CURRICULUM

OF

PLANT BREEDING AND GENETICS

BSc (Hons)
MSc (Hons)

(Revised 2014)

HIGHER EDUCATION COMMISSION
ISLAMABAD
**CURRICULUM DIVISION, HEC**

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
<td>Prof. Dr. Mukhtar Ahmed</td>
<td>Chairman</td>
</tr>
<tr>
<td>Mr. Fida Hussain</td>
<td>Director General (Acad)</td>
</tr>
<tr>
<td>Mr. Rizwan Shoukat</td>
<td>Deputy Director (Curr)</td>
</tr>
<tr>
<td>Mr. Abid Wahab</td>
<td>Assistant Director (Curr)</td>
</tr>
<tr>
<td>Mr. Riaz-ul-Haque</td>
<td>Assistant Director (Curr)</td>
</tr>
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Composed by: Mr. Tanveer Ali, HEC
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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

STAGE-I  STAGE-II  STAGE-III  STAGE-IV

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

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

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

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

IMPLE. OF CURRI.  BACK TO STAGE-I

ORIENTATION COURSES

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
MINUTES OF THE FINAL MEETING OF HEC NATIONAL CURRICULUM REVISION COMMITTEE FOR PLANT BREEDING & GENETICS HELD AT HEC REGIONAL CENTRE, KARACHI FROM MAY 07-09, 2014.

The Final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Plant Breeding & Genetics was held from May 07-09, 2014 at HEC Regional Centre, Karachi to finalize the draft of BSc/MSc (Hons) prepared in its preliminary meeting held on September 9-11, 2013 at the University of Agriculture, Peshawar, with recommendations for the promotion and development of the discipline. The following members attended the meeting:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name &amp; Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Hidayat-ur-Rahman, Professor, Department of Plant Breeding and Genetics, University of Agriculture, Peshawar. <a href="mailto:h_rahman_pbg@yahoo.com">h_rahman_pbg@yahoo.com</a></td>
</tr>
<tr>
<td>2.</td>
<td>Dr. Fida Muhammad, Professor &amp; Chairman, Department of Plant Breeding &amp; Genetics, University of Agriculture, Peshawar. <a href="mailto:fidauoa@yahoo.com">fidauoa@yahoo.com</a></td>
</tr>
<tr>
<td>3.</td>
<td>Dr. Iftikhar Hussain Khalil, Professor, Department of Plant Breeding &amp; Genetics, University of Agriculture, Peshawar. <a href="mailto:drihhalil@yahoo.com">drihhalil@yahoo.com</a></td>
</tr>
<tr>
<td>4.</td>
<td>Dr. Zulfiqar Ali, Associate Professor, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. <a href="mailto:zulfiqar_ali@uaf.edu.pk">zulfiqar_ali@uaf.edu.pk</a></td>
</tr>
<tr>
<td>5.</td>
<td>Dr. Abdul Qayyum, Associate Professor/Chairman, Department of Plant Breeding &amp; Genetics,</td>
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<tr>
<td>Sr. No.</td>
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<tr>
<td>6.</td>
<td>Dr. Ghulam Sarwar Markhand, Member</td>
</tr>
<tr>
<td></td>
<td>Department of Botany, Shah Abdul Latif University, Khairpur.</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:gmarkhand@gmail.com">gmarkhand@gmail.com</a></td>
</tr>
<tr>
<td>7.</td>
<td>Dr. Saif Ullah Ajmal, Member</td>
</tr>
<tr>
<td></td>
<td>Department of Plant Breeding &amp; Genetics, PMAS Arid Agriculture University, Rawalpindi.</td>
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<tr>
<td></td>
<td><a href="mailto:gondaldr@yahoo.com">gondaldr@yahoo.com</a></td>
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<tr>
<td>8.</td>
<td>Dr. Saeed Rauf, Member</td>
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<tr>
<td></td>
<td>Assistant Professor, Department of Plant Breeding &amp; Genetics, University College of Agriculture, University of Sargodha, Sargodha.</td>
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<tr>
<td></td>
<td><a href="mailto:saeed_rauf2001@yahoo.com">saeed_rauf2001@yahoo.com</a></td>
</tr>
<tr>
<td>9.</td>
<td>Mr. Shah Nawaz Mari, Member</td>
</tr>
<tr>
<td></td>
<td>Assistant Professor, Department of Plant Breeding &amp; Genetics, Sindh Agriculture University, Tandojam.</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:shahmari21@yahoo.com">shahmari21@yahoo.com</a></td>
</tr>
<tr>
<td>10.</td>
<td>Dr. Shahid Ali, Member</td>
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<tr>
<td></td>
<td>Assistant Professor/HOD, Centre for Biotechnology and Microbiology, University of Swat.</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:shahid2_khan@hotmail.com">shahid2_khan@hotmail.com</a></td>
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<tr>
<td>11.</td>
<td>Mr. Habib Rehman Lakho, Member</td>
</tr>
<tr>
<td></td>
<td>Lecturer, Department of Plant Breeding &amp; Genetics, Lasbela University of Agriculture,</td>
</tr>
</tbody>
</table>
Sr. No. | Name & Address
---|---
12. | Dr. Muhammad Jamil, Assistant Professor, Department of Biotechnology & Genetic Engineering, Kohat University of Science & Technology, Kohat 26000, KPK.

