of limiting factors, habitat and niche. Populations: distribution and abundance, population dynamics and distribution limits. Community: organization and various concepts, community dynamics. Ecosystem: structure and function, energy flow and material cycling within ecosystem and carrying capacity. Biomes of the world. Ecological production: primary and secondary productivity, productivity of different ecosystems.

Recommended Books:

1. Ecology (Concepts and Applications.) Moles, M C J 6th Edition. WCB/McGraw-Hill. New York, 2012.
2. Elements of Ecology. Thomas M. Smith and Robert L. Smith. 8thEd. Benjamin Cummings, 2012.
3. Ecology. Michael L Cain, William D. Bowman and Sally D. Hacker. 2nd Ed. Sinauer Associates, 2011.
4. Fundamentals of Ecology. Odum, E P. and Baret, G.W. 5thEd. Thomson Brooks/Cole, 2004.

SEMESTER 3**COURSE 13****CSC-101****Course Title: Introduction to ICT (Information and Communication Technology) 3(3-0)****Objectives:**

This objective of this course is to impart basic computing skills necessary for use of digital

support to modern education for acquiring knowledge through offline and online resources, analysis of data, composition of data and presentation of data in the in efficient and effective way.

Course Outline:

Definition, Types and classification of computers. Hardware: Input Hardware, Storage hardware, processing hardware, output hardware. Software: Application software, system software, software packages, Operating system (Windows), internet, e-mail, Local Area Network, Configurations, Introduction to MS-Word, Ms-Excel, Ms-Power Point, Ms-Access.

Recommended Books:

1. Fundamentals of Computer. Long, I and Long, N. 6th Ed.2001.
2. Understanding computers: Today and Tomorrow, Comprehensive. Morley D, Parker CS. Cengage Learning; 2014.

Course 14

MIC-301

INTRODUCTION TO MICROBIOLOGY

3(2-1)

Objectives:

To overview about the microbial world, scope and branches of microbiology and basic knowledge of different microorganisms. To theoretically and practically equip with basic techniques used in Microbiology. To impart some preliminary knowledge about the control, antimicrobial agents and antimicrobial drug resistance

Course contents:

Theory

Introduction and scope of Microbiology, Branches of Microbiology and an overview of Microorganisms, Historical Development in Microbiology, Microscope & Microscopy Principles, functions and differences of various types of light and electron microscopes, Classification and brief introduction of Microorganisms: Bacteria, Fungi, Algae, Protozoa, Parasites, Viruses etc, Nomenclature and general morphology (size, shape & arrangement) of microorganisms (bacteria), Cellular morphology of Bacteria: structures external to cell wall & cell wall, Cellular morphology of Bacteria: structures internal to cell wall, Bacterial growth and growth curve, Growth rate, generation time and their calculations, Growth requirements of bacteria (Physical), Growth requirements of bacteria (Chemical/Nutritional), Growth characteristics of bacteria on agar and in broth media, Culture Media: Classification, composition and use of culture media with examples, Bacterial spores and toxins, Phosphorylation: Substrate level phosphorylation, photophosphorylation, oxidative phosphorylation, General methods of studying microorganisms: cultivation, purification, identification and characterization, Control of microorganisms by physical and chemical methods, Basic properties of fungi, protozoa and algae, A brief introduction to viruses: classification, symmetries, cultivation and propagation, Bacteriophages: structure, lifecycle, cultivation and identification, Introduction to chemotherapeutic agents and antibiotics: mechanisms of action of antibiotics, Antimicrobial susceptibility testing: disc diffusion / agar well diffusion methods, Antimicrobial susceptibility testing/ MIC determination: micro broth dilution method and e-test.

Practical

Laboratory Safety: Containment and decontamination, Introduction to Microscopy, Introduction to materials and equipment used in Microbiology, Sterilization: Autoclave

& Dry heat sterilization (Hot air oven), Preparation and sterilization of culture media & glass wares, Isolation of bacteria: Pour plate and spread plate methods, Isolation of bacteria: Streak plate method, Staining of bacteria: Preparation and fixation of bacterial Smears, Gram's staining, Spore staining, Acid Fast staining, Enumeration of bacteria.

Recommended Books

1. Joanne Willey, Stanley Fischer, and Richard Startz. 2010. Prescott's Microbiology 8th edition. McGraw-Hill Higher Education
2. Baxter, A. P and E. Van der Linde (Eds.). 1999. Collecting and preserving fungi: A manual for mycology. ARC – Plant Protection Research Institute, South Africa. Ultra Litho (Pty) Ltd, Heriotdale, Johannesburg.
3. Goszczynska, T., J. J. Serfontein and S. Serfontein. 2000. Introduction to practical phytobacteriology: A manual for phytobacteriology. SAFRINET, the Southern African (SADC) Loop of BIONET-International, ARC-Plant Protection Institute, Pretoria, South Africa.

Course 15

ENV-201

APPLIED ECOLOGY

3(3-0)

Objectives:

This course will make the students aware of the concepts of applied ecology and understand some major environmental issues such as global climate change, sustainable agriculture, conservation of resources in ecological perspectives, their management and ecological restoration.

Course Outline:

Background and scope of applied ecology. Applications of ecological knowledge in solving different environmental issues. Energy and carbon balance: carbon emission and global climate change, effect of increased carbon dioxide concentration on agriculture. Human impact on Nitrogen cycle. Water as an ecological resource: Water and distribution of species, farming practices under limited water supply. Soil as a natural resource: soil salinity and waterlogging issues in Pakistan, soil erosion and conservation. Agro- ecology: ecology of food production, Sustainable agricultural practices. Forest ecology: conservation and management of forests and rangelands in Pakistan. Industrial ecology: impact of industrial pollution on ecosystems, pollutant transfer in plant and animals, phyto-remediation. Urban ecology: urban ecological footprint, urban environmental degradation, green cities. Ecological modeling in defining ecosystem problems. Ecological restoration: concepts and techniques.

Recommended Books:

1. Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. 2013. Clewell, A.F. 2nd Edition. Island Press.
2. A Primer of Conservation Biology. 2012. 5th Ed. Sinauer, P.R.B. Associates Inc. Publ. Sunderland.
3. Urban Ecology: Patterns, Processes, and Applications. 2011. Jari Niemela, Jurgen H. Breuste, Glenn Guntenspergen, Nancy E. McIntyre, Thomas Elmqvist, Philip James. Oxford University Press.
4. Ecology of Industrial Pollution. 2010. Ed. Lesley C. Batty and Kevin B. Hallberg. Cambridge University Press.
5. Applied Ecology and Environmental Management. Newman. E.I. 2nd ed. Blackwell Scientific Publications, Oxford. 2000

COURSE 16

ENV-202
ENVIRONMENTAL ECONOMICS 3(3-0)

Objectives:

The objective of this course is to provide an orientation to the students about the basic concepts and principles of Economics in order to build the foundation to understand the economic aspects of environmental protection, conservation, cost of environmental degradation. This course will laid the foundation for any advance course on environmental economics.

Course Outline:

Introduction to economics; scope and fundamental concepts of Economics: Consumer behavior, Producer behavior, and Resource allocation. Optimum utilization of resources from consumer, producer and community point of view. Economic development, economic progress, economic growth, economic welfare and difference among all. Man environmental relationship, Impact of economic activity on environment, Sustainable development, Measures for sustainable development. Sustainable development in developed and developing countries. Pakistan economic context: National income, concepts and measurement, Growth and development, poverty, Growth and Environment.

Environmental economics, Economic management and environmental quality, economic growth and its measurement, population and environmental quality, Natural resources and the economy, interaction between ecology and economic management. Economic functions of environment.

Recommended Books:

1. Economic Development. Todaro, M. P. 7thEd. Wesely Publishers, USA. 2008.
2. Development Economics through the Decades: Acritical Look at 30 Years of the World Development Report. Yusuf, S. World Bank Publications, USA. 2008.
3. World Development Report 2009: Reshaping Economic Geography. World Bank Publications. USA, 2008.
4. Environmental Economics in Theory and Practice. Hanley, N., Shogren, J. and White, B. Palgrave Macmillan, USA. 2007.
5. Economics. Michel Parkin. 5th Ed. Addison Wesley.2004.
6. Economics. Samuelson and Nordhaus. 18th Ed. McGraw-Hills, Inc.2004.

COURSE 17

ENV-203

ENERGY AND ENVIRONMENT

3 (3-0)

Objectives:

A course aiming to provide physical principles behind its generation, sources, uses and effects on our environment. To highlight the effect of production and use, on the environment, of the various energy resources being used by man and discuss viable alternatives

Course Outline:

Introduction: Energy Units, forms and types of energy, energy resources, energyuseandgrowthpatterns,energyconversion,energyuseindeveloping countries and losses; Energy Mix; Coal Characteristics; Problems associated with Mining & Transportation and use: Petroleum history and Processing; Problems associated with petroleum production, transportation and storage; Energy Conversion, Electric Power Generation;

Hydroelectricity: Environmental Issues during Survey, Population Displacement and Construction; Nuclear Energy: Nuclear Fission; Electromagnetic Spectrum, Solar Spectrum, Light Intensity at Earth, Problems with use of energy resources: Wood, Coal and Fossil fuels; local and global issues; Ecological Effects of Large Dams; Spent Nuclear Fuel Disposal Issues; Nuclear Accidents: three-Mile Island, Chernobyl, Fukushima etc. Renewable Energy Sources: Microhydel, wind, Solar thermal, Photovoltaic, Biogas etc.; Novel Energy sources: Biofuels, Geothermal, Wave, Tidal; Hydrogen as an Energy Carrier, Fuel Cells, Hybrid Vehicles.

Recommended Books:

1. Energy: Its use and the Environment, 5th Edition, Roger A. Hinrichs and Merlin Kleinbach, Brooks Cole, 2013
2. V. Quaschnig, Renewable Energy and Climate Change, Wiley-IEEE, 2010
3. D. Coley, Energy and Climate change, 2nd Edition, John Wiley, 2008
4. R. Ristinen and J.K. Kraushaar, Energy and Environment, John Wiley, 2006
5. Encyclopedia of Energy Technology and the Environment Four Volume Set, John Wiley & Sons Inc (US), 2005
6. G. Boyle, Renewable Energy, Oxford University Press, 2004.

COURSE 18

ENV-204

ENVIRONMENTAL MANAGEMENT SYSTEMS

3(2-1)

Objectives:

This course is aimed at providing training to students on designing Environmental Management Systems for any organization in order to enable them to contribute to planning and implementation of EMS in an organization.

Course Outline:

Introduction to the concept of Corporate Social Responsibility (CSR) and environmentally responsible business initiative. Introduction to principles of green economic growth.

Practical Work:

Classroom exercises on identification of environmental aspects; assessment of environmental impacts and suggestion of mitigation measures of activities of some hypothetical organization. Development of Environmental Management Plan by a group of students for a hypothetical or real organization. Industrial visits to identify environmental issues of management.

Recommended Books:

1. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations: NSF International Ann Arbor, Michigan, 2001.
2. Environmental Management Systems: General Guidelines on Principles, Systems and Support Techniques. American Society for Quality, International Organization for Standardization. 2nd Ed., American Society for Quality, 2005.
3. Environmental Management Systems: A step-by-step Guide to Implementation and Maintenance, Sheldon, C. and Yoxon, M., 3rd Edition 2006.

COURSE 19
ENV-205
ENVIRONMENTAL MICROBIOLOGY

3(2-1)

Objectives:

This course will provide an awareness and understanding to the students about the role of microorganisms in the environment. After completion of this course, students will be able to understand the significance, role and applications of microorganisms in the environment.

Course Outline:

Introduction and history of environmental microbiology. Groups of microorganisms: protozoans, algae, fungi, bacteria and viruses (general characteristics). Bacterial cell structure and metabolism. Eubacteria and archaea. Characterization of bacterial colonies and cells. Environmental factors affecting the microbial growth. Microbial genetics (Conjugation, transformation and transduction). Microbial interactions. Role of microbes in environment/industry: biogeochemical cycles, biodegradation and bioremediation, food and health, biological warfare agents.

Lab Work:

Introduction to basic techniques for sterilization/disinfection, isolation, purification and characterizations, Dilution plate technique, Mean plate count, microscopy. Measurement of bacterial growth.

Recommended Books:

1. Environmental Microbiology, Maier, F.M., Pepper, I.L. and Gerba, C.P. 2nd Edition, Academic Press, London, UK, 2009.
2. Principles and Applications of Soil Microbiology, Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. and Zuberer, D.A. Prentice Hall, New Jersey, USA, 2005.
3. Microbiology, Prescott, L.M., Harley, J.P. and Klein, D.A. McGraw-Hill Inc., USA, 2007.

COURSE 20
ENV-206
ENVIRONMENTAL TOXICOLOGY

3(2-1)

Objectives:

The course is focused on providing knowledge related to toxic chemicals in air, water and soil, dose response relationship in living organisms, short term (acute) and long-term (chronic) effects on organ system, their containment and control strategies.

Course Outline:

Introduction to Toxicology. Classification and properties of toxic substances: anthropogenic and natural poisons, acute and chronic effects, genotoxic, mutagens, teratogens, carcinogens and sensitizers. Biological properties of organic and inorganic pollutants: essentiality and toxicity. Routes of absorption. Bioaccumulation and bio-magnification. Quantification of toxicity: dose-response relationships, synergism, antagonism, LD50 and rating systems, Threshold Limit Values. Toxic impacts of atmospheric agents. Fate of absorbed toxins and xenobiotics, including detoxification and bioactivation. Natural detoxification processes. Risk management.

Lab Work:

Analysis of toxins, Dose-response relationship and D/R Curves. In vitro & In vivo techniques for toxicity testing. Proposed techniques (at least one of these); Ames test, Comet assay, CAM, TTC and Immuno-fluorescent assay or microscopic observation of changes in plant cell morphology after exposure to toxic substances.

Recommended Books:

1. Environmental Toxicology: Biological and health effects of pollutants. Yu M.H., Tsunoda H. and Tsunoda M. 3rd Edition. CRC Press, Taylor & Francis Group. 2011.
2. Casarrett & Doull's Toxicology- Science of Poisons, Klassen, W.D., 5th Edition, McGraw-Hill, USA, 2005

COURSE 21

ENV-207

CLIMATOLOGY

3(3-0)

Objectives:

The objective of this course is to provide know-how regarding Earth's climate and weather systems, processes and the relationships between the atmosphere and climate. Concepts of climate of Pakistan will also be provided.

Course Outlines:

Introduction To Climatology and A Brief History, The Earth Four Spheres, Weather and Climate, Vertical Structure of The Atmosphere, Heat and The Earth's Atmosphere, Radiation and Climate, Solar Radiations, Mechanism of Heat Transfer, The Hydrologic Cycle, Condensation and Cloud Formation, Cloud Classification, Clouds and Vertical Motion in the Atmosphere, Air Pressure, Factors Affecting Air Pressure, Surface Winds, Local Winds, Global Circulation, The Climate of Pakistan, Concept of Seasons in Classification of Climate, Climatic Zones of Pakistan.

Recommended Books:

1. The Physics of Atmospheres, John Houghton, Cambridge University Press, 2002.
2. Climatology, A. Austin Miller, Ninth Edition SHUBHI Publications, ISBN 81-87226-42-0
3. The Atmosphere, Fredrick K. Lutgens, Edward J. Tarbuck, Sixth Edition, ISBN 0-13-350612-6
4. Atmospheric Chemistry and Physics - From Air Pollution to Climate Change Seinfeld, John H.; Pandis, Spyros, N. 2nd Editions. John Wiley & Sons, 2006
5. The meteorology of Pakistan: The climate and weathers of Pakistan. Shamshad, K.M. Royal book company, sadder, Karachi, ISBN, 9694070821.1988.

Course 22

ENV-208

ENVIRONMENTAL ENTREPRENEURSHIP

3 (3-0)

Objectives

To familiarize students with the scope of issues and decisions that managers in environment face as their company progresses from its earliest stages to self-sustainability, and give students the vocabulary to participate and contribute to the business side of scientific enterprises

Course contents

Overview of the global environment industry, idea generation, business plan formulation, intellectual property protection, funding, personnel management including board composition, regulatory body interaction and company exits. This course is directed towards advanced students in environment.

Recommended Materials

1. Craig Shimasaki, ed.: *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Elsevier Inc., 2014. ISBN: 978-0-12-404730-3.
2. Burrill & Company Annual Biotechnology Industry Report William B. Bygrave and Andrew Zacharakis: *The Portable MBA in Entrepreneurship*. Wiley & Sons, Hoboken, NJ. 2009
3. William B. Bygrave and Andrew Zacharakis: *Entrepreneurship*. Wiley, Hoboken, NJ, 2010.

COURSE 23

FOR-303

PHYSICAL GEOGRAPHY AND CLIMATE CHANGE

3 (3-0)

Objective:

The aim of this course is to equip students with basic theoretical knowledge of geography and climate its impacts on world and Pakistan.

Course Contents:

Our Earth, Interior of Earth, The Atmosphere, Atmospheric Pressure, Winds, Variable Windows, Moisture in Atmosphere, Major land reform (Mountain, Plateaus); Hydrosphere Defining Climate, Climate system: Components; controls on climate; Latitude, Earth-sun relationships, Revolution, Rotation, Axial tilt and their combined effect, Distance to large bodies of water, Defining Climate Change, Climate change processes, Green House Gases' emission, Drivers and Indicators of Climate Change, Cause & Effect of Climate Change, Climate Change Policy, Impacts of Climate Change in Pakistan, Green Economy, Carbon Footprint, Technological Development and Changing climate, Climate Change matters, Present rapid warming, Projection of future climate change, Uncertainty in climate change projections, Climate change impacts-reasons for concern, Impacts on natural systems, societal systems, human health and comforts, Reactions and attitudes to climate change: Adaptation, Mitigation options: increased energy efficiency, fuel substitution, nuclear power, hydropower, solar energy, wind power, bioma Energy, tidal, wave and geothermal energy, hydrogen economy, changes in infrastructure and behavior.

Recommended Books:

1. Leal Filho, W. (2015) *Handbook of Climate Change Adaptation*, Springer-Verlag Berlin Heidelberg. 219p
2. Leal Filho, W. (2016) *Innovation in Climate Change Adaptation*. Springer-Verlag Berlin Heidelberg.388p
3. Valentino Piana. 2012. *Innovative Economic Policies For Climate Change Mitigation*. Economic web Institute .ISBN-13: 978-1445285856
4. IPCC (2013). *Climate Change 2013, The Physical Science Basis - Summary for Policymakers* (Available Online). https://www.ipcc.ch/pdf/assessment-report/ar5/.../WG1AR5_Frontmatter_FINAL.pdf
5. Mark Pelling . 2010. *Adaptation to climate change /*. Abingdon, Oxon, England;New York

6. Hardy, J. T. 2003. Climate Change Causes, Effects, and Solutions, 1st Edition, John Wiley & Sons.
7. IPCC. 2005. Climate Impact and Adaptation Assessment A Guide to the IPCC Approach, Earthscan Publication Ltd, London,

Course 24

ENV-209

ENVIRONMENTAL SOCIOLOGY

3 (3-0)

Objective:

The course aims to learn about environmental sociology and explore the relationship between human societies and the larger natural environment of which they are a part. It also reviews the history of resource use, wilderness preservation, pollution, various environmental movements, and other developments with significant ecological implications.

Course Contents:

Introduction:

- i. Definition and Concepts of Environmental Sociology
- ii. Scope and Importance of Environmental Sociology

Industrialization or Capitalism

- i. Ecological Conditions before the Industrial Revolution
- ii. The Environment at the Time of the Industrial Revolution.

