

**CURRICULUM
OF
PLANT PROTECTION
BS/BSc (Hons)/MS/MSc (Hons)
& PhD**

(Revised 2015)



**HIGHER EDUCATION COMMISSION
ISLAMABAD**

CURRICULUM DIVISION, HEC

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PREFACE

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

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

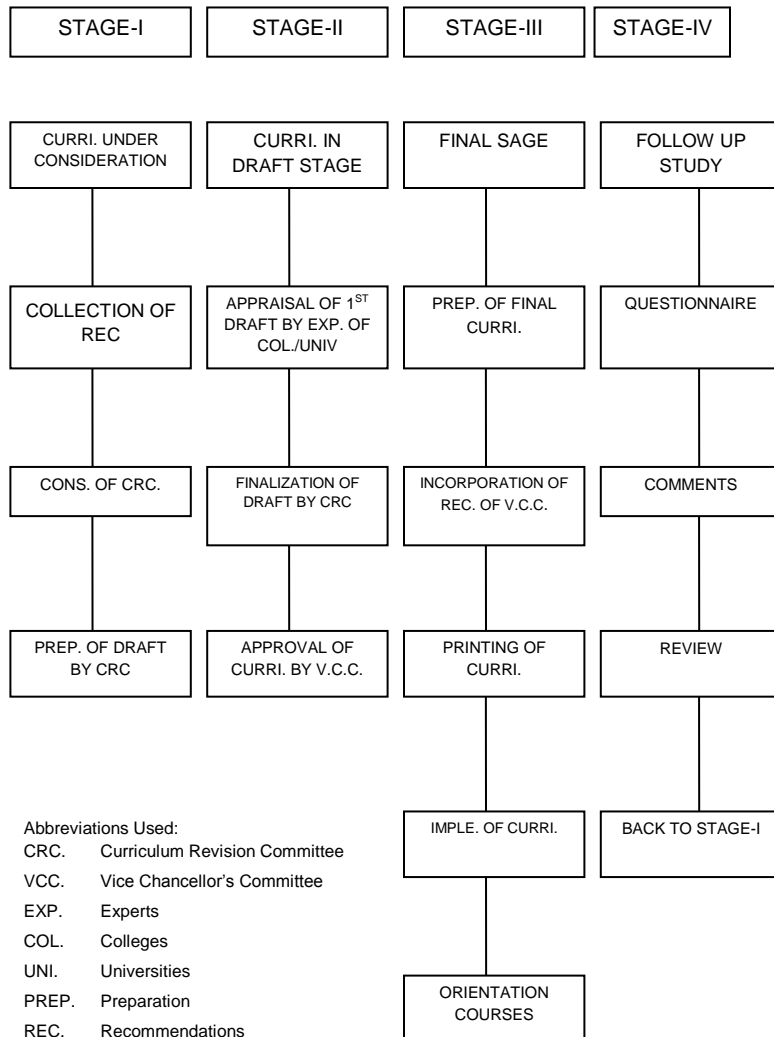
In compliance with the provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities,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

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

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

Fida Hussain
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



INTRODUCTION

The final meeting of the National Curriculum Revision Committee to review/revise the curriculum of BSc (Hons.), MSc (Hons.) and PhD in Plant Protection was held from April 28-30, 2015 at The Agriculture University of Faisalabad. Following experts attended:

Prof. Dr. Ghulam Jilani Dean, Faculty of Agriculture Department of Entomology/Plant Protection Lasbela University of Agriculture, water & Marine Sciences, Uthal Balochistan. drjilani@gmail.com	Member/ Convener
Dr. Ahmad-Ur-Rahman Saljoqi, Professor & Ex-Chairman, Department of Plant Protection, The University of Agriculture, Peshawar. drsaljoqi@yahoo.com drsaljoqi@aup.edu.pk	Member/ Secretary
Dr. Javed Iqbal Director (Technical) Pakistan Agricultural Research Council Plot 20, Sector G-5/1, Islamabad linkjaved@gmail.com	Member
Dr. Javaid Iqbal Head of Department/Assistant professor Department of Entomology University College of Agriculture &Environmental Sciences, The Islamia University of Bahawalpur, Bahawalpur. javaidiqbal@iub.edu.pk	Member
Dr. Inamullah Khan Professor, Department of Plant Protection, The University of Agriculture, Peshawar. dr.inam@aup.edu.pk	Member

Dr. Rashida Atiq Associate Professor, Department of Plant Pathology, Bahauddin Zakariya University, Multan. rashida133@hotmail.com	Member
Dr. Shahbaz Talib Sahi, Professor and Chairman, Department of Plant Pathology, University of Agriculture, Faisalabad. shahbazsahi@uaf.edu.pk	Member
Dr. Muhammad Mushtaq Professor Department of Plant Sciences, Faculty of Life Sciences BUITMS, Quetta. mmushtaq72@gmail.com	Member
Dr. Salik Nawaz Khan Assistant Professor, Institute of Agricultural Sciences, University of the Punjab, Lahore. salik_nawaz@yahoo.com	Member
Dr. M. Fareed Khan Professor/Chairman Department of Plant Breeding & Molecular Genetics, University of Poonch, Rawalakot, AJK muhammadfareed@upr.edu.pk	Member
Dr. Farman Ali Assistant Professor Department of Agriculture, Abdul Wali Khan University, Mardan. drfarman@gmail.com	Member
Prof. Dr. Zafar Iqbal Principal, University College of Agriculture, University of Sargodha, Lahore-Khushab Bypass Road, Sargodha. zaffarrohils@yahoo.com	Member

Dr. M. Ibrahim Khashkeli Assistant Professor, Department of Plant Protection, Faculty of Crop Protection, Sindh Agriculture University, Tandojam. mikhaskheli@gmail.com	Member
Dr. Mubashar Hussain Assistant Professor, Department of Zoology, University of Gujrat, BS Block, Hafiz Hayat Campus, Gujrat. dr.mubashar@uog.edu.pk	Member
Dr. Hadi Bux Assistant Professor, Institute of Plant Sciences. University of Sindh, Jamshoro. hadiqau@gmail.com	Member

Meeting started with recitation from the Holy Quran by Prof. Dr. Ahmad-Ur-Rahman Saljoqi. Ms. Ghayyur Fatima Director (Curri), HEC welcomed the participants and briefed about the obligations of the Commission for review/revision of curriculum. He briefed the participants about on-going activities of HEC for uplift of Higher Education in the Country.

The committee considered the existing curriculum and expatriate Pakistani expert's comments.

The committee agreed to recommend BSc (Hons) Plant Protection courses comprising core and supporting courses as compulsory for all students majoring in Plant Protection and relevant elective courses for their proper training in the subject. More emphasis has been given to the major courses in Plant Protection and Research at post graduate level. Sufficient flexibility has also been incorporated in the curriculum for giving more emphasis to the courses to cater the needs of the area where university/college is located.

The Committee agreed to recommend the Plant Protection courses for BSc (Hons) and MSc (Hons.)/PhD The committee agreed to incorporate Plant Protection subject in the interdisciplinary Foundation Courses like all other major courses.

Template for 4-Year BSc (Hons) in Agricultural Disciplines

1. Compulsory Courses

	Credit Hours
Mathematics / Biology	6 (3-0) (2-1)
Statistics	6 (3-0) (3-0)
Computer/IT	3 (2-1)
Pakistan Studies	2 (2-0)
Islamic Studies	2 (2-0)
Communication Skills	3 (3-0)
English	3 (3-0)
Basic Agriculture	3 (2-1)
Sub-Total: 28	

2. Interdisciplinary Foundation Courses

Agronomy	3 (2-1)
Plant Breeding & Genetics	3 (2-1)
Plant Protection	3 (2-1)
Entomology	3 (2-1)
Plant Pathology	3 (2-1)
Food technology	3 (2-1)
Horticulture	3 (2-1)
Soil Science	3 (2-1)
Agriculture economics	3 (2-1)
Sub-Total: 27	

3. Supporting courses {6-7 courses (3 Cr. hr.) amongst below}

Agriculture Extension	
Forestry & range Management	
Animal Science	
Marketing & Agri business	
Rural Development	
Human Nutrition	
Agriculture Chemistry	
Agriculture Engineering	
Water Management	
Any other discipline recommended by the university	
Sub-Total: 18-21	
Sub-Total during the first four semesters	70-76
Semester 5,6,7 & 8	56-60
Project/Internship	04
Grand Total	130-140

- 1 credit of theory = one contact hour per week for 16-18 weeks and 1 practical/lab hour = 3 contact hours per week for 16-18 weeks.
- In case of non-availability of department of supporting courses, courses from foundation courses can be opted.

**SCHEME OF STUDIES FOR BS/BSc (HONS)
PLANT PROTECTION**

I or II year 1st Semester - 4th Semester

S.No.	Course Name	Credit Hours
1.	Fundamentals of Plant Protection	3 (2-1)

III Year 5th Semester

1.	Principles of Plant Protection	3 (2-1)
2.	Pest Ecology	3 (2-1)
3.	Pesticides and their Application Techniques	3(2-1)
4.	Introductory Acarology	3 (2-1)
5.	Elective	3 (2-1)
Total		15

III Year 6th Semester

6.	Plant Nematology	3 (2-1)
7.	Pests of Field Crops	3 (2-1)
8.	Principles of Plant Disease Management	3 (2-1)
9.	Identification and Biology of Pests	3(2-1)
10.	Elective	3 (2-1)
Total		15

IV Year 7th Semester

11.	Introduction to Weeds and Phanerogamic Parasites	3 (2-1)
12.	Pests of Fruits, Vegetables and Ornamentals	3 (2-1)
13.	Vertebrate Pest Management	3 (2-1)
14.	Post-Harvest Pest Management	3 (2-1)
15.	Elective	3 (2-1)
Total		15

IV Year 8th Semester

16.	Range and Forest Pest Management	3 (2-1)
17.	Biological Control	3 (2-1)
18.	Scientific Writing and Presentation	3(3-0)
19.	Project/Internship	4(0-4)
Total		13

Grand Total 130 – 140

Note: *The University may re-adjust the above semester-wise scheme and can incorporate even some other elective courses apart from the list mentioned below as decided by the Board of Studies.*

List of Undergraduate Elective Courses

1.	Pest Scouting and Forecasting	3 (2-1)
2.	Pollinators and Plant Protection	3 (2-1)
3.	Plant Biosecurity and Biosafety	3 (2-1)
4.	Urban Pest management	3 (2-1)
5.	Molecular Diagnosis in Plant Protection	3 (2-1)

DETAIL OF COURSES FOR BS/BSc (Hons) IN PLANT PROTECTION

A- BASIC COURSES

FUNDAMENTALS OF PLANT PROTECTION

3(2-1)

Objectives:

To acquaint the students with the basics of plant protection.

Theory:

Introduction, importance and scope. The concepts of pest, predator, parasites, parasitoids and pathogens. Introduction to plant pests: insects, vertebrates, pathogens, weeds, parasitic plants, nematodes and mites. Losses and damages caused by pests. Methods of pest control (Cultural, mechanical, physical, biological, legislative, genetical, bio-pesticides, and chemical). Plant protection equipments. Introduction to Integrated Crop Management and Integrated Pest Management (ICM and IPM). Bio-technology in plant protection.

Practical:

Collection, preservation and identification of pests of field crops, fruits, vegetables and their natural enemies. Field/labs demonstration of damages and losses caused by major pests .Use of plant protection equipments.

Recommended Books:

1. Bhutta, A.R. 2010. Text book of introductory seed pathology, HEC., Islamabad.
2. Atwal, A. S and G. S, Dhaliwal. 2005. Agricultural Pests of South Asia and their Management, 5th ed. Kalyani Publishers, Ludhiana
3. Agrios, G. N. 2005. Plant Pathology, 5th ed. Elsevier Academic Press Inc., New York.
4. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3rd ed. B. Z. University Press, Multan.
5. Ahmad, I. and Bhutta, A. R. 2004. Text book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
6. Oudejans, J.H. 1991. Agro-Pesticides: Properties and functions in integrated crop protection. United Nation Pub. Bangkok. Thailand.

B. SPECIALIZATION IN PLANT PROTECTION

The committee has proposed the following “TITLES” with credit hours for specialization in Plant Protection during III year (5th and 6th semesters) and 4th year (7th and 8th semester). These are the “CORE” courses, comprising 56-60 credit hours including elective courses, internship, writing and presentation. To fulfill minimum requirements for the completion of the degree, each university may incorporate more courses according to their needs into their schemes of studies (Curricula).

5th SEMESTER

PRINCIPLES OF PLANT PROTECTION

3(2-1)

Objective:

To acquaint the students with the principles of plant protection.

Theory:

Introduction: Importance and scope. Methods of plant protection (Cultural, Mechanical, Physical, Biological, Ecological, Reproductive, Legislative & Chemical Control). Pesticide equipments. Agro-ecosystem. Integrated pest management (IPM). Principles and components of participatory IPM. Concept of field biodiversity conservation. Crop appraisal (Damage vs loss).

Practical:

Study of nature and extent of major pest damage. Demonstration of various methods of pest management and use of equipments. Demonstration of communication/facilitation skills. Field visits .

Recommended Books:

1. Lugtenberg, B. 2015. Principles of Plant-Microbe Interactions. Springer
2. Gordon, G and McKirdy, S . 2014. The Handbook of Plant Biosecurity. Springer
3. Gabriele, S. 2013. Natural Crop Protection in the Tropics. Margraf Scientific Books
4. Dharam, P. A. 2013. Integrated Pest Management: Current Concepts and Ecological perspectives. Academic Press
5. Feldmann, F. 2011. Crop and Sector-Specific Guidelines on integrated Plant Protection. Messeweg 11-12, 38104 Braunschweig Internet: www.phytomedizin.org

6. David, V and Alford, K.F.A. Walters and N. V. Hardwick. 2008. Pest and Disease Management Handbook. Wileyon Line Library.
7. Atwal, A.S and G.S, Dhaliwal.2005. Agricultural Pests of South Asia and their Management.5th ed. Kalyani Publishers, Ludhiana
8. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3rd ed. B. Z. University Press, Multan.
9. Gadewarr, A.V. 2006. Plant protection in new millennium. Vol. 1. Hardcover Publishers.
10. Pedigo, Larry. P. (2006). "Entomology and Pest Management", Pearson Education.
11. Upadhyay, R. K. 1999. Integrated Pest & Disease Management CAB International, Kew, UK.
12. Hashmi, A.A. 1994. Pest Management (Vol. I,II,III). PARC, Islamabad

PEST ECOLOGY

3(2-1)

Objective:

To acquaint the students with the basics of pest Ecology.