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

1. Dr. Khizar Hayat Bhatti, Assistant Professor/HOD, Department of Botany, University of Gujrat, Gujrat. khizar.hayat@uog.edu.pk

2. Prof. Dr. Raziuddin, Professor, Department of Plant Breeding and Genetics, The University of Agriculture, Peshawar. drraziuddin@gmail.com

3. Dr. Muhammad Kausar Nawaz Shah, Professor / Chairman, Department of Plant Breeding & Genetics, PMAS Arid Agriculture University, Rawalpindi. knshah@uaar.edu.pk

3. The meeting started with recitation of Verses from the Holy Quran by Mr. Riaz-ul-Haque. After brief introduction of participants, Mr. Ghulam Hyder Khan, Director RC Karachi, HEC inaugurated the session and welcomed the participants on behalf of the Executive Director, HEC and thanked them for their participation in this important exercise.
4. Prof. Dr. Hidayat-ur-Rehman, Department of Plant Breeding and Genetics, University of Agriculture, Peshawar, as Convener of the committee, nominated Dr. Iftikhar Hussain Khalil, Professor, Department of Plants Breeding & Genetics, University of Agriculture, Peshawar as Secretary of the meeting. Mr. Haque then requested the Convener of the Committee to start Technical Session in accordance with the agenda.

5. The Committee after thorough deliberations and having three days discussions finalized the draft curriculum of the Plant Breeding & Genetics for BSc/MSc (Hons) degrees, including revisiting of recommended books. The Committee agreed that the Recommendations framed during the meeting will be published as Annexure in the final booklet of curriculum circulated by HEC for Adoption/Implementation to universities/degree awarding institutes of Pakistan.

6. Mr. Riaz-ul-Haque, Assistant Director Curriculum, HEC thanked the Convener and all members of the committee for sparing precious time and for their quality contributions. The committee appreciated Mr. Riaz-ul-Haque, for his coordination and lauded the efforts by Mr. Ghulam Hyder Khan, Director RC Karachi and other officials for providing local hospitality.

7. The meeting ended with vote of thanks to and from the chair.
Template for 4-Year BSc (Hons) in Agricultural Disciplines

1. **Compulsory Courses**

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

Sub-Total 28

2. **Interdisciplinary Foundation Courses**

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

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: 04
Grand Total: 130-140
• 1 credit of theory = one contact hour per week for 16-18 weeks and 1 practical/Lab hour = 3 contact hours per week for 16-18 weeks.
• In case of non-availability of department of supporting courses, courses from foundation courses can be opted.
## Scheme of Studies for BSc (Hons) Degree Programs in Plant Breeding and Genetics