The Modern Economy and its Ecological Implications

- i. Expansion and Conservation
- ii. Imperialism and Ecology

Consumer Society

- i. Consumption and Materialism
- ii. The Fetishism of the Commodity and its Secret
- iii. The State of Consumption Today
- iv. Modern Environmentalism

The Origins of Modern Environmentalism

- i. The Ideology of Scientific Conservationism
- ii. The Growth of the Wilderness Idea

A New Paradigm Emerges

- i. The Ecology of Affluence
- ii. Sixties Seedtime

Environmental Movements

- i. Environmental Movements in Taiwan
- ii. Environmental Movements in Thailand
- iii. Environmental Movements in the Philippines
- iv. Culture and Asian Styles of Environmental Movements

Exploring Environmental Problems/Issues

- i. Air Pollution
- ii. Water Pollution
- iii. Noise Pollution
- iv. Depletion of Ozone layer

Social Justice and environmental issues

- i. Gender, Justice, and Environmental Issues
- ii. Race, Justice, and Environmental Issue
- iii. Social Class, Justice, and Environmental Issues

Causes of Environmental Disruption:

- i. The state and policy: Imperialism,
- ii. Exclusion and ecological violence as state policy
- iii. The science of nature and the nature of science

Recommended Books:

1. Bell, Michael Mayerfeld (2004). *An Invitation to Environmental Sociology*. Thousand
2. Bell, Michael Mayerfeld. 2004. *An Invitation to Environmental Sociology*. Thousand Oaks, California: Pine Forge Press.
3. Brown, Janet W., Pamela S. Chasek, and Gareth Porter. 2000. *Global Environmental Politics*. Boulder,
4. Brown, Lester R. 2001. "Eradicating Hunger." Pp. 43-62 in *State of the World 2001*, edited by Lester R.
5. *Environment, Development and Social Movements*. London and New York: Routledge.
6. Frey, R. Scott , R. Scott (ed.) (2001). *The Environment and Society Reader*. Boston,
7. Frey, R. Scott. 2001. "Environmental Problems from the Local to the Global." Pp. 4-25 in *The Environment*
8. Gardner, Gary, Erik Assadourian, and Radhika Sarin. 2004. "The State of Consumption Today." Pp. 3-21 in *State of the World 2004*, edited by Linda Starke. Washington: World Watch Institute.
9. Gardner, Gary. 2003. "Engaging Religion in the Quest for a Sustainable World." Pp. 152-176 in *State of the World 2003*, edited by Linda Starke. Washington: World watch Institute.
10. Gunter, Valerie and S. K. Smith (2007). *Volatile Places: A Sociology of communities and Haven*: Yale University Press.
11. Humphrey, C. R., T. L. Lewis, and F. H. Buttel (2003). *Environment, Energy, and Joseph Murphy and Maurie J. Cohen*. New York: Pergamon.
12. Ken Conca, Geoffrey, R. Scott D. Dabelko (eds.) (2004). *Green planet blues* :London, Toronto: Allyn and Bacon.
13. Murphy, Joseph, and Maurie J. Cohen. 2001. "Consumption, Environment, and Public Policy." Pp. 3-17 in *Exploring Sustainable Consumption: Environmental Policy and the Social Sciences*.
14. Narayanan, Vasudha. 2001. "Water, Wood, and Wisdom: Ecological Perspectives from the Hindu Oaks: Pine Forge.

SEMESTER 5

COURSE 25

ENV-301

WATER RESOURCES MANAGEMENT

3(2-1)

Objectives:

The aim of this course is to educate students about the Water Resources Management with reference to Pakistan, how to minimize the wastage and how to increase its efficiency

especially in irrigation sector.

Course Outline:

Water resource and its management, hydrological cycle, water quality and quantity aspects, water supply and demand management measures, virtual water, groundwater exploitation, its over-mining and pollution and urbanization aspects, improving water productivity/irrigation water efficiency, flood and droughts, water conservation and rain water harvesting in urban and rural environment, wetlands resources management, flood and drought management, recycling and re-use of wastewater, fisheries management, climate change and its impacts on our future water resources, precipitation distribution in Pakistan, Indus Water Treaty 1960 (IWT), Indus Water Accord 1991, water relevant institutions and authorities in Pakistan, water resources management and future challenges in Pakistan. Integrated water resources management (IWRM).

Lab Work:

1. Study tours to visit water supply & wastewater treatment plants, watershed/catchment, with drinking water facilities like springs, tube-wells, pollution aspects, like solid waste and wastewater disposal into the natural streams etc.
2. Recommended Books:
3. Pakistan's Water Economy Running Dry, Briscoe, J. and Qamar, U., Oxford University Press Karachi, 2006.
4. Problems and Politics of Water Sharing and Management in Pakistan, Cheema, P. I., Khan, R. A. and Malik, A. R., Asia Printer, Islamabad, 2006.
5. Integrated Water Resources Management in South and Southeast Asia, Biswas, A.K., Varis, O, and Tortajada, C, (eds.), Oxford University Press New Delhi, 2005.

COURSE 26

ENV-302

ENVIRONMENTAL POLLUTION AND REMEDIATION

3(3-0)

Objectives:

The course is focused on introducing environmental pollution and its sources. It will also cover the existing laws related to pollutants in Pakistan and the conventions ratified internationally.

Course Outline:

Environmental Pollution, sources, types and causes. Types of pollutants: Physical, chemical and biological; Characteristics of domestic & industrial effluents; Effects of Pollutants on human & other living organisms; Industrial and Municipal Solid Waste. Principles of Waste Management & Disposal; Fate of pollutants; Factors affecting movement of pollutants in soil, air and water. Monitoring of Environmental Pollution; Pollution Control Strategies; Environmental Laws: Pollutants Guidelines; International Protocols; Case Studies.

Recommended Books:

1. Understanding Environmental Pollution, Hill, M.K., 2nd Edition. Cambridge University Press, Cambridge UK, 2005.
2. Environment Pollution: Types, Sources & Management. Ghafoor, A., G. Murtaza, M.Z. Rehman, M. Sabir, H.R. Ahmad and Saifullah. Allied Book Centre, Lahore, Pakistan. 2012.

COURSE 27

Objectives:

To provide students with a comprehensive knowledge about the environmental resource base of Pakistan in order to learn its efficient utilization for sustainable development.

Course Outline:

Introduction to history of the region; Features: land, geography, people, culture, health, education; Ecological: ecological zones, major ecosystems, topographic zones; Economic: agriculture, industry, water resources, urbanization and pollution.

Recommended Books:

1. State of the Environment-Pakistan , Government ofPakistan,2005
2. National Conservation Strategy Government of Pakistan Ministry of Environment and IUCN -1993

COURSE 28

ENV-304

RESEARCH METHODS

3 (3-0)

Objectives:

At the end of this course, the students should be able to understand some basic concepts of research and its methodologies; identify appropriate research topics; select and define appropriate research problem and parameters. The students will learn how to prepare a project proposal (to undertake a project), organize and conduct research (advanced project) in a more appropriate manner.

Course Outline:

Purpose of Research; Research Project Conceptualization, Choice of Methods; Elements of a Research Proposal, Operationalization choices and illustrations. Research Design: formulation of research design, pretesting of research instruments and procedures, units of Analysis, time dimension; Experimental design and use of indicators in research, Survey Research: Guidelines for asking question and questionnaires construction, Self- administered questionnaires, Interview and other survey methods; their strength and weaknesses.

Sampling: the logic of sampling, concepts and terminologies, population and sampling frames, types of sampling design.

Field Studies:

Steps in the conducting field study; Evaluation Research: How to carry out evaluation research; Analytical tools in research: qualitative and quantitative methods. Statistical Analyses: Univariate, Bivariate and Multivariate analyses.

Recommended Books:

1. Students project in Environmental Science, Harrad, S., Batty, H., Diamon, M. and Arhonditsis, G, John and sons Ltd., Chichester, England, 2008.
2. Designing and Conducting Mixed Methods Research, Creswell, J. W. & Plano Clark, V.L. Thousand Oaks, Sage CA, USA,2007.
3. The Craft of Research by Wayne C. Booth, 2ndEdition, Univ. of Chicago Press. USA,2003.
4. Case Study Research: Design and Methods, Robert Yin, 3rdEdition, Sage Publishers.

COURSE 29

ENV-305

SOIL AND ENVIRONMENT

3 (2-1)

Objectives:

This course will provide students with the knowledge of the basic properties and significance of soil and its care for sustainable environment.

Course Outline:

Introduction, Soil forming minerals, Types and properties of parent materials, Physical and chemical processes of weathering, Factors and processes of soil formation, Physical and chemical properties of soil, Soil morphology and classification Cation and anion exchange, Soil buffering capacity and its importance, Soil degradation, management and green productivity, Environmental implications of fertilizers and agrochemicals, Environmental impact of agricultural and Industrial wastes, Soil as a natural sink for pollutants.

Recommended Books:

1. The Nature and Properties of Soils, Brady, N.C. and Weil, R.R. Prentice- Hall, 14th Edition. Upper Saddle River, NJ, USA,2007.
2. Soils in Our Environment, Miller, R.W.,Gardiner,D.T.,11thEdition,Prentice Hall, Upper Saddle River, NJ, USA,2007.

COURSE 306

Elective I

Semester 6

Course 31

ENV-307

SOLIDWASTE MANAGEMENT

3(3-0)

Objectives:

The students will learn the types, handling and management systems of solid wastes.

Course Outline:

Introduction to solid waste management; Solid waste characterization: Sources, quantities, quality; Waste collection and transport; Treatment technologies: Bioremediation strategies; Composting: Types and methods, environmental requirements, incineration, reuse and recycling; Landfills: Site design and management; Pollution and risk assessment of landfills; Biogas generation: Use of biogas digest; Recent technologies used for solid waste management.

Recommended Books:

1. Principles and Applications of Microbiology. Salivia, D.M., J.J. Fuhrman, G.P. Hartel and A.D. Zuberer. 2nd Ed. Prentice Hall, Upper Saddle River, NJ, USA. 2005.
2. Compost Science and Technology. Diaz, L.F., M. de Bertold and W. Bidlingmaier. Elsevier, London, UK.2007.
3. Compost. Kenneth, T. and E. Annelise. Dorling Kindersly, London, UK. 2007.
4. Organic Waste Recycling: Technology and Management. Polprasent, C. IWA,

COURSE 32
ENV-308
GEOGRAPHIC INFORMATION SYSTEM & REMOTE SENSING **3(2-1)**

Objectives:

This course has been designed to impart practical experience in use and interpretation of geographic/spatial data through GIS. The course will provide comprehensive instruction in the underlying concepts and principles of geographic information system (GIS) technology and its application to the analysis of environmental data. The focal point of the course includes fundamental understanding of spatial data acquisition, geo-processing, geo-statistical methods; visualization, and querying of spatial data; network modeling, terrain mapping, and spatial analysis. Students are trained to become proficient in usage of ESRI ArcGIS 9.X software through extensive computer lab sessions.

Course Outline:

Fundamentals of Remote Sensing, Electromagnetic Spectrum. History and data collection. Energy Sources, energy matter interaction in the atmosphere. History and platforms. Active and Passive remote sensing. Remote sensing of vegetation and landscape. Satellite Imageries, Image Processing: Image enhancement, Linear Stretch, Histogram equalization, Interpretation, visual interpretation, Preparation of thematic maps.

Fundamental of Geographic Information System(GIS). Integration with other technologies and its importance. Data acquisition, analysis and output. Types of data used in GIS. Cartography, GIS applications in: Agriculture, Forestry, Fishery and wildlife.

Lab Work:

Getting familiarization with Image processing and GIS software. Conversion of raster to vector data. Demonstration of GPS operations, Interpretation of satellite images for different application, Ground Truthing.

Recommended Books:

1. Remote Sensing and Image Interpretation. Thomas Lillesand (Author), Ralph W. Kiefer (Author), Jonathan Chipman Wiley; 6th edition (2007) ISBN-10:0470052457
2. Fundamentals of remote sensing and air photo interpretation Prentice Hall series in geographic information science, Authors Thomas Eugene Avery, Graydon Lennis Berlin 5th Edition, 2009 ISBN 0023050357
3. A Primer of GIS-fundamentals Geographic and Cartographic Concepts. Harvey, F. Guilford Press New York, 2009.
4. Introduction to GIS. Campbell. McGraw-Hill Education. 2008.
5. Remote Sensing of the environment: An Earth perspective. Jensen, R. Pearson Education, Inc. 2000.

COURSE CODE ENV-309
ANALYTICAL APPROACHES IN ENVIRONMENTAL SCIENCE **3(1-2)**

Objectives:

The course will educate the students about different types of solutions, instruments & analytical procedures and enhance their skills about practical aspects of environmental science so that knowledge becomes more productive.

Course Outline:

Quality assurance in an Environmental Science laboratory. Purposes and designs of environmental sampling. Sample collection and preservation methods. Standard solutions and standard curves. Instrumentations: principles and procedure for Potentiometer, Conductivity meter, pH meter, Titrimetry, Gravimetry, Spectroscopy and Chromatography. Analysis of water, wastewater and soil/solid waste samples.

Lab Work:

S.I. and derived S.I. units. Sample collection, handling, preparation and storage. Analytical techniques for soil, water and plant analysis. Data interpretation for quality control, precision and accuracy. Preparation of Standard solutions and Standard curve. Use of Potentiometry, Conductivitymetry, Titrimetry, Gravimetry, Spectroscopy and Chromatography for the analysis of environmental samples. Determination of chemical characteristics of water and waste water (pH, All Solids, BOD, COD, Fluoride, NO₃-N & NH₄-N), soil (NPK and organic matter contents, salinity & sodicity).

Recommended Books:

1. Fundamentals of Analytical Chemistry, 8th Edition. Skoog, D.A., West, D. M. and F. J. Holler. Thomson and Brooks, 2004.
2. Standard Methods for the Examination of Water & Wastewater. 21st Edition. A Greenberg (American Public Health Association), 2005.
3. Qualitative Chemical Analysis. 6th Edition. Harris, D. C., Freeman & Co., New York, 2003.

COURSE 34**ENV-310****CONSERVATION BIOLOGY****3(2-1)****Objectives:**

The objective of this course is to familiarize the students with different forms of biodiversity, threats to biodiversity and its conservation.

Course Outline:

Biodiversity: Introduction and levels of biodiversity (Alpha, Beta and Gamma). Biodiversity hotspots (tropical and coral reef ecosystems). Philosophical, ecological, economic, social and ethical values of biodiversity. Plants and animal resources of world and Pakistan. Conservation of biodiversity: Introduction to biological conservation, its history, guiding principles and characteristics. Need and approach of biodiversity conservation and prevailing threats. IUCN threatened species categories. Conservation at species and population level: applied population biology, establishing new populations, ex situ conservation strategies (botanical gardens and arboreta, zoos, seed banks and aquaria). Conservation at community and ecosystem level: protected areas, their categories and objectives, considerations for reserve design, ecotourism. Conservation outside protected areas: conservation in man-made ecosystems, croplands, cities. Legal protection of species and habitats: national and international laws and agreements for species and habitat protection, National Conservation Strategy of Pakistan.

Field Work:

Reconnaissance survey of different local communities. Study of analytical characteristics of local vegetation types: Population density (D), Relative density (RD), Frequency (F), Relative frequency (RF), Estimating biodiversity, Habitat and ecosystem diversity: Species diversity and

Genetic diversity. Indices of biodiversity: Species Richness (Richness Index), Species Diversity (Biodiversity Index), Similarity Index (Simpson's Similarity Index). Visit to National Park/Sanctuary, Zoo and Botanical Garden.

Recommended Books:

1. A Primer of Conservation Biology. 5th Ed. Sinauer, P.R.B. Associates Inc. Publ. Sunderland. 2012.
2. Conservation Biology: A Primer for South Asia. Bawa, K., Primack, S., Oommen, R.B. and Anna, M., 2011., Orient Black Swan
3. Essentials of Conservation Biology, 5th Ed., Primack, R. B. Sinauer, P.R.B associates Inc. Publishers, Sunderland MA, USA. 2010.
4. Conservation Biology: Foundations, Concepts, Applications. 2nd Ed. Dyke, F.V., Springer, 2010.

COURSE 35

ENV-311

ENVIRONMENTAL MONITORING

3(2-1)

Objectives:

This course aims to provide information of techniques used in environmental monitoring and evaluation of different standards of environmental factors i.e. air, water, soil and living organisms.

Course Outline:

Introduction, objectives of sampling and monitoring programme, design and types of samples, pre-sampling requirements/information, sampling and design purposes, application of national and international methods of sampling, regulatory purposes for NEQS compliance, EIA requirement, NOC for plant operation, Determination of concentration and distribution of a specific pollutant environment sampling techniques. Quality assurance and quality control, Planning analytic protocols, quality assurance programmes, quality control sampling. Considerations, quality assessment, field custody, laboratory custody. Preservation methods including pH control, chemical addition, refrigeration and freezing methods. Biological indicators for environmental monitoring, role of biomarkers in environmental assessment.

Practical Work:

Sampling techniques (air, water and soil) for physical and chemical monitoring, Study the indicators for biological monitoring of the river and canal water, the indicators for ecological monitoring in the field for fauna and flora, Use of various instrumental techniques for analysis of samples, Field visit/ study tour to water testing laboratory/local water authority and report writing,

Visit to EPAs for the study of air and water monitoring procedures, Report on monitoring of municipal waste

Recommended Books:

1. Earth Observation of Global Change, Chuviero, E. (ed) Springer, New York, USA, 2008
2. Environmental Monitoring Handbook, Burden, F. R, Mc Klivie, I.D., Forstner U. and Guethner. (eds.) McGraw-Hill, USA, 2002.
3. Environmental Sampling and Analysis: A Practical Guide. Keith, L. H, 2002.
4. Environmental Chemistry. Manahan, S. E. Lewis Publisher London, UK, 2000.

**COURSE 312
ELECTIVE-II**

SEMESTER 7

**COURSE 37
ENV-401
ENVIRONMENTAL IMPACT ASSESSMENT 3(2-1)**

Objectives:

The aim of this course is to enable the participants to build their capacity to integrate environmental concerns in project proposals. The specific objectives of the course are to help students to:

- Learn the principles, skills, procedures and practices of integrating environment in development through EIA;
- Become aware of the legal and regulatory obligations of integrating environment in development projects;
- Familiarize themselves with the techniques of getting public participation and integrate socio-economic aspects in development projects; and enable the participants to conduct an EIA study for a development project.

Course Outline:

Introduction: principles, concepts and purposes of IEE and EIA and its significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. Methods and techniques for impact prediction and evaluation. Integration during project life cycle. EIA review and post project analysis. EIA process management. Role of quality assurance and quality control in environmental analysis. EIA Regulations and guidelines in Pakistan.

Practical Work:

Screening & Scoping exercises, Using impact prediction and analysis tools; i) Checklist, Matrices, Networks, Overlays. Organizing public Participation; identifying stakeholders, role plays exercises,
Field Visit, One case study to be completed by the end of the semester.

Recommended Books:

1. Environmental Impact Assessment Handbook for Pakistan, Fischer, T.S. (ed.), 2014, Liverpool University Press, UK
2. Introduction to Environmental Impact Assessment, Glasson, J., Therivel, R., and Chadwick, A., Routledge, London, 2005.
3. EIA Manual: Training Resource Manual, Sadler, B., & McCabe, M., (ed.), 2nd Edition, United Nations Environment Programme, 2002.
4. Environmental Impact Assessment in Practice, Harrop, D.O. & Nixon, J.A., National Book Foundation, Islamabad, 2000.

**COURSE 38
ENV-402
NATURAL RESOURCE MANAGEMENT 3(3-0)**

Objectives:

This course aims at providing student with the basic understanding of principles and concepts of Natural Resource. Course is designed to provide student with the basic understanding of role performed by these natural resources, threats that are associated with them and approaches used for their management. Course will also emphasize on the issues and constraints involved in the management of these resources. Course is designed to provide student with a general overview keeping in view its undergraduate level however special focus will be on Pakistan's perspective.

Other objectives are:

- To provide students with the basic understanding of natural resources we are blessed with and what functions they perform in our lives;
- To investigate the major issues involved in Natural Resource Management in both the global and Pakistani context;
- To develop an integrated approach to the analysis and management of Natural Resources and issues associated with their management;

Course Outline:

Introduction: Natural resources, classification of natural resources, basic definitions and concepts (tragedy of the commons, resource degradation carrying capacity, ecological footprints), human demands on natural resources, existing situation in world in general while in Pakistan particularly, brief history of natural resource management, sustainable management of natural resources, different approaches to natural resource management, conservation, preservation, Community based natural resource management, development of natural resource management plan: needs, requirement, process and contents of the management plan. Forest management: forest types and its existing management, watershed management: Importance basic principles, methodologies, national example, wetland management: existing situation, importance, key threats, National wetland policy and brief introduction to Ramsar convention, rangeland management: existing status, importance, threats, causes and methods for its improvement. Rotational grazing, seasonal grazing, National Rangeland policy of Pakistan, livestock management, wildlife management: Management existing situation at national level, wildlife census, reasons for its decline and its possible remedies, existing management approaches, sustainable/trophy hunting projects and its role in local and national development, national and provincial legislation. Agriculture resource management: Existing situation of agriculture sector in Pakistan, agriculture products and their share in GDP, problem in agriculture, agriculture chemicals, their pros and cons, national agriculture policy, management options., Energy (coal, hydrocarbon, hydel) and Mineral Resource (Metallic and non-metallic deposits) Management, Land use Planning and Management: evolution of land use planning, review of land use plans developed by the various organizations, field visit to develop a land use plan for selected area.

Water Resource Management: water conservation at domestic, industrial and agricultural sectors. Flood control, drought management, channelization, desalinization, cloud seeding, rainwater harvesting and recharge wells. Technologies for watercourse improvement and Farm layout improvement, Laser land leveling, Improve cropping pattern, groundwater zoning and skimming wells. Fisheries Management: Types of fishes in Pakistan, existing situation reason for decline and its potential in the national economy, management options.

Recommended Books:

1. Environmental Science: working with Earth. 2013. Miller, T.G.9th Edition. Jack Cary Publisher London.
2. Basics of forestry and Applied Sciences, Concepts and Theory. Masood A.A Qureshi,

3rd Ed Vol-1, A-one Publishers 2005.

