CURRICULUM OF

HORTICULTURE

(Final 2014)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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

Composed by: Mr. Tanveer Ali, HEC

CONTENTS

PREFACE

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

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

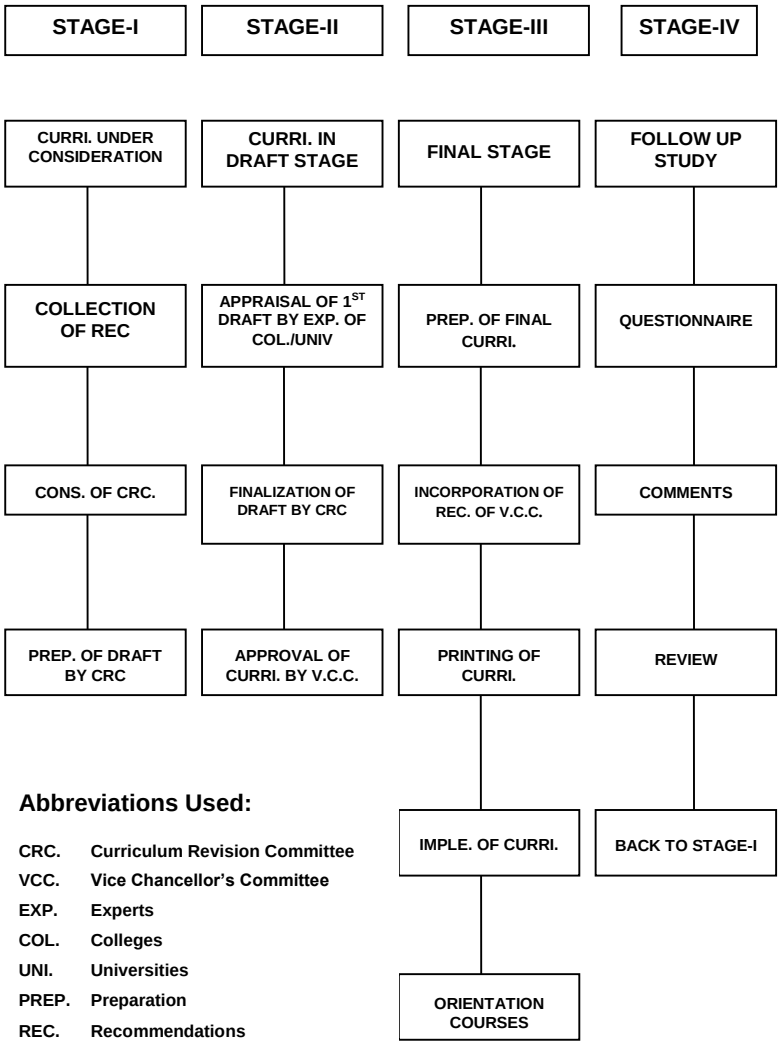
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector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

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

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

(Fida Hussain)
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



Abbreviations Used:

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

Minutes of the Final Meeting of National Curriculum Revision Committee in Horticulture 2014

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Horticulture was held on May 14 - 16, 2014 at HEJ Research Institute of Chemistry, University of Karachi, Karachi to finalize the draft curriculum for Horticulture at undergraduate and postgraduate levels. The following members of the committee attended the meeting.

1.	**Dr. Muhammad Aslam Pervez** Professor and Director Institute of Horticultural Sciences University of Agriculture, Faisalabad	Convener
2.	**Dr. Muhammad Akbar Anjum** Professor and Chairman Department of Horticulture Bahauddin Zakariya University, Multan	Member/Secretary
3.	**Dr. Abdur Rab** Professor and Chairman Department of Horticulture University of Agriculture, Peshawar	Member
4.	**Dr. Muhammad Jamil Ahmed** Professor/Registrar Department of Horticulture Faculty of Agriculture University of Poonch, Rawalakot	Member
5.	**Dr. Nadeem Akhtar Abbasi** Professor and Chairman Department of Horticulture PMAS-Arid Agriculture University, Rawalpindi	Member
6.	**Dr. Muhammad Saleem Jilani** Professor and Chairman Department of Horticulture Gomal University, Dera Ismail Khan	Member
7.	**Dr. Muhammad Ayub Baloch** Associate Professor and Chairman Department of Horticulture Sindh Agriculture University, Tandojam	Member
8.	**Dr. Saba Ambreen** Associate Professor Department of Horticulture Sindh Agriculture University, Tandojam	Member

9.	**Dr. Rashad Mukhtar Balal** Assistant Professor Department of Horticulture University College of Agriculture University of Sargodha, Sargodha	Member
10.	**Dr. Shahjahan Shabbir Ahmed** Assistant Professor Department of Biotechnology & Bioinformatics BUITEMS, Quetta.	Member
11.	**Mr. Malik Fiaz Hussain Ferdosi** Assistant Professor of Horticulture Institute of Agricultural Sciences University of the Punjab, Lahore	Member
12.	**Mr. Shah Masaud Khan** Assistant Professor Head of Horticultural Section Department of Agriculture University of Haripur, Haripur	Member
13.	**Mr. Ishtiaq Ahmad** Lecturer Department of Horticulture College of Agriculture and Environmental Sciences The Islamia University of Bahawalpur, Bahawalpur	Member

The meeting started with recitation of few verses from the Holy Qur'an by Dr. Tahir Ali Shah.

Dr. Tahir Ali Shah, Deputy Director (Academics), HEC, Islamabad welcomed the participants on behalf of the Chairman, HEC. He briefed the committee about the mandate of the Commission for review, revision and development of curricula for undergraduate and postgraduate degree programmes being offered by different universities/colleges of the country. He further intimated that the HEC is striving hard to enhance quality of education in public sector universities/institutions by making curriculum more compatible with international standards, job oriented and to match the needs of the society. He also briefed about HEC Academics Division's programmes regarding the strengthening of departmental libraries and laboratories. He further informed that HEC has started a curriculum based training to train the young teachers for curriculum development.

The Committee appreciated the efforts of HEC for providing a platform for development, revision and upgradation of the curricula. The members also

extended their sincere thanks to Dr. Tahir Ali Shah, Deputy Director (Academics), HEC, Islamabad for arranging and coordinating the meeting. They also thanked Mr. Ghulam Haider, Director and Mr. Mubashar Ahmed Memon, Deputy Director, HEC Regional Centre, Karachi and their staff for their cooperation, hospitality and providing logistics.

The committee unanimously decided to continue Prof. Dr. Muhammad Aslam Pervez as Convener and Prof. Dr. Muhammad Akbar Anjum as Secretary of the Committee.

The Committee considered the draft of Scheme of Studies in Horticulture and curricula/ syllabi at undergraduate and postgraduate levels in the discipline of Horticulture, developed in the preliminary meeting of National Curriculum Revision Committee (NCRC) held in November 2013 at the HEC Regional Centre, Lahore.

The Committee thoroughly reviewed the draft curricula and made necessary changes to update the proposed courses and also suggested latest books for each course. Learning outcomes were also added after contents of each course. According to Template for 4-Year B.Sc. (Hons.) Agriculture programme, the credit hours of “Internship were retained as four”. It was agreed that the universities/ colleges may offer Internship or Research Project in the final semester of the B.Sc. (Hons.) Agriculture and will be optional for institutions, not for students. Internship may be offered during the summer or winter vacations if students are placed outside the university/college. However, its duration will not be less than two months. The Committee proposed some new courses as optional to be offered during the final semester of B.Sc. (Hons) Agriculture depending upon the regional requirements and expertise available in the university/college. It was unanimously agreed that the Scheme of Studies should be flexible and the universities/colleges may modify the course codes and titles; and may make minor changes in the contents of courses. They may also offer an optional course in the final semester of B.Sc. (Hons.) depending upon the expertise of teachers, facilities available, agro-ecological conditions of the area, local and regional needs. Further, to provide better education, preferably there may be maximum of 25 students in one group of practical class. It was also unanimously agreed that duration of theory class should not be less than one hour and that of practical not less than two hours. It was also proposed that the students may be allowed to take/repeat up to two courses (6 credit hours) over and above their normal work load whenever the course is offered regularly or during summer semester/ session to pass the courses or improve their grades.

Regarding the M.Sc. (Hons.)/M.Phil. and Ph.D. Horticulture courses, the committee proposed important courses to be offered by the

universities/colleges. Some new courses were also developed and added in the Scheme of Studies to satisfy national and international needs. After fulfilling the HEC requirements, the universities/ institutions may develop and introduce some additional courses depending upon the expertise and facilities available and regional needs. However, there should be sufficient number of courses to strengthen the specific specialization of the students to fulfil the degree requirements.

Finally, the Committee, after three days discussion, recommended the revised curricula of Horticulture at undergraduate and postgraduate levels.

The meeting ended with vote of thanks to the chair.

FRAMEWORK/TEMPLATE OF 4-YEAR B.Sc. (HONS.) IN AGRICULTURAL DISCIPLINES

1. Compulsory Courses

	Credit Hours
Mathematics / Biology (2 courses)	6 (3-0) (2-1)
Statistics 1 & 2	6 (3-0) (3-0)
Computers / IT	3 (2-1)
Pakistan Studies	2 (2-0)
Islamic Studies	2 (2-0)
Communications 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)
Entomology	3 (2-1)
Plant Pathology	3 (2-1)
Food Technology	3 (2-1)
Horticulture	3 (2-1)
Soil Sciences	3 (2-1)
Agriculture Economics	3 (2-1)
	Sub-Total 24

3. Supporting Courses {6 – 8 courses (3 Cr. Hr) amongst below}

Agriculture Extension
Forestry & Range Management
Animal Science
Marketing & Agri. Business
Rural Development
Human Nutrition
Agriculture Chemistry
Agriculture Engineering
Water Management
Any other discipline recommended by the university

Sub-Total 18-24

Sub-Total during the first four semesters	**70 – 76**
Semester 5, 6, 7 & 8	**56-60**
Project / Internship	**4**
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 UNDERGRADUATE COURSES IN HORTICULTURE

GENERAL COURSES

Semesters 1 – 4

Hort. 201	Introductory Horticulture	3(2-1)
Hort. 202	Horticultural Crop Production	3(2-1)
		Total = 6

HORTICULTURE MAJOR GROUP

5th Semester

Hort. 301	Principles of Fruit Production	4(3-1)
Hort. 303	Principles of Vegetable Production	3(2-1)
Hort. 305	Principles of Ornamental Crop Production	3(2-1)
Hort. 307	Propagation and Nursery Management	3(1-2)
Hort. 309	In Vitro Propagation	2(1-1)
		Total = 15

6th Semester

Hort. 302	Tropical and Sub-Tropical Fruits	3(2-1)
Hort. 304	Summer Vegetables	3(2-1)
Hort. 306	Landscape Horticulture	3(2-1)
Hort. 308	Medicinal and Aromatic Plants	3(2-1)
Hort. 310	Post-Harvest Horticulture	3(2-1)
		Total = 15

7th Semester

Hort. 401	**Research Methods in Horticulture**	**3(1-2)**
Hort. 403	Temperate Fruits	3(2-1)
Hort. 405	Winter Vegetables	3(2-1)
Hort. 407	Commercial Flower Production	3(2-1)
Hort. 409	Breeding of Horticultural Crops	3(2-1)
		Total = 15

8th Semester

Hort. 402	Internship / Research Project	4(0-4)
Hort. 404	Vegetable and Flower Seed Production	3(2-1)
Hort. 406	Protected Horticulture	3(2-1)
Hort. 408	Indoor Plant Culture and Scaping	3(2-1)
Hort. 410	Business Management in Horticulture	3(3-0)
Hort. 412	Any other course (Optional)	2(1-1)
		Total = 18

OPTIONAL COURSES

Hort. 412	Project Planning and Scientific Writing	2(1-1)
	Arid Horticulture	
	Organic Horticulture	
	Peri-Urban Horticulture	
	Floral Designs and Arrangements	
	Soilless Horticultural Crop Production	
	Amenity Horticulture	
	Therapeutic Horticulture	
	Mushroom Culture	
	Introductory Plant Biotechnology	

OUTLINE OF COURSES FOR UNDERGRADUATE STUDIES IN HORTICULTURE

Hort. 201 INTRODUCTORY HORTICULTURE 3(2-1)

Prerequisites

F.Sc. (Pre-Medical)

Specific Objectives

To enable the students to understand the basics of Horticulture.

Theory

Introduction, history, importance and future scope, Definition and divisions of horticulture, Classification of horticultural crops, Plant parts, their modifications and functions, Plant environment; climate (temperature, light, humidity etc) and soil (structure, texture, fertility etc), Phases of plant growth, Propagation of horticultural plants.

Practical

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

Learning Outcomes:

Students must be able to prepare media, identify and propagate important horticultural plants

Recommended Books

- Chadha, K.L. 2006. Handbook of Horticulture (6th Ed.). ICAR, New Delhi, India.
- Christopher, E. P. 2012. Introductory Horticulture. Biotech books, new Dehli, India.
- Carrol,L., J.R.Shry and H.E. Reily. 2011. Introductory Horticulture (8th Ed.) Delmar-Thomson Learning , Albany, USA
- Hartmann, H.T., D.E. Kester, E.T. Davies and R.L. Geneve. 2009. Plant Propagation–Principles and Practices (7th Ed.). Prentice-Hall India Learning Pvt. Ltd., New Delhi, India.
- Malik, M.N. 1994. Horticulture. National Book Foundations, Islamabad.
- Peter, K.V. 2009. Basics of Horticulture. New India publishing Agency, New Dehli, India.
- Reiley, H.E., C.L. Shry (Jr). 2004. Introductory Horticulture (6th Ed.). Delmar- Thomson Learning, Albany, USA.