Theory:

Ecology in relation to pests. Biotic and abiotic factors and their effect on pests particularly insects, weeds, vertebrates and pathogens. Habitat, niche, diapause, degree days, food chain, food web and food mesh concepts. Introduction to life-table parameters. Concepts of environmental impact assessment (EIA's). Natural and agro-ecosystems. Host plant-pest interactions. Ecological succession. Population, its characteristics and estimation.

Practical:

Study of the relationship of the abiotic factors with the pests. Population estimation and construction of life-tables. Calculations of degree days.

Recommended Books:

1. Mark A. L., M. Philip, P. V. Sergei. 2013. Dispersal, Individual Movement and Spatial Ecology: A Mathematical Perspective. Springer.
2. Peter W. P., F Robert, M.D. Denno, D. L. Eubanks and I. Kaplan. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press.
3. Bruce Hannon and R. Matthias. 2008. Dispersal, Individual Movement and Spatial Ecology: A Mathematical Perspective. Springer.

4. Baret, G. 2004. Fundamentals of Ecology. Thomsons Learning.
5. Saleem, M. A and M. Ashfaq. 2004. Environmental Pollution and Agriculture. B. Z. University Press, Multan.
6. Henderson, P. 2003. Practical Methods in Ecology. Blackwell Science.
7. Smith, R. and Smith, T. 2002. Ecology and Field Biology: Hands-On Field package (With CD and Additional Printer Guide). 6th ed. Pearson Education.
8. Smith, R. and T. Smith. 2002. Elements of Ecology. 5th ed. Pearson Education.
9. Newman, E. I. 2001, Applied Ecology. Blackwell Science.
10. Schowalter, Y.D.. 2000. Insect Ecology - An Ecosystem Approach. Academic Press.
11. Southwood, T.R.E. and P.A. Henderson. 2000. Ecological Methods. 3rd ed, Blackwell publishers UK.
12. Ricklefs, R.R.E. and G.L. Miller.1999. Ecology. W. H. Freeman & Co.
13. Chapman, J.L. and M. J. Reiss. 1998. Ecology-Principles and Applications. 2nd ed. Cambridge University Press

PESTICIDES AND THEIR APPLICATION TECHNIQUES 3(2-1)

Objectives:

To acquaint the students with the nature and safe use of pesticides.

Theory:

Introduction, history, classification and formulation of pesticides. Pesticide regulation, registration and distribution in Pakistan. FAO code of conduct for pesticide use and handling (Codex Alimentarius) Pesticide hazards, user safety (protective devices, first-aid). Safe use of pesticides with special reference to conserve the bio-control agents. Pesticide storage, indoor, ground, aerial, soil applications and fogging. Pesticide compatibility and selectivity. Pesticide application equipments. Pesticides calculations and calibration methods.

Practical:

Pesticide safe handling, precautions and first aid Demonstration of pesticide equipment and their calibration. Calculation of dosage and application techniques. Types of sprayers, nozzles and their use. Measurement of droplet size. Visit to formulation plant/quality testing lab.

Recommended Books:

1. Matthews, G., Bateman, R., Miller, P. 2014. Pesticide Application Methods, 4th Edition. Wiley-Blackwell.

2. Mac Bean, C. 2013. The Pesticide Manual: A World Compendium-16th edition. BCPC.
3. Matthews, G. 2008. Pesticide Application Methods, 3rd Edition. Wiley-Blackwell.
4. Dodia, D.A. I.S. Patel and G.M. Patel. 2008. Botanical pesticides for pest management. Scientific publishers.
5. Pretty, J. 2005. The Pesticide Detox: Towards A More Sustainable Agriculture. Earthscan. London, UK.
6. Jorgen, S. 2004. Chemical pesticides: Mode of action and toxicology. CRC Press, London.
7. Mallis, A., Hedges, S.A. and Moreland, D. 2004. Pest control technology. 9th ed. The Mallis. Handbook of Pest Control technology.
8. Mathews, G. A. 2004. Pesticide application methods. 4th ed. World Science. Publishing Co.
9. Raj, B.S. Parmar and S.S. Tomar. 2004. Pesticide formulation: theory and practice. CBS publishers.
10. Ware, G. W. and Whitacre, D. M. 2004. The pesticide book. 6th ed. Meister PRO Information Resources
11. Rami, H.A. and Isaac, I. 2004. Insect pest management- field and protected crops. Springer.
12. Saleem, M. A. 2002. Principles of Insect Toxicology, Volume 1, Izhar sons Printers, 9 Rattangan Road, Lahore.

INTRODUCTORY ACAROLOGY

3(2-1)

Objective:

To acquaint the students regarding mites, their mode of damage and control.

Theory:

Introduction; morphology, biology and classification of mites. Mites as pests of field crops, vegetables, fruit trees, ornamentals and stored grain products. Parasitic and predatory mites, losses caused by mites and their management. Estimation of mites' population and their dispersal. Mites in relation to plant diseases.

Practical:

Collection, sampling, preservation, identification, and rearing techniques of phytophagous, predatory, parasitic and stored grain mites. Preparation of temporary and permanent slides. Population estimation, losses in crop plants and stored grain products.

Recommended Books:

1. Hoy M.A. 2011. Agricultural Acarology: Introduction to Integrated Pest Management. CRC Press Har/ Com edition.
2. Castilho, R.C., Moraes, G.J. De & Halliday, R.B. 2012. Catalogue of the mite family Rhodacaridae Oudemans, with notes on the classification of the Rhodacaroidea (Acari: Mesostigmata). Zootaxa 3471, Magnolia Press, Auckland, New Zealand,
3. Gulati, R. and Bhatnagar, P. 2007. Agricultural Acarology. S. Chhilar, Daya Publisher, India.
4. Zhang, Z.Q. 2003. Mites of green houses: Identification Biology and Control. Elsevier, New York.
5. Krantz, G.W. & Walter, D.E. (eds.) 2009. A Manual of Acarology. Third Edition. Texas Tech University Press; Lubbock, Texas, 807 pp.
6. Coons, L. B. & Alberti, G. 1999. Acari - Ticks. In: Harrison, F. W. (ed.) Microscopic Anatomy of Invertebrates. Vol. 8B. New York, Wiley & Sons.
7. Walter, David E. & Proctor, H. 1999. Mites: Ecology, Evolution and Behaviour. Sydney, University of New South Wales Press and Wallingford
9. Khuhro, R.D. 1998. Introduction to Acarology. Kashif Publishers, Hyderabad (Sindh), Pakistan.
9. Xin, J.-L., Lu, J.-Q. & Zhang, Z.-Q. 1998. Predatory Mites: Their Biology and Roles in Biological Control. Systematic and Applied Acarology Society, London.

6th SEMESTER**PLANT NEMATOTOLOGY****3(2-1)****Objective:**

To educate the students about nematodes and their management.

Theory:

Introduction; history and importance of nematodes in agriculture. General classification of nematodes. Morphology, taxonomy and biology of nematodes of agricultural importance. Types of plant parasitic nematodes (parasitism). Symptoms caused by plant parasitic nematodes. An overview of entomopathogenic nematodes. Nematodes as vectors and their interaction with other plant pathogens. Dispersal, survival and diseases of crops caused by plant parasitic nematodes. Nematode management.

Practical:

Sampling and extraction techniques of nematodes from soil and plant materials. Staining and preparation for microscopic studies. Identification and culture of nematodes. Preparation of temporary and permanent slides of nematodes. Demonstration of nematode management.

Recommended Books:

1. Ravichandra, N. G. (2014). Horticultural Nematology, Springer.
2. Perry, R. N. and M. Moens (2013). Plant Nematology: 2nd Edition, CABI Publishing.
3. Zuckerman, B. (2012). Plant Parasitic Nematodes, Elsevier Science.
4. Jones, J., G. Gheysen, et al. (2011). Genomics and Molecular Genetics of Plant- Nematode Interactions, Springer Netherlands.
5. Davies, K. and Y. Spiegel (2011). Biological Control of Plant-Parasitic Nematodes:: Building Coherence between Microbial Ecology and Molecular Mechanisms, Springer.
6. Johnathan, E. I. (2009). Nematology: Fundamentals and Applications, New India Publishing Agency.
7. Grewal, P.S., Ehler, R. and Shapiro-Ilen. 2008. Nematodes as biological control agents.
8. Agrios, G. N. 2005. Plant Pathology. 5th ed. Elsevier Academic Press Inc., New York.
9. Luc, M., R.A. Sikora and J. Bridge. 2005. Plant Parasitic Nematodes in Sub-tropical and tropical Agriculture. 2nd Ed. C.A.B. Intl. Inst. of Parasitology, London.
10. Maqbool, M.A. and F. Shahina. 2001. Systematic and distribution: Biodiversity of nematode Fauna in Pakistan
11. Siddiqi, M. R. 2002. Tylenchida: Parasites of plant and insects
12. Shurtleff, M.C. and Averre III, C.W. 2000. Diagnosing Plant Diseases Caused by Nematodes. APS
13. Alam, M.M and Sharma, N. 2002. Nematode control in crops. International book distributor, India.
14. Perry, R.N and Wright, D.T. 1998. The physiology and biotechnology of free living and plant parasitic nematodes. Willingford, cab, incorporated inc. UK.

PESTS OF FIELD CROPS**3(2-1)****Objective:**

To educate the students about pest of field crops.

Theory:

Introduction, identification, classification, distribution of pests (insect pest, pathogens, weeds and vertebrates) of economic importance and their symptoms. Mode of damage, life history and management techniques of pests of major field crops according to specific location/region (Cereals, legumes, fiber, oil seed, tobacco and sugarcane crop).

Practical:

Field visits, collection and identification of pests of major crops. Symptoms, mode of damage, loss assessment and management.

Recommended Books:

1. Bhargava M.C. and K.C. Kumawat. 2010. Pests of Stored Grains and Their Management New India Publisher.
2. Atwal, A.S and G.S,Dhaliwal.2005. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana
3. Hill. 2005. Pests Of Stored Products And Their Control (Pb)
4. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3rd ed. B. Z. University Press, Multan.
5. Amerika Singh, (2005). "Integrated Pest Management", CBS Pub.
6. Horowitz 2004. Insect Pest Management: Field And Protected Crops (Hb)
7. Norris, R F. (2002). "Concepts in Integrated Pest Management", Prentice Hall of India.
8. Hashmi, A.A. 1994. Insect Pest Management (Vol-I &III). PARC, Islamabad.
9. Hill, D.S. 1993. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press.

PRINCIPLES OF PLANT DISEASE MANAGEMENT**3(2-1)****Objective:**

To acquaint the students with plant diseases and their management.

Theory:

Introduction to integrated management of plant diseases. Symptoms and disease-index of important diseases of field crops, fruits and vegetables. Principles and methods of plant disease management. Role of environmental factors and nutrition in relation to plant disease development. Host plant resistance in disease management. Epidemiological basis of disease management strategies, such as plant disease forecasting, regulatory procedures, pathogen exclusion and

eradication. Seed health certification and good agricultural practices (GAP).

Practical:

Collection, identification and diagnosis of different plant diseases. Sampling techniques and assessment of disease index. Demonstration of different disease control methods including seed treatment.

Recommended Books:

1. Bhutta, A.R. 2010. Text book of introductory Seed Pathology. HEC Press.
2. Rajpal Sindh. 2008. Crop protection by Botanical pesticide CBS publishers and distributors.
3. Burns, R. 2007. Plant Pathology. Humana Press. USA.
4. Ciancio, A. 2007. Concepts In Integrated Pest And Disease Management. Springer publisher.
5. Agrios, G. N. 2005. Plant Pathology. 5th ed. Elsevier Academic Press Inc., New York.
6. Ahmad, I. and Bhutta, A. R. 2005. Text Book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
7. Strange, R. N. 2003. Introduction to Plant Pathology. New York, John Willey.
8. Mehrotra, R. S. 2003. Plant Pathology. TATA McGraw Hill. Pub. Company Ltd. New Delhi, India.
9. Trigiano, R.N., Windham, M.T. and A.S Windham. 2003. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, USA.
10. Kranz, J. 2002. Comparative Epidemiology of Plant Diseases. Springer Publisher.

IDENTIFICATION AND BIOLOGY OF PESTS

3(2-1)

Objective:

To educate the students regarding principles of insect classification.

Theory:

Introduction: Ontogeny and phylogeny, types of classification. Classification of insect orders up to family level with particular reference to insects of Pakistan.

Practical:

Study of representative types regarding phylogenetic arrangement of insect orders. Collection and identification of insects up to family level with the help of taxonomic keys.

Recommended Books:

1. Herbert, D. A. 2014. Pest Management Guide. Field Crops Virginia Cooperative Extension, USA.
2. Gullan P. J. and P. S. Cranston. 2010. The Insects. An Outline of Entomology. John Wiley & Sons Ltd. UK/USA
3. Srivastava, K. P and D. K. Buttan. 2009. Pest management in vegetables. Vol-1 and II.2nd ed. India.
4. Baily, P. T. 2007. Pests of field crops and pastures: identification and control. CSIRO Publishing Australia. 520p.
5. Atwal, A.S and G.S, Dhaliwal.2005. Agricultural Pests of South Asia and their Management.5th ed. Kalyani Publishers, Ludhiana
6. Gupta, H.C.L. 2005. "Management of Insect Pests of Horticultural Crops", Agrotech.
7. Buczacki, Stefan, Collins.2005. Pests, Diseases& disorders of Garden Plants
8. Gillott, C. Entomology. 2005. Edition 3. Springer Netherlands.
9. Zhang, Z.Q. 2003. Mites of greenhouses: identification, biology and control. CABI Publishing, UK, 244 pp
10. John, C. 2001. Handbook of Vegetable Pests. Academic Press.
11. Daly, H.V. Doyen J.T. Purcell A.H. and Daly, B.B. 1998. Introduction to Insect Biology and Diversity. Oxford University Press.
12. Hashmi, A.A. 1994. Insect Pest Management. Pests of Fruits. (Vol-II). PARC, Islamabad.

7th SEMESTER**INTRODUCTION TO WEEDS AND PHANEROGAMIC PARASITES****3(2-1)****Objective:**

To enable the students to know the basics of weeds, Phanerogamic parasites and their management.

Theory:

Introduction to weeds, invasive weeds, Phanerogamic parasites and their economic importance. Sampling, identification, classification, biology, ecology and dissemination. Competition of weeds and phanerogamic parasites with crops and losses .Weed-insect and weed-pathogen interactions. Principles and methods of weed and Phanerogamic parasites management. Selectivity and safe use of herbicides.

Practical:

Collection, preservation and identification of weeds and phanerogamic parasites. Sampling techniques, methods and determination of population density of weeds. Herbicide application, equipments and calibration.