3. Environment: Problems and Solutions. Asthana, D. K & Asthana, M, 5th Ed, S. Chand & company LTD 2006.
4. Environmental Science: Earth as Living Planet. Botkin, D., & Keller, E, 8th Ed. John Wiley and Sons 2000.
5. Environmental Science: working with Earth. Miller. T. G, 9th Edition, Jack Cary publisher 2003.

Course 39

ENV-403

Elective III

COURSE 40

ENV-404

OCCUPATIONAL HEALTH AND SAFETY

3(2-1)

Objectives:

The course will provide information on occupational health and safety as well as it will review various types of workplace hazards, their exposure and effects on the body. Focus will be on hazardous chemicals, carcinogens, effects of chemicals acute and chronic health problems related to work and safe use of chemicals at work. Awareness will also be created about the health and safety laws and enforcement, role of health and safety committees at work etc.

Course Outline:

Introduction to occupational health and safety: Accidents, Disease, Normal working, Health and safety problems worldwide, Importance of management and training in occupational health and safety. Common workplace associated hazards; biological, chemical, mechanical, physical and psychological hazards and their effects on health and safety, local effects, systemic effects, acute and chronic effects. Chemicals in the workplace, Noise at work, Manual handling, Controlling hazards: Methods of control, Elimination, Substitution, Engineering controls, Administrative controls, Personal protective equipment (PPE), Cumulative trauma disorder (CTD), Evaluation of job risk factors, Controlling vibration hazards. Male and female reproductive health hazards in the workplace, Health and safety for women and children, Labour code of Pakistan. Occupational health safety management system. Legislation related to health and safety at work, Check list, Role of health and safety representatives and labour union at work; meetings, reports, training education, negotiation, Role of government, Health and safety committee.

Recommended Books:

1. Occupational Health Hazards and Remedies. (2002). Mohapatra, R. Jaypee Brothers Medical Publishers Pvt. Ltd. India.
2. Biosafety Management: Principles and Applications. (2000). Aynor, P. L. Virginia Polytechnic Institute Publications. USA.
3. Hazardous Chemicals Handbook. (2002). 2nd ed. Carson, P. and Mumford, C. Butterworth Heinemann. Oxford, UK.
4. Basic Environmental Health. (2001). 1st ed. Yassi, A., Kjellstrom, T., deKok, T. and Guidotti, T. L. Oxford University Press. NY, USA.
5. Risk assessment of chemicals: An Introduction. 2007. Leeuwen, C.J.V. Springer, USA.

COURSE 41

SEMESTER 8

COURSE 405 ENVIRONMENTAL LAWS AND POLICY 3(3-0)

Objectives:

This course aims at giving an understanding of the role of state and its instruments in the governance of environment in order to enable the students to learn about responsibilities of state and rights of its citizens to live in environmentally sound conditions to contribute in sustainable development.

Course Outline:

The concept of governance and its relevance to environment; the role of government in a state; derivation of environmental legislation from constitution of Pakistan; Environmental Policies in Pakistan, federal, provincial and local legislation in Pakistan; rules and regulations made there under. Environmental institutions established for enforcement of environmental laws in Pakistan and their functions in federal and provincial level.

Recommended Books:

1. Environmental Laws and their implementation in Pakistan, Qadar, S. Law Books House, 2000.
2. Pakistan Environmental Protection Act, 1997, Government of Pakistan
3. Environmental Policies of Govt. of Pakistan
4. SNBP Local Government Ordinance, 2001.
5. Provincial Environmental Laws

COURSE 43 ENV-406 PUBLIC HEALTH AND ENVIRONMENT 3(3-0)

Objectives:

This course is designed to introduce basic concepts of health and disease with reference to environment, impart knowledge about hazards, risks assessment and management.

Course Outline:

Concepts and basic requirements for a healthy environment. Environmental Exposure: Measuring environmental quality; Human exposure and health Impact: Impact of environmental factors on health. Nature and types of environmental hazards. Health risk assessment and management. Health and disease concepts. Air, Water and sanitation, Food and agriculture. Human settlement and urbanization, Health and energy use. Health and development, Health indicators, Industrial pollution and health issues; Trans-boundary and global health concerns, Action to protect health and the environment; Classification of diseases, basic concepts of Epidemiology, Immunology, Pathology, Parasitology; Epidemiology of infectious diseases, Communicable diseases, Non-communicable diseases; Personal hygiene and health.

Recommended Books:

1. Environmental Science (The Way the World Works) Nebel, B. J. and Wright, R.T., 8th Edition. Prentice Hall International Inc. London, UK, 2004.
2. Park's Textbook of Preventive and Social Medicine, Park, K., 2nd Edition. M/s

Banarsid. 2002.

3. Basic Environmental Health. Yassi, A., Kjellström, T., de Kok, T. and Guidotti, T.L., 1st Edition. Oxford University Press New York, USA, 2001.

COURSE 44

ENV-407

POLLUTION CONTROL TECHNOLOGIES

3(3-0)

Objectives:

The objective of this course is to acquaint the students with the technological approaches used for control of pollution. The students will become familiar with different technologies and modern techniques for their control and abatement.

Course Outline:

Collection, treatment and distribution of drinking water supply; Collection, treatment and disposal of municipal and industrial wastewater; Low cost water treatment and sanitation techniques; Solid and hazardous waste management; Cleaner production techniques; Waste hierarchy (Reduce, re-use and recycling); Waste site investigation and remediation; Air pollution control; Noise pollution control.

Recommended Books:

1. Solid Waste Technology and Management, T. Christensen, John Wiley & Sons, 2011.
2. Water Treatment Technologies, B. Salopek, Akademijatehničkih znanosti Hrvatske, 2007.
3. Advanced Air and Noise Pollution Control, L.K. Wang, N.C. Pereira and Y.T. Hung, Humana Press, 2005.
4. Preventive Environmental Management, S.R. Asolekar, R. Gopichandran and Centre for Environment Education, Foundation Books, 2005.
5. Handbook of Solid Waste Management and Waste Minimization Technologies, N.P. Cheremisinoff, Butterworth-Heinemann, 2003.
6. Municipal solid waste management: strategies and technologies for sustainable solutions, C. Ludwig, S. Hellweg and S. Stucki, Springer, 2003.
7. Handbook of Water and Wastewater Treatment Technologies, N.P. Cheremisinoff, Butterworth-Heinemann, 2002.
8. Handbook of Air Pollution Prevention and Control, N.P. Cheremisinoff, Butterworth-Heinemann, 2002.
9. Air Pollution Control Technology Handbook, K.B. Schnelle and C.A. Brown, CRC Press, 2002.
10. Basics of solid and hazardous waste management technology, K.L. Shah, Prentice Hall, 2000.

COURSE 45

ENV-499

FINAL YEAR PROJECT/ INTERNSHIP

3 (3-0)

ELECTIVE COURSES

E-1

Objectives:

To provide updated knowledge of environmental problems and sustainable environmental management.

Course Contents:

Environment: Introduction, scope, pressure. Pollution: definition, classification and impact on habitats i. Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, remediation. Photochemical smog. Smog. Acid rain: Theory of acid rain, Adverse effects of acid rains. Chlorofluorocarbons and its effects. ii. Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution. iii. Sediments pollution: fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation. Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters. iv. Noise pollution. v. Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal. Forest: importance, deforestation, desertification and conservation. Ozone layer: i. Formation ii. Mechanism of depletion iii. Effects of ozone depletion. Greenhouse effect and global warming: causes, impacts. Human population explosion: impact on environment. Impact assessment: Industrial urban, civil developments. National conservation strategy: Brief review of major problems of Pakistan and their solutions. Sustainable Environmental management. Wetlands and sanctuaries protection: The pressures, problems and solutions. Range management: Types of rangelands, potential threats, sustainable management. Aerobiology (Pollen allergy & dust allergy).

Lab Outline:

- Examination of industrial waste water and Municipal sewage and sludge for i. Total dissolved solids. ii. pH and EC. iii. BOD/COD. iv. Chlorides, carbonate, and Nitrates.
- Examination of water samples forms different sites for the presence and diversity of organisms.
- Effect of air pollutants on plants.
- Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

- Piegorsch, W. W., & Bailer, A. J. (2020). Statistics for environmental biology and toxicology. Routledge.
- Woodward, F. I., & Sheehy, J. E. (2017). Principles and measurements in environmental biology. Elsevier.
- Bertrand, J. C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Ngando, T. S. (Eds.). (2015). Environmental microbiology: fundamentals and applications (pp. 3-7). Dordrecht, The Netherlands:: Springer.
- Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
- Newman, E. I. 2001. Applied Ecology. Blackwell Science. UK
- Mooney, H. A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
- Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A study of interrelationships. McGraw-Hill. USA.

- French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W. W. Norton and Company, NY.
- Hall, C. A. S. and Perez, C. L. 2000. Quantifying Sustainable Development. Academic Press, UK.
- Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
- Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
-

URBAN SOIL MANAGEMENT

3 (2-1)

Objective:

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

Definition of earth, geology and soil science; Disciplines of soil science. Factors and processes of soil formation. Soil forming rocks and minerals and types of parent material. Soil profile description. Physical, chemical and biological properties of soil. Soil classification and land use capability classes. Soil organic matter: Sources, composition and decomposition. Soil Fertility: Essential plant nutrients, organic and inorganic sources. Salt-affected and waterlogged soils. Soil and water conservation. Soil and water pollution Practical. Soil sampling and handling. Preparation of saturated soil paste and measurement of pHs and ECe. Determination of soil water contents. Determination of bulk density and total porosity. Soil texture: feel and hydrometer methods. Irrigation water analysis and interpretation. Identification and calculation of nutrient percentage from fertilizer. 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. 14th 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. 3rd Ed. Pearson Education, Upper Saddle River, NJ, USA.
4. Das, D.K. 2011. Introductory Soil Science. 3rd ed. Kalyani Publ. New Delhi-110002, India.

E-2

DISASTER RISK MANAGEMENT

3(3-0)

Objectives:

This course will provide know how in dealing with natural calamities and their management by encompassing the field of hazard and disaster studies. It discusses a wide range of aspects, i.e., assessment of factors which put societies in vulnerable situations to the disaster management continuum. To underline the importance of disasters in socio-economic development, this course also aims to make an assessment of the consequences of 'natural' catastrophic at both short and long terms. It finally tends to provide the students with basic knowledge on hazard reduction and vulnerability mitigation. The student will learn knowledge of DRM terms and concepts within the global perspective of increasing disaster risk, Explain the processes of hazard, vulnerability, capacity and risk assessment.

Course Outline:

Natural hazards and disasters: The need for hazard and disaster studies, Historical background on Hazard and Disaster research; Disaster its types: Natural vs Man-made; Flooding, Earthquake, Landslide; Natural cycles and their role, Prediction; Hazards, Risk and Vulnerability: Definitions and characterization, Factors leading to vulnerability, The impact of natural disasters: Direct and short-term impact of disasters, Indirect and long-term consequences of catastrophes, Disaster Management: Components of management, International phenomenon; identifying Risk, Flood Management: Organizational Role; Role of Government and Non-Governmental Organizations (NGOs); Role of Media in Disaster Management; Disaster Management Trainings and Policies, Earthquake and their damages, Landslides and their down slope movements.

Recommended Books:

1. Natural Hazards and Disasters. Donald Hyndman, David Hyndman. 2006
2. Science for disaster risk management 2017: knowing better and losing less. Poljansek K, Marín Ferrer M, De Groeve T, Clark I. ETH Zurich; 2017.

E-3**HYDROLOGY 3(3-0)****Objectives:**

Understanding of Hydrology and its systems in Environmental Science, Surface and groundwater and its applications.

Course Outline:

Principles of Hydrology, Surface water origin, Occurrence, Distribution and movement. Hydrologic Cycle, Hydrographs, Precipitation, Evaporation, Infiltration, Run-off and its types, Basic equations, Stream flow measurements. Groundwater Balance, Ground water exploitation and management, Surface- Groundwater interaction and Ecosystem dependence. Water Balance, Rainfall recharge. Erosion and Silting, Waterlogging and Salinity problems in Pakistan.

Recommended Books:

1. Todd, D.K., Mays, L.W., 2004. Groundwater Hydrology. John Wiley and Sons, ISBN-10: 0471059374 | ISBN-13: 978-0471059370.
2. Fundamentals of hydrology. Davie T, Quinn NW. Routledge; 2019.

E-4**AGRO-ECOLOGY 3(3-0)****Objectives:**

This course trains students to compare agro-ecosystems and attempt to integrate knowledge of natural ecosystems into agricultural practice. Learn to link ecology, socioeconomics and culture to sustain agricultural production, farming communities, and environmental health.

Course Outline:

Application of ecological principles to modern farming systems, goals of long-term food production without depleting Earth's resources. Explore on-farm and off-farm ecological implications of agricultural and livestock practices for crop biodiversity, riparian and wetland systems, agroforestry, soil fertility, and pasture. Application of ecological principles in agro-ecosystems viz; enhance recycling of biomass and optimizing nutrient availability and balance ingnutrient flow, securing favorable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity, minimizing losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil

management through increased soil cover, species and genetic diversification of the agro-ecosystems in time and space.

Recommended Books:

1. Gliessman, S. R. 2007. Agroecology: The Ecology of Sustainable Food Systems Taylor & Francis Group, CRC Press, N.W. Corporate Blvd., Boca Raton, FL 33431 ISBN0-8493-2845-4
2. Rosset PM, Altieri MA. 2017. Agroecology: science and politics. Practical Action Publishing.

E-5

ECOTOURISM 3(3-0)

Objectives:

The course has been designed for the students to enable them meet the existing global challenges for achieving a sustainable growth in a competitive environment of tourism industry.

Course Outline:

Introduction and general overview, Context and definitions of ecotourism, Types of Ecotourism, Alternative and mass tourism, Principles and philosophies of ecotourism, Ecotourism resources, Protected areas in ecotourism, Identifying and describing ecotourism products, Components of ecotourism, Impacts of ecotourism, Resources required for eco and urban tourism, Ecotourism practices, Environmental and ecological impacts of ecotourism, Ecotourism markets, Clients and motivation, Community based ecotourism, Ecotourism developments, Developing ecotourism products, Ecotourism in the national and global context, Field trip, Report writing.

Recommended Books:

1. Ecotourism. Weaver, D., Milton Qld: John Wiley & Sons.2008.
2. Ecotourism. Wearing S, Neil J. Routledge; 2009.

E-6

ENVIRONMENTAL BIOTECHNOLOGY 3(3-0)

Objectives:

This course will provide sound technical foundation for using biotechnology in solving environmental issues and cleanup of the polluted environments. After completion of this course ,students will be able to underset and the significance, and application of biotechnology in the environment.

Course Outline:

Introduction to biotechnology, Tools in environmental biotechnology, fundamentals of biological interventions, Recombinant DNA Technology, Genetic manipulations, GMOs: Release and Regulations, environmental applications of GMOs, biosafety concerns of GMOs, bio-strategies for pollution control, bioremediation, phytoremediation, biofilm, Biomarkers, Biosensor, Bioreactors. Ethic and legal problems in creations and use of transgenic organisms.

Recommended Books:

1. Environmental Microbiology. 2ndEdition. 2010. Edited by Ralph Mitchell and Ji-Dong Gu. John Wiley & Sons, Inc., Hoboken, New Jersey.
2. Environmental Biotechnology: Concepts and Applications, Hans- Joachim, J. and

- Josef, W. (ed.). Wiley-VCH Verlag, Germany, 2005.
3. Biotechnology, Smith, J.E., 5thEd. Cambridge University Press, New York, USA,2009.
 4. National Biosafety Guidelines. National Biotechnology Commission, Government of Pakistan. 2005.
 5. Environmental Biotechnology: Theory and Application. Gareth M. Evans and Judith C. Furlong. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2003.

E-7

ANTHROPOLOGY 3(3-0)

Objectives:

Environmental Anthropology is the study of applied action and/or advocacy research to address practical environmental problems, and concerns. The course will emphasize how anthropologists work and the students will also learn the use of anthropology in handling some of these issues and therefore application will frame much on class discussions.

Course Outline:

Relationship between environment, culture and society. Goals and expectations. Scope and application. Conceptualizing environment. Tripartite nature of environment. Understanding the environment-human relationship. Chronological. Perspective of human-environment evolution. Contemporary environmental status. Consumption, globalization and environmental issues. Science and the globalization of environmental discourse. The Ecology of global consumer culture. Ecotourism's impact on the environment. Contemporary environmental issues and debate. Use of environment for vested interest, power and hegemony.

Recommended Books:

1. Nature across cultures: Views of nature and the environment in non- western cultures. Selin,H. Ed. Kluwer Academic Publishers. 2003.
2. Environmental Risks and the Media, Adam, Allan & Carter., Routledge, UK, 2009.
3. The Environment in Anthropology: A Reader in Ecology, Culture, and Sustainable Living. Hannen, Nora and Wilk, R. (editors). New York: New York University Press, 2006.
4. Environmental Anthropology: From Pigs to Policies. Townsend, P.K. Prospect Heights, IL: Wavel and Press, Inc. 2005.
5. New Directions in Anthropology and Environment: Intersections, Crumley, C. L. (editor). Walnut Creek, CA: Alta Mira Press, 2001.

E-8

WETLAND CONSERVATION AND MANAGEMENT 3(3-0)

Objectives:

To understand the natural and manmade processes of wetland environments, impacts and management

Course Outline:

History of wetland science and management; significance, concept, types, functions, values and classification, elements of wetlands management; managerial issues,

stakeholders participation and case studies in wetlands of Pakistan; wetlands identification, delineation, wetlands assessment and monitoring; ecological survey design and sampling techniques; wetlands and water quality; natural wetland protection and riparian areas as buffers; management of exempt wetland activities, restoration, creation and constructed wetlands; ecosystem, biodiversity, ecology, ecology of streams and rivers, lake ecology; fishpond management and fish parasites; wetland and floodplain ecology, structure, functioning and special characteristics of tropical river and lake ecosystems; investigating activities/ processes in the watershed and its effects on freshwater ecosystems and relevant ecosystem services

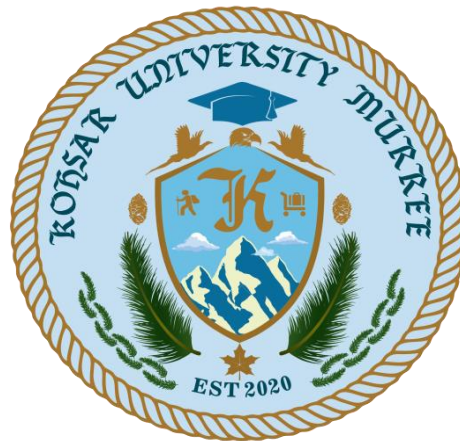
Practical:

Building a wetland filter; water sampling at key wetlands sites; field visits for ecological, mammal, plant, reptile, wildlife identification at key wetlands sites, insect and socio-economic, variations in different species at wetlands; evaluation and hydrological survey; designing a management plan for wetland conservation.

Recommended Books:

6. Mitsch, W. J. and James G. Gosselink. 2007. Wetlands. John Wiley & Sons, Inc., Hoboken, New Jersey.
2. Batzer, D. P. and R. Sharitz. 2007.
7. Ecology of Freshwater and Estuarine Wetlands. University of California Press.
3. Keddy, P. A. 2002.
8. Wetland Ecology: Principles and Conservation. Cambridge University Press, UK.
4. Haslam, S. M. 2000.
9. Understanding Wetlands: Fen, Bog and Marsh. Cambridge University Press, UK.
5. Tiner, R. W. 1999.
10. Wetland Indicators: A Guide to Wetland Identification, Delineation, Classification and Mapping. CRC Press, Boca Raton, Florida.
6. Moshiri, Gerald A. 1993.
11. Constructed Wetlands for Water Quality Improvement. Wetland Sciences Incorporated, Florida, USA.

KOHSAR UNIVERSITY MURREE
ADMIN BLOCK, KASHMIR POINT, MURREE
Tel. No. 051-9269170-71



Dossier for Launching the Program of
B.Sc. (Hons.) Agriculture

At

Department of Agriculture

Faculty of Mountain Agriculture and Environmental Science

Kohsar University Murree

KOHSAR UNIVERSITY MURREE

Kohsar University Murree's Vision Statement

VISION

As a premier higher education institution, the Kohsar University, Murree (KUM) aspires to be a leading provider of high-quality education in a broad range of disciplines, particularly those that are relevant to the needs of mountainous areas, while also striving for national and international competitiveness.

Kohsar University Murree's Mission Statement

MISSION

As a public university, KUM's mission is to advance knowledge and improve the lives of impoverished people by providing access to outstanding higher education, entrepreneurship, and research opportunities to them. Apart from that, enhancing outreach participation of dynamic and brilliant young brains, particularly those from mountainous regions, is important. Kohsar University of Murree (KUM) will be known as a university that cultivates a diverse and inclusive community of internationally engaged, energetic, and skilled future leaders.