- Reddy, R. and Shanker J.P.A. 2008. Horticulture. Commonwealth Publishers.
- Sharma, R.R. 2002. Propagation of Horticultural Crops: Principles and Practices. Kalyani Publishers, Ludhiana, New Delhi, India.

Journals/Periodicals

Worldwide Web

Hort. 202 HORTICULTURAL CROP PRODUCTION 3(2-1)

Prerequisites

Introductory Horticulture

Specific Objectives
To make students familiar with production technology of important horticultural crops.

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

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

Learning Outcomes
Students are expected to grow different horticultural crops of the region

Recommended Books
- Acquaah, G. 2009. Horticulture: Principles and Practices (4th Ed.). Prentice-Hall India Learning Pvt. Ltd. New Delhi, India.
- Adams, C. R., K.M. Bamford and M. P. Early. 2012. Principles of Horticulture (6th Ed.). Routledge, new yark, USA.
- Ingles, J. 2009. Ornamental Horticulture. Delmar 5 Maxwell Drive, Cifton, Park, New York.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crop. Kalyani Publishers, Ludhiana, New Delhi, India.
- Malik, M.N. 1994. Horticulture, National Book Foundation, Islamabad.

- Singh, B. 2007. Horticulture at a Glance. Kalyani Publishers, Ludhiana, New Delhi, India.
- Chottopadhay, T.K. 2000. A Textbook on Pomology, Vol: II. Kalyani Publishers, New Delhi.
- Laurie, A. and V.H. Ries. 2004. Floriculture: Fundamentals and Practices. Agrobios (India), Jodhpur, India.
- Pradeepkumar, T., B. Suma, Jyothibhaskar, K.N. Satheesan, K.V. Peter. 2008. Management of Horticultural Crops (Part 1). Horticulture Science Series Vol. 11. New India Publishing Agency, New Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.

Journals/Periodicals

Worldwide Web

Hort. 301 PRINCIPLES OF FRUIT PRODUCTION 4(3-1)

Prerequisites

Introductory Horticulture

Specific Objectives

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

Theory

Introduction to fruit science, Fruit-bud formation; initiation, development and controlling factors, Rest and dormancy, Plant growth regulators (PGRs) and their uses. Pollination and fruit setting problems, incompatibility, Fruit thinning. Parthenocarpy and seedlessness, Bud variations and mutations. Physiological disorders; Fruit drop, Biennial bearing etc.; causes and control, Maturity and harvesting indices, Harvesting methods, ripening and senescence.

Practical

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

Learning Outcomes

Students are expected to understand various stages of fruit plants phenology and physiology in order to solve related problems

Recommended Books

- Acquaah, G. 2009. Horticulture: Principles and Practices (4th Ed.). Prentice-Hall India Learning Pvt. Ltd. New Delhi, India.
- Chottopadhay, T.K. (Ed.). 2003. A Textbook on Pomology, Vol. I: Fundamentals of Fruit Growing. Kalyani Publishers, Ludhiana, New Delhi, India.
- Chottopadhay, T.K. 2000. A Textbook on Pomology, Vol. II: Tropical Fruits. Kalyani Publishers, New Delhi.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Duggar, B.M.2010. Plant Physiology with Special Reference to Plant Production. Biblio Bazaar, LLC, Charleston, South Carolina, USA.
- Jackson, D.I., N.E. Looney, M.Morley-Bonker and G. Thiele.. 2011. Temperate and Subtropical Fruit Production. CAB International Publishing, Wallingford, U.K.
- Singh, A. 2003. Fruit Physiology and Production. Kalyani Publication, Ludhiana, New Delhi, India.
- Singh, N.P. 2004. Basic Concepts of Fruit Science. International Book Distribution Company (Publishing Division), Lucknow, India.
- Gardener, V.R. 2001. The Fundamentals of Fruit Production (5th Ed.). McGraw-Hill Book Company, USA.

Journals/Periodicals

Worldwide Web

Hort. 303 PRINCIPLES OF VEGETABLE PRODUCTION 3(2-1)

Prerequisites

Introductory Horticulture

Specific Objectives

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

Theory

Introduction and importance, Classification of vegetables, Cropping systems; succession, relay and multiple cropping etc., Recent trends in vegetable production; off-season vegetable production, hydro and aero-ponics, organic farming, Factors affecting vegetable production, Bulb and tuber formation, Crop management and quality assurance; seed selection, nursery raising, hardening and transplanting, mulching, Pruning and staking, irrigation, harvesting etc Parthenocarpy and seedlessness. Physiological disorders, Production problems and their management, Use of plant growth regulators.

Practical

Identification and description of flower, fruit and seed of important cultivars, Seed priming, Methods of sowing, Practice in raising nursery, hardening and transplanting of seedlings, Pruning and staking practices, Visits to vegetable farms.

Learning Outcomes:

Students must be familiar with basic principles behind successful vegetable production.

Recommended Books

- Bose, T.K., M.G. Som and J. Kabir. 1993. Vegetable Crops. Naya Prokash, Calcutta-Six.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Hazra, P. and M.G. Som. 2005. Vegetable Science. Kalyani Publishers, Ludhiana, New Delhi, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers. 5th edition. John Willey and Sons, Inc., NewYork.
- Nonnecke, I.L. 2006. Vegetable Production. Springer Publishers, India.
- Rana, M. K. 2012. Modern Concepts of Vegetables Production. Biotech. Books, New Delhi.
- Swaider, J.M., G.W. Ware and J.P. McCollum. 2002. Producing Vegetable Crops (5th Ed.), Interstate Publishers Printers and Publishers Inc., Danville, Illinois.

- Singh, P. and S. P. Singh. 2012. Principles of Vegetable Production. Oxford book company New Delhi.
- Singh, A.P. 2003. A Textbook of Vegetable Culture. Kalyani Publishers, Ludhiana, New Delhi, India.
- Singh,P. and S. P. Singh. 2012. Principles of Vegetable Production. Oxford book company new Delhi.

Journals/Periodicals

Worldwide Web

Hort. 305 PRINCIPLES OF ORNAMENTAL CROP PRODUCTION 3(2-1)

Prerequisites

Introductory Horticulture

Specific Objectives:

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

Theory

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

Practical

Seeding, raising and transplanting of nursery, Identification of annuals, herbaceous perennials, foliage plants, succulents and flowering bulbs with their propagation methods and management practices (pinching, disbudding, deshooting etc.), Methods of breaking seed and bulb dormancy, Visits to ornamental nurseries, parks, cut flower shops, flower exhibitions and growing structures.

Learning Outcomes

Students are expected to have knowledge of basic principles of ornamental crop production.

Recommended Books

- Arora, J.S. 2003. Introductory Ornamental Horticulture (4th Ed.). Kalyani Publishers, New Delhi.
- Dey, S.C. 2010. Flowers from Bulbous Plants. Agribios, Jodhpur, India.

- Larson, RA. 1980. Introduction to Floriculture. Academic Press, New York.
- Laurie, A. and Ries V.S. 2004. Floriculture: Fundamentals and Practices. Agrobios (Inidia), Jodhpur, India.
- Hessayon, D.G. 2007. The Flowering Shrubs Expert (3rd Ed.). Transworld Publishers,London, U.K.
- Hessayon, D.G. 2007. The Flowering Bulbs Expert (3rd Ed.). Transworld Publishers,London, U.K
- Bhattacharjee, S.K. 2006. Advances in ornamental Horticulture. Eastern Book Corporation, Delhi, India.
- Raj, D. 2002. Floriculture and Landscaping. Kalyani Publisher, New Delhi.

Journals/Periodicals

Worldwide Web

Hort. 307 PROPAGATION AND NURSERY MANAGEMENT 3(1-2)

Prerequisites

Introductory Horticulture

Specific Objectives

To impart technical knowledge about nursery management and certification procedures.

Theory

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

Practical

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

Learning Outcomes
Students must be able to manage nurseries and propagate healthy horticultural plants.

Recommended Books

- Adriance, G.W., and F.R. Brison. 2000. Propagation of Horticultural Plants. Biotech Books, Delhi, India.
- Hartmann, H.T., D.E. Kester and F.T. Davies. 2011. Plant propagation: principles and practices (8th Ed.). prentice Hall, New Jersey, USA.
- Rajan, S. and B.L. Markose. 2007. Propagation of Horticultural Crops. New India publishing Agency, New Dehli, India.
- Ray,P.K. 2001. Plant Nursery Management:How to Start and Operate a Plant Nursery. Scientific publishers, Jodhpur, India.
- Sharma, R.R. 2002. Propagation of Horticultural Crops: Principles and Practices. Kalyani Publishers, Ludhiana, New Delhi, India.
- Sharma, R.R. and M. Srivastav. 2004. Plant Propagation and Nursery management. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Sharma, V.K. 1996. Plant Nurseries: Techniques, Production and Management. Indus Publishing Company, New Delhi, India.

Journals/Periodicals

Worldwide Web

Hort. 309 IN VITRO PROPAGATION 2(1-1)

Prerequisites

Introductory Horticulture

Specific Objectives
To acquaint the students with modern techniques of plant multiplication.

Theory

Introduction and importance; Basic terminology, application and constraints of plant tissue culture; Nutritional components of culture media (nutrients, carbohydrates, vitamins, growth regulators, amino acids and antibiotics), their types & functions; aseptic techniques; Initiation and maintenance of cultures; Physical factors for growth; transplanting and acclimatization; Preparation of synthetic seed; Concepts of plant biotechnology and its role in improvement of horticultural crops.

Practical

Laboratory safety precautions, sanitation, equipment; Calculations (preparation of molar, percent, normal, ppm etc solutions); Preparation of

stock solutions & media, sterilization techniques, inoculation and culture of explants, Acclimatization & transplanting.

Learning Outcomes
Students must understand the basic tissue culture techniques for *in vitro* propagation of horticultural crops.

Recommended Books

- Hartmann, H.T., D.E. Kester and F.T. Davies. 2011. Plant propagation: principles and practices (8th Ed.). prentice Hall, New Jersey, USA.
- Lindsey, K. (Ed). 2007. Plant Tissue Culture Mannual. Springer-Kluwer Academic Publishers New Delhi, India.
- George, E.F., M.A. Hall and G.J. De Klerk. 2008. Plant Propagation by Tissue Culture. 3rd Ed. Springer, Dordrecht, Netherlands.
- Razdan, M.K. 2003. Introduction to Plant Tissue Culture. Science Publishers Inc. (ISBN: 1-57808-237-4).
- Scoggins, H. and M. Bridgen. 2014. Plants from Test Tubes: An Introduction to Micro propagation (4th Ed.) Tiber Press.
- Smith,R. H. 2013. Plant Tissue Culture: Techniques and Experiments. Academic Press, London, UK.
- Trigiano, R. N. and J. G. Denis. 2011. Plant Tissue Culture, Development, and Biotechnology. CRC press, Boca Raton,Folorida,USA.
- Margit, L. and W. Rucker. 2004. Plant Tissue Culture: Plant Tissue Culture – 100 years since Gottlieb Haberlandt. CPL Scientific Publishers, (ISBN: 3211838392).
- Chandra, R. and M. Mishra (Eds). 2005. Comprehensive Micropropagation of Horticultural Crops International Book Distributing Co. (Publishing Division), Lucknow, India.

Journals/Periodicals

Worldwide Web

Hort. 302 TROPICAL AND SUB-TROPICAL FRUITS 3(2-1)

Prerequisites
Principles of Fruit Production

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

Theory

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

Practical

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

Learning Outcomes

Student must be able to produce important tropical and sub-tropical fruits

Recommended Books

- Alebrigo, L.G., L.W.Timmer and M.E. Rogers. 2014. Vol:II. Citrus (Crop Production Science in Horticulture). CABI
- Bali, S.S. 2003. Fruit Growing, Kalyani Publishers, New Delhi.
- Bose, T.K. and S.K. Mitra (Eds.). 1990. Fruits: Tropical and Subtropical. Naya Prokash, Calcutta-Six.
- Durate, O. and R.E. Paull, 2012. Tropical Fruits: Vol.II. Crop Production Science in Horticulture 24. CAB International Publishing.
- Chottopadhay, T.K. (Ed.). 2006. A Textbook on Pomology, Vol: II. Tropical Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Jackson, D., N. E. Looney, M. Morley-Bunker and G. Thiele. 2011. Temperate and Subtropical Fruit Production. CAB International Publishing, Wallingford, UK.
- Nakasone, H.Y. and R.E. Paull. 1998. Tropical Fruits. Crop Production Science in Horticulture 7. CAB International Publishing, Wallingford, U.K.
- Salunkhe, D.K., S.S. Kadam. 1995. Handbook of Fruit Science: production, composition, storage and processing. Marcel Dekker, Inc. New York
- Radha, T. and L. Mathew. 2007. Fruit Crops. New India Publishing Agency, New Delhi, India. (429 Pages).

Journals/Periodicals

Worldwide Web

Hort. 304 SUMMER VEGETABLES 3(2-1)

Prerequisites

Principles of Vegetable Production

Specific Objectives

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

Theory

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

Practical

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

Learning Outcomes

Students must be skilled in growing summer vegetables of the region.

Recommended Books

- Bose, T.K., M.G. Som and J. Kabir. 1993. Vegetable Crops. Naya Prokash, Calcutta-Six, India.
- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual for Cultivation. PHI learning private Ltd., New Delhi, India.Libner, N.S. 2006. Vegetable Production. Vedams Books Pvt. Ltd. New Delhi, India.
- Das, P.C. 2003. Vegetable Crops of India. Kalyani Publishers, New Delhi.
- Decoteau, D.R. 2002. Vegetable Crops. Prentice-Hall of India, New Delhi, India.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers (5th Ed.). John Willey and Sons Inc., New York.
- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana, New Delhi, India.
- Swaider, J.M., G.W. Ware and J.P. McCollum. 2002. Producing Vegetable Crops (5th Ed.), Interstate Publishers Printers and Publishers Inc., Danville, Illinois.