Recommended Books:

1. Robert L Zimdahl. 2013. Fundamentals of Weed Science, Fourth Edition. Elsevier.
2. Lewis H. Ziska, Jeffrey Dukes. 2010. Weed Biology and Climate Change. Wiley-Blackwell
3. Inderjit (2009) Management of Invasive Weeds (Invading Nature - Springer Series in Invasion Ecology) Springer
4. Robert L. Zimdahl. 2008. Weed-crop Competition: A Review. John Wiley & Sons, Inc.
5. Das. T.K., 2008. Weed Science Basics and Applications. Jain brothers, New Delhi.
6. Gupta,O.P. 2007. Fundamentals of weed science: A text book of weeds. agrobios
7. Walia. U.S. 2006. Weed Management, Kalayani Publishers, Ludhiana.
8. B D Booth, S D Murphy, C J Swanton (2003) Weed Ecology in Natural and Agricultural Systems. Cabi.
9. Robert E. L. Naylor .2002. Weed Management Handbook, 9th Edition. Wiley-Blackwell.
10. Monaco, T J; Weller, S.C. and Ashton, F.M. 2002. Weed Science Principles and Practices, 4th ed. John Wiley & Sons.
11. Gressel, J.B. . 2002. Molecular Biology of Weed Control. CRC Press.
12. Gupta, O. P. 2000. Modern Weed Management. Agro Botanica Bikaner, India.
13. Zimdahl, R.L. 1999. Fundamentals of Weed Science, Second Edition. Academic Press, San Diego, CA.

PESTS OF FRUITS, VEGETABLES AND ORNAMENTALS 3(2-1)**Objective:**

To acquaint the students with the pests of fruits, vegetables and ornamentals.

Theory:

Identification, distribution, host plants, economic importance of insect pests of fruits, vegetables and ornamentals. Extent and nature of damage, life history and integrated management of fruits, vegetables and ornamental pests. Evaluation of pest management options for having best IPM protocols.

Practical:

Field visit, collection, identification and nature of damage by pests of various fruits, vegetables and ornamentals. Collection and identification of parasitoids and predators of fruits, vegetables and ornamental pests.

Recommended Books:

1. Srivastava, K. P and D. K. Buttan. 2009. Pest management in vegetables. Vol-1 and II.2nd ed. India.
2. Atwal, A.S and G.S, Dhaliwal.2005. Agricultural Pests of South Asia and their Management.5th ed. Kalyani Publishers, Ludhiana.
3. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3rd ed. B. Z. University Press, Multan.
4. Gupta, H.C.L. 2005. "Management of Insect Pests of Horticultural Crops", Agrotech.
5. Buczacki, Stefan, Collins.2005. Pests, Diseases& disorders of Garden Plants
6. Arya, Arun, (2004). "Tropical Fruits: Disease and Pest", Kalyani Publishers.
7. John, C. 2001. Handbook of Vegetable Pests. Academic Press.
8. Olsen L-H., Sunesen J. and Pedersen B. V. 2001. Small woodland creatures. OUP, Oxford.
9. Hashmi, A.A. 1994. Insect Pest Management. Pests of Fruits. (Vol-II). PARC, Islamabad.

VERTEBRATE PESTS AND THEIR MANAGEMENT**3(2-1)****Objective:**

To educate students on vertebrate pests and their management.

Theory:

Introduction to vertebrate pests and their impact on agricultural economy. Principles of Vertebrate Pest Management. Major vertebrate pest species of Pakistan (commercial and field rodents, porcupine, wild boar and birds): their ecology, distribution, biology and behaviour. Damage pattern and damage assessment methods (pre-harvest and post-harvest). Economical impact of vertebrate pests (damage & diseases etc.). Causes and prevention of damage by vertebrate pest species to:

food and fiber plants and structures. Management of vertebrate pests; ecologically based management, physical, mechanical, cultural, biological and chemical control methods. Rodenticides/pesticides for control of vertebrate pests: their classification, modes of actions and related issues. Rodenticide bait formulations and methods of their application for control of various vertebrate pest species.

Practical:

Identification of important vertebrate pests. Population and damage assessment methods. Baits formulations, their application and field evaluation in control programmes. Use of fumigants.

Recommended Books:

1. Bhargava, M.C and K.C.Kumawat.2010.Pest of stored grain and their management. New India publishers.
2. Gerozisis,J, Hadlington, Phillip and J.staunton.2008.Urbon pest management in Australia.5th ed. University of new south wales press.
3. Sridhava,S. 2006. Vertebrate pests in agriculture. The Indian scenario scientific Pub, India.
4. Gosh,S.K and S.L.Durbey. 2003 Integrated management of stored grain pest. IBDCO.
5. Aplin, K.P., P.R. Brown, J. Jacob, C.J. Krebs and G.R. Singleton. 2003. Field methods for rodent studies in Asia and the Indo-Pacific. Australian Centre for International Agricultural Research, Canberra. 223 p.
6. Grant R. Singleton, Lyn A. Hinds, Charles J. Kreb and Dave M. Spratt. 2003. Rats Mice and People: Rodent biology and management. ACIAR Canberra, Australia.
7. Singleton, G.R., L. A. Hinds, C.J. Krebs and D.M. Spratt. 2002. Rats, Mice and People: Rodent Biology and Management. Australian Centre for International Agricultural Research, Canberra. 564 p.
8. Singleton, G.R., L. A. Hinds, H. Leirs and Z. Zhang. (eds.). 1999. Ecologically-based Rodent Management. Australian Centre for International Agricultural Research, Canberra. 494 p.
9. Ishwar Prakash.1988. Rodent Pest Management Boca Raton Florida CRC Press USA.
10. Buckle, A.P. and R.H. Smith. 1994. Rodent Pests and their Control. CAB International. Wallingford, Oxon OX10 8DE, UK, 405 p.
11. Jim Hone, 1994. Analysis of Vertebrate Pest Control, Publisher: Cambridge University Press.

12. Ahmad, E., J.E. Brooks, S. Muir and I. Hussain. 1990. Vertebrate Pest Management in Grain Storage. A GOP/USAID/DWRC Vertebrate Pest Control Project, NARC, Islamabad. 39 p.
13. Brooks, J.E., E. Ahmad, I. Hussain, S. Munir and A.A. Khan. (eds.). 1990. Training Manual: Vertebrate Pest Management. A GOP/USAID/DWRC Vertebrate Pest Control Project, NARC, Islamabad. 206 p.

POST-HARVEST PEST MANAGEMENT

3(2-1)

Objective:

To acquaint students with the management of pests and post-harvest losses.

Theory:

Types of post-harvest losses. Economic importance of post-harvest losses in vegetables, seeds, fruits, and grains. Factors affecting post-harvest losses (physical, physiological, biochemical and pathological considerations). Compositional and physical changes occurring during maturation and senescence. Biology and Ecology of storage pests and management. Methods of loss assessment; sampling techniques and quality analysis procedures. Storage structure and methods of storage at farm and public levels. Inspection and suitability of building and commodity. Grain storage management and fumigation technology.

Practical:

Post-harvest loss assessment. Godowns visits. Collection and identification of stored product pests and their natural enemies, assessment of rodent infestation in godowns. Demonstration of spray, fumigation, baits and traps techniques.

Recommended Books:

1. Chavan, U.D. 2012. Post harvest management and processing technology. Cereals, pulses, oil seed, fruit and vegetables. Daya publishing house.
2. Rajarathram, S. 2011. Advances in preservation and processing technologies of fruits and vegetables. (nipa)
3. Bhutta, A.R. 2010. Textbook of introductory Seed Pathology. HEC Press.
4. Sharma, Satish. 2010. Post harvest management and processing of fruits and vegetable: New Indian publishing Agency (nipa).
5. O' Dean L. Kurtz, Kenton L. Harris 2009 Micro-analytical entomology for Food Sanitation Control. Publisher Association of Official Agricultural Chemists.

6. Rajpal Sindh. 2008. Crop protection by Botanical pesticide CBS publishers and distributors.
7. P.Narayana Sany. 2006. Post harvest pathologies and diseases management. Wiley publication.
8. Jongen, W. 2005. Fruit and vegetable processing, improving quality 388 pages. Wood head publishing Ltd.
9. Bhutta, A. R., Hussain, A and Rehman, M. R, 2004. Handbook on Seed Processing and Storage, Publ. by Federal Seed Certification & Registration Department, GOP, Islamabad
10. avid Rees. 2004. Insects of Stored Products. Manson Publishing
11. Chakraverty, A. Muyumdar, A. S. Raghavan, GSV and Ramaswamy, H. S. 2003.
12. Handbook of Post Harvest Technology, Published by Marcel Dekhar Inc. New York, USA. P. 864
13. Dennis S. Hill. 2002. Pests of Stored Foodstuffs and their Control. Kluwer Academic Publishers
14. J A Bartz and J K Brecht . 2002. Postharvest Physiology and Pathology of Vegetables. Marcel Dekker, USA.
15. Bhutta, A. R. and Ahmad, I. 2000, Seed Pathological Techniques and their Application. Publ. National Book Foundation, Islamabad, Pakistan.
16. David.K.Muller. 1998. Stored product protection. A period of transition. Catalog #3770: Stored-Product-Pro.
17. Brodles.J.E.,E. Ahmad, I.Hussain, S.Munier and A.A.Khan. 1990. Vertebrate pest management (training manual) NARC, PARC

8th SEMESTER

RANGE AND FOREST PEST MANAGEMENT

3(2-1)

Objective:

To educate the students regarding range and forest pest management.

Theory:

Introduction. Pests of range and forest plantation. Identification, distribution, economic importance, life history of range and forest pests. Extent and nature of damage. Pest management in range, forest trees and nurseries.

Practical:

Collection and identification of forest pests; insects, mammals, diseased specimens and parasitic plants in range and forest. Demonstration of management techniques of range and forest pests.

Recommended Books:

1. Herbert, D. A. 2014. Pest Management Guide. Horticultural & Forest Crops. Virginia Cooperative Extension, USA.
2. Sathe, T.V. 2009. A text book of Forest Entomology. Daya Pub. New Delhi, India.
3. Jha, L. K and P. K. Sen- Sarma. 2008. Forest Entomology. APH Pub. Co. New Delhi, India.
4. Thakur, M. L. 2000. Forest Entomology: Ecology and Management. Sari Pub. Dehra Dun, New Delhi, India.
5. Tooke J E 2009 Textbook Of Forest Entomology.
6. Niar.S. 2007. Tropical Forest Insect Pest. Ecology, Impact and Management.
7. Winenouse.D. 2005. Ecological Methods in Forest Pest Management.
8. Barbosa. P, Wagner. M.R. Introduction to Forest and Shade Tree Insects.
9. Forest and Insect. Allan D. Watt, N.E. Sterk, Mark D. Hunter. (1997).
10. Ecology and Management of Forest Insects. Martin R. Speight, David Wain house. (1991).
11. Principles of Forest Pathology Tainter, F. H. (Frank H.) John Wiley 1996

BIOLOGICAL CONTROL**3(2-1)****Objective:**

To educate the students on principles and practices of biological control of insect pests

Theory:

Introduction, concept, history and scope of biological control. Ecological basis of biological control. Biological control agents: predators, parasites, parasitoids, and antagonists. Characteristics of bio-control agents. Procedure of biological control (introduction, colonization, conservation, screening, mass culture, augmentation, release and monitoring). Biological control of weeds. Role of biological control in IPM.

Practical:

Collection, preservation and identification of predators, parasitoids, and antagonists. Laboratory culture of important natural enemies. Extent of parasitism and predation of different bio-control agents. Visit to public/private bio-control labs.

Recommended Books:

1. Khan, A.G. 2014. Rearing Techniques for important predators and some parasitoids of insect pests of crops, vegetables and fruit trees of Pakistan. ISBN: 978-969-23025-0-0.
2. Khan, A.G. 2013. Rearing Techniques for important parasitoids of major insects of crops, vegetables and fruit trees in Pakistan. ISBN: 978-969-0-02494-7
3. Kalia, A. and Mudhar, R.K. 2011. Bioaugmentation, Biostimulation and Biocontrol. Springer Berlin Heidelberg Press.
4. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. Higher Education Commission, Islamabad, Pakistan.
5. Jervis, M.A. 2005. Insects as Natural Enemies: A Practical Perspective - Second edition. Springer Press.
6. Copping, L.G. 2004. The Manual of Biocontrol Agents. BCPC
7. Hajek, A. 2003. Natural Enemies - An Introduction to Biological Control. Cambridge University Press. 388 pp.
8. Helyer, 2003. A Color Handbook Of Biological Control In Plant Protection Neil Timber Press.
9. Samuel S.G 2002 Biological control of crop diseases (Pak book Corporation)
10. Flint, M.L. and S.H. Dreistadt. 1998. *Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control*. Oakland: Univ. Calif. Div. Agric. Nat. Res. Publ. 3386.
11. Van Driesche, R. G. and Bellows, T. S. 1996. Biological Control. An international publishing company, New York.

SCIENTIFIC WRITING AND PRESENTATION**3(3-0)****Objective:**

To familiarize the students with research methods, handling of experimental data and writing research papers & reports.

Theory:

Literature search and citation. Use of internet sources and databases for plant protection information. Layout of experiments. Collection, tabulation, analysis and interpretation of research data. Writing synopsis, research paper, research project and monograph. Preparation of multimedia presentations. Reference manager (endnote).

Books Recommended:

1. Jan. M. T., Shah, P., Hollington, P and Jamal, M. 2009. Agricultural Research; Design and Analysis. Department of Agronomy, Agricultural University Peshawar Pak.

2. Artha D. 2005. Scientific papers and presentations. Academic press.
3. Quinn, G.P. and J.K. Michael. 2002. Experimental Design and Data Analysis for Biology. Cambridge University Press.
4. Ghani, M.A. and M. Ashfaq (Edit). 1987, A resume of Post-Graduate Research, 1929-1985. Department of Entomology, University of Agriculture, Faisalabad
5. Gilbert, I. and C.J. Himalton, 1983, Entomology: A Guide of information sources, Mausell Publishing Co. Ltd
6. Baily, P. T. 2007. Pests of field crops and pastures: identification and control. CSIRO Publishing Australia. 520p.

PROJECT/INTERNSHIP

4(0-4)

Assessment by the Host organization (public / private)

UNDERGRADUATE ELECTIVE COURSES

PEST SCOUTING AND FORECASTING

3(2-1)

Objective:

To provide the concept of pest sampling, fluctuation; its measurement, and principles.

Theory:

Introduction; population sampling; population fluctuation and its measurement; population models, different methods of pest scouting and forecasting; losses caused by pests to different crops; economics and decision making for pest management concept of integrated pest management (IPM).