Department of Agriculture

Faculty of Mountain, Agriculture and Environmental sciences

Kohsar University Murree

Subject: Curricula for Bachelor of studies in Agriculture

Kohsar University Murree proposes to launch Bachelor of Studies in Agriculture (**B.Sc. (Hons.) Agriculture**) degree programme under **Department of Agriculture, Faculty of Mountain Agriculture and Environmental sciences** in the fall semester of 2022 at the **GPO Campus of Kohsar University Murree.**

The Pre-Board of Studies (including external experts, primarily from public sector universities, identified and solicited for their valuable feedback and input) was held, during which the following curriculum under the supervision of the Registrar & Dean/Incharge Academics, Kohsar University Murree, along with the help of guidelines provided by Higher Education Commission (HEC).

Academic Council approved the following curricula for the First Year (Fall-22 and Spring-23 semesters) under the supervision of the Department of Agriculture

KOHSAR UNIVERSITY MURREE

Under Higher Education Commission (HEC) letter No. Registrar/QA/HEC/NOC/Gen/2016/239, dated May 13, 2016

- L. BS degree approved title: **B.Sc. (Hons.) Agriculture**
- M. **Department** **Agriculture**
- N. Faculty **Mountain Agriculture and Environmental Sciences**
4. **Provision in Act/Charter of the University to offer the said program**

KOHSAR UNIVERSITY MURREE” Act 2020 (IX of 2020)

5. Brief Introduction of Program

Agriculture and Plant protection measures play an important part to strengthen the economic power of country. The department's goal is to introduce sustainable agriculture, organic farming in order to perpetuate the use of pesticides in order to conserve the environment, irrigation, soil, and to ensure minimal health hazards, as well as to achieve maximum agricultural wealth in the country by protecting from pests. Furthermore to protect Pakistan's agriculture, biodiversity and conservation and natural resources from pests by enforcing national and international quarantine and pesticides laws/regulations. The Mountain, Agriculture and Environmental Sciences department at Kohsar University Murree (KUM) seeks to provide students with opportunity to engage in an intensive academic environment that includes multi-disciplinary, cutting-edge research, and an entrepreneurial ecosystem. KUM's curriculum is carefully framed to suit the knowledge and skill sets required for the industry in the 21st century and beyond.

Students studying under the Department of Agriculture , Faculty of Mountain, Agriculture and Environmental Sciences at KUM will not only be able to lay the groundwork for Agriculture, and Biological control, but they will also have the opportunity to collaborate with the Entrepreneurship center and the office of research, innovation, and collaboration to develop smart pest management and forecasting tools. Plant protection involves all practical aspects of pest, disease, and

weed control, including the following topics: animal pest control of world crops. Control of crop plant diseases induced by microbes. Weed control and integrated management Elective courses in Plant pathology, Entomology, Host plant resistance, and biological control will provide students with a broad range of skill and knowledge development opportunities, allowing them to be sought after by employers and stakeholders both within and outside of Pakistan, and to be prepared for any challenge in their future work environments.

Vision:

The KUM's Faculty of Mountain, Agriculture and Environmental Sciences will lead in ecosystem restoration, Biodiversity preservation, Anthropogenic solutions and service not only to the students of Murree as well as to the world.

Mission:

Our mission is to generate and disseminate fundamental and applied scientific knowledge about sustainable Agriculture and conservation of biodiversity and the environment. Moreover, to engage citizens and policymakers/stakeholders in making informed proactive decisions that maximize the benefits, minimize the risks.

✚ We succeed by cultivating a collegial, inclusive, and enthusiastic department culture that values mutual respect, work/life balance, cross-disciplinary cooperation, and shared accomplishments.

6. Objectives to offer Program

Objectives: The Mountain, Agriculture and Environmental Sciences Faculty teaching mission is extensive, ranging from fundamental aspects of arthropod ecology, morphology, parasitology, physiology, systematics, and toxicity to applied disciplines such as apiculture, agricultural, medical, and veterinary pest management. We offer a diverse range of basic courses aimed at educating and inspiring BS students in agriculture about arthropod biology, as well as complete courses for undergraduate majors and advanced course work for outstanding graduate student education. Additionally, students studying insects have a range of interests, depending on their professional route. Regardless of their future orientation, there are similar learning goals and objectives that we will assist students in achieving

through their different education. Professional entomologists contribute to the advancement of humanity by identifying the role of insects in the spread of illness and developing methods for preventing damage to food and fiber crops, as well as cattle. They do research into the ways in which beneficial insects contribute to the health of humans, animals, and plants.

The primary Program Learning Objectives (PLOs) will be the following:

- ✚ Attain a solid foundation in Agriculture, insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity.
- ✚ Understand evolution and biodiversity generation through macro- and micro-evolutionary processes, including how these processes have formed and diversified insects.
- ✚ Develop the ability to read and interpret scientific papers in entomology, and critically assess content.
- ✚ Attain skills in written and verbal scientific communication.
- ✚ Develop the ability to design and perform a scientific study on insects, and to analyze results.
- ✚ Develop an understanding of the distributions and abundances of organisms including insects, and their interactions with each other and the environment.
- ✚ Learn modern techniques in insect science such as molecular biology, bioinformatics, and/or imaging.

O. Entry requirement of Program

B.Sc. (Hons.) Agriculture: The candidates holding F.Sc. Pre-Medical/Pre-Engineering/ F.Sc. Pre Agriculture with 45% marks

* **Note:** Due to the probability of a dominant covid-19 situation, a hybrid teaching (Zoom, google classroom, LMS, Kahoot) style and interactive education strategies will be used to instruct and assess the students via university online google classrooms/ zoom/LMS in case of lockdown period of COVID-19 pandemic.

P. Scope regarding market, social and employment perspective of program

Agriculture Scope and Careers

Students who earn a degree in BS Agriculture can expect a diverse range of professional prospects.

Private Industry

Seed Industry: Determine the vulnerability of new lines of olive, potatoes, apple, pear, plum, avocado, other crops to important insect pests (both field and laboratory research). Improving the quality of Strawberry fruits by Planting In Raised Pvc Pipes. Expertise in insect rearing is frequently required to supply insect pests for study.

Employers include, Hill Fruit Research Station Murree, Potato breeding sub-station Murree, Syngenta.

Agrochemical Industry: Conduct research on new crop protection chemicals against insect pests, as well as insects that are significant pests of human and veterinary health, forestry, household, turf grass, and other horticultural plants. Expertise in insect rearing is frequently required for product testing. **Employers include** large multinational organisations such as Bayer crop science, Syngenta, FMC, UPL Limited Pakistan and Evoyl group.

Food Industry: Insect pests of stored products are a significant issue in the food and feed industries. Conduct pest control plans that include pre- and post-harvest monitoring of insect pests in agricultural crops. **Employers include** Nestle Pakistan, Murree Brewery, National foods and Shan foods.

Crop Consultants: Provides independent pest control services to corporate growers, cooperatives, and individual growers, assisting growers in minimising losses due to insects, weeds, or diseases. **Employers include,** Maxim International, King agro industry, Pak Gharo Agri & Livestock Farms and Advanced Crop Management.

Urban Pest Control: Controlling bug problems is critical for a wide variety of institutions, including hospitals, schools, universities, hotels, nursing homes, and other public and private organisations. Private pest control operators are frequently used to handle urban pest control.

Federal and State

Military, both federal and state: The military employs and trains entomologists to safeguard troops from insect pests, particularly those that transmit contagious diseases.

Federal Research Laboratories: The federal government employs technicians with B.S. and M.S. degrees to assist in the completion of significant agricultural, environmental, and health research projects.

State Departments of Agriculture: State agencies responsible for agriculture and land stewardship hire entomologists to keep an eye out for newly imported species and to train and educate pesticide applicators.

State Departments of Natural Resources: Natural resource departments are frequently concerned with invasive species, particularly insects and other invertebrates. Additionally, they are concerned with the protection of natural resources such as forests, lakes, and rivers, as well as the plants and species that inhabit them.

Departments of Health at the state, county, and city levels: Governmental entities charged with the responsibility of protecting people and companion animals are concerned about public health pests. When evaluating potential public health hazards, entomologists in these positions are frequently tasked with deciding whether to spray, when to spray, and with which chemical to spray.

Extensive Services: Extension Services provide information and services to their stakeholders in a number of states. Some include identification of insects, particularly those that pose a threat to their environment or livelihood, pest control recommendations, and training for pesticide applicators.

Federal and State Regulatory Agencies: Entomologists work with federal and state regulatory agencies to register and/or enforce regulations, many of which include insect pests or pesticides. Domestically and internationally, pest management training and research are also done. Entomologists are also employed by quarantine and inspection services. Entomologists monitor shipments of nursery stock, produce, livestock, and pets that enter the state on a state-by-state basis.

Employers include,

Academic Institutions: Plant protection department in Punjab government, PMAS-Arid agriculture University Rawalpindi, University of Agriculture Faisalabad and international well-reputed universities e.g. Graduate school of Chinese Academy of Agricultural Sciences and Cornell University.

Organizations Non-Governmental

Zoos, Botanical Gardens, and Butterfly Houses: The current popularity and proliferation of insect exhibits has increased the demand for entomologists at all levels who are trained in insect management, as well as insect interpretation/presentation and appreciation.

Q. Course content of Program

The Scheme of Studies and course contents are given below:

R. Duration of the program

11. Minimum duration of Program: 4 years 8 Semesters (B.Sc. (Hons.) Agriculture)

S. Exact title of program that will appear on the degree

B.Sc. (Hons.) Agriculture

T. Approval of the University statutory body to start/launch new program (To be provided by the Register Office)

Subsequent to the approval by Academic Council, the curricula of the programme will be presented to the Syndicate, for the approval.

U. Affiliation Letter of University (if applicable)

N/A

V. NOC of Professional Councils (To be provided by the Departments, if so desired)

N/A

List of Courses and Scheme of Study for 4-Year BS-Agriculture

SCHEME OF STUDY BS-AGRICULTURE

Layout of Courses for BS-Agriculture		
Semester 1-4		
Course Code.	Course Title	Credit Hours
Semester-1		
AGR-101	Basic Agriculture of Mountainous region	3(2,1)
ENG-101	English – I (Reading and Writing Skills)	3(3,0)
SES-102	Introductory Soil Science	3(2,1)
BIO-101/ MTH-106	Introduction to Biology /Mathematics I	3(3,0) /3(3,0)
HOR-103	Introductory Horticulture	3(2,1)
IST-101/ETH-101	Islamic Studies/ Ethics and Moral Values	3(3,0)
Total		18
Semester – 2		
AEE-104	Introduction to Agricultural Extension Education	3(3,0)
AGR-105	Crop Production for Mountain Agriculture	3(2,1)
ENT -106	Introductory Entomology	3(2,1)
CSC-101	Introduction to Information and Communication Technology	3(3,0)
ENG-105	English –II (Composition Writing)	3(3,0)
STA-103	Introduction to Statistics	3(3,0)
Total		18
Semester – 3		
AEN-201	Introduction to Agriculture Engineering	3(3,0)
PBG-202	Introductory Plant Breeding and Genetics	3(2,1)
PPL-203	Introductory Plant Pathology	3(2,1)
MAB-204	Agri tourism and business Management	3(3,0)
ENT-205	Applied Entomology	3(2,1)
GEN-101	Pakistan Studies and Global Perspectives	2(2,0)
Total		17

Semester – 4		
AEC-206	Introductory Agricultural Economics	3(3,0)
HOR-207	Horticulture Crop Production	3(2,1)
FST-208	Mountain Agriculture and Food Security	3(2,1)
ENT-209	Environmental Entomology	3(2,1)
PPL-210	Beneficial Microorganisms for Sustainable Mountainous Agriculture	3(2,1)
FOR-206	Introduction to Forest and Watershed Management	3(2,1)
Total		18

Scheme of Studies for BS Agriculture Major (Entomology)		
Semester – 5		
ENT-301	Insect Morphology	3(2,1)
ENT-302	Principles of Insect Taxonomy	3(2,1)
ENT-303	Climate Change and Insect Ecology	3(2,1)
ENT-304	Insect Pests of Household, man and animals	3(2,1)
ENT-305	Insect Behavior	3(2,1)
STA -104	Experimental Design	3(3,0)
Total		18
Semester – 6		
ENT-306	Insect Physiology	3(2,1)
ENT-307	Insect Classification and Biodiversity	3(2,1)
ENT-308	Agricultural Pests and their Management	4(3,1)
ENT-309	Stored Products Pest and their Management	3(2,1)
ENT-310	Beneficial Insects	3(2,1)
Total		16
Semester – 7		
ENT-401	Integrated Pest Management (IPM)	4(3,1)
ENT-402	Plant Resistance to Insect Pests	3(2,1)
ENT-403	Insecticides and their Application	3(2,1)
ENT-404	Range and Forest Entomology	3(2,1)

ENT-405	Agriculture and Environmental Pollution	3(2,1)
Total		16
Semester – 8		
ENT-406	Scientific Writing and Presentation	3(2,1)
ENT-407	Apiculture	3(2,1)
ENT-408	Biological Control of Insect Pests	3(2,1)
ENT-409	Internship/Research/ Survey Report and Presentation	4(0,4)
Total		13

Scheme of Studies for BS Agriculture Major (Horticulture)		
Semester – 5		
HOR-301	Principles of Mountainous Fruit Production	3(2,1)
HOR-302	Principles of Mountainous Vegetable Production	3(2,1)
HOR-303	Principles of Ornamental Crop Production	3(2,1)
HOR-304	Propagation and Mountain Nursery Management	3(2,1)
HOR-305	In Vitro Propagation	3(2,1)
Total		15
Semester – 6		
HOR-306	Tropical and Sub-Tropical Fruits of Mountains	3(2,1)
HOR-307	Summer Vegetables	3(2,1)
HOR-308	Mountainous Landscape Horticulture	3(2,1)
HOR-309	Medicinal and Aromatic Plants of Mountains	3(2,1)
HOR-310	Post-Harvest Horticulture	3(2,1)
STA-104	Experimental Designs & Analysis	3(2,1)
Total		18
Semester – 7		
HOR-401	Research Methods in Horticulture	3(2,1)
HOR-402	Temperate Fruits of Mountains	3(2,1)
HOR-403	Winter Vegetables	3(2,1)
HOR-404	Commercial Flower Production	3(2,1)

HOR-405	Breeding of Horticultural Crops	3(2,1)
Total		15
Semester – 8		
HOR-406	Vegetable and Flower Seed Production	3(2,1)
HOR-407	Protected Horticulture	3(2,1)
HOR-408	Indoor Plant Culture and Scaping	3(2,1)
HOR-409	Business Management in Horticulture	3(3,0)
HOR-410	Internship/Research/ Survey Report and Presentation	4(0,4)
Total		16

COURSE CONTENTS BS-AGRICULTURE SEMESTER 1st TO 4th

Course Code: AGR-101

Course Title: Basic Agriculture of Mountainous Region

Credit Hours: 3(2-1)

Objective:

The aim of this course is to equip students with basic agriculture knowledge including Pakistan perspective.

Theory:

Introduction of Agriculture, history of agriculture, importance of agriculture, branches of agriculture and allied sciences. Pakistan's agriculture and its role on national development. Climate, water and land resources of Pakistan. Agro ecological zones of Pakistan. Farming systems. Tillage methods, modern tillage types, seed quality and types. Nutrients and its types, Manures and its types, fertilizers and types, sources and methods of application. Irrigation methods and systems, irrigation types and management. Crop protection methods and measures. Cropping methods, harvesting types and methods, post-harvest processing, modern and conventional storage methods and marketing of farm production agricultural industries.

Practical:

Practical knowledge of Crop protection methods and measures. Cropping methods, harvesting types and methods, post-harvest processing, modern and conventional storage methods and marketing of farm production. Agricultural industries.

Recommended Books:

- Abbas MA 2006. 'General Agriculture', Emporium, Urdu Bazar, Lahore.
- Cheema ZA & Farooq M 2007. 'Agriculture in Pakistan', Allied Book Centre, Urdu Bazar, Lahore.
- Khalil IA & Jan A 2002. 'Cropping Technology', National Book Foundation, Islamabad.
- Qureshi MA Zia MA & Qureshi MS 2006. 'Pakistan Agriculture Management and Development', A-One Publisher, Urdu Bazar, Lahore.

Course Code: ENG-101

Course title: English-I (Reading and Writing skills)

Credit Hours: 3(3-0)

Objective

The aim of this course is to enable students to identify main/topic sentences. To teach them to use effective strategies while reading texts. To acquaint them with cohesive devices and their function in the text.

Theory:

The course is designed to help students take a deep approach in reading and writing academic texts which involve effective learning strategies and techniques aimed at improving the desired skills. The course consists of two major parts: the 'reading section' focuses on recognizing a topic sentence, skimming, scanning, use of cohesive devices, identifying facts and opinions, guess meanings of unfamiliar words. The 'writing section' deals with the knowledge and use of various grammatical components such as, parts of speech, tenses, voice, narration, modals etc. in practical contexts.

1. Reading Skills

- Identify Main Idea / Topic sentences
- Skimming, Scanning, and Inference / Find Specific and General Information Quickly
- Distinguish Between Relevant and Irrelevant Information According to Purpose for Reading
- Recognize and Interpret Cohesive Devices
- Distinguish Between Fact and Opinion
- Guess the Meanings of Unfamiliar Words Using Context Clues
- Use the Dictionary for Finding out Meanings and Use of Unfamiliar Words

- Practice Exercises with Every Above Mentioned Aspect of Reading

2. Writing Skills

- Parts of Speech
- Phrase, clause and sentence structure
- Combining sentences
- Tenses: meaning and use
- Modals
- Use of active and passive voice
- Reported Speech
- Writing good sentences
- Error Free writing
- Paragraph writing with topic sentence
- Summary writing

Note: Teachers need to include practice activities, exercises and worksheets on the provided topics.

Recommended Books:

- Worthington, D. Fitch-Hauser, M. (2018). Listening: Processes, Functions, and Competency (2nd ed). Routledge.
- Siddons, S. (2008). The Complete Presentation Handbook. Kogan Page Ltd
- Hancock, M. (2012). English Pronunciation in Use (2nd ed). Cambridge
- Hughes, S., & Harwood, N. (2010). Materials to develop the speaking skill. English language teaching materials: Theory and practice, 207-224.

Course Code: SES-102

Course title: Introductory Soil Science

Credit Hours: 3(2-1)

Objective:

This course is designed to introduce the concept, introduction, and importance of soil and environmental science for agriculture students at under-graduate level.

Theory:

Introduction to Soil and environment, definition of earth, geology and soil science, disciplines of soil science; lithosphere, hydrosphere and biosphere, Soil forming rocks and minerals, types and their formation, weathering of rocks and minerals, agents and classification, parent materials definition and types, soil formation definitions, processes

and factors, Soil profile: definition and description, physical properties of soil and their significance, Introduction to soil classification and land use capability classes. Soil, water and air pollution: sources and types.

Practical:

Soil sampling and handling, Preparation of saturated soil paste, Determination of soil water contents, Analysis of irrigation water, report writing and interpretation, Determination of soil texture and bulk density, Fertilizers, identification, composition and calculation of nutrient percentage, Determination of soil pH and EC_e, Determination of soil organic matter.

Recommended Books:

- Brady, N.C. and R.R. Weil. 2007. The Nature and Properties of Soils. 14th Ed. Pearson Education, Upper Saddle River, NJ, USA.
- Brady, N.C. and R.R. Weil. 2009. Elements of the Nature and Properties of Soils. 3rd Ed. Pearson Education, Upper Saddle River, NJ, USA.
- Hillel, D. 2008. Soil in the Environment: Crucible of Terrestrial Life. Elsevier Inc., Burlington, MA, USA.
- Singer, M.J. and D.N. Munns. 2002. Soils- An Introduction. 5th ed. Prentice-Hall, Inc., Upper Saddle River, NJ, USA.

Course Code: BIO-101

Course title: Introduction to Biology

Credit Hours: 3(3-0)

Objective:

The key objective of the course is to provide the basic knowledge about Biology and its major fields of specialization.

Theory:

Introductory Biology and its major fields of specialization, biological molecules (carbohydrates, proteins, fats, nucleic acid), DNA structure, Viruses, Bacteria; Introduction to fungi and importance of fungi, Animal cell, Plant cell, Mitosis, Meiosis, Kingdom plantae: classification of plants, life cycle of gymnosperms, life cycle of angiosperms, economic importance of angiosperm families (rosacea, solanaceae, fabaceae, mimosaceae), Fruit formation: Types of fruits; Photosynthesis and its mechanism, Importance of Nematodes, Annelids and Arthropods, Nutrition (methods, association of plant feeding medium, digestion of food), Plant products of economic importance; Useful

herbs and medicinal plants; Animal products of economic importance

Recommended Books:

- Campbell N. A, J.B. Reece, L.A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky and R. B. Jackson. 2009. Biology. 8th ed. Pearson, London.
- Foster, A.S and Gifford ,E.M. Jr 1998.Comparative Morphology of Vascular Plants. W.H Freeman and Co
- Raven ,P.H. Evert, R.E. and Eichhorn , S.E.1999,Biology of Plants, W.H. Freeman and company Worth Publishers
- Ray,P.M. Steeves,T.A and Fultz , T.A 1998.Botany saunders college Publishing ,USA

Course Code: MTH-106

Course Title: Mathematics I

Credit Hours: 3(3-0)

Objective:

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.