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 401</td>
<td>Introductory Genetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 402</td>
<td>Introductory Plant Breeding</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td><strong>5th Semester Courses</strong></td>
<td></td>
</tr>
<tr>
<td>PBG 501</td>
<td>Principles of Genetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 503</td>
<td>Breeding Field Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 505</td>
<td>Cytogenetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 507</td>
<td>Fundamentals of Plant Biometry</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 509</td>
<td>Modern Techniques in Plant Breeding</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td><strong>Total= 15</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>6th Semester Courses</strong></td>
<td></td>
</tr>
<tr>
<td>PBG 502</td>
<td>Breeding Fibre Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 504</td>
<td>Breeding Sugar Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 506</td>
<td>Breeding Maize and Millets</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 508</td>
<td>Biodiversity and Plant Genetic Resources</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 510</td>
<td>Molecular Genetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td></td>
<td><strong>Total= 15</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>7th Semester Courses</strong></td>
<td></td>
</tr>
<tr>
<td>PBG 601</td>
<td>Breeding Oilseed Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 603</td>
<td>Breeding Pulse Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 605</td>
<td>Breeding Vegetable Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 607</td>
<td>Breeding Cereal Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 609</td>
<td>Experimentation in Plant Breeding</td>
<td>3(2-1)</td>
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<tr>
<td></td>
<td><strong>Total= 15</strong></td>
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<tr>
<td></td>
<td><strong>8th Semester Courses</strong></td>
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</tr>
<tr>
<td>PBG 602</td>
<td>Breeding Fodder and Forage Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 604</td>
<td>Breeding Minor Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 606</td>
<td>Crop Variety Registration and Intellectual Property Rights</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 608</td>
<td>Breeding for Crop Quality Traits</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 610</td>
<td>Fundamentals of Research &amp; Scientific Writing</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 612</td>
<td>Genomics in Agriculture</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 614</td>
<td>Bio-safety Measures in Crop Improvement</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 616</td>
<td>Breeding Medicinal Plants</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 618</td>
<td>Internship or Research Project</td>
<td>4(0-4)</td>
</tr>
</tbody>
</table>

*Only 13 credit hours will be mandatory including PBG 618 being compulsory. Courses listed in 5-8th semester can be swapped as and when needed except core courses.*
Objectives
To enable students to understand:
- Basic concepts of genetics
- Mechanism of heredity
- Chemical and molecular nature of nucleic acids

Theory

Practical
Study of cell divisions and gametogenesis. Calculation of monohybrid and dihybrid ratios. Numerical examples relating to gene interaction, multiple alleles and multiple factor inheritance. Calculation of linkage from test cross and $F_2$ data.

Recommended Books

World Wide Web
http://anthro.palomar.edu/mendel/mendel_1.htm
Objectives

To make students to understand:

- Basis of plant breeding
- Reproductive mechanisms in major crops
- Application of genetic principles in crop improvement
- Breeding methods in self and cross pollinated crops

Theory


Practical

Descriptive study of floral biology, scientific names, chromosome number and ploidy level of important field crops. Selfing and crossing techniques in major crops. List of approved varieties in major field crops.

Recommended Books

Objectives
To enable students to understand:
- Expansion of Mendelian inheritance
- Chemical nature of genetic material
- Genetic control of protein synthesis
- Molecular basis of gene
- Mutation and its types

Theory

Practical
Solving problems on dihybrid and multihybrid segregating generations and backcrosses. Numerical examples relating to multiple allelism and polygenic inheritance, sex linked inheritance, linkage and crossing over. Chromosome mapping.

Recommended Books
Objectives
To enable students to understand:
- Developmental history of various fibre crops
- Breeding fibre crops for yield and quality characteristics
- Breeding methods for incorporating resistance against biotic and abiotic stresses

Theory

Practical
Selfing and crossing techniques in fiber crops. Identification of different species of cotton. Collection of data on different quantitative traits of cotton, data analysis and its interpretation. Testing of fibre traits in cotton. Visit to research stations and fiber testing laboratories.

Recommended Books
Objectives
To enable students to understand:
- Achievements made in plant breeding
- Strategies of plant breeding
- Various breeding methods in self and cross pollinated crops

Theory

Practical
Selfing and crossing techniques in field crops. Data recording using descriptors, its analysis and interpretation. Assessment of variability in crops for biotic and abiotic stresses. Visits to field and research institutes.

Recommended Books
Objectives
To enable students to understand:
- Breeding methods in sugar crops
- Constraints in sugarcane breeding
- Different genetic systems in sugar crops

Theory

Practical

Recommended Books

World Wide Web
1. http://sugarcane-breeding.tn.nic.in
Objectives
To enable students to understand:
- Structure and functions of cell organelles
- Chromosomal structure, functions and their abnormalities

Theory

Practical

Recommended Books

World Wide Web
1. www.molecularcytogenetics.org
Objectives
To enable students to understand:

- Evolutionary pathways of maize and millet
- Breeding methods in maize and millet
- Hybrid maize production and its scope

Theory

Practical
Handling of inbred lines and hybrid material in maize. Development of various crosses and populations in maize and millets. Layout of experiments and recording of data on various growth stages at vegetative and reproductive phases. Visit to maize and millets research institutes and industry.