- Singh, A.P. 2002. Vegetable Growing in India. Kalyani Publishers, New Delhi.
- Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.

Journals/Periodicals

Worldwide Web

Hort. 306 LANDSCAPE HORTICULTURE 3(2-1)

Prerequisites

Principles of Ornamental Horticulture

Specific Objectives

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

Theory

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

Practical

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

Learning Outcomes

Students must be able to prepare designs, and manage landscape of various premises

Recommended Books

- Arora, J.S. 2003. Introductory Ornamental Horticulture (4^{th} Ed.). Kalyani Publishers, New Delhi.

- Biondo, R.J., and C.B. Schroeder. 2006. Introduction to Landscaping Design, Construction and Maintenance (3rd Ed.). ***International Book Distributing Company (Publishing Division), Lucknow, India.***
- Bhattacharjee, S.K. 2004. Landscape Gardening and Design with Plants. Aavishkar Publishers, Distributors, Jaipur, India.
- Gilmer, M. 2002. Water works. Contemporary Books McGraw Hill Companies, Sydney, Australia.
- Hessayon, D.G. 2007. Expert Series (Garden Expert, DIY Expert, The Easy Care Gardening Expert, The Rock and Water Garden Expert). Transworld Publishers, London, U.K.
- Ingels, J.E. 1992. Landscaping: Principles and Practices. Delmar Publishing Inc. New York.
- Raj, D. 2002. Floriculture and Landscaping. Kalyani Publishers, New Delhi.

Journals/Periodicals

Worldwide Web

Hort. 308 MEDICINAL AND AROMATIC PLANTS 3(2-1)

Prerequisites

Introductory Horticulture

Specific Objectives

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

Theory

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

Practical

Identification, collection and description, Introduction, acclimatization and multiplication of economically important plants, Parts used and important ingredients, Processing and extraction methods, Visits to various herbal institutions, "Pansari" markets and herbal gardens.

Learning Outcomes

Students must be able to identify and grow different condiments, spices and medicinal plants.

Recommended Books

- Bhattacharjee, S.K. 1999. Handbook of Medicinal Plants. Pointer Publishing Co. India.
- Das, P.C. 2014. Spice Crops Production Technology. Scientific publisher, Jodhpur, India
- Joshi, S.G. 2000. Medicinal Plants. Oxford and IBH, India.
- Farooqui, M.L.H. 2000. Medicinal Plants of Prophet Muhammad (PBUH). Sidrah Publishers, Lukhnow.
- Bimbraw,A.S 2006.Agrotechniques for umbelliferous medicinal and aromatic plants of India. International Book Distributing Co., India.
- Aslam, M. 2006. Guidelines for cultivation, collection, conservation and propagation of medicinal herbs. MINFAL, Pakistan.
- Serdar, O. and M. Milan. 2007. Medicinal and Aromatic Crops. Haworth Food & Agric. Products.
- Patil, D.A. 2008. Herbal cures a traditional approach. Aavishkar Publishers & Distributers, Jaipur, India.
- Bogers, R.J., L.E. Craker and D. Lange. 2006. Medicinal and Aromatic Plants. Haworth Food & Agric. Products.
- Raju, R.A. 2000. Wild Plants of Indian Sub-Continent and Their Economic Use. CBS Publishers and Distributors, New Delhi.

Journals/Periodicals

Worldwide Web

Hort. 310 POST-HARVEST HORTICULTURE 3(2-1)

Prerequisites

Introductory Horticulture

Specific Objectives

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

Theory

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

quality assurance, sanitary and phyto-sanitary measures, Shipment for local and foreign markets.

Practical
Machinery and equipment used for various operations, Demonstration of harvest indices, Practices in harvesting, curing, packing and preparation of different fruits, vegetables and cut flowers for marketing, Determination of total soluble solids; Determination of fruit firmness, starch-iodine test, color determination, Visits to the fruit, vegetable and floral markets, packing houses and cold storages etc.

Learning Outcomes
Students must have the knowledge of produce physiology and its application to ensure quality and shelf life.

Recommended Books

- Bhattacharjee S. K and L.C. De. 2005. Post-Harvest Technology of Flowers and Ornamental Plants. Pointer Publishers jaipur India.
- Burg. P. S. 2004. Post harvest Physiology and Hypobaric Storage of Fresh Produce. CABI Publishing.
- Choudhry, M. L and K. V. Parsad. 2003. Value Addition in Horticulture. Delhi Agri-Horticultural Society. Division of Floriculture and Landscaping Indian Agricultural Research Institute Pusa, New Delhi-110 012.
- Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of California Press, California, USA.
- Sadiq M., J. Ahmed, M.G. Lobo and F. Ozadali. 2012. Tropical and Subtropical Fruits: Postharvest Physiology, Processing and Packaging. Wiley-Balckwell Publisher.
- Simson, P.S. and Straus, M.C. 2010. Post-Harvest Technology of Horticultural Crops. Oxford Book Company, New Delhi.
- Singh, S.I. 2009. Post-Harvest Handling and Processing of Fruits and Vegetables. Westville Publishing House.
- Thompson, A.K. 1996. Post-Harvest Technology of Fruits and Vegetables. Blackwell Science Ltd., Oxford.

Journals/Periodicals

Worldwide Web

Hort. 401 RESEARCH METHODS IN HORTICULTURE 3(1-2)

Prerequisites
All the Major courses of 5th and 6th semesters.

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

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

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

Learning Outcomes
Students must be able to understand the problems, prepare research proposal and execute under field and laboratory conditions independently.

Recommended Books

- Laake,P., H. B. Benestad and B. R. Olsen. 2007. Research Methodology in the Medical and Biological Sciences. Academic press, San Diego, USA.
- Quinn,G. P. and M. J. Keough. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University press, Cambridge, UK.
- Mukul,G. and G. Deepa. 2011. Research Methodology. PHI Learning Private Ltd., New Dehli India.
- Singh, Y. K. 2006. Fundamental of Research Methodology and Statistics. New age international Pvt. Ltd., New Dehli, India.
- Pearce, S.C. 1976. Field Experimentation with Fruit and Other Perennial Plants. Tech. Communication No. 23. Commonwealth Bureau of Horticulture and Plantation Crops. East Malling, Kent.
- Petersen, R.G. 1994. Agricultural Field Experiments–Design and Analysis. Marcel Dekker, Inc., New York.
- Srivastav, M. and R.S. Yadav. 2007. Principles of Laboratory Techniques and Methods. International Book Distributing Company (Publishing Division), Ludhiana, India.

Journals/Periodicals

Worldwide Web

Hort. 403 TEMPERATE FRUITS 3(2-1)

Prerequisites

Principles of Fruit Production

Specific Objectives

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

Theory

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

Practical

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

Learning Outcomes

Student must be able to produce important temperate fruits.

Recommended Books

- Bali, S.S. 2003. Fruit Growing, Kalyani Publishers, New Delhi.
- Bose, T.K. and S.K. Mitra (Eds.). 1990. Fruits: Tropical and Subtropical. Naya Prokash, Calcutta-Six.
- Mitra, S.K., D.S. Rathore, and T.K. Bose (Eds.). 1991. Temperate Fruits. Horticulture and Allied Publishers, Calcutta.
- Barooh, S. 1998. Modern Fruit Culture. Kalyani Publishers, Ludhiana, New Delhi, India.
- Chottopadhay, T.K. (Ed.). 2009. A Textbook on Pomology, Vol: IV. Temperate Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Jackson, D.I., N. Looney, M. Morley-Bonker and G. Thiele. 2011. Temperate and Subtripical Fruit Production. CAB International Publishing, Wallingford, UK.
- Salunkhe, D.K., S.S. Kadam. 1995. Handbook of Fruit Science: production, composition, storage and processing. Marcel Dekker, Inc. New York

Journals/Periodicals

Worldwide Web

Hort. 405 WINTER VEGETABLES 3(2-1)

Prerequisites

Principles of Vegetable Production

Specific Objectives

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

Theory

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

Practical

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

Learning Outcomes:

Students must be skilled in growing winter vegetables of the region.

Recommended Books

- Bose, T.K., M.G. Som and J. Kabir. 1993. Vegetable Crops. Naya Prokash, Calcutta-Six, India.
- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual For Cultivation. PHI learning private Ltd., New Delhi, India.
- Libner, N.S. 2006. Vegetable Production. Vedams Books Pvt. Ltd. New Delhi, India.
- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana, New Delhi, India.
- Decoteau, D.R. 2002. Vegetable Crops. Prentice-Hall of India, New Delhi, India.
- Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers (5th Ed.). John Willey and Sons Inc., New York.
- Swaider, J.M., G.W. Ware and J.P. McCollum. 2002. Producing Vegetable Crops (5th Ed.), Interstate Publishers Printers and Publishers Inc., Danville, Illinois.
- Das, P.C. 2003. Vegetable Crops of India. Kalyani Publishers, New Delhi.

- Singh, A.P. 2002. Vegetable Growing in India. Kalyani Publishers, New Delhi.
- Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Maynard, D.N. and G.J. Hochmuth. 2007. Knott's Handbook of Vegetable Growers (5th Ed.). John Willey and Sons Inc., New York.

Journals/Periodicals

Worldwide Web

Hort. 407 COMMERCIAL FLOWER PRODUCTION 3(2-1)

Prerequisites

Introductory Horticulture and Principles of Ornamental Horticulture

Specific Objectives

To accustom students with production technology of economically important flowers.

Theory

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

Practical

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

Learning Outcomes

Students must be able to grow commercially important flowers of the region.

Recommended Books

- Armitage, A.M. and J.M. Laushman. 2003. Specialty Cut Flowers (2nd Ed.). Timber Press, Windsor, Australia.
- Bose, T.K., L.P. Yadav, P. Pal, V.A. Parthasarathy and P. Das. 2003. Commercial Flowers (2nd Ed.). Naya Udyog, Calcutta, India.

- Banerjee, U. 2001. Commercial Flower Production. Mangal Deep Publications, Jaipur, India.
- Prasad, S. and U. Kumar. 2005. Commercial Floriculture. Agrobios (India), Jodhpur, India.
- Dole, J.M. and H.F. Wilkins. 1999. Floriculture: Principles and Species. Ball Publishing, USA.
- Yadav, I.S. and M.L. Choudhry. 1997. Progressive Floriculture–Production Technologies of Important Commercial Flower Crops. The House of Sarpan, Banglore.
- Laurie, A. 2004. Floriculture: Fundamentals and Practices. McGraw Hill Book Company, New York.

Journals/Periodicals

Worldwide Web

Hort. 409 BREEDING OF HORTICULTURAL CROPS 3(2-1)

Prerequisites

Principles of Fruit Production, Principles of Vegetable Production and Principles of Ornamental Crop Production

Specific Objectives

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

Theory

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

Practical

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

Learning Outcomes

Students must be able to conduct breeding procedures independently.

Recommended Books

- Fageria, M.S., P.S. Arya and Choudhary, A.K. 2000. Vegetable Crops (Vol. 1): Breeding and Seed Production. Kalyani Publisher, Ludhiana, New Delhi, India.
- Bassett, M.J. 1986. Breeding Vegetable Crops. Avi Publishing Co. Inc., Westport, Connecticut.
- Shukla, A.K., A.K. Shukla and B.B. Vashishtha. 2004. Fruit Breeding: Approaches and Achievements. International Book Distributing Company (Publishing Division), Lucknow, India.
- Singh, A.P. 2003. Vegetable Breeding and Seed Production (1st Ed.). Kalyani Publisher, Ludhiana, New Delhi, India.
- Ram, H.H. 2005. Vegetable Breeding, Principles and Practices. Kalyani Publisher, Ludhiana, New Delhi, India.

Journals/Periodicals

Worldwide Web

Hort. 402 INTERNSHIP (OPTION I) 4(0-4)

Prerequisites

Courses of 5th, 6th and 7th Semesters

Specific Objectives

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

Practical

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

Learning Outcomes

Students must be able to execute both managerial and production skills.

Hort. 402 RESEARCH PROJECT (OPTION II) 4(0-4)

Prerequisites

Courses of 5th, 6th and 7th Semesters

Specific Objectives

Training of the student in study and evaluation of problems of horticultural industry and to find their solutions through research.

Practical
Identification of research problem, Consulting the relevant literature, Planning and essentials of research plan. Execution of project; data collection, analysis, formulation of tables & figures and interpretation of results & discussion, conclusion, recommendations, Report writing, submission and presentation.

Learning Outcomes
Students must be able to identify problems, conduct independent research and write the report.

Recommended Books

- Anonymous. 1999. Instructions to Authors. Amer. Soc. Hort. Sci. Alexandria, Virginia.
- Day, R.A. 1983. How to write and publish a scientific paper (2nd Ed.). ISI Press, Philadelphia.
- *Petersen, R.G. 1994. Agricultural Field Experiments–Design and Analysis. Marcel Dekker, Inc., New York.*
- Mukul,G. and G. Deepa. 2011. Research Methodology. PHI Learning Private Ltd., New Dehli India.
- Singh, Y. K. 2006. Fundamental of Research Methodology and Statistics. New age international Pvt. Ltd., New Dehli, India.

Journals/Periodicals

Worldwide Web

Hort.404 VEGETABLE AND FLOWER SEED PRODUCTION 3(2-1)

Prerequisites

Principles of Vegetable Production, Principles of Ornamental Crop Production, Summer Vegetables, Winter Vegetables and Commercial Flower Production**.**

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

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

Practical

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

Learning Outcomes

Students must be able to produce pure and hybrid seed of important vegetables and flowers.