Theory:

Real numbers, Relations and Functions, Inequalities, Quadratic Functions and Complex Numbers, Sequence and Series, Trigonometric Functions, Trigonometric Applications, Graph of Functions and Modelling, Limits and Continuity, Derivatives, Integration, Probability and Binomial Theorem.

Recommended Books:

- Gantert, A. X., Algebra 2 and Trigonometry, AMCOS School Publication INC. New York, 2009.
- Swokowski, E. W., Fundamental of Trigonometry, Latest Edition.
- Kaufmann, J.E., College Algebra and Trigonometry, PWS-Kent Company, Boston, Latest Edition.
- Thomas G.B., Finney A.R., 2002. Calculus. 10th ed. USA: Addison-Wesley.

Course Code: HOR-103

Course Title: Introductory Horticulture

Credit Hours: 3(2-1)

Objectives:

This course will enable the students to understand the basic fundamental terms and fields of Horticulture.

Theory:

Introduction of horticulture, its history, its importance & future scope, definition of horticulture & various divisions in horticulture, classification of horticulture crops, Parts of plant, modification & functioning of different parts, plant environment, climate (temperature, light, humidity etc.) and soil (structure, texture, fertility etc.) Plant growth phases, & propagation of horticulture plants.

Practical:

Visit of nurseries, commercial gardens and public parks. Identification and nomenclature of important fruits, vegetables and ornamental plants; Garden tools and their uses, Media preparation. Techniques of propagation.

Recommended Books:

- Chadha KL 2006. 'Handbook of Horticulture', (6th Ed.). ICAR, New Delhi, India.
- Christopher EP 2012. 'Introductory Horticulture', Biotech books, new Dehli, India.
- Carrol L Shry JR & Reily HE 2011. 'Introductory Horticulture', (8th Ed.) Delmar-Thomson Learning , Albany, USA
- Hartmann HT Kester DE Davies ET &Geneve RL 2009. "Plant Propagation: Principles and Practices", (7th Ed.).Prentice-Hall India Learning Pvt. Ltd., New Delhi, India.

Course Code: IST-111

Course Title: Islamic Studies

Credit Hours: 3(3-0)

Objective:

This course is aimed to provide Basic information about Islamic Studies, understanding of the students, regarding Islamic Civilization, improve skill to perform prayers and other worships and understanding of issues related to faith and religious life.

Theory:

Introduction to Qur'anic Studies, Basic Concepts of Qur'an, History of Quran, Uloom-ul-Quran

مطالعه قرآن (تعارف قرآن، سورة البقره، سورة الحجرات، سورة الفرقان، سورة المومنون، سورة الانعام، سورة الصف ترجمه و تفسیر)

Introduction to Sunnah, Basic Concepts of Hadith, history of Hadith, kinds of Hadith, Uloom –ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah

Selected Study from Text of Hadith

معالعه حدیث (متن حدیث ترجمه و تشریح)

﴿مطالعہ سیرت کی ضرورت و اہمیت، تعمیر سیرت و شخصیت کا نبوی منہاج، اقامت دین، میثاق مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات﴾

Islamic Culture & Civilization, Basic Concepts of Islamic Culture & Civilization, historical Development of Islamic Culture & Civilization , Characteristics of Islamic Culture & Civilization, Islamic Culture & Civilization and Contemporary Issues

اسلامی تہذیب و تمدن (اسلامی تہذیب کے ارکان و بنیادیں، خصوصیات، اسلامی تہذیب کے فکری، علمی، معاشرتی اور سماجی اثرات، عصری تہذیبی کشمکش اور اسلامی تہذیب، تہذیبی تصادم کے اثرات و نتائج

Recommended Books:

- Hameed ullah Muhammad, —Emergence of Islaml , IRI, Islamabad
- Hameed ullah Muhammad, —Muslim Conduct of State
- Hameed ullah Muhammad, _Introduction to Islam
- Dr. Muhammad Zia-ul-Haq, —Introduction to Al Sharia Al Islamiall Allama Iqbal Open University, Islamabad (2001)

Course Code: ETH-101

Course Title: Ethics and Moral Values

Credit Hours: 3(3-0)

Objective:

This course not only aims to provide basic knowledge about ethical values to the students but also to enhance their skill for understanding of issues related to faith and religious life.

Theory:

Definition and scope of ethics: relation of ethics to psychology, metaphysics and relegation. A brief review of major theories of the moral standard: The standard as law, the standard as happiness, the standard as perfection. Promotion of Moral Values in society through family and various educational and cultural institutions; concept of good and evil; freedom and responsibility; various theories of punishment. Ethical teachings of world religions with special reference to Hinduism, Buddhism, Judaism and Islam. 100 ethical precepts from the Quran and the sayings of the Holy Prophet (PBUH). Islam's attitudes towards minorities.

Books Recommended:

- Mackenzie, J.A., A Manual of Ethics, Latest editions University Tutorial Press Ltd., London.
- Syed AbulAalaMaudoodi, Islamic Riyasat, Islamic Publications Ltd., 13-E, Shah Alam

- Dr. Mazhar U. Kazi, A Treasury of Hadith, 1991, Ferozeson (Pvt.) Ltd., Lahore

Course Code: AEE-104

Course Title: Introduction to Agricultural Extension Education

Credit Hours: 3(3-0)

Objectives:

The course aim is to enable students to have basic knowledge and ability of agricultural extension to transfer useful information to farmer's community.

Theory:

Definition, importance, & objectives of agricultural extension. Education & its types, brief history & recent trends in agri. Extension. Organizational setup of agri. extension in Pakistan. Definition, concept, importance, objectives, and indicators of rural development Process of rural development & its elements. Rural development through agri. extension work in Pakistan. Characteristics & problems of farmers in Pakistan. Current issues & problems of rural development and extension work in Pakistan. Roles & duties of extension worker at various organizational levels. Extension programs and activities since 1947 in Pakistan. Role of communication and ICT in Agri. Extension & Rural Development Principles of effective extension work. Adoption & diffusion of agricultural innovations, agri. technology and its application for Pakistani farming community. Extension, research & farmer linkage .Concept of planning, monitoring & evaluation in Agri. Extension

Recommended Books:

- Ison R & Russell D (Eds.) 2004. 'Agricultural Extension and rural Development: Breaking out of Knowledge Transfer Traditions', Cambridge University Press.
- Bashir E (Ed.) 2005. 'Extension Methods', (2nd Edition), National Book Foundation, Islamabad.
- Ison R & David R 2000. 'Agricultural Extension and Rural Development: Breaking Out of Knowledge', Cambridge University Press.
- Leeuwis C & Van den Ban A 2004. 'Communication for rural Innovation: Rethinking Agricultural Extension', (3rd Edition), Wiley-Blackwell.

Course Code: AGR-105

Course Title: Crop Production for Mountain Agriculture

Credit Hours: 3(2-1)

Objective:

The main objective of this course is to familiarize the students with the basic concepts of

agronomic practices & crop production of mountainous region.

Theory:

Concept of crop production in mountainous region, Classification of mountainous region crops. Cropping scheme, cropping patterns, cropping systems, cropping intensity. Production technology of major mountainous region crops

Practical:

Demonstration and use of tillage implements; Preparatory tillage, seedbed preparation and intercultural operations, Seed purity analysis, Identification of organic and inorganic fertilizers and manures; Calculation of nutrient cum fertilizer unit value, Demonstration and layout of various irrigation methods

Recommended Books

- Balasubramanian 2004. 'Principles and Practices of Agronomy', Agrobios, Jodhpur, India.
- Khalil IA & Jan A 2002. 'Cropping Technology', National Book Foundation, Islamabad.
- Martin, J. H. Waldren RP & Stamp DL 2006. 'Principles of Field Crop Production', (4th Ed.) The McMillan Co., New York.

Course Code: ENT-106

Course Title: Introductory Entomology

Credit Hours: 3(2-1)

Objectives:

This course will enable students to understand arthropods particularly insects and the morphology & features of insects. .

Theory:

Introduction. Phylum Arthropoda and its classification. Metamorphosis and its types. External and internal morphology and physiology with a particular reference to typical insect. Insect classification and nomenclature. Salient characters of insect orders with important families and examples of important members.

Practical:

Characters of classes of Arthropoda; collection and preservation of insects; morphology and dissection of a typical insect (digestive, reproductive, excretory, nervous, circulatory and tracheal systems); temporary mounts of different types of appendages of insects; Observations for types of metamorphosis.

Recommended Books:

- Awastheir, V.B. 2009. Introduction to General and Applied Entomology. Scientific Publisher, Jodhpur, India.
- Dhaliwal, G.S. 2007. An Outline of Entomology. Kalyani Publishers, Ludhiana.
- Elzinga, R.J. 2003. Fundamentals of Entomology. Prentice Hall.
- Gullan, P. J. and P. S. Cranston. 2010. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
- McGavin GC 2001. 'Essential entomology: an order-by-order introduction', Oxford University Press, USA.

Course Code: CSC-101**Course Title: Introduction to Information and Communication Technology****Credit Hours: 3(3-0)****Course Objectives:**

The fundamental aim of this course is to teach students the basics of computing in a relative term. Students, in this course, will learn the fundamentals of computing including computer basics and organization, common tools and applications, data representations, algorithms and programming. To foster among students an interest and confidence in using computers.

Course Contents:

Introduction to Computers and computing; Classification of computers; Elements of computers; Basic Computer Architecture; Control Unit; Arithmetic & Logical Unit (ALU operations); Main Memory (ROM, RAM, Cache); CPU Operation; The Registers; Input & Output Devices; Storage Media; Data Representation; Software Concepts; System Software ; Operating Systems; Basic Input Output Software (BIOS); Disk Operating system; Application Software; Data base Management Systems; Communication System; Security Issues; Threats to computers & communication systems; Computer Networks; Internets; Artificial Intelligence-Commerce

Course Code: ENG-102**Course Title: English-II (Composition Writing)****Credit Hours: 3(3-0)****Objectives:**

The course aims to assist students identify the audience, message, and the purpose of writing, develop rhetorical knowledge and critical thinking and enable them express

themselves in a variety of writing styles also to help students write well organized academic texts including examination answers with topic/thesis statement and supporting details. To make students write argumentative essays and course assignments

Theory:

The course focuses on the basic strategies of composition and writing skills. Good writing skills not only help students obtain good grades but also optimize their chances to excel in professional life. The course includes modes of collecting information and arranging it in appropriate manner such as chronological order, cause and effect, compare and contrast, general to specific etc. It enables the students to write, edit, rewrite, redraft and proofread their own document for writing effective compositions. Because of the use of a significant amount of written communication on daily basis, sharp writing skills have always been valued highly in academic as well as professional spheres.

1. Writing Process

- Invention

- ✓ Generating Ideas (collecting information in various forms such as mind maps, tables, lists, charts etc)

- ✓ Identifying Audience, Purpose, and Message

- Ordering Information

- ✓ Chronology for a narrative

- ✓ Stages of a process

- ✓ From general to specific and vice versa

- ✓ From most important to least important

- ✓ Advantages and disadvantages

- ✓ Comparison and contrast

- ✓ Problem solution pattern

- Drafting

- ✓ Free Writing

- ✓ Revising

- ✓ Editing

2. Paraphrasing

3. Cohesion and Coherence

- Cohesive Devices
- Paragraph unity
- 4. Summary and Precis Writing
- 5. Creative Writing
- 6. Essay Writing
 - developing a thesis
 - organizing an essay
 - writing effective introduction and conclusion
 - Different types of essays
 - Use of various rhetorical modes including exposition, argumentation and analysis

Recommended Books:

- McCarthy, M. & O'Dell, F. (2016). *Academic Vocabulary in Use* (2nded). Cambridge
- Aristotle. (2007). *On Rhetoric: A theory of civic discourse* (2nded). New York: OUP.
- Bailey, S. (2014). *Academic Writing: A handbook for international students*. Routledge.
- Canagarajah, A. S. (2013). *Critical Academic Writing and Multilingual Students*. University of Michigan Press.

Course Code: STA-103

Course Title: Introduction to Statistics

Credit Hours: 3(3-0)

Objective:

The objective of this course is to impart basic and applied knowledge about statistics for interpretation of results and decision-making.

Theory:

Sampling and its types, Probability and non-Probability Sampling, Simple random sampling, stratified random sampling, Systematic sampling, Sampling and non-sampling error, Sampling distribution of mean and difference between two means. Inference 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 χ^2 (chi-square), Testing hypothesis about variance. ANOVA and its assumptions, One-way ANOVA, Two-way ANOVA.

Recommended Books:

- Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (2009)
- Faquir M. 2000. Statistical Methods and Data Analysis. KitabMarkaz, Aminpur Bazar, Faisalabad.
- Zar JH. 2009. Bio statistical Analysis. 4th ed. Pearson Education, Inc. and Dorling Kindersley Publishing Inc. (India).

Course Code: AEN-201

Course Title: Introduction to Agriculture Engineering

Credit Hours: 3(3-0)

Objectives:

The course will provide the introductory knowledge of agricultural engineering, its major fields including the agricultural machinery.

Theory:

Introduction, definition and importance of agriculture engineering. History of agriculture engineering. Field of specialization in agriculture engineering. Agricultural power and machinery. Land and water resources. Food processing and Energy systems. Current trends and modern technologies of agriculture. Agricultural mechanization in Pakistan. Introduction to Biosystems. Farm Power: Animal and manpower. Engines, tractors. Crop production, tillage equipment, water pumping, sprayers, planting equipment. Threshing and harvesting machines, drying machines, testing equipment.

Recommended Books:

- Agricultural Mechanics: Fundamentals & Applications 7th Edition by Ray V Herren 2014.
- ASABE Standards 2011: Standards Engineering Practices Data. (Asabe Standards (American Society of Agricultural Engineers)) by Asabe Agricultural engineering principles and practices by byEngrSegun R. Bello 2012.
- Smart Farming Technologies for Sustainable Agricultural Development (Advances in Environmental Engineering and Green Technologies) 1st Edition by Ramesh C.Poonia (Author, Editor), Xiao-Zhi Gao (Editor), Linesh Raja (Editor), Sugam Sharma (Editor), Sonali Vyas (Editor) 2018.

Course Code: PBG-202

Course Title: Introductory Plant Breeding and Genetics

Credit Hours: 3(2-1)

Objectives:

This course highlights to familiarize the students to understand the basic concepts of genetics, heredity mechanism and molecular nature of nucleic acid.

Theory:

Definition of genetics, concepts of heredity and variation. Cell and cell divisions. Mendelian genetics: chromosome theory of heredity, various genotypic and phenotypic ratios and their modifications. Differences between allelic and non-allelic interactions (epistasis), illustration of epistasis with suitable examples. Pleiotropy and multiple allelism. Multiple factor hypothesis. Linkage and crossing over. Sex determination: sex linked and sex influenced traits. Chromosomal aberrations. Nucleic acids: nature, structure and function, Classical vs modern concepts of gene.

Practical:

Preparation of culture medium and maintenance of Drosophila cultures in lab, Problems related to Mendelian inheritance, gene interaction, gene mapping, blood groups-ABO blood groups and Rh factors

Recommended Books:

- Brooker R.J. Genetics: Analysis and Principles. 2nd Ed. McGraw-Hill Book Co. Bostan. USA. 2005
- Snustad D. P. , M. J. Simmons, Principles of Genetics, 4th Ed, John Wiley and Sons; 2006 Singh BD 2004. 'Genetics', Kalyani Publishers, New Delhi, India.
- Klug WS & Cummings MR 2003. 'Concepts of Genetics', (7th ed.) Pearson Education, Singapore.
- Singh P 2003. 'Elements of Genetics' (2nd ed.), Kalyani Publishers, New Delhi, India
- Khan IA Azhar FM Ali Z & Khan AA 2008. 'Solving Numerical Genetic Problems', Department of PBG, University of Agriculture, Faisalabad.

Course Code: PPL-203

Course Title: Introductory Plant Pathology

Credit Hours: 3(2-1)

Objective

This course will familiarize the students with the concepts relating to Plant Pathology.

Theory:

Introduction and history of plant pathology; Basic characteristics of fungi, bacteria, viruses and nematodes. Concept of disease in plants; economic importance of plant diseases, Nature and cause of (biotic and abiotic) diseases, Components of plant disease development; Diagnosis of plant diseases, Principles of plant disease management, Introduction to IDM and IPM; symptoms, etiology, Mode of infection, disease cycle and management of representative diseases of agricultural and horticultural crops.

Practical:

Orientation of laboratory equipment's; sterilization of glassware, preparation of media and isolation of different plant pathogens; study of characteristics of various plant pathogens through slides, live specimens and their comparative account/study

Recommended Books:

- Agrios GN 2005. 'Plant Pathology', (5th ed.), Academic Press, New York, USA.
- Ahmad I & Bhutta AR 2005. 'A Text Book of Introductory Plant Pathology', National Book Foundation, Islamabad, Pakistan.
- Chaube HS & Singh R 2002. 'Introductory Plant Pathology', International Book Distributing Co.
- Hafiz A 1986. 'Plant Diseases', Pakistan Agricultural Research Council, Islamabad, Pakistan.
- Mehrotra RS & Agarwal A 2003. 'Plant Pathology', (2nd Ed.) TATA McGraw Hill. Publishing Company Ltd., New Delhi.
- Strange RN 2003. 'Introduction to Plant Pathology', John Willey & Sons, New York, USA.

Course Code: MAB-204

Course Title: Agri-Tourism and business Management

Credit Hours: 3(3-0)

Objectives:

To enable students get basic knowledge, understanding and approaches of agribusiness management

Theory:

Concepts, principles and issues in business management. Scope and objectives of

Agribusiness Management, Functions of management, Forms of business organizations, Balance Sheet, income statement and their analysis, Benefit Cost Analysis, Uncertainty and Risk in Farm Business, Risk Management Strategies, Role of Government in Agribusiness management, Supply chain management and Relevant Case studies, Principles and Techniques of farm planning, operation and management, Enterprise budgeting, Resource constraints, optimum combinations and alternate business plans.

Recommended Books:

- Downey WD & Enieson SP 2002. 'Agribusiness Management', McGraw Hill, Singapore
- Castle EN Becker MH & Nelson AG 2002. 'Farm Business Management', Macmillan, New York.
- Kinsey BIH 2000. 'Agri. Business and Rural Enterprises', London Lehm, Ltd.
- Goldberg Roy 2004. 'Agribusiness Management for Developing Countries', Harper Publishers, New York, USA.
- Buckett M 2011. 'An Introduction to Farm Organization and Management', Pergamon Press, New York, USA.

Course Code: ENT-205

Course Title: Applied Entomology

Credit Hours: 3(2-1)

Objectives:

The aim of the course is to familiarize students with advanced applied concepts of Entomology

Theory:

Introduction, Causes of success and economic importance of insects, Principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control, Introduction to IPM; insecticides, their classification, formulations and application equipment's, identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and locust, Entomological industries: apiculture, sericulture and lac-culture.

Practical:

Characters of classes of Arthropoda; collection and preservation of insects; morphology

and dissection of a typical insect (digestive, reproductive, excretory, nervous, circulatory and tracheal systems); temporary mounts of different types of appendages of insects; Observations for types of metamorphosis.

Recommended Books:

- Atwal AS 2005. 'Agricultural Pests of Southeast Asia and their Management', Kalyani Publishers, Ludhiana, India.
- Awastheir VB 2009. 'Introduction to General and Applied Entomology', Scientific Publisher, Jodhpur, India.
- Pedigo LP & Rice ME 2014. 'Entomology and pest management', (6th Ed.) Waveland Press Inc., USA.
- Duncton PA 2007. 'The Insect: Beneficial and Harmful Aspects', Kalyani Publishers, Ludhiana, India.

Course Code: PST-101

Course Title: Pakistan Studies and Global Perspectives

Credit Hours: 3(3-0)

Objective

The course aims to develop vision among the students about historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.

Theory:

Two Nation Theory and Ideology of Pakistan, Historical background of creation of Pakistan, Two Nation Theory in its historical context, definition and interpretations, Quaid-e-Azam and his political ideas, Political Dynamics of Pakistan, Constitutional Development in Pakistan 1947-73, Salient features of Constitution of Pakistan 1973, Institutions of Pakistan: Political Parties, Bureaucracy, Army, Judiciary and Media, Problems of Pakistan as a federal state, Socio-Economic Issues of Pakistan, Economical Problem, Social and Demographic Issues. Diplomatic Dynamics of Pakistan, Determinants and objectives of Pakistan's Foreign Policy, Pakistan's relations with its neighboring countries, Pakistan and the Muslim World, Comprehensive review of foreign policy of Pakistan

Recommended Books:

- Ikram SM. 2008. Modern Muslim India and the Birth of Pakistan. Delhi.
- Qureshi IH. 2007. Struggle for Pakistan. University of Karachi.