Practical:

Demonstration of different methods of pest scouting and forecasting; nature and extent of damage; assessment of crop losses by different methods; determination of economic threshold levels of different crop pests; identification of important bio-control agents; installation of light and pheromone traps; computation, preparation and field application of pesticide formulations; familiarity with irradiation techniques. Designing of IPM modules of important selected crops.

Recommended Books:

1. Atwal, A.S. and S.S. Bains. 2005. Agricultural pests of Southeast Asia and their management. Kalyani Publishers, Ludhiana, India.

2. Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
3. Binns, M.R. 2000. Sampling and Monitoring in Crop Protection. CABI Publishing Co.
4. Dhaliwal, G.S. and Arora, R. 2006. Integrated Pest Management. Kalyani Pub. Ludhiana.
5. Flint, M. L., 2012. IPM in Practice: Principles and Methods of Integrated Pest Management. Univ of California Agriculture & Natural Resources; 2nd edition. Pages 292.
6. Goodenough, J. L. and Mckineon, J.M. 1992. Basics of Insect Modelling. Amer. Soc. Agri. Engineers, USA.
7. House, P., I. Stevens and O. Jones. 1998. Insect pheromones and their use in pest management. Chapman and Hall, London, UK.
8. 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.
9. Peterson, R.K.D. and L.G. Sigley. 2001. Biotic stress and yield Loss.
10. Pimental, D. 2002. Encyclopedia of pest management. Maral Dekker Inc. USA.
11. Hashmi, A. A., 1994. Insect Pest Management, Cereal and Cash Crops Vols. I, II and III. Pakistan Agricultural Research Council, Islamabad.

POLLINATORS AND PLANT PROTECTION

3(2-1)

Objectives:

To educate basic concepts and benefits of pollination

Theory:

Structure of plant flower, Sexual reproduction, Role of insects or other external agents in sexual reproduction, Self and cross-pollination. Taxonomic procedures, diversity & density of insect pollinators, importance & scope of apiculture.

Habitat and niche; intra and interspecific interactions; natural and agro-ecosystems; Nesting sites, Introduction, history and concepts of IPM. Agro-ecosystem analysis, Scope of biological control with special reference to Pakistan; Toxicity and insecticides formulations suitable for pollinators. Habitat degradation, effect of pesticides, mixed cropping, weeding, role of natural flora, rearing of pollinators. Study of both wild and managed pollinators disappearing at alarming rates owing to habitat loss, pesticide poisoning, diseases and pests.

Practical:

Structure of flower and fruit, reproductive organs, process of fertilization. Methods of collection, preservation and labeling of insects; Practical demonstration of wild and domesticated bee colonies, observation of colonies; Effect of pesticides on pollinators, rearing of pollinators (bees and syrphids). Investigate pollination decline. Investigate economic impact.

Recommended Books:

1. Irshad, M. and Stephen, E. 2010. Facilitation manual Conservation and management of Pollinators for sustainable agriculture through ecosystem approach in Pakistan PARC, Islamabad FAO. 43 pp.
2. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. HEC Islamabad.
3. Michener C.D. 2007. The bees of the world. Second edition John Hopkins University Press Baltimore pp. 953.
4. Free, J. B. 1993. Insect pollinators of crops 2nd edition Academic Press, London, UK
5. Ahmad, R. 1979. A guide to bee keeping in Pakistan. Extension.
6. McGregor, S.E. 1976. Insect pollination of cultivated crop plants. (Online available)

PLANT BIOSECURITY AND BIOSAFETY**3(2-1)****Objective**

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

History of biosecurity, concept of biosecurity, components of biosecurity, biosafety risks of GMOs and invasive species, Biosafety rules and levels, biowarfare, emergence/resurgence of pests and diseases. Pest information system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity. Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications.

Practical:

Risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management.

Recommended Books:

1. Chand. 2015. Climate Change, Soil and Agricultural Technologies For Sustainable Development, Food And Social Security.
2. Seed Act (amended) 2014, Govt. of Pakistan.
3. Dharam, P. Abrol. 2013. Integrated Pest Management: Current Concepts and Ecological Perspective. ISBN-13: 978-0123985293 ISBN-10: 0123985293
4. Bandani, A. R. 2012. New Perspectives in Plant Protection. InTech, Chapters published April 11, under CC BY 3.0 license (ISBN 978-953-51-0490-2). Pages: 258.
5. Bhutta, A.R.2010. Text book of introductory Seed Pathology. HEC Press.
6. Leo M.L. Nollet, Hamir S. Rathore. 2009. Handbook of Pesticides: Methods of Pesticide Residues Analysis. CRC Press (ISBN 9781420082456). Pages 628.
7. Saha, L.R. and Dhaliwal G.S. 2009. Handbook of Plant Protection. Kalyani Publishers (ISBN-10: 8127231983; ISBN-13: 9788127231989). Pages: [x] + 550
8. FAO Biosecurity Toolkit 2008.
www.fao.org/docrep/010/a1140e/a1140e00.htm
9. Ranjann, S. 2007. Sanitary and Phytosanitary Measures-An introduction, Lefai University Press, India.
10. Fleming, Diane O. and Hunt, Debra L. 2006. Biological Safety - Principles and Practices (4th Edition). American Society for Microbiology (ASM) (Print ISBN: 978-1-55581-339-0; E-ISBN 978-1-61344-247-0).
11. Fleming, Diane O. and Hunt, Debra L. 2006. Biological Safety - Principles and Practices (4th Edition). American Society for Microbiology (ASM) (Print ISBN: 978-1-55581-339-0; E-ISBN 978-1-61344-247-0).
12. FAO. 2000. Multi lateral Trade Negotiation on Agriculture. A Resource Manual-III-SPS & TBT Agreement. Publ. FAO-UN, Rome, Italy.
13. Plant Quarantine Act 1976, Govt. of Pakistan.

MOLECULAR DIAGNOSIS IN PLANT PROTECTION**3(2-1)****Objective:**

To educate and train the students on the basic concepts, techniques and new advancement in Plant Protection.

Theory:

Introduction to the molecular and immunological tools used in plant pest diagnosis and identification. Brief introduction to molecular techniques such as PCR, ELISA, RIA, hybridization techniques for the identification of pests. Application of molecular techniques in plant quarantine.

Practical:

Nucleic acid (DNA/ RNA) extraction, PCR and hybridisation techniques, serological techniques such as ELISA and RIA.

Recommended Books:

1. Chaitanya, KV. 2013. Cell and Molecular Biology: A Lab Manual Paperback. Prentice-Hall of India Pvt. Ltd (ISBN-10: 8120348001; ISBN-13: 978-8120348004). Pages 156
2. Peter Paoella, 2010. Introduction to Molecular Biology. Tata McGraw-Hill Education Pvt. Ltd. (ISBN 10: 0071070575 / ISBN 13: 9780071070577)
3. Ramawat K G & Shaily Goyal. 2010. Molecular Biology and Biotechnology. S. Chand Publishing (ISBN : 9788121935128). Pages: 434
4. Narayanasamy, P. 2008. Molecular Biology in Plant Pathogenesis and Disease Management: Disease Management. Volume 1, 2 and 3. Springer.
5. Lakshman, D. 2007. Molecular Plant Pathology. Paragon, International Publishers.
6. Rastogi, S.C. 2006. Cell and Molecular Biology. New Age Publications (Academic).
7. Pena, L. 2005. Transgenic Plants. Methods and Protocol. Humana, USA.
8. Devi, P. 2005. Principles and Methods of Plant Molecular Biology, Biochemistry, Biotechnology and Genetics. Student Edition, India.
9. Hafeez, F., Y. Zafar and A. M. Khalid. 2005. Modern Techniques in Biotechnology. A Theoretical Manual. NIBGE, Faisalabad.
10. Naqvi, S.A.M.H. 2004. Diseases of Fruits and Vegetables: Diagnosis and Management vol. 2. Springer.
11. Mathew, J.D. 2003. Molecular Plant Pathology. Bios Scientific Publishers, Ltd., UK.
12. Riley, M. B., Williamson, M. R., and Maloy, O. 2002. Plant disease diagnosis. Online. The Plant Health Instructor. The American Phytopathological Society. DOI:10.1094/PHI-I-2002-1021-01. (Source: <http://www.apsnet.org/edcenter/intropp/topics/Pages/PlantDiseaseDiagnosis.aspx>).
13. Narayanasamy, P. 2001. Plant Pathogen-Detection & Disease Diagnosis. 2nd ed. CRC Press.

URBAN PEST MANAGEMENT

3(2-1)

Objective:

To educate the students on urban pest management.

Theory:

Identification, life history, habits and habitats of pests: microorganisms, obnoxious insects, mites, birds, rats, nematodes and other pests of human habitations attacking house hold commodities (food, wood, fabrics etc.) and public health. Physical control methods: sanitation, traps, sound, radiation, baits, attractants and repellents. Principles of fumigation: evaporation, diffusion and penetration. Dosimetry and toxicity of fumigants to pests. Fumigation of mills, ships, barges, cargo, bagged goods etc. Fumigant application techniques.

Practical:

Survey, collection, identification and preservation of important pests. Demonstration of fumigation techniques, dosimetry and control methodologies.

Recommended Books:

1. Chartered Institute of Environmental Health. 2008. Urban pests and their public health significance – A CIEH summary. available online at: www.urbanpestsbook.com/downloads/WHO-Summary.pdf
2. Chartered Institute of Environmental Health. 2008. Urban pests and their public health significance – A CIEH summary. available online at: www.urbanpestsbook.com/downloads/WHO-Summary.pdf
3. Atwal, A.S and Dhaliwal, G.S. 2005. Agricultural Pests of Asia and their Management. 5th ed. Kalyani Publishers, India.
4. Ogg, B., Ferraro, D. and C. Ogg. 2005. Cockroach manual. <http://pested.unl.edu.ckcom.htm>
5. Termite Handbook. 2005. <http://pested.unl.edu/termite>
6. Ebeling, W, 2002. Urban Entomology. www.entomology.ucr.edu
7. Gerozisis, J. and Hadlington, P. 2001. Urban Pest Management in Australia 4th ed. UNSW Press, Australia.

**PART-II
POSTGRADUATE COURSES
PLANT PROTECTION**

A. MSc (Hons.)

Contents	Credit hours
1. Course work	24
a. Major/Core	12
b. Minor	6
c. *Compulsory	6
2. Thesis	6-10
Grand total	30-34

* Biochemistry and Statistics

The committee drafted the following postgraduate courses for the scheme of studies of Plant Protection.

1.	Insect Pathology	3(2-1)
2.	*Advanced Biological Control	3(2-1)
3.	Biotechnology in Plant Protection	3(2-1)
4.	Host Plant Resistance	3(2-1)
5.	Vectors of Plant Diseases	3(2-1)
6.	*Advanced Integrated Pest Management	3(2-1)
7.	Pesticide Toxicology	3(2-1)
8.	Pesticide Residue Analysis	3(2-1)
9.	Research Methods in Plant Protection	3(2-1)
10.	Microbial Control of pests.	3(2-1)
11.	Plant Protection and Environment	3(2-1)
12.	*Advanced Ecology	3(2-1)
13.	Pesticide Resistance Management	3(2-1)
14.	SPS Measure and Quarantine	3(2-1)
15.	Community Integrated Pest Management	3(2-1)
16.	Pest Management Informatics	3(2-1)
17.	International Agreements and Plant Protection	3(2-1)
18.	*Advanced biochemical methods	3(2-1)
19.	*Advanced Acarology	3(2-1)
20.	*Advanced host plant resistance	3(2-1)
21.	Entomopathogenic Nematology	3(2-1)
22.	*Advanced Nematological Techniques	3(2-1)

23	Advances in Plant Protection	3(2-1)
24	Special Problem	1(0-1)
25	Seminar	1(0-1)

Courses taken in MSc (Hons.) will not be taken again in PhD degree program as per HEC rule.

* The courses are designed only for PhD degree program.

MAJOR/CORE COURSES

The following shall be the core courses in Plant protection at M.Sc. (Hons.) level.

- | | | |
|----|--------------------------------------|--------|
| 1. | Research Methods in Plant Protection | 3(2-1) |
| 2. | Community Integrated Pest Management | 3(2-1) |
| 3. | Plant Protection and Environment | 3(2-1) |
| 4. | Host Plant Resistance | 3(2-1) |

PhD

The committee recommended that course work should be compulsory pre-requisite for the PhD degree. It was further decided that for a PhD degree, a student shall have to complete minimum of 18 credit hours, out of which 2/3 credit hours shall be from major courses and 1/3 from minor courses and a comprehensive examination (written and oral) shall follow.

CORE COURSES

- | | | |
|----|-------------------------------------|---------|
| 1. | Advanced Integrated Pest Management | 3 (2-1) |
| 2. | Advanced Biological Control | 3 (2-1) |

INSECT PATHOLOGY

3(2-1)

Objective:

To educate the students on the injuries and methods of infection by pathogens in insects.

Theory:

Introduction, history and scope. Types of insect pathogens (bacteria, fungi, viruses, nematodes etc). Characteristics of insect pathogens. Identification of entomopathogens with conventional and molecular methods. Resistance and immunity in insects. Transmission of insect pathogens. Host range, persistence and virulence of insect pathogens. Types of injuries and methods of infection by pathogens in insects. Pathogenic diseases and their diagnosis in insects, extra-cellular and

intra-cellular microbiota of healthy insects. Co-evolution of host and pathogen. Management of microbial diseases of useful insects. Role of entomopathogens in IPM.

Practical:

Isolation, purification, culture and identification of insect pathogens from the diseased insects. Diagnosis of different pathogenic diseases in insects. Bioassays of entomopathogens. Bioassays of entomopathogens. Determination of extent of parasitism by pathogens in insects.

Recommended Books:

1. Vega, F. E. and H. K. Kaya. 2012. Insect pathology, Academic Press.
2. Poinar, G. (2012). Diagnostic Manual for the Identification of Insect Pathogens, Springer US.
3. Beckage, N. E., S. A. Thompson, et al. (2012). Parasites and Pathogens of Insects: Parasites, Elsevier Science.
4. Steinhaus, E. A. (2012). Principles of Insect Pathology, Literary Licensing, LLC.
5. Asgari, S. and K. N. Johnson (2010). Insect Virology, Caister Academic
6. Ehlers, R. U. (2008). Insect Pathogens and Insect Parasitic Nematodes, International Organization for Biological and Integrated Control of Noxious Animals and Plants, West Palearctic Regional Section.
7. Gaugler, R. 2001. Entomopathogenic Nematology. CABI Publishing UK.
8. Navon, A. 2000. Bioassays of Entomopathogenic Microbes and Nematodes. CABI Publishing UK.
9. Boucias, D.G. 1998. Principles of Insect Pathology. Chapman Hall, London.
10. Van Dreische, R. G. 1996. Biological Control. An International Thomson Publishing Company
11. Fuxa, J. R. and Y. Tanada (1987). Epizootiology of Insect Diseases, Wiley.