Recommended Books

- Desai, B.B., P.M. Kotecha and D.K. Salunkhe. 1997. Seeds Handbook Biology, Production, Processing and Storage. Marcel Dekker Inc., New York.
- McDonald, M.B. and L.O. Copeland. 1998. Seed Production – Principles and Practices. CBS Publishers and Distributors, New Delhi.
- Singh, A.P. 1999. Vegetable Seed Production Principles (1st Ed.). Kalyani Publisher, Ludhiana, New Delhi, India.
- Khare, D., M.S. Bhale. 2005. Seed Technology. Scientific Publishers, New Delhi, India.
- Singh, P. and B.S. Asati. 2008. Seed Production Technology of Vegetables. Daya Publishing Home, Delhi, India.
- Singh, N., D.K. Singh, Y.K. Singh and V. Kumar. 2006. Vegetable Seed Production Technology. International Book Distributing Company (Publishing Division), Lucknow, India.
- Singh, P.K., S.K. Dasgupta and S.K. Tripathi. 2005. Hybrid Vegetable Development, CRC Press Boca Raton, USA.

Journals/Periodicals

Worldwide Web

Hort. 406 PROTECTED HORTICULTURE 3(2-1)

Prerequisites

Principles of Vegetable Production, Principles of Ornamental Crop Production, Summer Vegetables, Winter Vegetables and Commercial Flower Production

Specific Objectives

To make student familiar with modern technology for production of high quality horticultural commodities round the year.

Theory

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

Practical

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

Learning Outcomes

Students must be able to produce various important horticultural crops under controlled environment.

Recommended Books

- Abbasi, N.A. and U. Habib. 2008. Protected Horticulture. Dept. of Horticulture, PMAS-Arid Agriculture University Rawalpindi, Pakistan.
- Arunkumar, R., K.R. Vijayalatha, K. Kannan, V. Thirumalmurugan, K. Latha and S.N. Kumar. 2008. Innovative Horticulture. New India publishing Agency, new Dehli, India.
- Manohar, K.R. and C. Igathinathane. 2007. Greenhouse Technology and Management (2nd Ed.). BS Publications, Hyderabad, India.
- Prasad, K. and U. Kumar. 2005. Greenhouse Management for Horticultural Crops (2nd Ed.). Agrobios (India), Jodhpur, India.
- Resh, H.M. 1989. Hydroponic Food Production. Westbridge Press Publishing Company, Santabarbra, California, USA.

- Sharaf,S. 2012. Green House Management of Horticulture Crops. Oxford book company new Dehli India.
- Tiwari, G. N. 2003. Greenhouse Technology for Controlled Environment. Alpha Science International Ltd., Pangbourne, UK.

Journals/Periodicals

Worldwide Web

Hort. 408 INDOOR PLANT CULTURE AND SCAPING 3(2-1)

Prerequisites

Principles of Ornamental Horticulture

Specific Objectives

To impart knowledge about interiors aping by using foliage plants inside the building for making the environment pleasing.

Theory

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

Practical

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

Learning Outcomes

Students must be able to grow and manage indoor/house plants for interiors aping.

Recommended Books

- Dole, J.M. and H.F. Wilkins. 1999. Floriculture: Principles and Species. Ball Publishing, USA.
- Hessayon, D.G. 2007. House Plant Expert. Transworld Publishers, London, U.K.
- Hessayon, D.G. 2007. Indoor Plant Spotter. Transworld Publishers, London, U.K.
- Davidson, W. 1991. House Plants. Tiger Books International, London.

- Zachos, E. 2005. Tempting Tropical: 175. Irresistible Indoor Plants. Timber Press Inc.
- Pleasant, B. 2005. The Complete House Plant Survival Manual: Essential Gardening Know-How for Keeping (Not Killing) More Than 160 Plants. Storey Publishing, LLC.

Journals/Periodicals

Worldwide Web

Hort. 410 BUSINESS MANAGEMENT IN HORTICULTURE 3(3-0)

Prerequisites

Post-Harvest Horticulture and Commercial Flower Production

Specific Objectives

To promote entrepreneurship and business management capabilities of horticultural graduates.

Theory

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

Learning Outcomes

Students must be able to establish and manage their own enterprise.

Book recommended

- Meena, R.K. and J. Yadev. 2001. Horticulture Marketing and Post-harvest Management. Pointer Publisher, Jaipur, Rajisthan.
- Raju, M.S.S. 2002. Fruit Marketing in India. Daya Publishing House, Delhi, India.
- Sharma, K. and S. Jagmohn. 1991. Marketing Management of Horticultural Produce. Deep & Deep Publications, New Delhi, India.
- Labaste, P. (Ed). 2005. The European Horticulture Market; Opportunities for Sub-Saharan African Exporters. The International Bank for Reconstruction and Development/ the World Bank, Washington D. C.

Journals/Periodicals

Worldwide Web

Hort. 412 PROJECT PLANNING AND SCIENTIFIC WRITING 2(1-1)

Prerequisites

Research Methods in Horticulture.

Specific Objectives

To develop ability in the students to identify and plan research projects in different areas of Horticulture and write their reports.

Theory

Concept of research, Identification of research problem, Planning and essential of research plan, Scientific method and experiment, Steps in experimentation, Writing of research proposal, Layout of field experiments, Observation of field trials, Measurement of crop growth and yield, Collection, tabulation and analysis of data, Measures of experimental variability, Interpretation of data, Writing and summarizing of scientific paper, report and thesis.

Practical

Preparation of research proposal, Layout of field experiments, Collection and tabulation of data, Analysis of data, Presentation of data in tables, curves, histograms etc, processing and interpretation, Writing of scientific paper.

Learning Outcomes

Students must be able to plan and execute experiments along with scientific report writing.

Recommended Books

- Awan, J.A. 2003. Scientific Presentation. Uni-tech Communication, Faisalabad, Pakistan*.*
- Micheal, J.K. 2009. From Research to manuscript: A guide to scientific writing. Spinger-Verlag.
- Robert, A.D. 2006. How to write and publish a scientific paper (6th Ed.). Greenwood.
- Shahzad, W. 2002 .Synopsis and thesis manual (1st Ed.). National Unv. Sci. Technol, HQ Rawalpindi.
- Mathews, J.R., J.M. Brown and R.W. Mathews. 2000. Successful Scientific Writing: A Step-by-Step Guide for Bio-Medical Scientists, 2nd Edition. Cambridge University Press, Cambridge, U.K.
- Petersen, R.G. 1994. Agricultural Field Experiments–Design and Analysis. Marcel Dekker, Inc., New York.

Journals/Periodicals

Worldwide Web

Hort. 412 ARID HORTICULTURE 2(1-1)

Prerequisites

Specific Objectives

To impart knowledge to the students for utilization of arid areas for sustainable production of horticultural crops.

Theory

Introduction, Economic aspects of arid zone horticulture, Formulation of rainfall distribution models for arid zone, Arid ecology, Problems associated with arid zone horticulture, Rainfall analysis and crop planning, Soil and moisture conservation, Agro-techniques for horticultural crops, Physiology of drought and salinity tolerance in horticultural crops. Suitable crops for arid areas and their production technologies. Dry climate landscape (Xeroscape).

Practical

Orchard management in arid fruits, evaluation of moisture conservation techniques like organic and inorganic mulches, studies of critical stages of irrigation in various arid horticultural crops, studies of irrigation systems (drip and sprinkler) and their impact on productivity of arid fruits and vegetables, water harvesting techniques, control of water loss through evapotranspiration, integrated nutrient management in arid horticultural crops.

Learning Outcomes

Students must be able to grow and manage horticultural crops in dry-land areas.

Recommended Books

- Saroj, P.L., B. Vashishtha and D.G. Dhandar. 2004. Advances in Arid Horticulture. Vol I: Present Status. International Book Distribution Co. Lucknow, India.
- Saroj, P.L., B. Vashishtha and D.G. Dhandar. 2004. Advances in Arid Horticulture. Vol II: Present Status. International Book Distribution Co. Lucknow, India
- Chandra, A., A. Chandra and I.C. Gupta. 1994. Arid Fruit Research. New Delhi, India.
- Chundawat, B.S. 1990. Arid Fruit Culture. Pub. Oxford and IBH Co. Ltd. New Delhi, India.

Journals/Periodicals

Worldwide Web

Hort. 412 ORGANIC HORTICULTURE 2(1-1)

Prerequisites

Specific Objectives

To impart training to the students for producing safe and other chemicals-free horticultural produce.

Theory

Introduction and importance of organic farming, Principles of organic horticulture, Selection and use of materials and resources, Soil fertility and plant nutrition under organic farming, Managing physical and chemical properties of growing substrate, Organic manure production/composting, Mulching, Tillage, Sustainability and environmental impact, Integrated farming system, Insect pests, weeds and disease control under organic system, Organic crop production of selected fruits, vegetables and flowering crops, Certification of organic produce.

Practical

Identification and production of organic fertilizers, Developing organic fertilizer application programme for different horticultural crops, Integrated weed and pest management, Organic crop production techniques in greenhouse and field, Visits to organic and non-organic progressive gardens.

Learning Outcomes

Students must know the techniques to prepare organic fertilizers and grow horticultural crops organically on sustainable basis.

Recommended Books

- Arunkumar, R., K.R. Vijayalatha, K. Kannan, V. Thirumalmurugan, K. Latha and S.N. Kumar. 2008. Innovative Horticulture. New India publishing Agency, new Dehli, India.
- Barker, A.V. 2010. Science and Technology of Organic Farming. CRC Press, Taylor & Francis Group, USA.
- Davies, F. and L. Margi. 2006. Organic Vegetable Production: A Complete Guide. Henry Doubleday Research Association Publications, U.K.
- Gehlot, D. 2005. Organic Farming Standards, Accreditation, Certification and Inspection. Agrobios (India), Agro House, Jodhpur, India.
- Gillman, J. 2008. The Truth about Organic Gardening: Benefits, Drawbacks and the Bottom Line. Timber Press.
- Lind, G., K. Lafer, K. Scholfer and G. Innerhofer. 2003. Organic Fruit Growing. CAB International Publishing, Wallingford, U.K.

- Lampkin, N. 2002. Organic Farming. Old Pond Publishing 104 Valley Road Ipswich, IPI 4 PA UK.
- Gupta, S.K. 2008. Organic Vegetable Production. Rajat Publications, India.
- Palaniappan, S.P., S. Palaniappan and K. Annadorai. 2010. Organic Farming : Theory and Practices. Scientific publishers Jodhpur India.
- Reddy, P. 2008. Organic Farming for Sustainable Horticulture. Jodhpur, Scientific

Journals/Periodicals

Worldwide Web

Hort. 412 PERI-URBAN HORTICULTURE 2(1-1)

Prerequisites

Specific Objectives

To provide information about horticulture within and immediate surroundings of cities.

Theory

Introduction and historical background, Present status of peri-urban horticulture in the world and Pakistan, Recent trends in peri-urban horticulture, Need for changing the scenario, Crop production (vegetables, flowers, fruits) on small scale, Safe use of waste water, Soil and water management, Organic farming, Health and food safety, Marketing strategies for peri-urban horticulture.

Practical

Visits of peri-urban horticulture farms and waste recycling projects, Practice in layout of peri-urban farms, Waste water treatments, Use of solid waste as growing media, Practice in nursery raising and transplanting, Management of cultural practices.

Learning Outcomes:

Students must be familiar with the techniques of peri-urban production and management of horticultural crops.

Recommended Books

- Baud, I.S.A., J. Post and C. Furedy. 2004. Solid Waste Management and Recycling. Kluwer Academic Publishers, Netherland.
- Duncan, M., D. Simon and D. Thompson. 2005. The Peri-Urban Interface. Approaches to Sustainable Natural and Human Resource Use. Royal Holloway, University of London, London, UK.

- Fall, S. Toure and Y. Akinbamijo. 2000. Integrated Peri-Urban Systems: Horticulture and Livestock in West African Cities. International Trypanotolerance Center Annual Technical Report Year II, June 1999 - June. (Centre File 03934-97-0021-01).
- McGregor, D. and D. Simon. 2012. The Peri-Urban Interface: Approaches to Sustainable Natural and Human Resource Use. Earthscan, New York, USA.
- Mukherjee, N. and M. Jayaswal. 2006. Chained by Food: Marginalized Voices from Peri-Urban India : Poor Households as Food Producers and Consumers in Peri-Urban India.Vedams eBooks (P) Ltd. Pitampura, New Delhi, India.
- Smit, J., A. Ratta, and J. Nasr. 1996. Urban agriculture: Food, Jobs and Sustainable Cities. UNDP, Urban Development Unit, New York, U.S.A.

Journals/Periodicals

Worldwide Web

Hort. 412 FLORAL DESIGNS AND ARRANGMENTS 2(1-1)

Prerequisites

Ornamental Horticulture

Specific Objectives

To develop ability of the students to make different floral arrangements and designs for different occasions.

Theory

Introduction; Principles and elements of floral designs and arrangements; Basic techniques and styles; Cut flowers and foliage, European and Asian floral designs; Contemporary and thematic designs, Dried arrangements; Speciality floral designs; Business practices.

Practical

Identification of cut flowers and foliage, Design tools and materials; Basic floral design and using proper techniques; Care and handling of flowers and foliage; Seasonal, holiday and special occasion designs; Marketing techniques, florist shops visit.

Learning Outcomes

Students must be trained in making bouquet of different styles and other floral designs and arrangements for different occasions.