- Khan H. 2009. Constitutional and Political History of Pakistan. Pak Book Lahore.
- Ali K. 2005. The Political Economy of Rural Development. Sang-e-Meel, Lahore.
- Afzal MR. 2008. Political Parties in Pakistan. Historical Research Society, Islamabad.

Course Code: AEC-206

Course Title: Introductory Agricultural Economics

Credit Hours: 3(3-0)

Objective:

At the completion of this course, students will be capable to understand some basic concepts related to economics and applying them in agriculture sector.

Theory:

Definitions and overview of economics and related terms; Subject Matter & Scope; Theory of consumer behavior; Scale of preferences; Utility, Indifference Curve & related concepts; Demand & Supply analysis; Elasticity of Demand and Supply; Market Equilibrium. Production, factors of production, laws of return and their significance in agriculture; Concept of macroeconomics; approaches to national income estimation; Growth, Unemployment & Inflation; Important macroeconomic issues in agriculture sector of Pakistan.

Recommended Books:

- Penson JB Capps O Rossen CP & Woodward R 2013. 'Introduction to Agricultural Economics', (5th Ed.) New Jersey, Prentice Hall, USA.
- Samuelson PA & Nordhaus WD 2009. 'Economics', (19th Ed.), McGraw Hills, New York, USA.
- McConnel CR Brue SL & Flynn SM 2011. 'Economics: Principles, Problems and Policies', (19th Ed.), McGraw-Hills, New York, USA.
- Mankiw NG 2011) 'Principles of Economics', (5th Ed.), Mason, South-Western Cengage learning Publisher.
- Penson JB Capps O Rossen CP & Woodward R 2013. 'Introduction to Agricultural Economics', (5th Ed.), Prentice Hall, New Jersey, USA.

Course Code: HOR-207

Course Title: Horticulture Crop Production

Credit Hours: 3(2-1)

Objectives:

This course will help students to familiarize with production technologies of significant horticulture crops.

Theory:

Establishment of orchards, vegetable farms and ornamental gardens; Site selection, layout methods, windbreaks and their role. Management practices; irrigation, manures and fertilizers, training and pruning, cultivation and weed control. Climate, soil, propagation, rootstocks, cultivars. Important pests, Harvesting, post-harvest handling and marketing of important horticultural crops (fruits, vegetables and ornamentals) of the region.

Practical:

Practice in layout methods, Selection of plants from nursery, propagation methods. Planting and after care. Production techniques and identification of important cultivars of horticultural crops of the region.

Recommended Books:

- Acquaah G 2009. 'Horticulture: Principles and Practices', (4th Ed.), Prentice Hall Learning Pvt. Ltd. New Delhi, India.
- Adams CR Bamford KM & Early MP 2012. 'Principles of Horticulture', (6th Ed.), Routledge, New York, USA.
- Ingles J 2009. 'Ornamental Horticulture', Delmar 5 Maxwell Drive, Cifton, Park, New York, USA.
- Dhaliwal MS 2008. 'Handbook of Vegetable Crop', Kalyani Publishers, Ludhiana, New Delhi, India.

Course Code: FST-208

Course Title: Mountain Agriculture and Food Security

Credit Hours: 3(2-1)

Objectives:

This is an introductory course, which enables the students to understand the basics of food science and technology.

Theory:

Introduction to food science, food technology, relationship with other disciplines, Career opportunities. Significance of food science and technology, Food industry: history, developments, important food industries in Pakistan, Food sources: plants, animals and marine, Food constituents and their functions: water, carbohydrates, lipids, proteins,

vitamins, minerals. Classification of foods based on perishability and pH, Food spoilage agents: enzymes, microorganisms, pests, physical factors

Practical:

Use of laboratory equipment's. Estimation of moisture, fat, protein, carbohydrates, fiber and ash in food samples. Determination of specific gravity, soluble solids, pH, acidity, total solids, refractive index and peroxide value.

Recommended Books:

- Awan, J. A. (2018). Food science and technology. Unitech Communications, Faisalabad
- Robert, L. S., Ramirez, A. O., Clarke, A. D. (2015). Introducing Food Science. 2nd Ed. CRC Press.
- Robert, L. S., Ramirez, A. O., Clarke, A. D. (2015). Introducing Food Science. 2nd Ed. CRC Press.
- Potter, N. N., and Hotchkiss, J. H. (2007). Food science. The AVI Pub. Co. Inc., Westport, Connecticut, USA.

Course Code: ENT-209

Course Title: Environmental Entomology

Credit Hours: 3(2-1)

Objectives:

To provide the basic concept of impact of environment on insects, and insects as indices of environmental changes.

Theory:

Introduction; diversity of insects in different ecosystems; interactions of various groups of insects with biological, chemical and physical constituents of the environment; physical and chemical characterization of environmental contaminants, impact of pollutants on insects and non-target organisms at different levels; biological responses to pollutants and biogeochemical cycles; insects as indicators of levels of pollution.

Practical:

Insect sampling, collection and preservation techniques; culturing devices; exercises in microtomy, preparation of permanent slides, soft wares for morphometrics and data analysis; scientific photography; electron microscopy; maintenance and measurement of microclimate; use of different equipment in entomological experiments, tabulation,

analysis and interpretation of data; bioassay; demonstration of insect DNA amplification through PCR methods.

Course Code: PPL-210

Course Title: Beneficial Microorganisms for Sustainable Agriculture

Credit Hours: 3(2-1)

Objectives:

This course will make students with beneficial aspects of microbes

Theory:

Introduction to beneficial microorganisms; role of microorganisms in bioremediation and biodegradation of agricultural and industrial byproducts/wastes; use of microorganisms (bacteria, cyanobacteria, nematodes and fungi inclusive of mycorrhizae) in bio-geochemical cycling and biocontrol of plant diseases; cultivation of edible fungi and yeasts; classification of soils based on their microbiological properties; principles and strategies for controlling the soil microflora for optimum crop production and protection; application of beneficial microorganisms; functions of microorganisms: putrefaction, fermentation, and synthesis; Introduction to use of cellulose decomposing fungi in paper and textile industry; use of fungi such as *Penicillium* and *Aspergillus* species in food processing including cheese ripening, pickle production etc; organisms as experimental tools and supplements of human food and animal feed (single cell protein, fodder yeast etc.); bacteriophages.

Practical:

Isolation and identification of microorganisms from various substrates and screening and mass multiplication of industrially important microbes; demonstration of antagonism, competition and antibiosis; Isolation and identification of nitrogen fixing bacteria.

Recommended Books:

- Chang, S.T. and P.G. Miles. 2004. Mushroom Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC Press, NYC, USA.
- Dinesh K. and D.K. Maheshwari. 2012. Bacteria in Agrobiolgy: Plant Probiotics. Springer. 371 pp.
- Elmerich, C. and W. Edward Newton. 2007. Associative and Endophytic Nitrogen-fixing Bacteria and Cyanobacterial. Springer. 322 pp.
- Eugene, R. and G. Uri. 2011. Beneficial Microorganisms in Multicellular Life Forms. Springer. 348 pp.

Course Code: FOR-206

Course Title: Introduction to Forest and Watershed Management

Credit Hours: 3(2-1)

Objective:

This course will lead the students to gain knowledge about forestry & forest resources in Pakistan and to understand about the principles for watershed management

Theory:

Introduction to Forest and watershed management. Forest resources of Pakistan (description, composition, distribution and status) in different ecological zones. Importance of these natural resources of Pakistan. Constraints and problems in natural resource management. Principles of sustainable forest management. Forestry practices (Agroforestry, social forestry etc.). Principles of Watershed Management. Watersheds of various streams/rivers of Pakistan, their area, distribution, land use patterns, past history, climatic, physiographic, ecological and socio-economic features. Hydrological cycle. Management problems and potentials of various watersheds, afforestation programmers. Watershed as a source of power generation and irrigation. Watershed research and education.

Practical:

Visit to different forest types of Pakistan for studying the management practices. Calculation of mean precipitation in a watershed by different methods Determination of features of Watershed: Drainage density, Mean elevation, Area, Drop per Kilometer & Mean slope

Recommended Books:

- Franzel S Scherr SJ 2001. 'Trees on the Farm', CAB International.
- Quraishi MAA 2002. 'Watershed Management in Pakistan', Department of Forestry, University of Agriculture, Faisalabad.
- Quraishi MAA & Siddiqui MT 2002. 'Practical manual of watershed management', Department of Forestry, University of Agriculture, Faisalabad.
- Siddiqui MT, Sands R & Shah AH 2009. 'Glossary of forestry terms', Pulschay Publishers. Faisalabad.

COURSE CONTENTS (MAJOR ENTOMOLOGY) SEMESTER 5th TO 8th

Course Code: ENT-301

Course Title: Insect Morphology

Credit Hours: 3(2-1)

Objectives:

Familiarize students with the comparative morphology of organ system of insects and introduced the students how the morphology of an organ is related to its function.

Theory:

Introduction to insect morphology. Integument and its derivatives. Different body regions segments, sclerites and sulci. Appendages of head thorax and abdomen of economically important insect orders. Endoskeleton and internal organ systems. Exocrine and endocrine organs

Practical:

Structure of integument and its derivatives. Comparative external and internal morphology of economically important insect orders Preparation for illustrations

Recommended books:

- Beutel, R. G., Friedrich, F., Yang, Xing-Ke and Ge, Si-Qin. 2014. Insect Morphology and Phylogeny. Walter De Gruyter Inc publisher.
- Chapman, R. F. 2012. The insects: Structure and Function (5th Ed.). Cambridge University Press.
- Dunston P.A. 2004. The Insect Structure, Function and Bio-Diversity. Kalyani Publishers, Ludhiana.
- Gilbert, L.I., Iatrou, K. and Gill, S. S. 2005. Comprehensive Molecular Insect Science. 2nd edition, Elsevier/Pergamon.

Course Code: ENT-302

Course Title: Principles of Insect Taxonomy

Credit Hours: 3(2-1)

Objectives:

Introduce students about classification of insects at family level, including species of environmental and economic importance.

Theory:

Introduction of insect taxonomy. History functions and concepts of insect taxonomy. Tasks of taxonomist. Taxonomic categories. Taxonomic procedures. Collection and methods of sampling. Identification. Taxonomic characters. Variations in population descriptions.

Taxonomic keys, concepts of species. Kinds of species and phylogenies, preparation of taxonomic papers. Code of zoological nomenclature. Introduction to numerical and molecular taxonomy. Phenetics and cladistics.

Practical:

Methods of insect collection, Preparation of taxonomic keys, Preservation and labeling. Identification of insects. Cataloguing and writing descriptions of identified insects. Preparation of phenograms. Iadogram and phylogenetic trees using morpho-metrics.

Recommended Books:

- Manzoor, F. 2006. Morphometric Studies on Termite Genus *Odontotermes*. Published by, Higher Education Commission, Islamabad.
- Schuh, R. T. and Andrew V. Z. B. 2009. Biological Systematics Principles and Applications. Cornell University Press, Sage House, 512 East State Street, Ithaca, New York, USA.
- Triplehorn, C.A. and Johnson, N.F. 2005. Borror and DeLong's Introduction to the study of Insects. Brooks Cole. 7th Ed.

Course Code: ENT-303

Course Title: Climate Change and Insect Ecology

Credit Hours: 3(2-1)

Objectives:

Provides basic ecological background with an applied interpretation, emphasizing influences of insect populations and communities on ecosystem processes that influence landscape structure, function and change.

Theory:

Overview of insect ecology. Divisions of ecology. Habitat and niche. Intra and interspecific interactions. Types of ecosystems. Flow of energy in ecosystem. Trophic relations: food chain food web and food mesh. Concepts of: ecological succession; population and its characteristics like natality. Mortality migration, dispersal. Key factors, density dependent and density independent factors. Introduction to life tables and diversity indices.

Practical:

Maintenance and measurement of a biotic factors (temperature, humidity, light, wind etc) with different instruments. Population sampling, estimation and construction of life tables.

Recommended Books:

- Odum, E. P. and Gary W.B. 2005. Fundamentals of Ecology. Thomson Brooks/Cole 10 Davis Drive Belmont, CA 94002 USA
- Price, P. W., Denno, R.F. Eubanks, M.D. Finke, D.L. and Kaplan, I. 2011. Insect Ecology: Behaviour, Populations and Communities, Cambridge University Press, Cambridge, UK, 801 pages.
- Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3rd Ed. Blackwell Science.
- Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles, Princeton University Press.

Course Code: ENT-304

Course Title: Insect Pests of Household, Man and Animals

Credit Hours: 3(2-1)

Objectives:

Student should be able to identify, collect and manage different insects of household, man and animals. Students should be able to collect and identify major insect/mite pest species damaging food products at home or annoying them or their livestock individuals. The students will be demonstrated about the control practices for these household insect pests.

Theory:

Introduction. Identification. Biology and control of different insect pests like Ants, cockroaches, termites. Silver-fish, cricket, carpet beetle, Powder-post beetle, cloth-moths, psocids, Bed-bugs, lice, fleas, Mosquitoes, wasps, house flies, Sand flies, stable flies, blow flies, Tsetse flies, flesh flies, Black flies and midges

Practical:

Collection. Identification. Demonstration of management of different household man and animal insect pests.

Recommended Books:

- Agarwal, S. 2009. Insect Pests of Cereals and their Management. Oxford Book Co. India.
- Aldridge, B. 2004. Medical Entomology. Text book of Public Health and Veterinary Sciences. Chapman and Hall, London.
- Fernald, H.T. 2008. Applied Entomology, An Introductory Textbook of Insects in their Relation to Man. Kessinger Publishing (Amazon).

- Gold, R. E. and John, S. C. 2010, Hand book of Household & Structural Insect pest published by Entomological Society of America 160 pp
- Lohar, M.K. 2013. General Entomology. 2nd edition, Department of Entomology. Sindh Agriculture University Tandojam Sindh, Pakistan. Pakistan.
- Service, M. 2012. Medical Entomology for students Cambridge University Press 303 pp.

Course Code: ENT-305

Course Title: Insect Behavior

Credit Hours: 3(2-1)

Objectives:

The students will acquire good knowledge of basic concepts of insect behavior.

Theory:

Types of behavior, Reflexes, orientation (kinesis and taxes); learning; periodicity, Patterns of behavior; communications; visual; auditory; tactile; chemical. Territoriality; nervous, endocrine, genetic and biological, Functions of behavior, host finding, feeding and reproductive behavior, Escape, defense, offence and predation; dispersal and migration; dormancy.

Practical:

Communication of insects. Chemical communication. Mating behavior. Host finding behavior. Auditory behavior. Social behavior in lab or in field conditions

Recommended Books:

- Fellows, N. and Holloway, G. 2005. Insect Evolutionary Behaviour. CABI
- Goulson, D. 2003. Bumble Bees: Behaviour and Ecology. Oxford University Press.
- Matthews, R. W. and Matthews J. R. 2010. Insect Behavior. 2nd Edition. Springer Dordrecht Heidelberg London New York.
- Parihar, R. 2001. Reproductive Behaviour and Biology of Sex. Dominant Publishers and Distributors, Delhi.
- Prakash, M. 2008. Encyclopedia of Entomology II: Insect Behaviour. Discovery Publishing House, PVT. LTD. Darya Ganj, New Delhi.
- Vijay, K. 2008. Insect Behaviour. Vista International Publication House.

Course Code: STA-104

Course Title: Experimental Design and Analysis

Credit Hours: 3(3-0)

Objectives:

This course provides the fundamentals of experimental designs and their uses in different disciplines. To provide basic and advanced learning of investigation for conclusions through planning and designing of experiments. To train students through innovative instruction in design theory and methodology that will help them in addressing the significance of experimental design in statistics and across the universal disciplines.

Theory:

Introduction to experimental design and its terminology; Planning and designing of experiment and research; Aspects of experimental design, basic principles of experimental design, fixed and random effects. Analysis of variance, estimation of model parameters. Checking model adequacy, Inference beyond ANOVA multiple comparisons, Contrast analysis, orthogonal polynomial contrasts and trend analysis. Basic experimental designs; Completely randomized design randomized complete block design and Latin square design. Relative efficiency of these designs. Incomplete block designs (IBD), balanced incomplete block designs (BIBD) and partially balanced incomplete block designs (PBIBD). Intra-block and Inter-block analysis of IBD.

Recommended Books:

- Kehul, R.O. (2000). Design of Experiments: Statistical Principles of Research Design and Analysis, Duxbury/ Thomson Learning, New York, USA.
- Montgomery, D.C. (2012). Design and Analysis of Experiments, John Wiley & Sons, New York, USA.
- Oehlert, G.W. (2000). A first course in design and analysis of experiments, W.H. Freeman, New York, USA.
- Steel, R.G.D, Torrie , J.H. and Dickey D.A. (2008). Principles and Procedures of Statistics: A Biometrical Approach. McGraw-Hill, Michigan, USA.

Course Code: ENT-306

Course Title: Insect Physiology

Credit Hours: 3(2-1)

Objectives:

This course aims to provide concepts of basic physiology and their functions in insects. Students will learn the basic structural and functional principles of various insect body

systems such as insect respiratory, circulatory, reproduction, nervous, excretory, digestive systems, muscular and functioning of different insect sense organs and perception; sound and light production, thermoregulation; production and function of hormones and pheromones.

Theory:

Introduction. Embryonic and post-embryonic development, Physiology of integument, tracheal, Digestive, circulatory, excretory, muscular, reproductive and nervous systems, Sense organs and perception. Sound and light production. Thermoregulation; production and function of hormones and pheromones.

Practical:

Study of integument. Physiology of digestion. Tracheal, circulation, excretion, reproduction, musculature and sensation; hormones and pheromones.

Recommended Books:

- Ashfaq, A. and Sohail, A. 2002. Manual of Insect Physiology. Pakistan Science Foundation.
- Klowden, M.J. 2002. Physiological Systems in Insects. Academic Press.
- Litwack, G. 2005. Insect Hormones (Vitamins and Hormones). Elsevier Academic Press, California.
- Liu, N. 2008. Recent Advances in Insect Physiology, Toxicology and Molecular Biology. Research Signpost Publishers.
- Patanaik, B.D. 2002. Physiology of Insects. Dominant Publishers and Distributors, Delhi, India.
- Yadave, M. 2003. Physiology of Insects. Discovery Publishing House, New Delhi.

Course Code: ENT-307

Course Title: Insect Classification and Biodiversity

Credit Hours: 3(2-1)

Objectives:

To familiarize the students with the basics of insect classification and biodiversity of different insect orders up to family level. Students will learn the adaptation strategies of adult insects in different geographical regions and about their adaptive and phylogenetic relations. They will study the available insect fauna diversity in Pakistan.

Theory:

Introduction, Schemes of classification. Types and components of biodiversity. History of insects. Phylogenetic affinities of different orders. Insect adaptation in various geographical regions. Speciation and biodiversity. Classification of insect orders up to family level with particular reference to insect fauna of Pakistan

Practical:

Collection. Preservation. Identification and classification of insects upto family level. Methods of studying biodiversity

Recommended Books:

- Footitt, R.G. and Adler, P.T. 2009. Insect Biodiversity Science and Society. Wiley – Blackwell Publication UK.
- Gaston, K. J. and Spicer, J. I. 2004. Biodiversity: An Introduction. 2nd Edition. Blackwell Science Ltd.
- Gupta, R.K. 2003. Advances in Insect Biodiversity. Agrobios, New Delhi, India.
- Richards, O.W. and Davies, R.G. 1984. Imm's General Text Book of Entomology. Vol. II. 10th Ed. (Revised), Chapman and Hall, London.
- Suhail, A. 2008. A Note Book of Classification of Adult Insects (Insect History, Biodiversity, Collection and Classification), 2nd Edition, Faisalabad.
- Triplehorn, C.A. and Johnson, N.F. 2005. Borror and DeLong's Introduction to the study of Insects. Brooks Cole. 7th Ed.
- Wheeler, W.M. 2006. Insects: their origin and evolution. Discovery Publishing House, New Delhi

Course Code: ENT-308

Course Title: Agricultural Pests and Their Management

Credit Hours: 4(3-1)

Objectives:

To introduce the students with pest distribution, biology, host plants, nature of damage and management of insect and mite pests of field crops, vegetables, orchards and other important vertebrate and invertebrate pests.