ADVANCED BIOLOGICAL CONTROL

3(2-1)

Objective:

To educate the students on advances in biological control.

Theory:

Recent developments in biological control. Parasitoids and Predators of Arthropods and Molluscs. Entomopathogenic organisms (Fungi, Bacteria, Virus and Nematodes) as bio-control agents. Herbivores and Pathogens used for Weed Control. Biological Control of Plant Pathogens and Nematodes. Behavior of Insect Parasites, Parasitoids and Predators. Biology of Arthropod Parasitoids and Predators. Natural enemy Monitoring and Evaluation Techniques. Integration of Biological Control into Pest Management System. Latest research articles on biological control. Challenges and limitations in biological control.

Practical:

Demonstration and Estimation of Predation and Parasitism. Collection, Identification and Preservation of natural enemies. Mass rearing of important natural enemies and their field application techniques. Sampling methods of bio-control agents for pest management. Screening of pesticides against natural enemies. Visits to bio-control labs.

Recommended Books

1. Khan, A.G. 2014. Rearing Techniques for important predators and some parasitoids of insect pests of crops, vegetables and fruit trees of Pakistan. ISBN: 978-969-23025-0-0.
2. Khan, A.G. 2013. Rearing Techniques for important parasitoids of major insects of crops, vegetables and fruit trees in Pakistan. ISBN: 978-969-0-02494-7
3. Kalia, A. and Mudhar, R.K. 2011. Bioaugmentation, Biostimulation and Biocontrol. Springer Berlin Heidelberg Press.
4. Copping, L.G. 2009. The Manual of Biocontrol Agents– Fourth edition. BCPC. 896 pp.
5. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. Higher Education Commission, Islamabad, Pakistan.
6. Muniappan. 2007. Biological control of tropical weeds using arthropods R. Cambridge University Press.
7. Jervis, Mark, A. 2007 Insects as Natural Enemies, Springer UK.
8. Chincholkar, S. B. 2006 Biological control of plant diseases. Haworth food & agricultural products press.
9. Hajek, A. 2004. Natural Enemies – An Introduction to Biological Control, Cambridge University Press.
10. Bellows, T.S., Fisher, T. W., Catagirane, L.E., Dahlsten, D.L., Huffaker, C. and Gardh, G. 1999. Hand Book of Biological Control, Principles and Application of Biological Control. Academic Press, USA.

11. Jerrvis, M. and Kidd, N. 1997. Insect Natural Enemies- Practical Approaches to their Study and Evaluation. Chapman and Hall, New York.
12. Van Driesche, R.G. and Bellows, T.S. 1996. Biological Control. Chapman and Hall, New York.

BIOTECHNOLOGY IN PLANT PROTECTION

3(2-1)

Objectives:

To educate the students on the role of biotechnology in plant protection.

Theory:

Importance and scope of biotechnology in plant improvement and use of model organism in biotechnology. Tools of biotechnology for plant improvement. Amplification of recombinant DNA molecules, Gene transformation, Agrobacterium mediated transformation, genetic diversity in plant/insect. Markers for gene/insects (biotypes) identification, ELISA, PCR, gene cloning, SDS-PAGE, GMOs, incorporation of novel genes for tolerance against biotic and abiotic stresses, gene for insect and disease resistance. Standard media, explants, in vitro culture, micro propagation, callus culture and protoplast culture.

Practical:

Plant tissue culture, DNA isolation from plant/pests, agrobacterium mediated transformation of plant cells, ELISA, PCR, Nucleic acid and protein quantification, gel electrophoresis. Visits to biotechnology labs.

Recommended Books:

1. Sharma. R. 2014. Biotechnology and its application in Agricultural Science. Anmol Publications Pvt Ltd.
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis: An Introduction. Willy- Blackwell, UK.
3. Fowler, M.W., Warren, G.S. and Young, M. M. 2008. Plant Biotechnology, Oxford Press.
4. Sharma, H.C. 2008. Biotechnological approaches for pest management and ecological sustainability. CRC Press.
5. Slater. A., Scott, N. W and Fowler, M. R. 2008. Plant Biotechnology. The Genetic Manipulation of Plants. Oxford University Press, London.UK.
6. Nag, A. 2008. Textbook of Agricultural Biotechnology. Prentice-hall of India.
7. Sharma, H.C. 2008. Biotechnological approaches for pest management and ecological sustainability. CRC Press.

8. Slater. A., Scott, N. W and Fowler, M. R. 2008. Plant Biotechnology. The Genetic Manipulation of Plants. Oxford University Press, London.UK.
9. Nag, A. 2008. Textbook of Agricultural Biotechnology. Prentice-hall of India.
10. Fowler, M.W., Warren, G.S. and Young, M. M. 2008. Plant Biotechnology, Oxford Press.
11. Naidu, C.K. 2006 Applied Biotechnology. Aavishkar, India.
12. Srivastava. S, A. Narula, S. S. Bhojwani, 2004. "Plant Biotechnology and Molecular Markers" Inc Net Library, publishers Springer UK.
13. Handler, A.M.and James, A.A. 2004. Insect Transgenesis methods and applications, comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues, CRC Press, USA.
14. Hoy, M.A.2003.Insect Molecular Genetics: An introduction to principles and applications. 2nd ed. Academic press, London, UK.
15. Hoy, M.A.2003.Insect Molecular Genetics: An introduction to principles and applications. 2nd ed. Academic press, London, UK.

HOST PLANT RESISTANCE

3(2-1)

Objective:

To educate students on the mechanism of host plant resistance.

Theory:

Introduction, types and mechanisms of resistance against insects, nematodes and pathogens. Ecological and physiological factors in induced and genetic resistance. Role of allelochemicals and phytochemicals in pest resistance. Antixenosis, antibiosis, tolerance, disease escape & immunity. Genetic basis of resistance. Effect of environment on resistance and biotypes development. Measurement of resistance. Development of resistant varieties. Screening of germplasm for resistance. Comprehensive review of the concepts and achievements in resistance. Study of various infection types on host differentials. Resistance through genetic engineering.

Practical:

Testing and measurement of relative plant resistance to pests. Determination of factors and mechanisms of resistance. Preparation of mass inocula of various plant pathogens and methods of application to host plants. Screening of crop germplasm for the detection of sources of resistance.

Recommended Books:

1. Koul, O and Cuperus G.W. 2007. Ecologically Based Integrated Pest Management. CABI, London
2. Smith, C.M. 2005. Plant resistance to arthropods: molecular and conventional approaches. Springer, UK.
3. Sadasivan, S. and Thayumanavan, B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, USA.
4. Sterr, J.L., Cook, R and Bridge J 2002. Plant Resistance to parasitic nematodes. CABI Publishing, UK.
5. Mills, D., Kunoh, H. Keen, N. and Mayama, S. 1996. Molecular Aspects of pathogenicity and Resistance Requirements for Signal Transduction. American Phytopathology Society Press, St., Paul. Minnesota, USA.
6. Pedigo, L.P. 1996. Entomology & Pest Management. Prentis & Hall. Inc. London.
7. Smith, C.M., Khan, Z. R. and Pathak, M.D. 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, U.S.A.
8. Smith, C.M., 1989. Plant Resistance to Insects. A Fundamental Approach. John Wiley & Sons., New York.
9. Agrawal, A. A., Tuzun S. and Bent, E. 1999. Induced Plant defence against pathogens and herbivores. APS. Press, St. Paul Minnesota, USA.

VECTORS OF PLANT DISEASES**3(2-1)****Objective:**

To educate the students on vectors of plant diseases.

Theory:

Introduction, identification & bionomics of different vectors. Inter-relationship of plants and vectors. Mode and mechanism of transmission of plant pathogens by insects, nematodes and mites. Seed and plant propagating materials as a carrier of plant diseases. Factors affecting the mechanism of transmission of plant diseases. Study of causal organisms, etiology, symptoms and management of important fungal, bacterial, viral and nematode disease vectors.

Practical:

Collection and identification of insects, mites, nematodes and pathogens vectors. Culture of pathogens on artificial media for inoculation. Rearing and handling of vectors for plant pathological studies. Bioassay and mode of transmission of pathogens in plants by vectors. Demonstration of vector management techniques.

Recommended Books:

1. Bhutta, A.R.2010. Text book of introductory Seed Pathology. HEC Press.
2. Van Emden, H. F. and Service, M. 2004. Pest and Vector Control. Cambridge University Press, UK.
3. Taylor, C. E. and Brown, D. J. F.1997. Nematode vectors of plant viruses. Wallingford CAB International, UK
4. Basu, A.N. and Gerry, B.K.1993. The essentials of viruses: Vectors and Plant Diseases. Wiley, Eastern Ltd. New Delhi, India.
5. Julian, G.L. 1997. Insect transmission of plant diseases. Biotech Books Publishers Delhi, India.
6. Pierre, J. 1988. Inter relationship between insects and plants. CRC Press, London.

ADVANCED INTEGRATED PEST MANAGEMENT**3(2-1)****Objectives:**

To educate the students on advanced techniques of integrated pest management.

Theory:

Introduction, history and concepts of IPM. IPM in present scenario. Agro-ecosystem analysis. Components of IPM. Quantitative basis of IPM and sampling methods. Analyses of key pests and their natural enemies. Economic levels in IPM. Principles of IPM technology transfer. Resurgences and outbreaks of pests. Role of parasites, parasitoids, predators, nematodes, pathogens, pheromones, feeding deterrents and anti-metabolites in IPM. Plant resistance in IPM. Role of genetic control and transgenic technology in IPM. Pesticides, bio-pesticides, botanicals and IGR's in IPM. Comprehensive review of IPM in Pakistan.

Practical:

Methods of pest scouting, monitoring and forecasting. Estimation of losses by different sampling techniques. Losses caused by insects, mites, pathogens, and weeds. Determination of economic levels. Visit to Training of facilitators (TOF), farmer field school (FFS) and woman open school (WOS).

Recommended Books:

1. Pimentel, D and Peshin, R. 2014. Integrated pest management: Pesticides Problem Vol. 3. Springer, New York, London.
2. Dharam P. A. 2013. Integrated Pest Management: Current Concepts and Ecological perspectives. Academic Press.

3. Jarvis, D.I., Padoch, C. and Cooper, H.D. 2013. Managing biodiversity in agricultural ecosystems. Columbia University Press New York
4. Dharam, P. A. and Uma, S. 2012. Integrated Pest Management: Principles and Practice. CAB International.
5. Wylie, F. R. and Speight, M. 2012. Integrated pest management (IPM). CAB International
6. Edward B. Radcliffe, William D. Hutchison and Rafael E. Cancelado 2009. Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies. Cambridge University Press, U.K.
7. Bethke, C. M. 2005. Integrated Pest Management: Principles And Applications (2 Vols Set)
8. Rami, H.A. and Isaac, I. 2004. Insect Pest Management – Field and Protected Crops. Springer, UK.
9. Dhaliwal, G. S. and Ramesh, A. 2004. Integrated pest management. Kalyani Publishers, India.

PESTICIDE TOXICOLOGY

3(2-1)

Objective:

To educate the students on toxicity and poisoning of pesticide.

Theory:

Introduction, nomenclature, classification, chemistry and mode of action of pesticides, toxicity of pesticides, compatibility of pesticides, physico-chemical properties, residues of pesticides, pesticide resistance. Anti-cholinesterases, acetylcholine receptor agents, axonic poisons, mixed function oxidase (MFO) inhibitors, chitin synthesis inhibitors, inhibitors of mitochondrial electron transport, uncouplers of oxidative phosphorylation, inhibitors of cell division etc. Pesticide metabolism: Phase-I and Phase-II reactions. Toxicokinetics: pesticide absorption, distribution and excretion in insects and humans. Antidotes against pesticides poisoning. Phytotoxicity in crop plants. Detoxification mechanisms Safety measures.

Practical:

Instructions regarding laboratory equipment used in the toxicological experiments. Gross symptoms produced by representative pesticides in insects and rodents. Determination of Concentration x Time product in comparing relative toxicity of pesticides. Bio-assay of pesticides and probit analysis. Visit to pesticide industries/field visits

Recommended Books:

1. Saleem, M.A. 2009. Principles of Insect Toxicology. Vol.-I. Izhar

- sons Printers. Lahore.
2. Dodia, D.A. Petel, I.S. and Petal, G.M. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India) Jodhpur.
 3. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.
 4. Ware, G. W. and Whitacre, D. M. 2004. The pesticide book.6th ed. Meister PRO Information Resources, USA.
 5. Tomlin, C. 2003. The Pesticide Manual. 13th ed. CPC, USA
 6. Mathews G.A. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK.
 7. 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
 8. Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida.
 9. Roberts, T. 2000. Metabolism of Agrochemicals in Plants. John Wiley & Sons, UK.
 10. Roberts, T. 2000. Metabolism of Agrochemicals in Plants. John Wiley & Sons, UK.
 11. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, India.
 12. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, India.
 13. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi.

PESTICIDE RESIDUE ANALYSIS

3(2-1)

Objective:

To educate the students on residual effects of pesticides and their analysis.

Theory:

Theoretical and practical aspects of modern analytical techniques used in the qualitative and quantitative analysis of pesticides and their residues. Separation and quantification techniques: gas chromatography, high performance liquid chromatography (HPLC), affinity chromatography, electrophoresis, and immuno-chemistry. Identification of pesticides and their metabolites through mass spectroscopy

techniques, infrared, nuclear magnetic resonance, and ultraviolet spectroscopy. International food security standards.

Practical:

Use of laboratory equipment for the above mentioned techniques. Interpretation of spectra of pesticide chemicals. Use of TLC, GLC, HPLC and other chromatographic & spectrometric equipment in pesticides residue analysis.

Recommended Books

1. Pedigo, L.P. 2007. Entomology and Pest Management. 5th Ed. Prentice Hall, Intl. Limited, London
2. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.
3. Horwitz, W. 2004. Official Methods of Analysis of AOAC International. 18th Eds. AOAC International, USA.
4. Lee, P.W. 2004. Hand book of residue analytical methods for agrochemicals. 2 volume set. Wiley & Sons, USA.
5. Tomlin, C. 2003. The Pesticide Manual. 13th ed. BCP, USA.
6. Ohannesian, L. and Streeter, A. J. 2001. Handbook of Pharmaceutical Analysis. Marcel Dekker, USA.
7. U. S. Food and Drug Administration. 1999. Pesticide Analytical Manual Volume I (PAM).
<http://www.cfsan.fda.gov/~download/pami-all.exe>
8. Mathews, G.A. and Thornhill, E.W. 1995. Pesticide Application Equipments for use in Agriculture. FAO Agriculture Series Bulletin

RESEARCH METHODS IN PLANT PROTECTION

3(2-1)

Objective:

To acquaint students with the research techniques used in plant protection.