Recommended Books
Objectives
To enable students to understand:
- Concepts of Biostatistics
- Various experimental layout and designs
- Statistical softwares

Theory

Practical
Use of softwares for estimation of basic statistics. Construction of ANOVA. Numerical problems related to estimation of genetic, environmental and phenotypic variances/co-variances from ANOVA/ANCOVA.

Recommended Books
Objectives
To enable students to understand:
- Importance of biodiversity in plant breeding
- Strategies of germplasm collection and conservation
- Role of novel techniques in germplasm identification and preservation

Theory

Recommended Books:
Objectives
To enable students to understand:
- Application of genetic principles in cereal breeding
- Various reproductive systems in cereals
- Variety development and release procedures

Theory

Practical
Development of genetic material using appropriate mating techniques. Assessment of various phenological stages in cereal crops. Handling of segregating populations. Data recording of various plant attributes using descriptors.

Recommended Books
Objectives
To enable students to understand:
• Concept of genetic codes and gene function
• Basics of genetic engineering and biotechnology

Theory

Practical
DNA extraction, isolation and quantification. DNA amplification/PCR. Gel electrophoresis, Primer designing.

Recommended Books
Objectives
To enable students to understand:
- Status of oilseeds in Pakistan
- Significance of conventional and non-conventional oilseed crops
- Breeding methods in oilseed crops

Theory

Practical

Recommended Books

World Wide Web
Objectives
To enable students to understand:
- Significance of fodder and forages in livestock sector
- Genetic and cytoplasmic basis of reproductive systems in forages
- Breeding methods in fodder and forages

Theory

Practical

Recommended Books
Objectives

To enable students to understand:

- Significance and status of pulses
- Constraints in pulse breeding
- Breeding methods for biotic and abiotic stresses

Theory


Practical


Recommended Books

**Objectives**

To enable students to understand:
- Significance and status of minor crops
- Breeding objectives of minor crops
- Breeding methods in minor crops

**Theory**


**Practical**

Selfing and crossing techniques. Layout of experiments, recording and analysis of data on various plant parameters. Screening of germplasm for biotic and abiotic stresses. Visit to research Institutes and industry.

**Recommended Books**

Objectives

To enable students to understand:
- Significance and classification of vegetables
- Reproductive mechanisms in various vegetables
- Role of innovative tools in vegetable improvement

Theory


Practical

Study of reproductive biology of important vegetables. Selfing and crossing techniques in major vegetables. Layout of field experiments and data recording for various genetic parameters. Visit to research stations.

Recommended Books

Objectives
To enable students to understand:
- Registration of crop varieties and seed certification
- Intellectual property rights
- Concerns of Plant Breeders and farmers rights

Theory
Intellectual Property Rights (IPR): introduction, need and implementation of IPR; issues and challenges. Strategies to maximize benefits from IPR. Plant Breeder’s Rights Act: background, requirements; advantages and disadvantages. Plant Variety Protection (PVP) and farmer's rights. Patenting biological material. International harmonization of patent laws. Plant variety registration and approval. Production of various classes of seeds and certification procedures. An overview of “WTO, Biological Diversity Act, TRIPS and seed industry in Pakistan”.

Recommended Books
5. www.wipo.org
Objectives
To enable students to understand:
- Modern breeding tools in crop improvement.
- Application of new techniques in plant breeding.

Theory

Practical

Recommended Books

World Wide Web.
1. www.accessexcellence.org/LC/ST/st2bgplant.html
Objectives
To enable students to understand:

- Regional and International quality standards in cereal crops.
- WTO role in marketing via quality control of crops

Theory
Defining the quality aspects of crop products, role of WTO in classification and standardization of quality parameters, relationship of crop quality with yield and yield components. Introduction to techniques and procedures to evaluate quality traits in different crops. Genetic improvement of quality traits in different crops.

Practical
Instruments used to evaluate quality parameters in crop plants. Introduction to various techniques for measuring quality traits in various crops.

RECOMMENDED BOOKS
Objectives
To enable students to understand
- Application of biometrical techniques in genetics and breeding
- Recording and analyzing qualitative and quantitative data
- Various statistical techniques used in plant breeding

Theory

Practical
Estimation of correlations, regression, heritability, selection differential, response to selection, genetic advance, heterotic effect and inbreeding depression.

Recommended Books
Objectives
To enable students to understand:
- Different types of research and scientific reports.