Recommended Books

- Webb, I. 1988. The Complete Guide to Flower & Foliage Arrangement. Ebury Press, London.
- Armitage, A.M. and J.M. Laushman 2008. Specialty Cut Flowers. Varsity/ Timber Press, Portland.
- Hunter, N.T. 1999. The Art of Floral Design. Delmar Thomson Learning.
- Perry, L.P. 1998. Herbaceous Perennial Production: A Guide from Propagation to Marketing. NRAES, Cornell, Ithaca, NY.
- Pryke, P. 2004. The Complete Book of Floral Design. Kevin summers, Rizzoli International Publications, New York.
- Stevens, A. 1997. Field Grown Cut Flowers. Avatar's World, 106 E, Hurd Road, Edgerton, WI 53534.
- De, L. C. 2011. Value Addition in Flowers and Orchids. New india publishing agency. New Dehli India.
- McHoy, P. 2002. The Ultimate Rose Book. Anness Publishing Inc. New York, USA.
- Aruna, P., T.L. Preethi, V. Ponnuswami, V. Swamiminathan and R. Shankaranarayanan. 2011. Post-Harvest Techniques and Management for Dry Flowers. New India Publishing Agency New Delhi, India

Journals/Periodicals

Worldwide Web

Hort. 412 MUSHROOM CULTURE 2(1-1)

Prerequisites

Introductory Horticulture and Horticultural Crop Production

Specific Objectives

To acquaint the students to understand the basics of mushroom cultivation

Theory

Introduction, nutritional and medicinal value, general biology, spawn production, growing structures and systems, different substrates and their preparation, fruiting body formation, environmental requirements, production technology of the important mushroom species, Postharvest handling and packing.

Practical

Identification of different edible species, Media and substrate preparation, isolation of pure culture for spawn, compost preparation, practices in growing methods of different cultivated mushrooms, visits of mushroom houses.

Learning Outcomes

Students must be trained in identifying and growing different mushroom species.

Book recommended

- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual For Cultivation. PHI learning private Ltd., New Delhi, India.
- Chang, S. and P.G. Miles. 2004. Mushrooms: cultivation, nutritional value, medicinal effect, and environmental impact. CRC Press. USA.
- Miles, P.G. and S. Chang. 1997. Mushroom Biology: Concise basics and current developments. World Scientific Publishing Co. Pte. Ltd. Singapore.
- Bahl, N. 1984. Handbook of Mushrooms. Oxford and IBH publishing Co. New Delhi.

Journals/Periodicals

Worldwide Web

SCHEME OF STUDIES FOR POSTGRADUATE COURSES IN HORTICULTURE

Course No.	Title of the course	Credit hours
Hort. 701	Mineral Nutrition of Horticultural Crops	3(2-1)
Hort. 702	Plant Growth Regulators	3(2-1)
Hort. 703	Environmental Horticulture	3(2-1)
Hort. 704	Plant Tissue Culture	3(1-2)
Hort. 705	Prospective Horticultural Crops	3(2-1)
Hort. 706	Rootstocks for Horticultural Crops	3(2-1)
Hort. 707	Fruit Breeding	3(2-1)
Hort. 708	Citriculture	3(2-1)
Hort. 709	Mango and Date Palm Culture	3(2-1)
Hort. 710	Minor Fruits	3(2-1)
Hort. 711	Vegetable Breeding	3(2-1)
Hort. 712	Vegetable Seed Production and Marketing	3(2-1)
Hort. 713	Solanaceous Crops	3(2-1)
Hort. 714	Spices and Condiments	3(2-1)
Hort. 715	Mushroom Biology and Technology	3(2-1)
Hort. 716	Landscape Designs	3(2-1)
Hort. 717	Turfgrass Management	3(2-1)
Hort. 718	Advanced Fruit Science	3(2-1)
Hort. 719	Advanced Vegetable Science	3(2-1)
Hort. 720	Landscape Ecology	3(3-0)
Hort. 721	Horticultural Seed Science and Technology	3(2-1)
Hort. 722	Biotechnology of Horticultural Crops	3(2-1)
Hort. 723	Physiology of Horticultural Crops	3(2-1)
Hort. 724	Post-Harvest Physiology	3(2-1)
Hort. 725	Horticultural Production under Abiotic Stresses	3(2-1)
Hort. 726	Special problem	1(0-1)
Hort. 727	Seminar	1(0-1)
Hort. 728	Research and Thesis	6(0-6)

OUTLINE OF COURSES FOR POSTGRADUATE STUDIES IN HORTICULTURE

Hort. 701 MINERAL NUTRITION OF HORTICULTURAL CROPS 3(2-1)

Specific Objectives

To develop understanding among students about role of nutrients, their uptake and utilization in horticultural crops.

Theory

Nutrient elements in plants and their classification, Criteria of essentiality and role of mineral nutrients in plants, Requirements and plant composition, Mechanism and factors affecting absorption and translocation of nutrients, Ion interactions, Nutrient concepts, Methods for evaluation of nutrients and their application, Deficiencies and toxicities, Growth yield and quality as affected by nutrient status.

Practical

Relevant field and laboratory studies, Survey for deficiency/toxicity symptoms (Identification and sample collection) of fruits, vegetables and ornamental plants, Techniques for evaluations of nutrients, Practice of nutrient application (spreading, dressing, foliar application, fertigation etc.), Visit of nutrient analytical laboratories.

Learning Outcomes

Students must be skilled to diagnose specific nutrient deficiency and toxicity symptoms and suggest the remedies.

Recommended Books

- Alloway, B. J. 2008. Micronutrient Deficiencies in Global Crop Production. CPL Scientific Publishing Services Limited, U.K.
- Emanuel E. and Arnold. J.B. 2005. Mineral Nutrition of Plants: Principles and Perspectives. Academic Press. Sinauer Associates. 23 Plumtree Road, Sunderland, U.S.A.
- Schilling, G. 2000. Plant Nutrition and Fertilizer Application. Verlag Eugen Ulmer, Stuttgart.
- Marschner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press, London.
- Mengel, K., and E.A. Kirkby. 2001. Principles of Plant Nutrition. International Potash, Institute, Bern, Switzerland.
- Nijjar, G.S. 1996. Nutrition of Fruit Trees. Kalyani Publisher, New Delhi.
- Kumar, D.D. 2000. Micronutrients-Their Behaviour in Soil and Plants. Kalyani Publisher, New Delhi.

- Allen, V.B. and D.J. Pilbeam. 2007. Handbook of Plant Nutrition. CRC Somerset Press.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 702 PLANT GROWTH REGULATORS 3(2-1)

Specific Objectives

To acquaint the students with growth manipulation in horticultural crops.

Theory

Introduction, History, classification of growth regulators (PGRs), Biosynthetic pathways, Source sink relationship in relation to PGR, Occurrence and role of growth regulators in plants, Chemical nature of plant regulators and its relation with physiological activities, Theories of action and interactions of growth regulators, Interrelationships between growth regulators and other organic and inorganic plant substances, Applications in horticulture; growth, propagation, parthenocarpy, flower and fruit thinning, control of pre-harvest drop, fruit maturity, dormancy and storage, seed treatment and weed control, Uses in vegetable and flower nursery, Advances in PGR's.

Practical

Relevant field and Laboratory studies, surveys and assignments, Study of effects of PGRs in propagation, physiology, growth, flower manipulation, ripening and yield of different horticultural plants.

Learning Outcomes

Students must have knowledge of various plant growth regulators and their application for growth manipulation.

Recommended Books

- Arteca, R.N. 1997. Plant Growth Substances: Principles and Applications. CBS Publishers and Distributors, New Delhi, India.
- Basra, A.S. (Ed.). 2007. Plant Growth Regulators in Agriculture and Horticulture: Their Role and Commercial Uses. CRC Press.
- Davis, P.J. 1995. Plant Hormones: Physiology, Biochemistry and Molecular Biology (2nd Ed.) Kulwer Academic Publishers, Netherlands.
- Nickell, L.G. 2011. Plant Growth Regulators: Agricultural Uses. Springer, London, UK.
- Hayat,S. and A. Ahmad. 2007. Salicylic Acid: A Plant Hormone. Springer, Dordrecht. The Netherlands.
- Srivastava, L.M. 2002. Plant Growth and Development: Hormones and Environment. Academic Press, U.S.A.

- Nickell, L.G. 1982. Plant Growth Regulators (Agricultural Uses). Springer-Verlag, Berlin, Heidelberg, New York.
- Wearer, R.V. 1992, Plant Growth Substances in Agriculture. W.H. Freeman Co., San Francisco.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 703 ENVIRONMENTAL HORTICULTURE 3(2-1)

Specific Objectives

To impart knowledge about the role of Horticulture to combat environmental hazards.

Theory

Introduction and importance, Plant and their environments, Biodiversity and conservation, Ecologically sound and sustainable designs, Functional uses of plants; plants for the control of environment and bio-remediation; Pollutants types and role of plants to minimize pollution, Selection of plants for various environments, Environmental problems caused by plants, Horticultural science in sociosphere, Aesthetic horticulture, Amenity horticulture; Phyto-remediation, types and uses.

Practical

Identification of plants for control of environmental hazards, Monitoring plant health in polluted areas (industries and motor-ways etc.) and their comparison with field grown plants, Vegetation impact on microclimate, Visits to industrial areas causing pollution, Morphological changes in plants due to pollution, Environmental impact studies, Poster preparation about environmental hazards and role of plants.

Learning Outcomes

Students must be able to conduct environmental impact studies and reduce environmental hazards through plantation.

Recommended Books

- Saliba, C. 2009. A Book about Environmental Toxins. Knopf, Canada.
- Kaushik, A. and C.P. Kaushik. 2006. Perspectives in Environmental Studies. New Age International Publishers, New Delhi, India.
- Hussain, M. 1998. Environmental Degradation: Realities and Remedies. Feroz Sons Pvt. Ltd., Lahore.
- Hussain, S.S. 1992. Pakistan Manual of Plant Ecology. National Book Foundation, Islamabad, Pakistan.
- McKinney, M.L. and R.M. Schoch. 1998. Environmental Science: Systems and Solutions. Jones and Bartlett Pub. Inc., Sadbury.

- Smith, K. 1992. Environmental Hazards: Assessing Risk and Reducing Disaster. Rutledge, London.
- Robinette, G.O. 1977. Plants, People and Environmental Quality. US Department of Interior, National Park Service, Washington, DC.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 704 PLANT TISSUE CULTURE 3(1-2)

Specific Objectives:

To impart training of students in the field of plant cell, tissue and organ culture techniques and their applications in Horticulture.

Theory

Introduction, history and importance, Tissue culture media, Asepsis, Types of culture (organ, callus, cell suspension, protoplast culture etc.), Types of regeneration (callogenesis, organogenesis and embryogenesis), Micropropagation, micrografting, Synthetic seed technology, Indexing of tissue cultured-plants for pathogens, Physiology and anatomy of tissue cultured-plants, Germplasm conservation, Secondary plant products.

Practical

Laboratory equipment and supplies, Stock solutions and media preparation, Maintenance of asepsis, Different types of explants culture (shoot-tip, nodal segments, leaf disks, embryo, ovule, anther/pollen, callus, cell suspension, Protoplast fusion, Plantlet regeneration), *In vitro* grafting, Production and testing of virus free plants, Transfer of plantlets from tissue culture to greenhouse and field, Preparation of synthetic seeds, Visits to tissue culture laboratories.

Learning Outcomes

Students must be able to culture different ex-plants *in vitro* and regenerate plantlets

Recommended Books

- Chawla, H.S. 2003. Plant Biotechnology. Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Evans, D.E., J.O.D. Coleman and A. Kearns. 2003. Plant Cell Culture (The Basics). BIOS Scientific Publishers, London, New York.
- Kumar, U. 2005. Methods in Plant Tissue Culture. Agrobios, Jodhpur, India.
- Lindsey, K. (Ed.). 2007. Plant Tissue Culture Manual. Springer – Kluwer Academic Publishers, New Delhi, India.

- Neumann,K.H., A. Kumar, J. Imani. 2009. Plant Cell and Tissue Culture: A Tool in Biotechnology: Basic and Application. Springer Verlag, Berlin, Heidelberg.
- Kumar, B. 2014. Culture of Plant Cells, Tissues and Organs. Random Publications, New Delhi, India.
- Razdan, M.K. 2004. Introduction to Plant Tissue Culture (2nd Ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. Stafford, A. and G. Warren. 1991. Plant Cell and Tissue Culture. Open University Press, Milton Keynes. U.K.
- Scoggins, H. and M. Bridgen. 2014. Plants from Test Tubes: An Introduction to Micro propagation (4th Ed.) Tiber Press.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 705 PROSPECTIVE HORTICULTURAL CROPS 3(2-1)

Specific Objectives:

To make the students familiar with minor horticultural crops having potential in selected areas of the country.

Theory

Introduction, importance, present status and future scope, Soil and climatic requirements, propagation, cultural operations, harvesting, processing and marketing of following crops: oil palm, jojoba, amla, avocado, pecans, hazel nut, jack fruit, cashew nut, kiwi fruit, kronda, tea, saffron, leek, celery, asparagus, and Brussel's sprout etc.

Practical

Identification of plants, propagation, raising of nursery, management practices, harvesting and handling.

Learning Outcomes

Students must be able to propagate and grow prospective horticultural crops as per regional climatic conditions.

Recommended Books

- Bose, T.K. and S.K. Mitra. 1990. Fruits: Tropical and Subtropical. Naya Prokash, Calculta-Six.
- Mazumdar, B.C. 2004. Minor Fruit crops of India: Tropical and Subtropical. Daya Publishing House, India.
- Singh, A.P. 2002. Vegetable Growing in India. Kalyani Publisher, New Delhi.
- Das, P.C. 2003. Vegetable Crops of India. Kalyani Publisher, New Delhi.