Theory:

Introduction to Research, principles of research; Research Ethics and Integrity. Quantitative and qualitative research methods. Challenges in research. Art of scientific investigation, identification of problems, aims and objectives of work plan. Scientific background of research plan, techniques including experimental designs and apparatus employed in plant protection research. Scientific photography and digital image processing. Online information collection, digital library search, bibliographic and other software in plant protection. Data collection,

analysis, interpretation and presentation. Project planning, execution and report writing. Plagiarism and similarity index test

Practical:

Lab exercises based on the matters described above.

Recommended Books:

1. Creswell, J. W. Research design: Qualitative, quantitative and mixed methods approaches. 4th Ed. Thousand Oaks, CA: Sage. 2014.
2. Jan. M. T., Shah, P., Hollington, P and Jamal, M. 2009. Agricultural Research; Design and Analysis. Department of Agronomy, Agricultural University Peshawar Pak.
3. Kothari, C.R. 2006. Research Methodology: Methods and Techniques. New Age International Publishers. New Delhi.
4. Hicks, C.R. and Turner, K.V. 1999. Fundamental Concepts in the Design & Analysis of experiments. 5th ed. Oxford University Press, USA
5. Hicks, C.R. and Turner, K.V. 1999. Solutions Manual for Fundamental Concepts in the Design & Analysis of experiments. 5th ed. Oxford University Press, USA
6. Zar, J. H. 1999. Biostatistical Analysis. 4th ed. Prentice-Hall, Inc., Upper Saddle River, USA.
7. Sokal, R. R. and Rohlf, F. J. 1995. Biometry: the principles and practice of statistics in biological research. 3rd ed. W. H. Freeman and Co., USA.
8. Tonapai, G.T. 1994. Experimental Entomology – An aid to Laboratory and Field Studies. CBS Publishers and Distributors, India.

MICROBIAL CONTROL OF PESTS

3(2-1)

Objective:

To educate the students on microbes as source of management.

Theory:

Introduction, history & scope. Ecological basis of microbial control. Characteristics of pathogens of pest species. Mode of action of antagonistic microbes (predatory, parasitic or chemical relation) against different plant pests. Management of insects, mites, weeds, nematodes and plant pathogens by pathogenic bacteria, fungi, viruses, nematodes and protozoans. Mass production of antagonistic microbes. Mode of action, storage, infectivity, virulence, biosafety and bioassay of plant pathogens. Microbial control as a component of IPM. Microbial

pesticides: production, standardization, formulation and application. Compatibility of microbial pesticides with synthetic pesticides and bio-control agents. Transgenic microorganisms as a bio-control agents. Knowledge of the commercially available bio-pesticides.

Practical:

Collection, preservation, screening and identification of pathogenic fungi, bacteria, nematodes, protozoa and viruses. Diagnosis of insect diseases. Isolation, purification, culture, formulation and application of pathogens. Awareness, safety and quality control of microbial pesticides. Mass production of microbial bio-control agents. Compatibility test of microbial-pesticides with other bio-control agents.

Recommended Books:

1. Huffaker, C. B. (Ed.). 2012. Theory and practice of biological control. Elsevier.
2. Ravensberg, W. J. 2011. Roadmap to the Successful Development and Commercialization of Microbial Pest Control Products for Control of Arthropods (Vol. 10). Springer Science & Business Media.
3. Copping, L. G. 2009. The manual of biocontrol agents: a world compendium (No. Ed. 4). British Crop Production Council.
4. Hajek, A. E., Glare, T. and O' Callaghan, M. 2009. Use of microbes for control and eradication of invasive arthropods. Vol. 6. Springer, UK.
5. Koul, O. and Dhaliwal, G. S. 2001. Microbial Biopesticides. CRC Press, USA.
6. Gaugler, R. 2001. Entomopathogenic Nematology. CABI Publishing UK.
7. Khetan, S. K. 2000. Microbial Pest Control. Marcel Dekkar, USA.
8. Trividei, P. C. 1998. Plant Nematode Management: A biocontrol Approach.
9. Van Driesche, R. G. and Bellows, T. S. 1996. Biological Control. International Publishing company, USA.

PLANT PROTECTION AND ENVIRONMENT

3(2-1)

Objective:

To educate students on plant protection with reference to environment.

Theory:

Introduction, concept with environmental perspective. Classification and management of environmental pollution (Air, Water, Soil and Noise Pollution). Diversity of pests in different environments. Interactions of

various groups of pests with biological, chemical and physical parameters of their environments. Impact of air, water, soil pollutants and agrochemicals on pests and non-target organisms. Biological responses to pollutants and biogeochemical cycles. Insects as bio-indicators of environmental pollution. Pesticide pollution. Sources of organic contaminants in the soil environment. Key processes affecting pesticides fate and behavior in soil. Transport and off-site migration of organic compounds.

Practical:

Underground water testing, Human blood sampling, hospital visits to know the patients status, Air and soil pollutions. Pollutants effects on useful fauna.

Recommended Books:

1. Rathore, H. S. and Nollet, L.M.L. 2012. Evaluation of Environmental Pollution. CRC Press.
2. Colopy, C. 2012. Dirty, Sacred Rivers: Confronting South Asia's Water Crisis. Oxford University Press.
3. Stoytcheva, M. 2011. Pesticides - The Impacts of Pesticides Exposure. ISBN Publisher.
4. Earnhart, D.H. and Glicksman, R.L. 2011. Glicksman Pollution Limits and Polluters' Efforts to Comply: The Role of Government Monitoring and Enforcement. Stanford Economics and Finance Publisher.
5. Ross, B. and Amter, S. 2010. The Polluters: The Making of Our Chemically Altered Environment. Oxford University Press..
6. Rana, S.V.S. 2006. Environmental Pollution: Health and Toxicology. Alpha Science International Limited.
7. Pretty, J. 2005. The Pesticide Detox: Towards a more sustainable agriculture. Earthscan. London, UK.
8. Saleem, M. A. and Ashfaq, M. 2004. Environmental Pollution and Agriculture. B. Z. University Press, Pakistan.
9. Hill, M. K 2004. Understanding Environmental Pollution, A Primer, 2nd ed. Cambridge University Press, UK.
10. Hokka, N. Heikki, M. T. 2003. Environmental Impacts of Microbial Insecticides Kluwer Academic, USA.
11. Timbrell, J. A. 2002. Introduction to Toxicology, 3rd ed. Taylor and Francis, USA.
12. Terry, R. 2000. Metabolism of agrochemicals in plants. John Willey and Sons, USA.

ADVANCED PEST ECOLOGY

3(2-1)

Objective:

To educate the students on the principles and advances in ecology.

Theory:

Population growth theories, life-tables, key factor analysis, regression, co-existence, co-habitation, competition & mutual displacement, variation, speciation and diversity. A mathematical approach to the dynamics of single and multi-species populations and communities with analytical and simulation model techniques: mathematical and statistical techniques applied to population dynamics and community ecologies. Critical survey of models of population growth, niche matrices, competition, predation, ecological genetics, species diversity & distribution and ecological succession.

Practical:

Use of computer simulations in population of agricultural pests. Computer modeling used by ecologists to clarify and interpret large field data by clustering, transforming, matrices and multivariate analysis. Life table in selective environments.

Recommended Books:

1. Mark A. L., M. Philip , P. V. Sergei. 2013. Dispersal, Individual Movement and Spatial Ecology: A Mathematical Perspective. Springer.
2. Peter W. P., F Robert, M.D. Denno, D. L. Eubanks and I. Kaplan. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press.
3. Bruce Hannon and R. Matthias. 2008. Dispersal, Individual Movement and Spatial Ecology: A Mathematical Perspective. Springer.
4. Rockwood, L. L. 2006. Introduction to population ecology. Willey, Johns & Sons, USA.
5. Bernstein, R. 2003. Population Ecology: An Introduction to Computer Simulations . Willey & Sons, USA.
6. Mario, G. 2003. Multi Scale integrated analysis of agro systems. CRC Press, USA.
7. Vandermeer, J. H. and Goldberg, D.E.2003. Population ecology: First Principles. Princeton University Press, USA.
8. Linda, A. 2003. An Introduction to Stochastic Processes with Biology Applications. Pearson Education, USA.

9. Mario Giampietro . 2003. Multi-Scale Integrated Analysis of Agroecosystems. CRC Press .
10. Williams, B. K., Nichols, J. D. and Conroy, M. J. 2002. Analysis and Management of Animal Populations. Academic Press, USA.
11. McGlade, J. 1999. Advanced Ecological Theory. Blackwell Publisher, UK.

PESTICIDE RESISTANCE MANAGEMENT

3(2-1)

Objective:

To educate the students on development and management of resistance in pests.

Theory:

Introduction. Development and types of resistance. Mechanisms of resistance: biochemical, behavioral and genetical resistance. Comparative metabolism of pesticides: activation and detoxification mechanism in pests. Monitoring and management of resistance against various pests. IPM as a tool for resistance management. Resistance management in transgenic crops. Ways, means and strategies in resistance management. Comprehensive review of resistance development in Agricultural pests of Pakistan.

Practical:

Collection of potentially resistant strains/biotypes of pests from the pesticide treated fields. Detection of levels of resistance in resistant strains. Biochemical basis of resistance. Demonstration of resistance-breaking techniques.

Recommended Books:

1. Sharma, H.C. 2008. Biotechnological approaches for pest management and ecological sustainability. CRC , USA.
2. Whalon, M.E. 2008. Global Pesticides Resistance in arthropods. CABI, UK.
3. Pedigo, L.P. 2007. Entomology and Pest Management. 5th ed. McMillan Publishing Co., USA.
4. Onstand, D.W. 2007. Insect Resistance Management. Academic Press.
5. Pedigo, L.P. 2007. Entomology and Pest Management 5th Ed. Prentice Hall, Intl. Limited, London.
6. Saleem, M. A. 2005. Insecticide Resistance and Management. B. Z. University Press, Multan, Pakistan.
7. Brooks, G.T. 2005. Pesticide chemistry and bioscience the food-environment challenge. Woodhead Publishing Limited, UK.

8. FAO. 2001. Policy and strategy for rational use of pesticides in Pakistan. FAO-UN, Pakistan.
9. Denholm, I. 1999. Insecticide Resistance from Mechanism to Management. Prentice Hall. London.
10. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
11. Roush, R.T and B.E. Tabashink (Eds.) 1990. Pesticides resistance in arthropods. Chapman & hall. New York.
12. Green, M.B. LeBaron, H.M. and Moberg, W.K. (Eds.). 1990. Managing Resistance to Agrochemicals. American Chemical Society. Washington.

SPS MEASURES AND QUARANTINE

3(2-1)

Objective:

To educate the students on Sanitary and Phytosanitary (SPS) Measures and quarantine regulations.

Theory:

Introduction to Sanitary and Phytosanitary (SPS) Measures under WTO regime. Plant and pest related issues. Quarantine concept and principles. Domestic and international quarantine measures. Quarantine Act, standards and rules in Pakistan. Quarantine regulated and non-regulated pests. Phytosanitary certificates and trade documents, entry and shipment guidelines for "Agricultural commodities" Outbreaks of pests introduced in Pakistan and elsewhere through import of plant and planting materials. Pest risk analysis and management. Seed Act, 1976 (Seed Amendment Bill 2014) and its implementations in seed import/export. Impact of SPS and quarantine measures on economy of Pakistan. Identification of pests and inspection procedure of import/export consignment. International Standards of Phytosanitary Measures (ISPM). Procedures and measures adopted under National Animal and Plant Health Inspection Service (NAPHIS).

Practical.

Analysis of various plants and planting material from exportable & importable consignments. Visit of port of entry, dry port and quarantine facilities. Demonstration of quarantine procedures and inspection. Seed sampling, testing procedure and Registration by Federal Seed Certification and Registration Department (FSCRD) and Department of Plant Protection, Government of Pakistan.

Recommended Books:

1. Bhutta, A.R.2010. Text book of introductory Seed Pathology. HEC Press.
2. Ranjann, S. 2007. Sanitary and Phytosanitary Measures-An introduction, Lefai University Press, India.
3. Bhutta, A.R. and Ahmad, I. 2000. Seed pathological techniques and their application. National Book Foundation, Pakistan.
4. FAO. 2000. Multi lateral Trade Negotiation on Agriculture. A Resource Manual-III-SPS & TBT Agreement. Publ. FAO-UN, Rome, Italy.
5. Plant Quarantine Act 1976, Govt. of Pakistan.
6. Seed Act (amended) 2008, Govt. of Pakistan.
7. WTO Publications.

Web sites:

1. <http://plantprotection.gov.pk/wp-content/uploads/Act%20and%20Rules%20PDF/Plant%20Quarantine%20Act%201976.pdf>
2. <http://www.corpoica.org.co/SitioWeb/WebBac/Documentos/Principalesofplanthealthandquarantine.pdf>
3. http://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm
4. <https://ustr.gov/sites/default/files/2013%20SPS.pdf>
5. <http://faolex.fao.org/docs/pdf/ins116323.pdf>

COMMUNITY INTEGRATED PEST MANAGEMENT**3(2-1)****Objective:**

To educate the students on integrated pest management approach at community level.

Theory:

Community IPM basics; Community IPM at farmer's fields, homes, schools, industrial work places, office buildings, parks and recreational areas and public property etc. Agro-ecosystem analysis. Field base diagnostics. Biodiversity conservation. Educational foundations of the farmer field schools Farmer field experimentation & research. Participatory approach in Community IPM. Non-formal education, group dynamics and community IPM in Asia. Government policies and their impacts on community IPM. Curriculum development of training of facilitators (TOF). Women Open School (WOS) and Children Ecological Clubs(CEC).

Practical:

visits to Farmer Field School and Insectariums. Farmers field experiments. Collection, identification and preservation of pests, natural enemies and diseased specimens.