Theory:

Introduction. Concepts of IPM technology. Identification. Distribution. Host plants, biology, damage and management of mites, Insect pests of field crops, Insect pests of vegetables and orchards. Brief introduction of important vertebrate pests

Practical:

Collection of insects. Identification and distribution. Host plants of insect pests. Biology of insect pests. Mode of damage and management of insect. Mite pests of field crops, vegetables and orchards. Important vertebrate pests other than insects

Recommended Books:

- Agarwal, S. 2009. Insect Pests of Cereals and their Management. Oxford Book Co. India
- Atwal, A.S. and Dhaliwal, G.S. 2005. Agricultural Pests of South East Asia and their Management. Kalyani Publishers, Ludhiana.
- Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
- Fenemore, P.G. 2006. Applied Entomology. New age International, Publication.
- Fernald, H.T. 2008. Applied Entomology, An Introductory Textbook of Insects in their Relation to Man. Kessinger Publishing (Amazon).
- Lohar, M. K. 2013. Applied Entomology. 2nd Ed. Kashif Publications, Hyderabad, Pakistan.
- Maredia, K.M. Dakouo, D. and Mota-Sanchez, D. 2003. Integrated Pest Management in the Global Arena. CABI publishing UK.
- Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
- Abrol, D. P. and Shankar, U. 2012. Integrated Pest Management: Principles and Practice. CAB International.

Course Code: ENT-309

Course Title: Stored Product Pests and Their Management

Credit Hours: 3(2-1)

Objectives:

Students will learn about the stored product pest management, storage principles and storage losses due to insect pests. Biology and ecology of insect and mite pests in stored products. Factors affecting the grain and other stored food products in storage structures.

Course Contents:

Introduction about stored product pest. Identification, biology and management of different stored product pests Principles and types of storages. Factors affecting grain and

other products in storages. Stored product losses and their prevention.

Practical:

Visits to different godowns. Demonstration of sampling methods and estimation. Collection, identification and management of different stored product pests. Culture of some stored products insect pests under different climatic conditions

Recommended Books:

- Ashfaq, M. Saleem, M. A. and Ahmad, F. 2009. Zari Ajnaski Mahfooz Zakhira Kari (in Urdu). Pak Book Empire, Lahore.
- Hill, D.S. 2002. Pests of Stored Food Stuffs and Their Control, Springer Publisher.
- Rees, D. 2009. Insects of Stored Products. Manson Publishing Company.

Course Code: ENT-310

Course Title: Beneficial Insects

Credit Hours: 3(2-1)

Objectives:

This course emphasizes on concept of different types and uses of beneficial insects including medicinal use of insects, aesthetic importance of insects, pollination services by insects, insects as scavengers, decomposers, and soil conditioners and weed feeding insects, which are employed in biological pest control industry.

Theory:

Introduction about beneficial insects. Insects of medicinal food and aesthetic value. Insect pollinators. Scavengers. Entomophagous insects (predators and parasitoids). Weed-feeding insects. Beneficial insect industries (Apiculture, sericulture and lac culture)

Practical:

Practical instructions in beneficial insects rearing. Collection and identification of beneficial insects (pollinators, predators and parasitoids).

Recommended Books:

- Ashfaq, M. and Suhail, A. 2001. Magasbani kay JadeedTreeqay (in Urdu), Deptt. of Entomology. U.A. Faisalabad.
- Ashfaq, M. and Akram, W. 2000. ReshamkeKeerayPalna (in Urdu), Deptt. of Entomology. U.A. Faisalabad.
- Carter G.A. 2004. Bee Keeping. Biotech Books, New Delhi.
- Irshad, M. Khan. M.R. and Rafi. M.A. 2005. Insect Pests and their Parasitoids,

Predators and Pathogens in Pakistan. PIPS (Pvt.) Ltd. Islamabad.

Course Code: ENT-401

Course Title: Integrated Pest Management

Credit Hours: 4(3-1)

Objectives:

To provide the basic concept of principles and requirements of IPM. This course provides comprehensive information related to the integrated pest management strategies. Students will learn to integrate the control methods to minimize the use of pesticides.

Theory:

Introduction. History. Concept and principles of Integrated Pest Management (IPM). Organic farming. Economics of pest management. Different methods of insect pest scouting and forecasting; losses caused by Insect pests to different crops. Methods of pest management: Cultural, physical, mechanical, legislative, chemical, biological, microbial, biotechnological and genetic control measures, feeding deterrents, insect growth regulators (IGRs) and pheromones.

Practical:

Demonstration of different methods of pest scouting and monitoring. Nature and extent of damage. Assessment of crop losses by different methods. Estimation of economic threshold levels of different crop pests. Installation of light and pheromone traps. Designing of IPM modules of important selected crops.

Recommended Books:

- Atwal, A.S. and Bains, S.S. 2005. Agricultural Pests of South East Asia and their Management. Kalyani Publishers, Ludhiana.
- Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
- Dhaliwal, G.S. and Arora, R. 2006. Integrated Pest Management. Kalyani Pub. Ludhiana.
- Flint, M. L., 2012. IPM in Practice: Principles and Methods of Integrated Pest Management. Univ of California Agriculture & Natural Resources; 2nd edition. Pages 292.

Course Code: ENT-402

Course Title: Plant Resistance to Insect Pests

Credit Hours: 3(2-1)

Objectives:

To provide the concept of plant resistance and transgenic crops to insect pests.

Theory:

Introduction about plant resistance. Concepts of resistant and transgenic crops. Mechanism of resistance. Factors of resistance: ecological, physiological, asynchrony. Induced genetic antixenosis, antibiosis and tolerance. Genetic basis of resistance. Effect of environment on resistance. Biotypes and resistance. Measurement of resistance. Effect of transgenic crops on non-target organism

Practical:

Screening and measurement of relative plant resistance to insects in different crops and transgenic plants. Observation about morphological, physiological and bio-chemical plant resistance.

Recommended Books:

- Dhaliwal, G. S. and Singh, R. 2004. Host plant resistance to insects: concepts and application. Panima Publishing Corporation, New Delhi.
- Maxwell, F.G. and Jennings, P.R. 1980. Breeding Plants Resistant to Insect Pests. John Wiley and Sons New York.
- Panda, N. 1980. Principles of Host Plant Resistance to Insect Pests. Allenheld, London.
- Panda, N. and Khush, G.S. 1995, Host Plant resistance to Insects. IRRI, Biddles Ltd. Guildford, UK.
- Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
- Sadasivam, S. and Thayumanavan, B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker Inc. New York.
- Saleem, M. A. 2005. Insecticide Resistance and Management. B. Z. University Press, Multan, Pakistan.
- Painter, R.H. 1951. Insect Resistance in Crop Plants. McMillan Co., N.Y

Course Code: ENT-403

Course Title: Insecticides and Their Application

Credit Hours: 3(2-1)

Objectives:

To provide concept of toxicity and insecticide formulations, mode of action, residues of insecticides and various types of spray equipment.

Theory:

Introduction about insecticide. Nomenclature, classification on the basis of (mode of entry, mode of action and chemical nature). Toxicity and insecticides formulations. Compatibility Physico-chemical properties. Residues of insecticides. Insecticide resistance and its management. Hazards and safety measures. Equipment for insecticide application. Types of nozzles. Types of sprayers. Information about insecticide legislation.

Practical:

Computation, preparation and field application of different formulations of insecticides. Identification, classification, handling and maintenance of application equipments. Visit to pesticides industries/field visits.

Recommended Books:

- Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
- Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA
- Dodia, D.A. Petel, I.S. and Petal, G.M. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India) Jodhpur.
- Mathews G.A. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK.
- Otto, D. and Weber, B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., U.K.
- Roy, N.K. 2006. Chemistry of Pesticides. Asia PrintographShahdara Delhi.
- Saleem, M.A. 2009. Principles of Insect Toxicology. Vol.-I. Izhar sons Printers. Lahore.
- Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida.

Course Code: ENT-404

Course Title: Range and Forest Entomology

Credit Hours: 3(2-1)

Objectives:

To provide the concept of range and forest entomology in range land and forest ecosystem.

Theory:

Importance of range and forest entomology. Insect pests of range and forest trees. Lawn insects, their identification, biology, distribution, host plants, Nature of damage of forest insects. Estimation of losses and management. Competition and complementary role of insects with range livestock.

Practical:

- Survey and collection of forest insects
- Preservation and identification of insect pests of range and forest trees
- Study of nature of damage and demonstration of control measure
- Field visits to range/ forests/ forest departments.

Recommended Books:

- Dajoz, R. 2000. Insects and Forests. Intercept Ltd. UK.
- Hashmi, A. A. 1994. Insect Pest Management, Horticultural and Forest Crops Volume 2 Pakistan Agricultural Research Council, Islamabad.
- Jha, K. 2003. Forest Entomology. Ashish Publishing House. India. Jha. L. K. and Sen-Sarma. P.K. 2008. Forest Entomology APH Publishing.
- Nair, K.S.S. 2007. Tropical Forest Insect Pests: Ecology, Impact, and Management. Cambridge University Press, UK.
- Sathe, T.V. 2009. A Text Book of Forest Entomology. Daya Publishing House Delhi.
- Thakur, M.I. 2000. Forest Entomology: Ecology and Management. S.A.I. Publishing Co.
- Wylie, R. and Speight M. R. 2012. Insect pests in tropical forestry CABI publishing 399 pp 2nd edition.

Course Code: ENT-405

Course Title: Agriculture and Environmental Pollution

Credit Hours: 3(2-1)

Objectives:

To provide the concepts of environmental pollution and deterioration with their effects on agriculture, forest and living organisms etc.

Theory:

Introduction about environmental pollution. General concept of pollutants. Sources and nature of pollutants. Environmental deterioration and its effect on agriculture. Greenhouse effect. Types of pollution with reference to agriculture and forest. Pesticide and fertilizer pollution. Effect of pollution on soil, water, air, plants and living organisms. Management of pollution

Practical:

Practical demonstration of biological responses to pollutants. Practical demonstration of biological responses to biogeochemical cycles. Practical demonstration of insects as indicators of levels of pollution

Recommended Books:

- Ashfaq M. and Saleem, M.A. 2010. Environmental Pollution and Agriculture. Pak Book Empire, Lahore.
- Suhail, A and Ahmad, S. 2003. A Workbook of Agriculture & Environmental Pollution. Deptt. of Agri. Entomology, University of Agriculture, Faisalabad.

Course Code: ENT-406

Course Title: Scientific Writing and Presentation

Credit Hours: 3(2-1)

Objectives:

To familiarize the students to research methods, handling of experimental data and writing of a research report. The main objective of this course is to give students practical exposure in the field. Students will be assigned individual research assignments and they will learn how to independently execute and finalized a research project and how to collect, analyze and present data of the research experiments.

Theory:

Introduction. Literature search for entomological information. Citation. Collection of data Tabulation, Analysis and interpretation of research data. Report writing. Lab/field experimental designs. Concepts of synopsis. Thesis writing. Research paper writing. Research project and monographs. Presentation skills.

Practical:

Use of internet sources and databases for entomological information. Layout of experiments. Collection of data, tabulation, analysis and interpretation of research data;

Writing synopsis, thesis, research paper, research project and monographs. Preparation and delivery of multimedia presentations. Visit and use of digital libraries.

Recommended Books:

- Davis, M. 2005. Scientific Papers and Presentations. Academic Press.
- Dawson, C. 2009. Introduction to Research Methods: A practical guide for anyone undertaking a research project. 4th edition. Howtobooks, UK.
- Gomez, K. A. and A. A. Gomez, 1984. Statistical Procedures in Agricultural Research, Second Edition, Wiley New York, Chichester, etc.:, pp. 680.
- Knisely, K. 2009. A Student Handbook for Writing in Biology, 4th Edition, Sinauer Associates, Inc. W.H. Freeman and Company.
- Quinn, G.P. and Michael, J.K. 2002. Experimental Design and Data Analysis for Biology. Cambridge University Press.

Course Code: ENT-407

Course Title: Apiculture

Credit Hours: 3(2-1)

Objectives:

Students will learn about the scope of apiculture, types of bee species, their biological and ecological characteristics and about their better management strategies for enhancing their productivity. Moreover, students will be practically demonstrated all the beekeeping activities including season management, queen and colony management and honey extraction protocols.

Theory:

Introduction, importance, scope of apiculture industry. Bee species and their biology, morphology, behavior and products. Bee flora their distribution and flowering time. Beekeeping equipment's, seasonal management, uniting, dividing and preparation for shifting colonies; bee stings, queen rearing and swarming. Pest and diseases of bees and their management. Honey extraction; factors affecting honey yield. Importance of bees in pollination. Honey, its properties and uses; granulation, fermentation and storage of honey. Uses of other bee products. Beekeeping as an enterprise.

Practical:

Practical demonstration of bee colonies. Observation of colonies and different casts. Beekeeping equipment; preparation of frames and comb foundation for their hives.

Colony inspection. Visit to apiaries.

Recommended Books:

- Devillers, J., Phame, M. and Delegue, M. 2002. Honey Bees.

Course Code: ENT-408

Course Title: Biological Control of Insect Pests

Credit Hours: 3(2-1)

Objectives:

To enable the students know about principles and practices of biological control. The course aims to elaborate the introduction, concept, history and scope, ecological basis of biological control, natural enemies: predators, parasitoids and insect pathogens advantages and disadvantages, characteristics of bio-control agents, procedure of biological control.

Theory:

Introduction and concept about principles and practices of biological control. History and scope of biological control. Ecological basis of biological control. Natural enemies. Predators. Parasitoids and insect pathogens. Advantages and disadvantages. Characteristics of bio-control agents. Procedure of biological control. Introduction of bio control agents (introduction, conservation, mass culture, augmentation, release, monitoring and importation). Rearing techniques of bio-control agents and their host insects. Role of biological control in IPM. Commercialization of biocontrol agents. Quality management in biological control agent rearing. Establishment of biological control system

Practical:

Collection, Preservation and identification of predators & parasitoids. Laboratory rearing and culturing of important natural enemies. Study of extent of parasitism/predation of different bio-control agents. Storage, shipping and field release methods. Visit to public/private bio-control labs

Recommended Books:

- Copping, L.G. 2004. The Manual of Biocontrol Agents. BCPC
- De Bach, P. and Rosen, D. 1991. Biological Control by Natural Enemies. CUP Archive.
- Hajek, A. 2003. Natural Enemies: An Introduction to Biological Control. Cambridge University Press

Course Code: ENT-409

Course Title: Internship/Research Project/Survey Report and Presentation

Credit Hours: 4(0-4)

(Including report writing and presentation)

Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive farms and private farms, university fields/laboratories aimed at their practical training as per feasibility of the institution. Upon completion of internship/research, students are required to submit a report and give presentation of internship/research experiments.

COURSE CONTENTS (MAJOR HORTICULTURE) SEMESTER 5th TO 8th

Course Code: HOR-301

Course Title: Principles of Mountainous Fruit Production

Credit Hours: 3(2-1)

Objectives:

To make students aware of principles and physiology of fruit production.

Theory:

Basic Introduction and definitions related to fruit science. Introduction of fruit-bud formation, growth and monitoring aspects. Basic plant development regulators and their uses. Fruit setting complications and pollination, incompatibility and Fruit thinning. Bud differences and mutations. Physiological disorders; Fruit drop, Biennial bearing etc.; causes and control. Maturity and harvesting indices, harvesting methods, ripening and senescence.

Practical:

Identification of various developmental stages of buds, Fruit bearing habits, Training and pruning of important evergreen and deciduous fruit trees, Thinning of fruits, Practices to control irregular bearing. Preparation of PGR solutions and their applications. Identification of phonological stages in fruit plants.

Recommended Books:

- Acquaah, G. 2009. Horticulture: Principles and Practices (4thEd.). Prentice-Hall India Learning Pvt. Ltd. New Delhi, India.
- Chottopadhyay, T.K. (Ed.). 2003. A Textbook on Pomology, Vol. I: Fundamentals of Fruit Growing. Kalyani Publishers, Ludhiana, New Delhi, India.
- Chottopadhyay, T.K. 2000. A Textbook on Pomology, Vol. II: Tropical Fruits. Kalyani Publishers, New Delhi.

Course Code: HOR-302

Course Title: Principles of Mountain Vegetable Production

Credit Hours: 3(2-1)

Objectives:

To develop understanding among the students regarding principles and physiology of vegetable production.

Theory:

Introduction, importance and classifications of vegetables. Cropping systems; succession, relay and multiple cropping etc. Recent advancements in vegetable production. Production of off-season vegetable, hydroponics and aeroponic. Principles of organic farming, Factors effecting vegetable production. Introduction to tuber and bulb formation. Crop management, seed selection, quality assurance, nursery raising, transplanting and hardening. Fundamentals of staking and pruning, mulching, irrigation, harvesting. Physiological complaints, Production issues and their control. Plant development regulators.

Practical:

Description and identification of flowers, fruit and seed of important cultivars. Seed priming. Methods of sowing. Practice in raising nursery. Hardening and transplanting of seedlings. Pruning and staking practices. Visits to vegetable farms

Recommended Books:

- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Hazra, P. and M.G. Som. 2005. Vegetable Science. Kalyani Publishers, Ludhiana, New Delhi, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers. 5th edition. John Willey and Sons, Inc., NewYork.
- Nonnecke, I.L. 2006. Vegetable Production. Springer Publishers, India.
- Rana, M. K. 2012. Modern Concepts of Vegetables Production. Biotech. Books, New Delhi.
- Swaider, J.M., G.W. Ware and J.P. McCollum. 2002. Producing Vegetable Crops (5th Ed.), Interstate Publishers Printers and Publishers Inc., Danville, Illinois. 18
- Singh, P. and S. P. Singh. 2012. Principles of Vegetable Production. Oxford book

company New Delhi.

Course Code: HOR-303

Course Title: Principles of Ornamental Crop Production

Credit Hours: 3(2-1)

Objectives:

To provide knowledge of basic principles and physiology of ornamental crop production to the students of Horticulture.

Theory:

Introduction and importance. Present status and future scope. Raising techniques of annuals. Flowering perennials. Foliage plants, succulents and flowering bulbs with their propagation and crop management. Seed and bulb dormancy, Pruning, training and shaping. Use of growth regulators, Manipulation of growth and flowering. Concept of Bonsai and topiary, Outdoor and indoor decoration, Flower exhibition, Flower arrangements

Practical:

Seeding, raising and transplanting of nursery. Identification of annuals, herbaceous perennials, foliage plants. Succulents and flowering bulbs with their propagation methods and management practices. Visits to ornamental nurseries, parks, cut flower shops, flower exhibitions and growing structures.

Recommended Books:

- Arora, J.S. 2003. Introductory Ornamental Horticulture (4th Ed.). Kalyani Publishers, New Delhi.
- Dey, S.C. 2010. Flowers from Bulbous Plants. Agribios, Jodhpur, India. 19
- Laurie, A. and Ries V.S. 2004. Floriculture: Fundamentals and Practices. Agrobios (India), Jodhpur, India.
- Hessayon, D.G. 2007. The Flowering Shrubs Expert (3rd Ed.). Transworld Publishers, London, U.K.
- Hessayon, D.G. 2007. The Flowering Bulbs Expert (3rd Ed.). Transworld Publishers, London, U.K.

Course Code: HOR-304

Course Title: Propagation and Mountain Nursery Management

Credit Hours: 3(2-1)

Objectives:

To impart technical knowledge about nursery management and certification procedures.

Theory:

Introduction and importance. Types of horticultural nurseries. Management practices (water, nutrient, weeds, diseases, insect-pests). Protection against temperature extremities and radiation. Important nursery operations. Propagation methods and their importance. Rootstocks for horticultural plants, Raising of stock seedlings. Pre-sowing treatments of seeds; Apomixes and polyembryony, stannic interactions, Graft compatibility and incompatibility. Use of growth regulators for propagation, Certification systems; standards, rules & regulation and procedures, Certification of planting material and nursery plants, Marketing of nursery plants.

Practical:

Raising of rootstocks. Identification of rootstocks for different fruit plants. Selection and preparation of bud wood. Practices in seed collection. Seed treatment and propagation methods. Plant growing structures, media and mixtures. Media sterilization, Management of progeny plants, Virus indexing. Visit to germplasm units.

Recommended Books:

- Adriance, G.W., and F.R. Brison. 2000. Propagation of Horticultural Plants. Biotech Books, Delhi, India.
- Hartmann, H.T., D.E. Kester and F.T. Davies. 2011. Plant propagation: principles and practices (8th Ed.). prentice Hall, New Jersey, USA.
- Rajan, S. and B.L. Markose. 2007. Propagation of Horticultural Crops. New India publishing Agency, New Dehli, India.

Course Code: HORT-305

Course Title: In Vitro Propagation

Credit Hours: 3(2-1)

Objectives:

To acquaint the students with modern techniques of plant multiplication.

Theory:

Introduction and importance. Basic terminology, application and constraints of plant tissue culture. Nutritional components of culture media (nutrients, carbohydrates, vitamins, growth regulators, amino acids and antibiotics), their types & functions. Aseptic techniques;

Initiation and maintenance of cultures. Physical factors for growth; transplanting and acclimatization. Preparation of synthetic seed; Concepts of plant biotechnology and its role in improvement of horticultural crops.