Theory
Introduction of concept of science and scientific method. The concept, purpose and kinds of research project and Scientific Reports. Collection and organizing source materials: reviewing the literature and preparing bibliography. The techniques of composition: rules of scientific writing, word usage in scientific writing, style for composing scientific writing. Writing thesis, scientific papers, and project reports; table of contents, list of tables, the use of scientific quotations, illustrations, appendices, statistics and tables, standard abbreviations. Preparing preliminary draft, editing, and evaluating the final draft. Preparation of PC forms. Plagiarism, its types and testing methods. Policy of HEC on Plagiarism.

Practical
Exercise of scientific writing and research proposal. Exercise of collecting material from different sources on assigned topics and oral presentations. Use of reference manager, endnote and Turnitin software.

Recommended Books
9. Handbook of postgraduate Research students. UHI Millennium Institute, Perth College, Scotland, UK. WWW.PERTH.AC.UK.
Objectives
To enable students to understand:
- Emerging trends of genomics in relation to Agriculture and Crops Breeding

Theory

Practical

Recommended Books

Articles

Websites
1. www.expasy.ch
2. www.justbio.com
Objectives
To enable students to understand:
• Importance of biosafety laws and standards related to GM crops.

Theory
Concept of biosafety measures. Cartagena protocol on biosafety; field and laboratory biosecurity and biosafety; risk assessment; development of biosafety measures in crop improvement, agencies regulating biosafety rules. Potential threats of agricultural biotechnology, transgenic plants and animals. Regulations to access safety of GM crops.

Practical
Classes of chemicals, handling, storage and transportation of hazardous chemicals. Safe work practices. Making plans of risk assessment; Handling radioactive material. Assays to quarantine biological materials.

Recommended Books
Objectives
To enable students to understand:
- Significance of medicinal plants in national and international perspectives
- Role of conventional and molecular tools for improvement of medicinal plants

Theory

Practical

Recommended Books
Objectives
To enable students to understand:
- Importance of planning and conducting research project
- Data collection, analysing and interpretation
- Logical presentation of results

Practical
Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive/private farms.
OR
To undertake a research project at university fields/laboratories aimed at their practical training. Planning, layout and execution of experiment. Collection, analysis, and interpretation of data.

Upon completion of internship/research project, students are required to submit a report and give presentation of internship/research experiment.

Recommended Books
### Post Graduate Courses

#### Core Courses for MSc (Hons) Students

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 701</td>
<td>Principles of Plant Breeding</td>
<td>3(2-1)</td>
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<tr>
<td>PBG 702</td>
<td>Advanced Genetics</td>
<td>3(3-0)</td>
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<tr>
<td>PBG 703</td>
<td>Molecular Plant Breeding</td>
<td>3(2-1)</td>
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<tr>
<td>PBG 704</td>
<td>Cytogenetics of Crop Plants</td>
<td>3(2-1)</td>
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#### General Courses for Post Graduate Students

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>PBG-705</td>
<td>Breeding and Genetics of Fodder Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-706</td>
<td>Breeding for Stress Environments</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-707</td>
<td>Mutation Breeding</td>
<td>3(2-1)</td>
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<tr>
<td>PBG-708</td>
<td>Population Genetics</td>
<td>3(3-0)</td>
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<tr>
<td>PBG-709</td>
<td>Cereal Genetics and Breeding</td>
<td>3(2-1)</td>
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<tr>
<td>PBG-710</td>
<td>Cotton Genetics and Breeding</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-711</td>
<td>Genetics and Breeding of Oilseed Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-712</td>
<td>Genetics and Breeding of Sugar Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-713</td>
<td>Genetic Engineering in Plants</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-714</td>
<td>Evolution of Field Crops</td>
<td>3(3-0)</td>
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<tr>
<td>PBG-715</td>
<td>Advanced Cytogenetics</td>
<td>3(3-0)</td>
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<tr>
<td>PBG-716</td>
<td>Plant Genomics</td>
<td>3(2-1)</td>
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<tr>
<td>PBG-717</td>
<td>Advanced Methods in Plant Breeding</td>
<td>3(2-1)</td>
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<tr>
<td>PBG-718</td>
<td>Genetics of Plant Disease and Insect Resistance</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-719</td>
<td>Development of Hybrid and Seed Production</td>
<td>3(2-1)</td>
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<tr>
<td>PBG-720</td>
<td>Biometrical Techniques in Plant Breeding</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG-721</td>
<td>Special Problem</td>
<td>1(1-0)</td>
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<tr>
<td>PBG 722</td>
<td>Seminar (MSc Hons)</td>
<td>1(1-0)</td>
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<tr>
<td>PBG 723</td>
<td>Thesis (MSc Hons)</td>
<td>10(0-10)</td>
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<tr>
<td>PBG-724</td>
<td>Special Problem</td>
<td>1(1-0)</td>
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<tr>
<td>PBG-724</td>
<td>Seminar-I (PhD)</td>
<td>1(1-0)</td>
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<tr>
<td>PBG-725</td>
<td>Seminar-II (PhD)</td>
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</tr>
<tr>
<td>PBG-726</td>
<td>PhD Dissertation</td>
<td>20(0-20)</td>
</tr>
</tbody>
</table>
Theory