Recommended Books:

1. Duveskog, D. and Friis-Hansen, E. 2008. Farmer Field Schools: a platform for transformative learning in rural Africa. In "Transformative Learning in Action: Handbook of Practice", edited by Mezirow, J. and Taylor, E., Jossey-Bass Press
2. community IPM. 2005. <http://www.communityipm.org/doc>
3. IPM-Based Landscape Design. 2005. <http://www.efn.org/~ipmpa/D-Mhome.html>
4. Fundamentals of a Low Maintenance, Integrated Pest Management Approach to Landscape Design. 2005. <http://www.efn.org/~ipmpa/des-cnsd.html>
5. FAO 2004. Environmental education for poor farmers. FAO-EU IPM Program for cotton in Asia. FAO Regional office for Asia and the Pacific, Bangkok, Thailand.
6. Van den Berg .2004. Farmer Field Research: An analysis of experiences in Indonesia. FAO Regional office for Asia and the Pacific, Bangkok, Thailand.
7. Ahmad, I. and Bhutta, A. R. 2004. Text book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
8. Kazmi, M. R. and R. Zada 2003 . Facilitation Skills: A Resource Book. National IPM Program, NARC, Islamabad.
9. John Pontius, Russell Dilts, Andrew Bartlett. 2002. From Farmer Field School to Community IPM: Ten Years of IPM Training in Asia. FAO Community IPM Programme, Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific, 2002
10. Reijntius, J. and Dilts, R. and Bartlett, A. (eds.), 2002. From Farmer field school to community IPM, Ten years of IPM training in Asia. Published by FAO community IPM Programmes, FAO-UN, Regional Office for Asia and the Pacific, Bangkok, Thailand.
11. CABI Bioscience. 2000 Learning to cut the chemicals in cotton. CABI-Bioscience & PAN UK.

PEST MANAGEMENT INFORMATICS**3(2-1)****Objective:**

To educate the students on pest management informatics and internet-based computer application of IPM.

Theory:

Information Technology in Plant Protection. The Internet facilities. Internet-based IPM Informatics and decision support. IPM resources on the world wide web. Site specific IPM. Invasive species, databases, and decision making: Current Issues. Good laboratory practices. Biological compliance. Data analysis and visualization. Getting started with HTML. Advanced HTML. Library searching the scientific literature. World wide web technology. Basics of photographic and video capture microphotography. Basics of scientific illustration, and image modification/enhancement. Geospatial technology. Production and scanning, ideography, microphotography, disease informatics. Bioportal.

Practical

Visits to Data Visualization Laboratories. Projects, assignments and presentations Use of bioinformatics software for data analysis. Access to relevant databases

Recommended Books:

1. Choudhuri , S. 2014. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, 1st Edition. Academic Press (Print Book ISBN: 9780124104716; eBook ISBN: 9780124105102). Pages 238.
2. Alexis Leon and Mathews Leon. 2009. Fundamentals of Information Technology, 2nd Editions. Pages 602.
3. Dass, S. K. and Y.K. Singh. 2007. Internet and information technology. Shree publisher. India
4. Narendrasinh, C., Jhala and J, Sarvaiya. 2005. Information Technology for Agricultural Production, Education and Management. Satish Serial Publishers, India.
5. Doja, M. N., deep and Deep. 2005. Fundamentals of Computers and Information Technology. India.
6. Date, C.J. 2004. Database systems. 8th ed. Addison Wesley Pub. co.
7. Connolly, R and P, Begg. 2009. Database Systems: A practical approach to design, Implementation and Management. 5th ed. Addison-Wesley Pub. Co.
8. Coral Pak xp-4 CD. 2009. For photo editing. Web Designing and Image Tracing Software.
9. U lead Video Studio 11.5. Plus. 2009 Advances Video Editing Software.
10. Burger, Peter and Gillies, D.F 2003. Interactive computer graphics: Functional procedural and device level methods. Addison-Wesley Pub. Co., USA.

11. Williams, Brian K. and Sawyer, Stacey C. 2003. Using Information Technology: A Practical Introduction to Computers & Communications : Complete Version. Publisher: McGraw-Hill (Tx) (ISBN 10: 0071112421 / 0-07-111242-1; ISBN 13: 9780071112420).

INTERNATIONAL AGREEMENTS AND PLANT PROTECTION 3(3-0)

Objective:

To educate the students on international obligations and agreements with reference to plant protection.

Theory:

International treaties, agreements and their relevance to plant protection. An over view of Cartagena Protocol on Biosafety, Codex Alimentarius Commission (CAC), International Seed Testing Association (ISTA), Union of Plant Variety Protection (UPOV), World Intellectual Property Organization (WIPO), Intellectual Property Rights (IPR), International Plant Protection Convention (IPPC), regional organizations and their working strategies. Stockholm Convention on POPs. Main disputes, issues and problems in export & import of plant and plant products. Impact of major international agreements on economy of Pakistan. WTO Agreements for SPS. Writing of assignment/report on international agreements of Pakistan with other countries. Requirement of Material Transfer Agreement (MTA) and application of Plant Breeder's Rights (PBR).

Recommended Book:

1. Osmanczyk, E and Mango, A. 2003. Encyclopedia of the United Nations and International Agreements, 3rd ed. 3500 pp (4 Vol. Set).
2. FAO, 2000. Multilateral Trade Negotiation on Agriculture. A Resource Manual-III.SPS&TBT Agreement. Pub. by FAO-UN Rome. Italy
3. WTO Publications

ADVANCED BIOCHEMICAL METHODS

3(2-1)

Objective:

To educate the students on the advanced biochemical techniques.

Theory:

Sample preparation. Spectroscopic methods for matrix characterization. Quantification of enzymes and their substrates. Quantitative immunoassays with labels. Immunological methods, Biosensors.

Principles, types & applications of electrophoresis. Isoelectric focusing. Centrifugation methods. Chromatography of biomolecules. Applications of NMR and mass spectrometry in analysis of biomolecules. Concepts and techniques in metabolites. Recent reviews. Use of bioinformatics tools

Practical:

Preparation of samples, extraction and analyses. Isolation, purification and characterization of major enzymes with the help of chromatographic technique. Research techniques based on the topics discussed in theory sessions. Fluorescent and Confocal microscopy.

Recommended Books:

1. Hall, B.G. 2007. Phylogenetic Trees Made Easy: A How to Manual. 3rd Ed. Sinauer Associates.
2. Gilbert, L. 2005. Comprehensive Molecular Insect Science. 1-7 Vol.
3. Gordon G. Hammes. 2005. Spectroscopy for the Biological Sciences. Wiley.
4. Susan R. Mikkelsen, Eduardo Cortón. 2004. Bioanalytical Chemistry. Wiley.
5. Alfred Pingoud, Claus Urbanke, Jim Hoggett, Albert Jeltsch. 2002. Biochemical Methods: A Concise Guide for Students and Researchers. Wiley.
6. Methods of Biochemical Analysis (Multi-voluminous treatise, issued each year) Advances in Enzymology and Related Areas of Molecular Biology, (Multi-voluminous treatise, issued each year)
7. Hoy, M.A.2000. Insect Transgenesis: Methods and Application. CRC Press.
Segel, I.R. 1976. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition. Wiley.

ADVANCED ACAROLOGY

3(2-1)

Objectives:

To educate the students on destructive and useful Acarina

Theory:

Introduction, history and identification. Diagnosis, Anatomy, Phylogeny and Systematics. Physiology and genetics. Evolutionary changes in mites. Biology of economic important mite pests; and parasitic and predatory mites. Ecology of mites. Managements of economically

important pest mites through biologicals agents, resistant plants and chemicals. Integrated programs for some noxious mite pests.

Practical:

Sampling techniques, population elements. Sampling frequency, habitat and distributions. Estimation of population size, Numerical sampling and data analysis. Sampling and pest management decision. Mounting techniques, preservation, clearing, mounting of the pest and predatory mites.

Recommended Books:

1. Castilho, R.C., Moraes, G.J. De & Halliday, R.B. 2012. Catalogue of the mite family Rhodacaridae Oudemans, with notes on the classification of the Rhodacaroidea (Acari: Mesostigmata). Zootaxa 3471, Magnolia Press, Auckland, New Zealand,
2. Hoy M.A. 2011. Agricultural Acarology: Introduction to Integrated Pest Management. CRC Press Har/ Corn edition.
3. El-Banhawy, E. M. & Knapp, M. 2011. Mites of the family Phytoseiidae Berlese from Kenya (Acari: Mesostigmata); Zootaxa 2945; Magnolia Press, Auckland.
4. Gupta, S.K. 2010. Medical, Veterinary and Public Health Important Ticks and Mites: a handbook. Delhi : Nature Books India.
5. Radovsky, F.J. 2010. Revision of genera of the parasitic mite family Macronyssidae (Mesostigmata: Dermanyssoidea) of the world. USA, Michigan, West Bloomfield, Indira Publishing House.
6. Saito, Y. 2010. Plant Mites and Sociality. Diversity and Evolution. Springer.
7. Vacante, V. 2010. Citrus Mites Identification, Bionomy and Control. CABI Publishing, Wallingford, Oxfordshire, UK Cambridge.
4. Zhang, Z.Q. 2003. Mites of green houses: Indification Biology and Control. Elsevier, New York.
8. Krantz, G.W. & Walter, D.E. (eds.) 2009. A Manual of Acarology. Third Edition. Texas Tech University Press; Lubbock, Texas, 807 pp.
9. Chant, D.A. and McMurtry, J.A. 2007. Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world. Indira Publishing House.
10. Gulati, R. and Bhatnagar, P. 2007. Agricultural Acarology. S. Chhilar, Daya Publisher, India.
11. Gerson, U., Smiley, R.L. & Ochoa, R. 2003. Mites (Acari) for Pest Control. Blackwell Science, Oxford. 539pp

12. Gupta, S.K. 2003. A Monograph on Plant Inhabiting Predatory Mites of India: Part 2. Order: Mesostigmata. Zoological Survey of India.
13. Walter, David E. & Proctor, H. 1999. Mites : Ecology, Evolution and Behaviour. Sydney, University of New South Wales Press and Wallingford.
14. Xin, J.-L., Lu, J.-Q. & Zhang, Z.-Q. 1998. Predatory Mites: Their Biology and Roles in Biological Control. Systematic and Applied Acarology Society, London.

ADVANCED HOST PLANT RESISTANCE

3(2-1)

Objective:

To familiarize the students with recent advances in resistance of plants to pests and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

Theory:

Historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool. Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; Biotechnological approaches in host plant resistance-genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding. Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on pest responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical:

Understanding mechanisms of resistance for orientation, feeding, oviposition *etc.*, allelochemical bases of insect pests resistance; macroculturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

Recommended Books:

1. Parker J. 2008. Molecular Aspects of Plant Diseases Resistance. Blackwell Publ.
2. Koul O & Cuperus GW. 2007. Ecologically Based Integrated Pest Management. CABI, London.
2. Smith CM. 2005. Plant Resistance to Arthropods – Molecular and Conventional Approaches. Springer, Berlin.

3. Dhaliwal GS & Singh R. (Eds). 2004. Host Plant Resistance to Insects - Concepts and Applications. Panima Publ., New Delhi.
4. Sadasivam S & Thayumanavan B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, New York.
5. Smith CM, Khan ZR & Pathak MD. 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, Boca Raton, Florida.
6. Panda N. 1979. Principles of Host Plant Resistance to Insects. Allenheld, Osum & Co., New York.
7. Rosenthal GA & Janzen DH. (Eds.). 1979. Herbivores – their Interactions with Secondary Plant Metabolites. Vol. I, II. Academic Press, New York.

ENTOMOPATHOGENIC NEMATOLOGY

3(2-1)

Objectives:

To educate the students about the basic and applied aspects of entomopathogenic nematodes (EPN), and to realize them the importance of the use of EPN as a bio-insecticide.

Theory:

Introduction, history of entomopathogenic nematology, taxonomy and systematics of EPN, biogeography, generalized life cycle, host range, tripartite interaction between symbiotically associated entomopathogenic bacteria, nematodes and their insect hosts. Biology and taxonomy of the symbiotic bacteria of EPN, physiology and biochemistry of EPN. Survival biology and behavioral ecology. Use of EPN in IPM. Production technology, formulation and application technology of EPN. Safety regulations.

Practical:

Identification of entomopathogenic nematodes both inside and outside the host. Microscopic studies for identification of dauer and adult stages Isolation of EPN from soil samples: techniques and field visits. In vivo rearing techniques of EPN. Bioassays for biocontrol with EPN. Microscopic observation of endotokia matricida. Demonstration of EPN application.

Recommended Books:

1. Nguyen, K. B. (2015). "Morphology and taxonomy of entomopathogenic nematodes." Available at <http://entnem.ifas.ufl.edu/nguyen/morph/kbnstein.htm>
2. Ehlers, R. U. (2008). Insect Pathogens and Insect Parasitic Nematodes, International Organization for Biological and

Integrated Control of Noxious Animals and Plants, West Palearctic Regional Section

3. Nguyen, K. B. and D. D. J. Hunt (2007). Entomopathogenic nematodes: systematics, phylogeny and bacterial symbionts, Brill.
4. Grewal, P. S., R. U. Ehlers, et al. (2005). Nematodes as biocontrol agents, CABI.
5. Gaugler, R. (2002). Entomopathogenic Nematology. Wallingford, CABI publishing.
6. Navon, A. (2000). Bioassays of Entomopathogenic Microbes and Nematodes. CABI Publishing UK.
7. Bedding, R. A., R. J. Akhurst, et al. (1993). Nematodes and the biological control of insect pests, CSIRO Publishing.
8. Gaugler, R. and H. K. Kaya (1990). Entomopathogenic nematodes in biological control, CRC Press Inc.

ADVANCED NEMATOLOGY TECHNIQUES

3(2-1)

Objectives:

To educate the students about the advanced nematology techniques to make them able to process nematodes and perform nematological research after their training, regardless of their situation (laboratory conditions and taxa of free-living, plant-parasitic or Entomopathogenic nematodes).

Theory:

Knowledge of the biology of the major groups of plant and soil inhabiting nematodes. Sampling and quantification of nematodes (introduction to the theory and practice). Habitats of nematodes. Diagnosis of nematode problems in the field considering all aspects involved in sampling. Identification principles. Recent articles on specific techniques.

Practical:

Methods for extraction of cysts from soil. Extraction methods for vermiform nematodes from soil, plants and/or animals (staining, centrifugation, sieving and decanting). Techniques of Handling, Killing, Fixing, Staining and Mounting nematodes. Making temporary and permanent mounts: comparison of different methods. Identification methods (morphological and molecular). Designing experimental set-ups for tests with nematodes. Counting nematodes (different stages). Measuring nematodes (conventional drawings vs software based measurements). Preparation of nematode inoculum and culturing nematodes.

Recommended Books:

1. Lacey, L. A. 2012. Manual of techniques in insect pathology, Academic Press.
2. Stock, S. P. and J. Vanderberg 2009. Insect pathogens: molecular approaches and techniques, CABI.
3. Ravichandra, N. G. 2010. Methods and Techniques in Plant Nematology, Prentice-Hall of India Pvt. Limited.
4. Kaya, H. K., L. A. Lacey, et al. 2007. Field manual of techniques in invertebrate pathology: Application and evaluation of pathogens for control of insects and other invertebrate pests, Springer.
5. Coyne, D. L., J. M. Nicol, et al. 2007. Practical plant nematology: a field and laboratory guide. Cotonou, IITA.
6. Van Bezooijen, J. 2006. Methods and techniques for nematology, Wageningen University.
7. Navon, A. 2000. Bioassays of Entomopathogenic Microbes and Nematodes. CABI Publishing UK.
8. Nickle, W. R. 1991. Manual of Agricultural Nematology, Taylor & Francis.
9. Bird AF, Bird J. 1991. The structure of nematodes. San Diego, California: Academic Press, Inc.
10. Southey, J.F. 1986. Laboratory methods for work with plant and soil nematodes.