- Das, B.C. and S.N. Das. 2000. Cultivation of Minor Fruits. Kalyani Publisher, New Delhi.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 706 ROOTSTOCKS FOR HORTICULTUAL CROPS 3(2-1)

Specific Objectives

To make students familiar with various rootstocks and stionic interaction in horticultural crops.

Theory

Introduction and importance, Types of rootstocks, Role of rootstocks in fruits and ornamental plants, Factors affecting stock-scion relationship. Compatibility and incompatibility, types and their impact on rootstock efficiency, Rootstock adaptability under various soils and climatic conditions, Rootstock of major fruits and ornamental plants in relation to vigor, quality, longevity, fruitfulness and resistance to drought, salinity, pest and diseases, Improvement of rootstocks in changing climate scenario, Role of rootstocks in high density plantation.

Practical

Identification, selection and multiplication of important rootstocks, Identification of different types of incompatibility, Survey of rootstocks used in various commercial gardens, research stations and plant nurseries.

Learning Outcomes

Students must be able to identify, propagate various types of rootstocks.

Recommended Books

- Adriance, G.W., and F.R. Brison. 2000. Propagation of Horticultural Plants. Biotech Books, Delhi, India.
- Hartmann, H.T., D.E. Kester, E.T. Davies and R.L. Geneve. 2009. Plant Propagation: Principles and Practices (7th Ed.). Prentice-Hall India Learning Pvt. Ltd., New Delhi, India.
- Rajan, S. and P.L. Markose. 2007. Propagation of Horticultural Crops. New India Publishing Agency, India.
- Rom, R.C. and H.F. Carlson (Eds.). 1987. Rootstocks for Fruit Plants. John Wiley and Sons, New York.
- Sharma, R.R. 2002. Propagation of Horticultural Crops: Principles and Practices. Kalyani Publishers, Ludhiana, New Delhi, India.
- Sharma, R.R. and M. Srivastav. 2004. Plant Propagation and Nursery management. International Book Distributing Co. (Publishing Division), Lucknow, India.

- Sharma, V.K. 1996. Plant Nurseries: Techniques, Production and Management. Indus Publishing Company, New Delhi, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 707 FRUIT BREEDING 3(2-1)

Specific Objectives

To make students familiar with breeding techniques and methodologies in fruit crops.

Theory

Objectives of fruit breeding, Importance of germplasm and its maintenance, Breeding techniques, Pollen and seed management, Hybridization and handling seedling population, Breeding of regionally important fruits, Breeding for disease and stress resistance, Mutation breeding.

Practical

Study of floral characters of various fruits, Crossing techniques of important fruits, Selectable markers for fruit breeding, Study of different types of chimera, Visits to germplasm units.

Learning Outcomes

Students must be familiar with different breeding techniques and their application in fruit crops.

Recommended Books

- Janick, J. and J.N. Moore. 1975. Advances in Fruit Breeding. Purdue Univ. Press, West Lafayette, Indiana
- Moore, G.N. and J. Janick. 1983. Methods in Fruit Breeding. Purdue Univ. Press West Lafayette, Indiana.
- Hancock, J.F. (Ed.) 2008. Temperate Fruit Crop Breeding. Springer Netherlands.
- Badenes, M.L., and D.H. Byrne. 2010. Handbook of Plant Breeding Series. Fruit Breeding (1st Ed.), Vol. 8. Springer Netherlands.
- Shukla, A.K., A.K. Shukla and B.B. Vashishtha. 2004. Fruit Breeding: Approaches and Achievements. International Book Distributing Company (Publishing Division), Lucknow, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 708 CITRICULTURE 3(2-1)

Specific Objectives

To in-calculate awareness of scientific knowledge about citrus fruits, and induce aptitude of research.

Theory

Introduction; Present status and future prospects, history and species concept; Botany; Pomological classification; Phenology; Mineral nutrition; Rootstocks; Spacing of trees; Water relations; Pests, disease and weed control; Pre and Post-harvest physiology; Production problems (decline, alternate bearing, fruit drop and unfruitfulness) and export issues; Varietal improvement; Modern trends in citriculture. Measures for the improvement of Citrus Industry in Pakistan.

Practical

Morphological studies of flowers, leaves and fruits of different citrus species and their varieties; Identification of different physiological disorders; Diagnosing various nutritional deficiencies, insects and diseases effect; Crossing for inter- and intra-specific hybridization.

Learning Outcomes

Students must be able to establish and manage citrus orchards.

Recommended Books

- Alebrigo, L.G., L.W. Timmer and M.E. Rogers. 2014. Citrus, Vol:II. Crop Production Science in Horticulture. CABI.
- Davies, F.S. and L.G. Albrigo. 2003. Citrus Fruits. CAB International, Wallingford, UK.
- Mukhopadhyay, S. 2004. Citrus Production, Postharvest, Diseases and Pest Management. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.
- Khan, I. 2007. Citrus Genetics, Breeding and Biotechnology. CAB International, London, UK.
- Singh, S., V.J. Shivanker, A.K. Srivastava and I.P. Singh. 2004. Advances in Citriculture. Jagmander Book Agency, New Delhi, India.
- Rajput, C.B.S. and R. Sri Hariau. 1985. Citriculture. Kalyani Publishers, New Delhi.
- Reuther, W., H.J. Webber, L.D. Batchelor and others. 1967-1989. The Citrus Industry - Vol. I to V. Univ. of Calif. Press, Berkeley.
- Wardowski, W.F., S. Nagy and W. Grierson. 1986. Fresh Citrus Fruits. Avi Publishing Company Inc., Westport, Connecticut.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 709 MANGO AND DATE PALM CULTURE 3(2-1)

Specific Objectives

To equip the students with scientific knowledge about the most important fruits of the region.

Theory

History and distribution; Importance, Present status and future prospects, Botany, classification, phenology, climate and environments; Vegetative and reproductive physiology; Orchards management operations and practices, Curing and post-harvest handling; Post harvest chemistry and physiology; Physico-chemical changes; Production problems and disorders; Export issues.

Practical

Identification of different varieties of mango and date palm; Fruit description Propagation techniques; Date palm pollination; Maturity indices and Curing of mango and date palm. Preparation for export market.

Learning Outcomes

Students must be able to grow and manage mango and date palm cultivars.

Recommended Books

- Singh, H.S., V. Nath, A. Singh and S. Mandal. 2008. Mango: Preventive Practices and Curative Measures. Satish Serial Publishing House, Delhi, India.
- Yadav, P.K. 2007. Fruit Production Technology. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Srivastava, R.P. (Ed.). 1998. Mango Cultivation. International Book Distributing Co. (Publishing Division), Lucknow, India.
- Litz, R.E. 2009. The Mango: Botany, Production and Uses. 2nd Edition. CAB International, Wallingford, UK..
- Ahmad, S. 2004. Mangoes in Pakistan. The Horticultural Foundation of Pakistan, Islamabad.

Relevant Journals/Periodicals and Worldwide Webs.

- The Date Palm Journal. Published half yearly by the F AO Regional Project for Palm and Dates Research Center in the Near East and North Africa.
- Proceedings of the 1st & 2nd Symposia on Date palm in Saudi Arabia. 1983 & 1991. King Faisal Univ., Al-Hassa, K.S.A.

Hort. 710 MINOR FRUITS 3(2-1)

Specific Objectives

To create know how among the students about different fruits grown in different areas of Pakistan at small scale.

Theory

Introduction and importance, Acreage, production, botany, composition and uses, climate, soil, propagation, rootstocks, cultural practices, cultivars, important insect-pests and diseases, harvesting, post-harvest handling and marketing of fruits such as ber, berries, chiku, coconut, custard apple, fig, falsa, jaman, loquat, mulberry, olive, papaya, pecan pineapple and quince etc.

Practical

Identification of minor fruit plants and their fruits, layout systems, propagation methods, pruning, harvesting and handling techniques.

Learning Outcomes

Students must be able to identify and grow minor fruits of the region.

Recommended Books

- Alford, D.V. 2007. Pests of Fruit Crops. Manson Publishing Delhi, India.
- Das, D.C. and S.N. Das. 2006. Cultivation of Minor Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Philip, S. 2002. Fruit Crops. Kalyani Publishers, Ludhiana, New Delhi, India.
- Singh, S.P. 2005. Commercial Fruits. Kalyani Publishers, Ludhiana, New Delhi, India.
- Steferud, A. 2005. Diseases of Fruits and Nuts. Publisher Biotech Books, Delhi, India.

Journals/Periodicals and Worldwide Web:

Hort. 711 VEGETABLE BREEDING 3(2-1)

Specific Objectives

To make students familiar with breeding techniques and methodologies in vegetable crops.

Theory

Objectives of vegetable breeding, Planning breeding programmes, Development of inbred lines, Combining ability, Exploitation of male sterility,

Hybrid seed production, Breeding for diseases and stress resistance, Breeding of commercially important vegetables, Improvement of asexually propagated vegetables.

Practical

Study of floral characters of self and cross-pollinated vegetables, Crossing techniques for important self and cross pollinated vegetables, Selection procedure in cultivars development, Methods of hybrid seed production.

Learning Outcomes

Students must be skilled in different breeding techniques and their application in vegetable crops.

Recommended Books

- Bassett, M.J. 1986. Breeding Vegetable Crops. Avi. Pub. Co. Inc., Westport, Connecticut.
- Singh, P.K, S.K. Dasgupta and S.K. Tripathi (Eds.). 2005. Hybrid Vegetable Development. CRC Press, Boca Raton, USA.
- Singh, A.P. 2003. Vegetable Breeding and Seed Production. Kalyani Publishers, New Delhi.
- Basra, A.S. 2000. Hybrid Seed Production in Vegetables. CRC Press, Boca Raton, USA.
- Ram, H.H. 2005. Vegetable Breeding, Principles and Practices. Kalyani Publisher, New Delhi.
- Peter,K. V. and T. Pradeepkumar. 2008. Genetics and Breeding of Vegetable Crops. Indian Council of Agricultural Research , New Dehli, India .
- Acquaah, G. 2012. Principles of Plant Genetics and Breeding. Blackwell publishing, Oxford, UK.
- Kumar,N. 2006. Breeding of Horticultural Crops: Principles and Practices. New India publishing Agency, new Dehli, India
- Rai,N. and M. Rai. 2006. Heterosis Breeding in Vegetable Crops. . New India publishing Agency, new Dehli, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 712 VEGETABLE SEED PRODUCTION AND MARKETING 3(2-1)

Specific Objectives

To make students familiar with techniques and methodologies of seed production, handling, storage, certification, quality control and marketing of vegetable crops.

Theory

Concept and benefits, Issues in seed production, Ecological aspects of seed production, Seed production and its problems in Pakistan, Seed Production planning and Methods, Seed formation and Development, Hybrid Seed Production, Seed Harvesting Techniques, Seed conditioning and Handling, Quality control and seed marketing, Pests, diseases and their Control.

Practical

Seed identification, pollination techniques, seed production techniques, Rouging and maintaining isolation, Seed harvesting, Seed extraction, drying and storage.

Learning Outcomes

Students must be able to understand the various aspects of seed production and marketing.

Recommended Books

- George R.A.T. 2009. Vegetable Seed Production (3rd Ed.). CAB International.
- Singh, P. and B.S. Asati. 2008. Seed Production Technology of Vegetable Crops. Daya Publishing House, Delhi, India.
- Kumar, V., N. Singh, Y.K. Singh and D.K. Singh. 2006. Vegetable Seed production technology. International Book Distributing Co., Lucknow, India.
- Singh, T., and K. Agrawal. 2001. Seed Technology and Seed Pathology. Pointer Pub. Rajasthan, India.
- Doijode, S.D. 2002. Seed Storage of Horticultural Crops. CBS Publishers & Distributors, India.
- Copeland, L.O. and M.B.McDonald.2005. Principles of Seed Science and Technology. 4th Ed. Springer (India) Private Ltd., New Delhi, India.
- Arya, P.S. 2001. Vegetable Seed Production Principles. Kalyani Publishers, India.
- Syed, I.A. 1992. Seed Certification Manual. National Book Foundation, Islamabad.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 713 SOLANACEOUS CROPS 3(2-1)

Specific Objectives

To equip the students with scientific knowledge about the most important vegetables of the region and world.

Theory

Introduction, Botany, Classification, Centers of origin, Distribution in the world, Physiology, Nursery raising and crop establishment, Production problems, Seed production and supply of certified seed, Breeding and improvement of the following crops: potato, tomato, brinjal (aubergine), chilies and peppers.

Practical

Morphology, identification and handling of the seed materials; Seed diseases; Planting methods; Varietal evaluation. In vitro pre-basic seed production.

Learning Outcomes

Students must be able to identify and grow Solanaceous crops.

Recommended Books

- Rai N. and D.S. Yadav. 2005. Advances in Vegetable Production. Researchco Book Centre, New Delhi.
- Swiader, J.M. and G. W. Ware. 2002. Producing Vegetable Crops. 5th Ed. Interstate publishers Inc. Danville, Illinois.
- Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co., Lucknow, India.
- Razdan, M.K. and A. K. Mattoo. 2005. Genetic Improvement of Solanaceous Crops. Vol. 1: Potato. Science Publishers, Inc., Enfield, NH.
- Razdan, M.K. and A. K. Mattoo. 2006. Genetic Improvement of Solanaceous Crops, Vol. 2: Tomato. Science Publishers, Inc., Enfield, NH.
- Bose, T.K., M.G. Som and J. Kabir. 1993. Vegetable Crops. Naya Prokash, Calcutta-Six.
- Libner, N.S. 2006. Vegetable Production. Vedams Books Pvt. Ltd. New Delhi, India.
- Decoteau, D.R. 2002. Vegetable Crops. Prentice-Hall of India, New Delhi, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 714 CONDIMENTS AND SPICES 3(2-1)

Specific Objectives

To create awareness of the potential spices and condiments in our daily life.