Practical

Recommended Books
Theory


Recommended Books

Theory


Practical

DNA extraction. Primer designing. PCR, gel scoring, phenotypic and genotypic data collection. Software based data analysis to develop QTLs. In silico mapping – physical position of a marker - a case study in completely sequenced plant genome. Analysis of upstream and downstream genes of a marker. Genome browsing of sequenced plant genomes. Promoter analysis.

Recommended Books

Theory


Practical


Recommended Books

Theory


Practical

Classification of various rabi and kharif fodders. Study of floral structure in different fodder crops. Selfing and crossing techniques for various fodders; handling breeding material and its evaluation.

Recommended Books

Theory


Practical

Field and laboratory study of stress parameters. Screening under simulated stress conditions. Genetic analysis of tolerance related traits. Visits to research institutes.

Recommended Books

Theory


Practical


Recommended Books


World Wide Web

http://tilling.fhcrc.org:9366/files/Welcome_to_ATP.html
http://www.licor.com/bio/applications/4300_applications/tilling.jsp
Theory


Recommended Books

Theory

Practical
Problems relating to genetic analysis in wheat, rice, maize and barley. Estimation of grain quality. Identification and scoring of cereal diseases, screening of cereal cultivars for drought resistance and salt tolerance in lab and field conditions. Visit to various cereal research institutes.

Recommended Books
Theory

Practical
Methods of measuring cotton fibre strength, fineness and maturity. Cladogram construction of various gene families involved in fiber development. Exploring cotton fibre EST databases. DNA markers for various traits. Data recording on plant and fibre characters and genetic analyses.

Recommended Books

World Wide Web:
http://www.cotton.org/journal/archive.cfm
Theory


Practical

Specification and characteristics of edible oil, oil content, fatty acid, iodine number, acid value, hydrogenation and saponification. Methods and equipment used for oil extraction and analysis. Fatty acid profile of various edible and industrial oils. Genetic evaluation of different fatty acids in oilseeds. Visit to various vegetable oil and ghee industries.

Recommended Books


World Wide Web

Theory


Practical

Estimation of Brix value of sugarcane. Collection of data for various plant traits in sugar crops and their statistical analysis. Visit to research institutes and sugar industries.

Recommended Books

Theory

Practical
Extraction and purification of plasmid, genomic DNA and RNA. Restriction mapping. PCR and electrophoresis. Genetic transformation of bacteria and plants. Visit to National Institutions working in Genetic Engineering and Biotechnology.

Recommended Books
Theory

Recommended Books
Theory

Recommended Books
Theory


Practical


Recommended Books

Theory


Practical


Recommended Books

Theory

Practical

Recommended Books
Theory


Practical

Development of inbred lines. Estimation of GCA and SCA. Selection and maintenance of A, B and R lines under field conditions. Use of gametocytes, induction of male sterility and evaluation of hybrids. Visit to private and public research institutes engaged in commercial hybrid seed production.

Recommended Books

Theory


Practical

Numerical examples regarding genetic analysis. Assessment of genotypic and phenotypic correlations, and partitioning of genotypic correlation into direct and indirect path ways. Use of software for biometrical analysis.

Recommended Books

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<td>Seminar-II (PhD)</td>
<td>1(1-0)</td>
</tr>
<tr>
<td>PBG 726</td>
<td>PhD Dissertation</td>
<td>20(0-20)</td>
</tr>
</tbody>
</table>

Student will be assigned a special topic for searching literature relevant to a particular problem or conducting an experiment or any other appropriate activity. Student has to compile a comprehensive report on the title assigned.