Practical:

Laboratory safety precautions, sanitation, equipment. Calculations (preparation of molar, percent, normal, ppm etc solutions). Preparation of stock solutions & media, sterilization techniques, inoculation and culture of explants. Acclimatization & transplanting.

Recommended Books:

- Hartmann, H.T., D.E. Kester and F.T. Davies. 2011. Plant propagation: principles and practices (8th Ed.). prentice Hall, New Jersey, USA.
- Lindsey, K. (Ed). 2007. Plant Tissue Culture Manual. Springer-Kluwer Academic Publishers New Delhi, India.
- George, E.F., M.A. Hall and G.J. De Klerk. 2008. Plant Propagation by Tissue Culture. 3rd Ed. Springer, Dordrecht, Netherlands.
- Razdan, M.K. 2003. Introduction to Plant Tissue Culture. Science Publishers Inc. (ISBN: 1-57808-237-4).

Course Code: HORT-306

Course Title: Tropical and Sub-tropical Fruits of Mountains

Credit Hours: 3(2-1)

Objectives:

To accustom students with production technology of major tropical and sub-tropical fruits of Pakistan.

Theory:

Classification of tropical and sub-tropical fruits. Cultivation with reference to acreage, production, botany, cultivars, rootstocks, propagation, climate, soil. Cultural practices (water, nutrition, weeds, diseases, disorders and pest management), Maturity, ripening, harvesting. Quality assurance and marketing of major tropical and sub-tropical fruits of Pakistan.

Practical:

Practices in fruit health management. Pollination in commercial fruits. Cost of production, Description and identification of commercial cultivars of important tropical and sub-

tropical fruits. Visit to research institutes and commercial orchards.

Recommended Books:

- Alebrigo, L.G., L.W.Timmer and M.E. Rogers. 2014. Vol:II. Citrus (Crop Production Science in Horticulture). CABI
- Bali, S.S. 2003. Fruit Growing, Kalyani Publishers, New Delhi.
- Durate, O. and R.E. Paull, 2012. Tropical Fruits: Vol.II. Crop Production Science in Horticulture 24. CAB International Publishing.
- Chottopadhyay, T.K. (Ed.). 2006. A Textbook on Pomology, Vol: II. Tropical Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.

Course Code: HOR-307

Course Title: Summer Vegetables

Credit Hours: 3(2-1)

Objectives:

To accustom students with production technology of major summer vegetables of Pakistan.

Theory:

Introduction, importance and issues of summer vegetables, Types of vegetable farming Cultivation of summer vegetables with reference to their acreage, production, botany, cultivars, climate, soil, cultural practices, maturity indices. Harvesting, grading, packing, Quality assurance, marketing, production problems, important weeds, insect-pests, Diseases and their control.

Practical:

Practice in raising of summer vegetables including mushrooms. Eradication of weeds and control measures of insects and diseases, Harvesting, grading and packing of vegetables, Economics of summer vegetable production,

Recommended Books:

- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual for Cultivation. PHI learning private Ltd., New Delhi, India. Libner, N.S. 2006. Vegetable Production. Vedams Books Pvt. Ltd. New Delhi, India.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana,

New Delhi, India.

- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers (5th Ed.). John Willey and Sons Inc., New York.
- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana, New Delhi, India.

Course Code: HOR-308

Course Title: Mountainous Landscape Horticulture

Credit Hours: 3(2-1)

Objectives:

To provide the students with opportunity to combine science of horticulture and their creative abilities in provision of aesthetically beautiful and functional environment.

Theory:

Classification of landscape plants. Growth habits, foliage and flowering effects, Propagation and maintenance of important landscape plants and turf grasses Introduction to landscape design, hardscape and softscape, Principles, elements and types of landscape, Suitability of various plants for different purposes and locations, Irrigation systems for different landscapes, Landscape planning, installation, maintenance, and budget estimation.

Practical:

Study of various soft and hard landscape designs. Aesthetic study of stem, branches, leaves, flowers and fruits. Mapping of landscape designs; Landscape designs for individual houses, municipal and national parks. Shaping of plants by pruning and training practices,

Recommended Books:

- Arora, J.S. 2003. Introductory Ornamental Horticulture (4th Ed.). Kalyani Publishers, New Delhi.
- Biondo, R.J., and C.B. Schroeder. 2006. Introduction to Landscaping Design, Construction and Maintenance (3rd Ed.). International Book Distributing Company (Publishing Division), Lucknow, India.
- Bhattacharjee, S.K. 2004. Landscape Gardening and Design with Plants. Aavishkar Publishers, Distributors, Jaipur, India.
- Gilmer, M. 2002. Water works. Contemporary Books McGraw Hill Companies, Sydney, Australia.

Course Code: HOR-309

Course Title: Medicinal and Aromatic Plants of Mountains

Credit Hours: 3(2-1)

Objectives:

To provide information about medicinal and aromatic values of different plants.

Theory:

Importance of condiments. Spices and medicinal plants. Origin and habitat, classification and botany. Climatic requirements, Cultivation and production. Chemical and pharmacological properties. Products and their culinary and medicinal uses. Methods of plant collection and extraction, Processing, marketing and export potential

Practical:

Identification, collection and description, Introduction, acclimatization and multiplication of economically important plants. Parts used and important ingredients. Processing and extraction methods,

Recommended Books:

- Das, P.C. 2014. Spice Crops Production Technology. Scientific publisher, Jodhpur, India
- Farooqui, M.L.H. 2000. Medicinal Plants of Prophet Muhammad (PBUH). Sidrah Publishers, Lakhnow.
- Bimbraw, A.S 2006. Agrotechniques for umbelliferous medicinal and aromatic plants of India. International Book Distributing Co., India.
- Aslam, M. 2006. Guidelines for cultivation, collection, conservation and propagation of medicinal herbs. MINFAL, Pakistan.
- Serdar, O. and M. Milan. 2007. Medicinal and Aromatic Crops. Haworth Food & Agric. Products.
- Patil, D.A. 2008. Herbal cures a traditional approach. Aavishkar Publishers & Distributers, Jaipur, India.

Course Code: HOR-310

Course Title: Post-harvest Horticulture

Credit Hours: 3(2-1)

Objectives:

To equip students with the techniques to prolong shelf-life of perishable horticultural

produce.

Theory:

Introduction and importance, Pre- and post-harvest factors affecting quality, Climacteric and non-climacteric commodities, Indices of crop maturity / ripening, harvesting and pre-cooling, Curing and artificial ripening of horticultural commodities, Packing house operations; culling, grading, washing, cleaning, coloring, waxing and packaging of important horticultural commodities, Packing materials and containers, Storage; principles and types, storage life and factors determining it, International standards and quality assurance, sanitary and phyto-sanitary measures, Shipment for local and foreign markets.

Practical:

Machinery and equipment used for various operations. Demonstration of harvest indices. Practices in harvesting, curing, packing and preparation of different fruits, vegetables and cut flowers for marketing. Determination of total soluble solids. Determination of fruit firmness, starch-iodine test, colour determination.

Recommended Books:

- Bhattacharjee S. K and L.C. De. 2005. Post-Harvest Technology of Flowers and Ornamental Plants. Pointer Publishers Jaipur India.
- Burg. P. S. 2004. Postharvest Physiology and Hypobaric Storage of Fresh Produce. CABI Publishing.
- Choudhry, M. L and K. V. Parsad. 2003. Value Addition in Horticulture. Delhi Agri-Horticultural Society. Division of Floriculture and Landscaping Indian Agricultural Research Institute Pusa, New Delhi- 110 012.
- Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of California Press, California, USA.

Course Code: STA-104

Course Title: Experimental Design and Analysis

Credit Hours: 3(3-0)

Objectives:

This course provides the fundamentals of experimental designs and their uses in different disciplines. To provide basic and advanced learning of investigation for conclusions through planning and designing of experiments. To train students through innovative instruction in design theory and methodology that will help them in addressing the

significance of experimental design in statistics and across the universal disciplines.

Theory:

Introduction to experimental design and its terminology; Planning and designing of experiment and research; Aspects of experimental design, basic principles of experimental design, fixed and random effects. Analysis of variance, estimation of model parameters. Checking model adequacy, Inference beyond ANOVA multiple comparisons, Contrast analysis, orthogonal polynomial contrasts and trend analysis. Basic experimental designs; Completely randomized design randomized complete block design and Latin square design. Relative efficiency of these designs. Incomplete block designs (IBD), balanced incomplete block designs (BIBD) and partially balanced incomplete block designs (PBIBD). Intra-block and Inter-block analysis of IBD.

Recommended Books:

- Kehul, R.O. (2000). Design of Experiments: Statistical Principles of Research Design and Analysis, Duxbury/ Thomson Learning, New York, USA.
- Montgomery, D.C. (2012). Design and Analysis of Experiments, John Wiley & Sons, New York, USA.
- Oehlert, G.W. (2000). A first course in design and analysis of experiments, W.H. Freeman, New York, USA.
- Steel, R.G.D, Torrie , J.H. and Dickey D.A. (2008). Principles and Procedures of Statistics: A Biometrical Approach. McGraw-Hill, Michigan, USA.

Course Code: HORT-401

Course Title: Research Methods in Horticulture

Credit Hours: 3(2-1)

Objectives:

To develop ability of the students to identify and address the researchable problems in different areas of Horticulture.

Theory:

Areas of research in Horticulture. Preparation of research proposal, Research methodology Hypothesis and experimentation. Research parameters (morphological, physiological, biochemical, growth and yield characteristics), Sampling and data collection. Data processing, tabulation, analysis and interpretation of result, Computer application, word processing, graphics and data analysis packages.

Practical:

Practices in field layout of experimental design, Sampling and data collection. Laboratory practices in physio-chemical analyses. Use of computer (word processing, data processing and graphics) in horticultural research.

Recommended Books:

- Laake,P., H. B. Benestad and B. R. Olsen. 2007. Research Methodology in the Medical and Biological Sciences. Academic press, San Diego, USA.
- Quinn,G. P. and M. J. Keough. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University press, Cambridge, UK.
- Mukul,G. and G. Deepa. 2011. Research Methodology. PHI Learning Private Ltd., New Dehli India.
- Singh, Y. K. 2006. Fundamental of Research Methodology and Statistics. New age international Pvt. Ltd., New Dehli, India.

Course Code: HOR-402

Course Title: Temperate Fruits of Mountains

Credit Hours: 3(2-1)

Objectives:

To accustom students with production technology of major temperate fruits of Pakistan.

Theory:

Classification of temperate fruits. Cultivation with reference to acreage. Production, botany, cultivars, rootstocks, propagation, Climate, soil, cultural practices (water, nutrition, weeds, diseases, disorders and pest management). Maturity, ripening, harvesting, quality assurance and marketing of major temperate fruits of Pakistan.

Practical:

Practices in fruit health management. Pollination in commercial fruits, Cost of production, Description and identification of commercial cultivars of important temperate fruits, Visit to research institutes and commercial orchards.

Recommended Books:

- Bali, S.S. 2003. Fruit Growing, Kalyani Publishers, New Delhi.
- Chottopadhyay, T.K. (Ed.). 2009. A Textbook on Pomology, Vol: IV. Temperate Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing

Co. (Publishing Division), Lucknow, India.

- Jackson, D.I., N. Looney, M. Morley-Bonker and G. Thiele. 2011. Temperate and Subtropical Fruit Production. CAB International Publishing, Wallingford, UK.

Course Code: HOR-403

Course Title: Winter Vegetables

Credit Hours: 3(2-1)

Objectives:

To accustom students with production technology of major winter vegetables of Pakistan.

Theory:

Introduction, importance and issues. Types of vegetable farming. Cultivation of winter vegetables with reference to their acreage. Production, botany, cultivars, climate, soil. Cultural practices, maturity indices. Harvesting, grading, packing, quality assurance, marketing. Production problems, important weeds, insect-pests. Diseases and their control.

Practical:

Practice in raising of winter vegetables including mushrooms, Eradication of weeds and control measures of insects and diseases, Harvesting, grading and packing of vegetables. Economics of winter vegetable production,

Recommended Books:

- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual For Cultivation. PHI learning private Ltd., New Delhi, India.
- Libner, N.S. 2006. Vegetable Production. Vedams Books Pvt. Ltd. New Delhi, India.
- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana, New Delhi, India.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers (5th Ed.). John Willey and Sons Inc., New York.

Course Code: HOR-404

Course Title: Commercial Flower Production

Credit Hours: 3(2-1)

Objectives:

To accustom students with production technology of economically important flowers.

Theory:

Introduction and importance, Overview of world flower trade. Economics and feasibility. Environmental simulation. Climate and soils. Propagation, crop management practices, harvesting, post-harvest handling and marketing of important floral crops such as amaryllis, anemone, calendula, carnation, chrysanthemum, crocus, dahlia, freesia, geranium, gerbera, gladiolus, gypso- gypso, iris, liliium, marigold, narcissus, nemesia, orchid, poinsettia, roses, stock, sweet pea, snapdragon, statice, tulip, tuberose, zinnia.

Practical:

Identification, nursery raising, planting, cultural operations. Harvesting and packing of important flowers for marketing. Visits of production areas and floral markets.

Recommended Books:

- Armitage, A.M. and J.M. Laushman. 2003. Specialty Cut Flowers (2nd Ed.). Timber Press, Windsor, Australia.
- Bose, T.K., L.P. Yadav, P. Pal, V.A. Parthasarathy and P. Das. 2003. Commercial Flowers (2nd Ed.). NayaUdyog, Calcutta, India. 32
- Prasad, S. and U. Kumar. 2005. Commercial Floriculture. Agrobios (India), Jodhpur, India.
- Laurie, A. 2004. Floriculture: Fundamentals and Practices. McGraw Hill Book Company, New York.

Course Code: HOR-405

Course Title: Breeding of Horticultural Crops

Credit Hours: 3(2-1)

Objectives:

To teach breeding methods for improvement of horticultural crops for specific objectives such as quality and yields.

Theory:

Principles of plant breeding. Reproductive systems in horticultural crops. Self-incompatibility and male sterility; centres of origin, sources of genetic variability Cytological basis of breeding, Heterosis. Theories of heterosis, Inbreeding depression, Apomixes. Role of mutation and polyploidy in breeding, Somatic selection and chimeras Breeding objective, Methods of breeding of self and cross-pollinated crops. Crop improvement and cultivars development. Soma clonal variations, Germplasm

conservation

Concept of genetic manipulation and transgenic plants

Practical:

Description of flowers of important fruits, vegetables and ornamentals. Emasculation, selfing and crossing techniques, Polyembryony tests. Pollen viability tests, inducing polyploidy by chemicals.

Recommended Books:

- Fageria, M.S., P.S. Arya and Choudhary, A.K. 2000. Vegetable Crops (Vol. 1): Breeding and Seed Production. Kalyani Publisher, Ludhiana, New Delhi, India.
- Shukla, A.K., A.K. Shukla and B.B. Vashishtha. 2004. Fruit Breeding: Approaches and Achievements. International Book Distributing Company (Publishing Division), Lucknow, India.
- Singh, A.P. 2003. Vegetable Breeding and Seed Production (1st Ed.). Kalyani Publisher, Ludhiana, New Delhi, India.
- Ram, H.H. 2005. Vegetable Breeding, Principles and Practices. Kalyani Publisher, Ludhiana, New Delhi, India.

Course Code: HOR-406

Course Title: Vegetable and Flower Seed Production

Credit Hours: 3(2-1)

Objectives:

To provide technical knowledge about pure and hybrid seed production of horticultural crops.

Theory:

Introduction and importance, Principles of seed production, Seed classes, Pre-basic, basic, certified and approved seed, Reproductive systems, Modes of pollination and seed production, Pure and hybrid seed production, Methods and procedures for seed production of important vegetables and flowers, Seed handling technology, Seed testing, Packing and storage, Seed certification and registration.

Practical:

Pollination techniques, Maintenance of self and cross-pollinated lines, Methods of seed collection, cleaning, grading, desiccation, treatments and storage, Seed testing and packing techniques.

Recommended Books:

- Khare, D., M.S. Bhale. 2005. Seed Technology. Scientific Publishers, New Delhi, India.
- Singh, P. and B.S. Asati. 2008. Seed Production Technology of Vegetables. Daya Publishing Home, Delhi, India.
- Singh, N., D.K. Singh, Y.K. Singh and V. Kumar. 2006. Vegetable Seed Production Technology. International Book Distributing Company (Publishing Division), Lucknow, India.
- Singh, P.K., S.K. Dasgupta and S.K. Tripathi. 2005. Hybrid Vegetable Development, CRC Press Boca Raton, USA.

Course Code: HOR-407

Course Title: Protected Horticulture

Credit Hours: 3(2-1)

Objectives:

This course will enable students to understand advanced technologies to produce highly qualitative horticulture commodities.

Theory:

Introduction and economic importance, Different structures and their construction, Selection of site and orientation, Environment control and maintenance, Seed and nursery raising, Crops/cultivars suitable for forcing, Production technology of different crops, Soilless culture, Media, Soil mixtures, containers, nutrient management and irrigation systems, Pruning, training and staking, Insects, diseases, Disorders and problem management, Economics of protected and conventional production.

Practical:

Structural demonstration of greenhouses, plastic tunnels and other types, Study of environmental control systems, Preparation of growing media, Tools and types of containers, Raising of crops, Pruning, training and staking techniques, pests and diseases management, Visits to commercial greenhouses and plastic tunnels.

Recommended Books:

- Abbasi NA & Habib U 2008. 'Protected Horticulture', Department of Horticulture, PMAS-Arid Agriculture University Rawalpindi, Pakistan.
- Arunkumar R Vijayalatha KR Kannan K Thirumalmurugan V Latha K & Kumar SN

2008. 'Innovative Horticulture', New India publishing Agency, New Dehli, India.
- Manohar KR &lgathinathane C 2007. 'Greenhouse Technology and Management', (2nd Ed.), BS Publications, Hyderabad, India.
 - Prasad K & Kumar U 2005. 'Greenhouse Management for Horticultural Crops', (2nd Ed.), Agrobios, Jodhpur, India.
 - Sharaf S 2012. 'Green House Management of Horticulture Crops', Oxford book company New Delhi, India.
 - Tiwari GN 2003. 'Greenhouse Technology for Controlled Environment', Alpha Science International Ltd., Pangbourne, UK.

Course Code: HOR-408

Course Title: Indoor Plant Culture and Escaping

Credit Hours: 3(2-1)

Objectives:

This course will guide students to gain understanding about indoor plantations to make pleasant and conducive environment inside the buildings.

Theory:

Introduction and importance of indoor plant culture and escaping, Environmental requirements: light, temperature, humidity and moisture, Air pollutants and other hazards in growing indoor plants. Cultural requirements, Production of flowering and foliage plants for shade and semi-shade area, Growing media; essential nutrients, watering, pests and diseases. Acclimatization and management practices for important indoor plants. Decorative and functional uses of indoor plants, Principles and guidelines for interiors aping. Planters. Terrarium and other escaping types.

Practical:

Identification of indoor plants. Practices in propagation. Watering and nutrient management, preparation of soil mixtures, potting and re-potting. Diagnosis of problems and solutions. Visits of nurseries and garden centers.

Recommended Books:

- Hessayon DG 2007. 'House Plant Expert', Transworld Publishers, London, U.K.
- Zachos E 2005. 'Tempting Tropical: 175. Irresistible Indoor Plants', Timber Press Inc.
- Pleasant B 2005. 'The Complete House Plant Survival Manual: Essential Gardening

Know-How for Keeping (Not Killing) More Than 160 Plants', Storey Publishing, LLC.

Course Code: HOR-409

Course Title: Business Management in Horticulture

Credit Hours: 3(2-1)

Objectives:

This course will encourage students to understand how to promote entrepreneurship and enabling students to gain competencies for business management particularly for horticulture based business.

Theory:

Introduction and importance of horticultural enterprise. Classified business management for fruits, vegetables and ornamental crops. National and international marketing channels, Market demand and quality control Export prospects, Procedure/documentation for import and export. International standards and product handling for export. Processing industry and marketing of value added commodities. Pricing, policy and market regulations, Global trade and Pakistan, W.T.O., Opportunities and challenges.

Recommended Books:

- Meena RK &Yadev J 2001. 'Horticulture Marketing and Post-harvest Management', Pointer Publisher, Jaipur, Rajasthan.
- Labaste P (Ed.) 2005. 'The European Horticulture Market; Opportunities for Sub-Saharan African Exporters', The International Bank for Reconstruction and Development, the World Bank, Washington D. C.

Course Code: HOR-410

Course Title: Internship/Research/Survey Report and Presentation

Credit Hours: 4(0-4)

Objectives:

To strengthen the practical knowledge of students and their involvement in various horticultural projects.

Practical:

Placement of students at various public and private organizations. Study, discussion and their practical involvement in ongoing programs/projects. Performance of practical managerial duties or practical demonstration of important operations in the concerned

places, Submission of report and oral presentation at the end of the semester.