Theory

Introduction and importance, Individual condiment and spices (History, distribution, cultivation, diseases, pests, improvement), Products and end uses, Processing and manufacturing, Standard specification, production, trade and marketing of following condiments and spices: Chilies, coriander, garlic, ginger, mint, onion, tamarind, turmeric, black pepper, cardamom, cinnamon, clove, cumins etc.

Practical

Identification, cultivation, harvesting, drying, cleaning, processing and storage of spices. Visits to relevant markets and Spices manufacturing units.

Learning Outcomes

Students must be able to identify and grow spices and condiments of the region

Recommended Books

- Weiss, E.A. 2002. Spices Crops. CAB International, Wallingford, UK.
- Shanmughavelu, K.G., N. Kumar and K.V. Peter. 2005. Production Technology of Spices and Plantation Crops. Agrobios Publishers, India.
- Caker, L., J.E. Simon. 2002. Herbs, Spices and Medicinal Plants – Recent Advances in Botany, Horticulture and Pharmacology. Volumes 1-4. CBS Publishers and Distributors, New Delhi, India.
- Das, P.C. 2014. Spice Crops Production Technology. Scientific publisher, Jodhpur, India
- Paul W. B. and E.J. Votava. 2012. Peppers: Vegetable and Spice Capsicums. Cab international, Wallingford, UK.
- Serdar, O. and M. Milan. 2007. Medicinal and Aromatic Crops. Haworth Food & Agric. Products.
- Bogers, R.J., L.E. Craker and D. Lange. 2006. Medicinal and Aromatic Plants. Haworth Food & Agric. Products.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 715 MUSHROOM BIOLOGY AND TECHNOLOGY 3(2-1)

Specific Objectives

To impart knowledge about the mushrooms and develop skills about production technology of commercially important mushrooms.

Theory

Introduction; present status and future prospects, Nutritional and medicinal values; Classification, morphology and general biology; Spawn preparation; Growing structures and systems; Substrates; Fruiting body formation; Cultivation technology with emphasis on *Agaricus, Pleurotus, Lentinus and Volvariella* species etc.; production problems and disorders, Postharvest handling and value addition, Economics of mushroom production.

Practical

Media and substrate preparation; Isolation of pure culture for spawn; Structural demonstration of mushroom houses; Environmental control systems; Compost preparation; Practices in growing methods of different cultivated mushrooms.

Learning Outcomes:

Students must be able to identify and grow different species of mushrooms

Recommended Books

- Biswas, S., M. Datta and S.V. Ngachan. 2011. Mushrooms: A Manual For Cultivation. PHI learning private Ltd., New Delhi, India.
- Chang, S.T., & P.G. Miles: 2004. Mushrooms. Cultivation, Nutritional Value, Medicinal Effects, and Environmental Impact. 2nd Edition CRC, Press.
- Stamets, P. 1993. Growing Gourment & Medicinal Mushrooms. Ten Speed Press, Berkeley, CA.
- Bahl, N. 1994. Handbook on Mushrooms (3rd edition). Oxford & IBH Publishing Company. New Delhi.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 716 LANDSCAPE DESIGNS 3(2-1)

Specific Objectives

To impart knowledge and develop skills about aesthetical and environment-friendly planning of public and private open spaces.

Theory

Importance of landscape gardening and design, Principles and elements of landscape design, Landscape design materials, Types of designs; formal and informal garden designs, Rockeries, terrace, roof and aquatic gardens, different land forms and their manipulation; functional, architectural and aesthetic uses of plants, landscape design for parks, play fields, highway and roadside

plantations, Efficient irrigation system, Cost estimates for landscape, Recent trends in modern landscape.

Practical

Design process; site inventory and analysis; client interview; base map; master plan; scale drawings; Introduction to computer added designs, Small projects of landscape design (self designed and executed), Water features (ponds, fountains, waterfalls) design and execution; Demonstration of water efficient irrigation systems, Visits to different parks and gardens.

Learning Outcomes

Students must have skills to design, develop and maintain different landscapes.

Recommended Books

- Biondo, R.J., and C.B. Schroeder. 2006. Introduction to Landscaping Design, Construction and Maintenance (3rd Ed.). International Book Distributing Company (Publishing Division), Lucknow, India.
- Simonds, J.O. and B. Strake. 2006. Landscape Architecture: A Manual of Land Planning and Design (4th Ed.). McGraw Hill, New York, USA.
- Robinson, P. 2005. The Practical Rock and Water Garden. Anness Publishing Limited, London, U.K.
- Bhattacharjee, S.K. 2004. Landscape Gardening and Design with Plants. Aavishkar Publishers, Distributors, Jaipur, India.
- Raj, D. 2002. Floriculture and Landscaping. Kalyani Publishers, New Delhi, India.
- Ingels, J.E. 1992. Landscaping: Principles and Practices. Delmar Publishing Inc. New York.
- Khan, M.A. and T.A. Bader. 1992. Landscape Designs, Student Manual. University Printing Press, University of Agriculture, Faisalabad.
- Sovinski, R.W. 2009. Materials and their applications in Landscape Design. John Wiley and Sons Inc., Hoboken, New Jersey, U.S.A.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 717 TURFGRASS MANAGEMENT 3(2-1)

Specific Objectives

To develop knowledge about various turfgrasses for different purposes and their management.

Theory

Introduction and Importance, Types of grasses and their comparisons for different purposes (lawns, golf courses, playfields), Climate and grass

growth. Land preparation, Soil test and soil amendments, Propagation, seeding, soding/plugging and carpeting, Care for lawn grasses, Cultural practices; watering, mowing, fertilization, weeding, insects-pests, diseases and their control, thatching and aeration etc.

Practical

Identification of lawn grasses. Establishing lawn plots by seed, soding and carpeting, Growth monitoring, Mowing regimes, Aeration, thatching and other management practices, Identification of turf insects, pests and diseases.

Learning Outcomes

Students must be able to establish and maintain turf grasses in different premises.

Recommended Books

- Aldous, D. 1991. Lawn Care and Lawn Care Alternatives. Lothian Publishing, Australia.
- Hessayon, D.G. 1998. The Lawn Expert, PBI Publishing, England.
- Christians, N. 2003. Fundamentals of Turfgrass Management (2 sub edition) Wiley
- Puhalla, J., J. Krans and M. Goathley. 1999. Sports Fields: A Manual for Design, Construction and Maintenance. John Wiley and Sons, New Jersey, U.S.A.
- Quast, D.H. and W. Otto. 2004. Golf Course Turf Management: Tools and Techniques. McGraw Hill Book Co, U.S.A.
- John, R. 2003. Turfgrass Installation, Management and Maintenance. McGraw Hill Co., U.S.A.
- Turgeon, A.J.J. 2007. Turfgrass Management (8th Ed.). Prentice-Hall.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 718 ADVANCED FRUIT SCIENCE 3(2-1)

Specific Objectives

To equip the students with recent advances in fruit science.

Theory

Present status and future scope of fruit industry, Recent advances in fruit science, Plant relations with water, nutrition, light, temperature etc. Tree phenology; vegetative and reproductive physiology, Source sink manipulation, Problems related to fruitfulness, Fruit setting and development, High density planting and its management, Commercial uses of growth substances.

Practical
Relevant field and laboratory studies, surveys and assignments, Identification of fruit production problems, Nutrition management, high efficiency irrigation, pruning and training of fruit trees, Visits of global GAP registered orchards and nurseries.

Learning Outcomes
Students must be able to apply recent advances in fruit science for quality production of fruits.

Recommended Books

- Singh, A. 2003. Fruit Physiology and Production (5th Ed.). Kalyani Publishers, New Delhi.
- Gardener, V.R. 2001. The Fundamentals of Fruit Production (5th Ed.). McGraw Hill Book Company, USA.
- Barooh, S. 1998. Modern Fruit Culture. Kalyani Publishers, New Delhi.
- Chottopadhay, T.K. (Ed.). 2003. A Textbook on Pomology, Vol. I: Fundamentals of Fruit Growing. Kalyani Publishers, Ludhiana, New Delhi, India.
- Jackson, D.I., N.E. Looney (Eds.). 1999. Temperate and Subtropical Fruit Production (2nd Ed.). CAB International Publishing, Wallingford, U.K.
- Joseph, H.G. 2008. Modern Fruit Production. Stratford Press Inc., New York.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 719 ADVANCED VEGETABLE SCIENCE 3(2-1)

Specific Objectives
To equip the students with recent advances in vegetable science.

Theory
Introduction, Principles of crop establishment and flower induction in vegetables, Role of environment on physiology, growth, development and yield, Recent advances in vegetable science, Trends in organic vegetable production, Soil-less culture, Mechanization in vegetable production and harvesting, Seedlessness in vegetables (watermelon, cucumber tomatoes, etc), Conservation of indigenous germplasm, Concepts for production, grading and quality standards according to GLOBALGAP certification and WTO regimes.

Practical
Relevant field and laboratory studies (including biochemical analysis), Surveys and assignments, Identification of vegetable production problems and their remedies, Food safety measures, Visit to progressive vegetable farms.

Learning Outcomes
Students must be able to apply recent advances in vegetable science for quality production of vegetables.

Recommended Books

- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana, New Delhi, India.
- Rana, M. K. 2012. Modern Concepts of Vegetables Production. Biotech. Books, New Delhi.
- Rai N. and D.S. Yadav. 2005. Advances in Vegetable Production. Researchco Book Centre, New Dehli.
- Swiader, J.M. and G. W. Ware. 2002. Producing Vegetable Crops. 5th Ed. Interstate publishers Inc. Danville, Illinois.
- Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co., Lucknow, India.
- Nonnecke, I.L. 2006. Vegetable Production. Springer Publishers, India.
- Singh,J.,S K Jain and L. K. Dashora. 2013. Precision Farming in Horticulture. New india publishing agency. New Dehli India.
- Arunkumar, R., K.R. Vijayalatha, K. Kannan, V. Thirumalmurugan, K. Latha and S.N. Kumar. 2008. Innovative Horticulture. New India publishing Agency, new Dehli, India.
- Singh,P. K., S. K. Dasgupta, S. K. Tripathi. 2006. Hybrid vegetable development. International book distributing co. Luknow, India.
- Sharaf,S. 2012. Green House Management of Horticulture Crops. Oxford Book Company New Dehli, India.
- Wein, H.C. 1997. The Physiology of Vegetable Crops. CAB. International Publications, New York.
- Gupta, S.K. 2008. Organic Vegetable Production. Rajat Publications, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 720 LANDSCAPE ECOLOGY 3(3-0)

Specific Objectives
To acquaint students with ecological approaches to Landscape design for sustainable environment.

Theory
Introduction, Spatial pattern and process, Characterization of spatial pattern, Detecting and characterizing landscape patterns, Finding the characteristic scale of spatial pattern, defining the elements of pattern, connectedness, fractal geometry and percolating networks, and their interrelation in

landscapes, Development of landscapes patterns, Agents of pattern formation: the physical template of environmental constraints, biotic processes and disturbance regimes. Landscape dynamics, Change of landscape patterns and processes through time, including techniques for detecting, analyzing, or simulating landscape change; Modeling populations or communities in landscape mosaics (including spatially implemented meta-population models). Implications of landscape pattern with focus on populations and meta-populations, communities, and ecosystem processes. Landscape management: Humans approach in managing complex landscapes to achieve management objectives, Conservation biology and ecosystem management.

Learning Outcomes
Students must be able to understand the ecological aspects of landscape establishment and management.

Recommended Books

- Wu, J. and R.J. Hobbs. 2009. Key Topics in Landscape Ecology. Cambridge University Press, Cambridge, UK.
- Burel, F. and J. Baudry. 2003. Landscape Ecology: Concepts, Methods and Applications. Science Publishers, Enfield NH.
- Turner, M.G., R.H. Gardner and R.V. O'Neill. 2001. Landscape Ecology in Theory and Practice: Pattern and Process. Springer-Verlag, New York.
- Hitchmough, J.1994. Urban Landscape Management. Inkata Press, Sydney.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 721 HORTICULTURAL SEED SCIENCE AND TECHNOLOGY 3(2-1)

Specific Objectives

To acquaint students with modern seed production, processing and handling techniques.

Theory
Introduction and importance, Seed classification, Pre and post harvest factors affecting seed quality, Seed harvesting techniques, Conditioning and handling, Quality control, Seed dormancy, after ripening and their treatments, Seed moisture and desiccation in relation to seed quality, Storage and longevity, Seed testing; Ageing and deterioration, Priming, Coating, their merits and demerits, Seed certification and registration systems.

Practical
Seed identification of horticultural crops, Demonstration on cross sectional diagrams of seed structures, Harvesting and extraction, Handling of seed,

Drying and storage of seed, Seed desiccation and moisture determination methods, Seed viability and vigor tests.

Learning Outcomes
Students must be able to understand the various aspects of seed science and technology.