ADVANCES IN PLANT PROTECTION**3(3-0)****Objectives:**

To educate the students regarding the emerging issues, new techniques and advancement in Plant Protection.

Theory:

Advances in diagnosis, characterization, biology and management of pests. Emerging pest scenario, Impact of climate change, need for novel approaches for pest management. Food safety and security, Impact of synthetic pesticides and fertilizers, crop cultivation technology of pest development. FAO and FSCRD standards of agricultural produce for import/export. International Standards for Phytosanitary Measures (ISPM). Application of latest biotechnological approaches to plant protection (Impact and consequences of transgenic plants); intensive integrated pest management;

Recommended Books:

1. Rajinder Peshin, David Pimentel. 2014. Integrated Pest

Management: Experiences with Implementation, Global Overview, Vol.4 Springer Publisher, ISBN: 978-94-007-7801-6 (Print) 978-94-007-7802-3 (Online). LVI, 574 p.

2. Dharam, P. Abrol (2013). Integrated Pest Management: Current Concepts and Ecological Perspective. ISBN-13: 978-0123985293 ISBN-10: 0123985293.
3. Parvatha Reddy, P. 2013. Recent advances in crop protection. Publisher: Springer.
4. Bandani, A. R. 2012. New Perspectives in Plant Protection. InTech, Chapters published April 11, under CC BY 3.0 license (ISBN 978-953-51-0490-2). Pages: 258.
5. Beiquan, Mou and Ralph Scorza. 2011. Transgenic Horticultural Crops: Challenges and Opportunities. CR
6. Leo M.L. Nollet, Hamir S. Rathore. 2009. Handbook of Pesticides: Methods of Pesticide Residues Analysis. CRC Press (ISBN 9781420082456). Pages 628.
7. Saha, L.R. and Dhaliwal G.S. 2009. Handbook of Plant Protection. Kalyani Publishers (ISBN-10: 8127231983; ISBN-13: 9788127231989). Pages: [x] + 550
8. Narayanasamy, P. 2008. Molecular Biology in Plant Pathogenesis and Disease Management. Springer Science+Business Media B.V. (ISBN 978-1-4020-8244-3).
9. David Pimentel, 2007. Encyclopedia of Pest Management, Volume II. CRC Press (ISBN 9781420053616). Pages: 784.
10. Fleming, Diane O. and Hunt, Debra L. 2006. Biological Safety - Principles and Practices (4th Edition). American Society for Microbiology (ASM) (Print ISBN: 978-1-55581-339-0; E-ISBN 978-1-61344-247-0).
11. Fleming, Diane O. and Hunt, Debra L. 2006. Biological Safety - Principles and Practices (4th Edition). American Society for Microbiology (ASM) (Print ISBN: 978-1-55581-339-0; E-ISBN 978-1-61344-247-0).
12. Agrios, G.N. 2005. Plant Pathology. Fifth Edition, Academic Press, Inc.

Websites:

1. Bowtie: <http://bowtie-bio.sourceforge.net/index.shtml>
2. BLAST: <http://blast.ncbi.nlm.nih.gov/>
3. KEGG: <http://www.genome.jp/kegg/>
4. Gene Ontology: <http://www.geneontology.org/>
5. BGI WEGO: <http://wego.genomics.org.cn/cgi-bin/wego/index.pl>
6. Venny: <http://bioinfogp.cnb.csic.es/tools/venny/index.html>
7. NCCA: <http://www.cotton.org/econ/cropinfo/cropdata/index.cfm>

ANNEXURE - A

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

Basics of grammar

Parts of speech and use of articles

Sentence structure, active and passive voice

Practice in unified sentence

Analysis of phrase, clause and sentence structure

Transitive and intransitive verbs

Punctuation and spelling

Comprehension

Answers to questions on a given text

Discussion

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

Listening

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

Translation skills

Urdu to English

Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books:

1. Functional English

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1 (3^r ed) Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2 (3rd). Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

English II (Communication Skills)

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

Course Contents:

Paragraph writing

Practice in writing a good, unified and coherent paragraph

Essay writing

Introduction

CV and job application

Translation skills

Urdu to English

Study skills

Skimming and scanning, intensive and extensive, and speed reading, summary and precise writing and comprehension

Academic skills

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

Presentation skills

Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended Books

Communication Skills

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2 (3rd). Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.

2. Reading and Study Skills by John Langan
3. Study Skills by Richard York.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents:

Presentation skills

Essay writing

Descriptive, narrative, discursive, argumentative

Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

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

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
 3. Patterns of College Writing (4th ed.) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
- b) Presentation Skills
- c) Reading
- The Mercury Reader. A Custom Publication. Compiled by Northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

ANNEXURE - B

Pakistan Studies (Compulsory)

Introduction/Objectives

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
 - i. Indus civilization
 - ii. Muslim advent
 - iii. Location and geo-physical features

2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

Recommended Books:

1. Burki, Shahid Javed. *State & Society in Pakistan*, The MacMillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S. M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: Wm Dawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K. K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

ANNEXURE - C

ISLAMIC STUDIES (Compulsory)

Objectives

This course is aimed at:

- 1 To provide basic information about Islamic studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies

- 1) Basic concepts of Quran
- 2) History of Quran
- 3) Uloom-ul-Quran

Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Baqara related to faith (Verse No-284-286)
- 2) Verses of Surah Al-Hujrat related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon related to characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan related to social ethics (Verse No.63-77)
- 5) Verses of Surah Al-Inam related to Ihkam (Verse No-152-154)

Study of Selected Text of Holly Quran

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

Seerat of Holy Prophet (S.A.W) I

- 1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah
- 3) Important lessons derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important events of life of Holy Prophet in Madina
- 3) Important lessons derived from the life of Holy Prophet in Madina

Introduction to Sunnah

- 1) Basic concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence

- 1) Basic concepts of Islamic law & jurisprudence
- 2) History & importance of Islamic law & jurisprudence
- 3) Sources of Islamic law & jurisprudence
- 4) Nature of differences in Islamic law
- 5) Islam and sectarianism

Islamic Culture & Civilization

- 1) Basic concepts of Islamic culture & civilization
- 2) Historical development of Islamic culture & civilization
- 3) Characteristics of Islamic culture & civilization
- 4) Islamic culture & civilization and contemporary issues

Islam & Science

- 1) Basic concepts of Islam & science
- 2) Contributions of Muslims in the development of science
- 3) Quran & science

Islamic Economic System

- 1) Basic concepts of Islamic economic system
- 2) Means of distribution of wealth in Islamic economics
- 3) Islamic concept of riba

- 4) Islamic ways of trade & commerce

Political System of Islam

- 1) Basic concepts of Islamic political system
- 2) Islamic concept of sovereignty
- 3) Basic institutions of Govt. in Islam

Islamic History

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

Social System of Islam

- 1) Basic Concepts of Social System of Islam
- 2) Elements of Family
- 3) Ethical Values of Islam

Recommended Books

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H. S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

**COMPULSORY MATHEMATICS
COURSES FOR BS (4 YEAR)
(FOR STUDENTS NOT MAJORING IN
MATHEMATICS)**

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

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

Course Outline:

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

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

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

Recommended Books:

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)

2. Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

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

Course Outline:

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

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

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

Recommended Books:

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

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

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

Course Outline

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

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

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

Recommended Books:

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

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

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

Aims : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

Objectives : After completion of this course the student will be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents :

1. Algebra

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

2. Statistics

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

Recommended Books:

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

4. Wilcox, R. R., '*Statistics for The Social Sciences*'

5. MATHEMATICS FOR CHEMISTRY

Credit Hours: 3

Prerequisites: Mathematics at Secondary level

Course Objectives

To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline

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

Recommended Books:

1. Thomas, Calculus, 11th ed. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th ed. John Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd ed. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelsohn, Calculus, Schaum's Outline Series, (4th ed,) 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

6. MATHEMATICS FOR PHYSICS

Contents

1. Preliminary calculus

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

2. Complex numbers and hyperbolic functions

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

3. Series and limits

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

4. Partial differentiation

- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

5. Multiple integrals

- Double integrals
- Triple integrals
- Applications of multiple integrals
areas and volumes; masses, centers of mass and centri Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals
change of variables in double integr

6. Vector algebra

- Scalars and vectors
- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors
Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes
Equation of a line; equation of a plane
- Using vectors to find distances
Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

7. Matrices and vector spaces

- Vectors spaces Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix
Properties of determinants
- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations
N simultaneous linear equations in N unknowns
- Special square matrices
Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
- Eigen vectors and eigen values
of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
- Determination of eigen values and eigen vectors Degenerate eigen values

8. Vector calculus

- Differentiation of vectors composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators
- Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae
- Vector operators acting on sums and products; combinations of grad, div and curl
- Cylindrical and spherical polar coordinates
- Cylindrical polar coordinates; spherical polar coordinates

ANNEXURE - E

Statistics-I

Credit 3 (2-1)

Definition and importance of statistics in agriculture, data different types of data and variables

Classification and tabulation of data, frequency distribution, stem-and-Leaf diagram, graphical representation of data histogram, frequency polygon, frequency curve.

Measure of central tendency, definition and calculation of arithmetic mean, geometric mean, harmonic mean, median quantiles and mode in grouped and un-grouped data.

Measure of dispersion, definition and calculation of range, quartile deviation, mean deviation, standard deviation and variance, coefficient of variation.

Practical

- a. Frequency distribution
- b. Stem-and-leaf diagram
- c. Various types of graphs
- d. Mean, geometric mean harmonic mean,
- e. Median, quartiles deviation, mean deviation.
- f. Standard deviation, variance, coefficient of variation,
- g. Skewness and kenosis

Recommended Books

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crashaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2nd Ed. (1986) Fran II. Dietrich-II and Thomas J. Keans

Statistics-II**Credit 3 (2-1)**

Sampling: probability and non-Probability sampling, simple random sampling stratified random sampling systematic sampling error, sampling distribution of mean and difference between two means. interference Theory: estimation and testing of hypothesis, type—I and type-II error, testing of hypothesis about mean and difference between two means using Z-test and t-test, paired t-test, test of association of attributes using X² (chi-square) testing hypothesis about variance.

Practical

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

Recommended Books:

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2nd Edition, 1980 by R. G. D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2nd Edition (1980) by K. A. Gomez and A. A. Gomez

ANNEXURE - F

Introduction to Information and Communication Technologies

Course Structure: Lectures: 2 Labs: 1 **Credit Hours: 3**

Pre-requisite: None **Semester: 1**

Course Description

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

Course Contents

Basic definitions & concepts

Hardware: computer systems & components

Storage devices, number systems

Software: operating systems, programming and application software

Introduction to programming, databases and Information systems

Networks

Data communication

The internet, browsers and search engines

The internet: email, collaborative computing and social networking

The internet: e-commerce

IT security and other issues
Project week
Review week

Text Books/Reference Books

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill
2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition, McGraw-Hill
3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer
Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.

ANNEXURE - G

Functional Biology-I Credit Hours 3+0

Biological Methods

Principles of cellular Life

Chemical basis

Structure and function

Principles of metabolism

Energy acquisition

Principles of inheritance

Mitosis and meiosis

Chromosomes

Observable Inheritance Patterns

DNA structure and function

RNA and proteins

Genes

Genetic engineering and biotechnology

Biodiversity

Fundamental Concept of Biodiversity

One or two examples of each of the following from commonly found organism

Prions

Viruses

Bacteria

Protistans

Algae

Fungi

Plants

Crops

Animals

Invertebrates

Vertebrates

Reading

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

Functional Biology-II Credit Hours 3+0

Myths and realities of evolution

Microevolution

Speciation

Macroevolution

Level of organization

Plants

Tissues

Nutrition and transport

Reproduction

Growth and development

Animals

Tissue, organ system and homeostasis

Information flow and neuron

Nervous system

Circulation and immunity

Nutrition and respiration

Reproduction and development

Ecology and behavior

Ecosystems

Biosphere

Social interactions

Community interactions

Human impact on biosphere

Environment conservation

Reading

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

Note

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

Functional Biology-II Credit Hours 3+0

Myths and realities of evolution

Microevolution

Speciation

Macroevolution

Level of organization

Plants

Tissues

Nutrition and transport

Reproduction

Growth and development

Animals

Tissue, organ system and homeostasis

Information flow and neuron

Nervous system

Circulation and immunity

Nutrition and respiration
Reproduction and development
Ecology and behavior
Ecosystems
Biosphere
Social interactions
Community interactions
Human impact on biosphere
Environment conservation

Reading

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

Note

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

GENERAL RECOMMENDATIONS

1. All the universities should implement the revised curriculum (2015) of Plant Protection in its true spirit.
2. University should ensure that all recommended books in the HEC curriculum are made available in the university/departmental libraries.
3. It is strongly recommended by the committee members that refresher courses/workshops/training/seminars be arranged inland/abroad and funded by the HEC in Plant Protection and relevant fields.
4. HEC should provide opportunities/resources to the teachers to visit International/National universities/institutions to update their knowledge in their respective fields.
5. The universities should arrange to provide sufficient number of faculty to teach courses at various degree programs, keeping in view the student teacher ratio per University rules as recommended by HEC.
6. It is highly recommended that HEC should provide funds to equip laboratories with apparatus and chemicals especially to the universities where these are not available. The process involved in funding should be simplified.
7. Adequately qualified and trained technicians/engineers, Lab assistants and Lab attendants be employed by Universities for the processing of samples and maintenance of sophisticated laboratory equipment. The in-service technicians/ engineers should also be provided training facilities to update their knowledge.
8. HEC should provide initial startup financial support to local MSc/PhD students in the Universities.
9. It is recommended that the universities should follow uniform thesis examination policy.
10. The committee members realized that three days allocated to discuss curriculum were not sufficient. It is recommended that at least four working days should be

allocated for the same.

11. It is highly recommended that Plant Protection as a major subject should be introduced in all Agricultural Colleges/Faculties at under graduate and post graduate levels.
12. In every Plant Protection curricula meeting, there should be at least two representatives from stakeholders/concerned Universities.
13. There should be the representation of other organizations like as Federal Seed certification and Registration Department, Federal Plant Protection Department, Various Plant Protection Research Institutes etc.