Recommended Books

- Basra, A.S. 2006. Handbook of Seed Science and Technology (1st Ed.). CRC Press.
- Chakrabarti,S.K. 2010. Seed Production and Quality Control. Kalyani Publishers, Ludhiana, India.
- George R.A.T. 2009. Vegetable Seed Production (3rd Ed.). CAB International.
- McDonald, M.B. and F.Y. Kwong. 2005. Flower Seeds: Biology and Technology. CAB International.
- Vanangamudi, K., N. Natarajan, A. Bharathi, R. Umarani, K. Natrajan and T. Saravanan. 2006. Advances in Seed Science and Technology, Vol. 1: Recent Trends in Seed Technology and Management. Agrobios, India.
- Roberto, L., B. Arnold and R.A. Sanchez. 2004. Handbooks of Seed Physiology: Applications to Agriculture. Food Products Press.
- Doijode, S.D. 2002. Seed Storage of Horticultural Crops. CBS Publishers & Distributors, India.
- Arya, P.S. 2001. Vegetable Seed Production Principles. Kalyani Publishers, India.
- Syed, I.A. 1992. Seed Certification Manual. N.B.F., Islamabad.
- Singh, T., and K. Agrawal. 2001. Seed Technology and Seed Pathology. Pointer Pub. Rajasthan, India.
- Anonymous. 1976. Seed Act. Government of Pakistan, Federal Seed Certification Department. Ministry of Food, Agriculture and Cooperatives, Islamabad.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 722 BIOTECNOLOGY OF HORTICULTURAL CROPS 3(2-1)

Specific Objectives
To acquaint the student with the genetic tools and their use for improvement of horticultural crops.

Theory
Definition & origin, Basic terminologies, Modern concept of Biotechnology, Multiple faces of Biotechnology, Biotechnology for the improvement of

Horticultural crops, Somaclonal variation, Somatic hybridization, Cytoplasmic hybridization, Isolation of plant DNA, DNA Sequencing, Molecular markers and markers assisted selection of crop cultivars (MAS), Genetic engineering techniques, Cell & tissue culture technology, Genetic transformation, *In vitro* mutation breeding, Serological and biochemical methods for plant indexing.

Practical
Protoplast isolation and fusion, Isolation and quantification of DNA & RNA, Polymerase Chain Reaction (PCR), DNA markers, General procedure for ELISA, Protein extraction, Gel Electrophoresis, Agro-bacterium mediated transformation, *In vitro* mutation breeding methods, Use of different mutagens.

Learning Outcomes
Students must be able to understand the biotechnological aspects of horticultural crops establishment and management.

Recommended Books

- Chawla, H.S. 2002. Introduction to Plant Biotechnology. Science Publishers, USA.
- Vyas, S.P. and D.V. Kohli. 2003. Methods in Plant Biotechnology and Bioengineering. CBS Publishers & Distributors, New Delhi, India.
- Debnath,M. 2011. Tools and Techniques of Biotechnology. Pointer Publishers, Jaipur, India.
- Keshavachandran, R. and K.V. Peter. 2008. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan pvt. Ltd., Chennai, India
- Prasad, S. 2004. Impact of Plant Biotechnology on Horticulture (3rd Ed.). Agrobios, Jodhpur, India.
- Purohit, S. S. 2007. A Laboratory Manual of Plant Biotechnology (2nd Ed.). Agrobios, Jodhpur, India.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 723 PHYSIOLOGY OF HORTICULTURAL PLANTS 3(2-1)

Specific Objectives
To impart knowledge on physiological processes of growth and productivity in horticultural crops.

Theory
Introduction and importance, Physiological basis of growth and crop productivity, Crop responses to various environmental factors (light, temperature, water and nutrient regimes etc.), Source-sink relationship, Dormancy; important types, mechanism and management, Floral development mechanism, Physiology of fruit setting, development,

maturation, ripening, abscission and senescence, Pigmentation, Physiology of climacteric and non-climacteric commodities in relations to respiration, Photosynthetic efficiency of C_3, C_4 and CAM plants, Physiological responses in relation to drought, water logging, temperature and salinity, Crop responses to CO_2 fertilization.

Practical
Experiments to study the effects of drought, water logging, temperature (high and low) and salinity on germination, growth, yield and quality, Study of cell membrane stability under stress conditions through conductivity meter, Studies on vegetative and reproductive buds development stages in various horticultural crops, Physiology of ripening stages of fruits and vegetables. Visit to horticulture fields and laboratories of advance research.

Learning Outcomes
Students must be able to identify, propagate various types of rootstocks.

Recommended Books

- Bleasdale, J.K.A. 2014. Plant Physiology in Relation to Horticulture, 2nd Ed. Scientific publishers, Jodhpur, India.
- Dugger, B.M. 2009. Plant Physiology with special reference to plant production. Bibliobazaar, LLC.
- Salisbury, F.B. and C.W. Ross. 2007. Plant Physiology (4th Ed.) Thomson Wadsworth, Inc., Anubha printers, Noida U.P.
- Trivedi, P.C. 2006. Advances in Plant Physiology. ICAR, Punjab Agricultural University, Ludhiana, India.
- Taiz, L. and E. Zeiger. 2002. Plant physiology (4th Ed.) Sinuer Associates, Inc., Publishers Sunerland, Massachusetts.
- Davis, P.J. 1995. Plant Hormones: Physiology, Biochemistry and Molecular Biology (2nd Ed.). Kulwer Academic Publishers, Netherlands.
- Wein, H.C. (Ed.). 1997. The Physiology of Vegetable Crops. CAB International Publications, New York.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 724 POST-HARVEST PHYSIOLOGY 3(2-1)

Specific Objectives
To teach the students about physiology of horticultural produce to minimize post-harvest losses.

Theory
Introduction, Factors affecting produce quality and shelf-life, Perishable and non-perishable commodities, Compositional changes, Physiological and biochemical processes in horticultural commodities under different types of

storage in relations to maturation, ripening and senescence, Role of ethylene in ripening, Ethylene scrubbers, Role and regulation of environmental factors in storage, temperature, humidity, oxygen, carbon dioxide and ethylene, Physiological and pathological disorders in storage.

Practical

Methods of assessing maturity indices of horticultural produce, Starch iodine test, Firmness, TSS, sugars and ascorbic acid; Calculation of titratable acidity, Vase life of cut flowers; Identification of postharvest physiological disorders; Electrolyte Leakage; Packaging methods of different horticultural commodities, Other Relevant field and laboratory studies, Visit of grading and processing plant and cold stores.

Learning Outcomes

Students must be able to apply their knowledge to maintain quality and extend storage life of horticultural produce.

Recommended Books

- Bleasdale, J.K.A. 2014. Plant Physiology in Relation to Horticulture, 2nd Ed. Scientific publishers, Jodhpur, India.
- Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. Oakland University of California, Division of Agriculture and Natural Resources Publication.
- Kays, S.J. 1998. Postharvest Physiology of Perishable Plant Products. CBS Publishers & Distributors, New Delhi, India.
- Kumar, P.S. and M. Kanwat. 2009. Post-harvest Physiology and Quality Management of Fruits and Vegetables. Publisher: Agrotech Books, India.
- Mitra, S.K. 1997. Post-Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International Publishing, Wallingford, U.K.
- Sadiq M., J. Ahmed, M.G. Lobo and F. Ozadali. 2012. Tropical and Subtropical Fruits: Postharvest Physiology, Processing and Packaging. Wiley-Balckwell Publisher.
- Shewfelt, R.L. and S.E. Prussia (Eds.). 1993. Postharvest Handling: A Systems Approach. Academic Press, California, USA.
- Wills, R.B.H., B. McGlasson and D. Graham, 1998. Post-Harvest: An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 725 HORTICULTURAL PRODUCTION UNDER ABIOTIC STRESSES 3(2-1)

Specific Objectives

To train students about horticultural crop production under environmental stresses stressed and their mitigation

Theory

Introduction, Types of abiotic stresses and their impacts on growth and productivity, (salinity, drought, temperature, herbicide and heavy metals), Potential morpho-physiological and biochemical indicators of stresses, Mechanism of stress tolerance; Role of enzymatic and non-enzymatic systems in stress tolerance, Strategies to mitigate stress induced phytotoxicity and augmentation in stress tolerance potential.

Practical

Relevant field and Laboratory studies, surveys and assignments, Study of effects of abiotic stresses in propagation, physiology, growth, flower manipulation and yield of different horticultural crops.

Learning Outcomes:

Students must have knowledge of various abiotic stresses, their phytotoxicity and alleviation techniques.

Recommended Books

- Shahbala, S. 2012. Plant Stress Physiology. CABI, USA.
- Rao, K. V. M., Raghavendra, A. S., Reddy, J. K. 2006. Physiology and Molecular Biology of Stress Tolerance in Plants. Springer
- Pareek, A. S. 2009. Abiotic Stress Adaptation in Plants. Springer, Dordrecht, Neatherland.
- Upadhyay, R. 2012., Plant Stress Physiology; Physiological and Biochemical Perspectives. LAP Lambert Academic Publishing, Germany.
- Venkateswarlu, B. 2012. Crop Stress and its Management: Prospective and Strategies. Springer Dordrecht Heidelberg London, New York.
- Tuteja, N. 2011. Omics and Plant Abiotic Stress Tolerance. Bentham Books, USA.
- Rao,K.V. M., A.S. Raghavendra, K. J. Reddy . 2006. Physiology and Molecular Biology of Stress Tolerance in Plants. Springer, Dordrecht, The Netherland.
- Peter, K. V. 2011.The Science of Horticulture (Vol.II). New India publishing Agency, New Dehli, India
- Vahdati, K. and C. Leslie. 2013. Abiotic Stress - Plant Responses and Applications in Agriculture. InTech, Rijaka, Croatia.

Relevant Journals/Periodicals and Worldwide Webs.

Hort. 726	**SPECIAL PROBLEM**	**1(0-1)**
Hort. 727	**SEMINAR**	**1(0-1)**
Hort. 728	**RESEARCH AND THESIS**	**6(0-6)**

ANNEXURE - A

ENGLISH I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

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

Comprehension
Answers to questions on a given text

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

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

Translation skills

Urdu to English

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

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books

1. **Functional English**

a) Grammar

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

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

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise 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. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

English II (Communication Skills)

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

Course Contents

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

Essay writing
Introduction

CV and job application

Translation skills
Urdu to English

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

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

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

Note: documentaries to be shown for discussion and review
Recommended Books
Communication Skills
a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing
   1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
   2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading
   1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
   2. Reading and Study Skills by John Langan
   3. Study Skills by Richard York.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents:

Presentation skills

Essay writing
Descriptive, narrative, discursive, argumentative

Academic writing
How to write a proposal for research paper/term paper

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

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended Books

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by Northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (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 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

Reference Books

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

ANNEXURE - D

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

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

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

Course Outline

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

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

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

Recommended Books

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)
2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (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 edition), 2005, John Wiley, New York
2. Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)
3. Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
4. Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

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

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

Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books

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

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

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

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

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

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

Contents :

1. *Algebra*

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

Specific Objectives of Course:

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

Course Outline:

Preliminaries: Real Numbers and the Real Line, *Functions and their graphs*: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions.

Integration and Indefinite Integrals: Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books

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

6. MATHEMATICS FOR PHYSICS

Contents:

1. Preliminary calculus.

- Differentiation

  Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.
- Integration

  Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions

- The need for complex numbers
- Manipulation of complex numbers

  Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
- Polar representation of complex numbers Multiplication and division in polar form
- de Moivre's theorem

  Trigonometrical identities; finding the nth roots of unity; solving polynomial equations
- Complex logarithms and complex powers

- Applications to differentiation and integration
- Hyperbolic functions
  Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits

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

4. Partial differentiation

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

5. Multiple integrals

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

6. Vector algebra

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

7. Matrices and vector spaces

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

8. Vector calculus

- Differentiation of vectors Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields

- Vector operators
- Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae
- Vector operators acting on sums and products; combinations of grad, div and curl
- Cylindrical and spherical polar coordinates
- Cylindrical polar coordinates; spherical polar coordinates.

ANNEXURE - E

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

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

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

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

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

Practical

a. Frequency Distribution

b. Stem-and-Leaf diagram

c. Various types of Graphs

d. Mean, Geometric mean Harmonic Mean,

e. Median, Quartiles Deviation, mean Deviation.

f. Standard Deviation, Variance, Coefficient of variation,

g. Skewness and kenosis

Recommended Books

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crashaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 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
4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.

ANNEXURE - G

FUNCTIONAL BIOLOGY-I **Credit Hours 3+0**

Biological Methods

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

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

Reading

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

Functional Biology-II **Credit Hours 3+0**

Myths and Realities of Evolution

Microevolution
Speciation
Macroevolution

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

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

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

Reading

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

Note

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

RECOMMENDATIONS

After a comprehensive discussion, the participants of the curriculum revision committee of Horticulture made the following recommendations:

1. In service training of the faculty members should be continued by the HEC in the field of Horticulture inland and abroad on priority basis.
2. Minimum credit hours for B.Sc. (Hons.) degree in Agriculture (Horticulture) should be uniform in all universities. A list of optional courses is also being recommended by the committee, which may be adopted by the institutions as needed.
3. All agricultural universities and colleges should adopt semester system with HEC approved curriculum.
4. In-view of the rising importance of horticultural crops, the departments of Horticulture may be upgraded with provision of adequate funds.
5. HEC should arrange and supply at least ten copies of each book from the list of recommended books to each university / college to strengthen the education.
6. HEC should provide adequate funds for the strengthening of laboratories, libraries, audio-video aids and provision of Research Journals.
7. Faculty development programme should be established for those who hold master degrees and crossed the age limit to upgrade their qualification up to Ph.D.
8. Post Doctoral research in foreign universities / research organizations be encouraged with a special quota for scholars / teachers holding Ph.D. in Horticulture from local universities.
9. In NCRCs, participation from the R&D / S&T organizations should be ensured.
10. Keeping in view the diversity of Horticulture, a strong interaction among the faculty is required at national level. HEC may facilitate to arrange and organize the meeting of research groups/scientists.
11. The NCRC members should be appropriately rewarded, especially Convenor and Secretary, with proper incentives / honorarium to encourage their participation and efficient working.