Student will be given a topic on a particular problem in the field of plant breeding and genetics. Student has to deliver a presentation in an open house gathering on the title assigned.

Student has to defend his/her Ph.D Synopsis in an open house gathering.
English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

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

Comprehension
Answers to questions on a given text

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

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

Translation skills
Urdu to English

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

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books:
1. Functional English
   a) Grammar

b) Writing

c) Reading/Comprehension

d) Speaking

   **English II (Communication Skills)**

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

   **Course Contents:**

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

   **Essay writing**
   Introduction

   **CV and job application**
   Translation skills
   Urdu to English

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

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

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

   **Note:** documentaries to be shown for discussion and review

   **Recommended Books:**
   **Communication Skills**
   a) Grammar

b) Writing

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

**English III (Technical Writing and Presentation Skills)**

**Objectives:** Enhance language skills and develop critical thinking

**Course Contents:**

**Presentation skills**

**Essay writing**
Descriptive, narrative, discursive, argumentative

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

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

**Technical Report writing**

**Progress report writing**

*Note: Extensive reading is required for vocabulary building*

**Recommended Books:**

Technical Writing and Presentation Skills
a) Essay Writing and Academic Writing

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by Northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).
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
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. Government and Politics in Pakistan
   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward

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

Recommended Books

ISLAMIC STUDIES
(Compulsory)

Objectives:
This course is aimed at:
1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies
1. Basic Concepts of Quran
2. History of Quran
3. Uloom-ul-Quran

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

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

Seerat of Holy Prophet (S.A.W) I
1. Life of Muhammad Bin Abdullah (Before Prophet Hood)
2. Life of Holy Prophet (S.A.W) in Makkah
3. Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II
1. Life of Holy Prophet (S.A.W) in Madina
2. Important Events of Life Holy Prophet in Madina
3. Important Lessons Derived from the life of Holy Prophet in Madina
Introduction to Sunnah
1. Basic Concepts of Hadith
2. History of Hadith
3. Kinds of Hadith
4. Uloom -ul-Hadith
5. Sunnah & Hadith
6. Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence
1. Basic Concepts of Islamic Law & Jurisprudence
2. History & Importance of Islamic Law & Jurisprudence
3. Sources of Islamic Law & Jurisprudence
4. Nature of Differences in Islamic Law
5. Islam and Sectarianism

Islamic Culture & Civilization
1. Basic Concepts of Islamic Culture & Civilization
2. Historical Development of Islamic Culture & Civilization
3. Characteristics of Islamic Culture & Civilization
4. Islamic Culture & Civilization and Contemporary Issues

Islam & Science
1. Basic Concepts of Islam & Science
2. Contributions of Muslims in the Development of Science
3. Quran & Science

Islamic Economic System
1. Basic Concepts of Islamic Economic System
2. Means of Distribution of wealth in Islamic Economics
3. Islamic Concept of Riba
4. Islamic Ways of Trade & Commerce

Political System of Islam
1. Basic Concepts of Islamic Political System
2. Islamic Concept of Sovereignty
3. Basic Institutions of Govt. in Islam

Islamic History
1. Period of 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,”
Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level
Credit Hours: 3 + 0

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

Course Outline:

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

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


Recommended Books:

2. MATHEMATICS II (CALCULUS)

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

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

Course Outline:

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

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

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

Recommended Books:
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

4. COURSE FOR NON-MATHMATICS MAJORS IN SOCIAL SCIENCES

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

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

Objectives : After completion of this course the student should be able to:
- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents :
1. Algebra
2. **Statistics**
   

**Recommended Books:**

5. **MATHEMATICS FOR CHEMISTRY**

**Credit Hours:** 3

**Prerequisites:** Mathematics at Secondary level

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

**Course Outline:**

Recommended Books

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
4. Basic Statistics an Inferential Approach 2nd Ed. (1986) Fran II. Dietrich-II and Thomas J. Kears

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
Edition, 1980 by R. G. D Steel and James H. Torrie
K. A. Gomez and A. A. Gomez
Introduction to Information and Communication Technologies

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

Course Description:

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

Course Contents:

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

Text Books/Reference Books:

ANNEXURE - G

**Functional Biology-I**

**Credit Hours 3+0**

**Biological Methods**

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

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

**Reading**

Functional Biology-II

Credit Hours 3+0

Myths and Realities of Evolution

Microevolution
Speciation
Macroevolution

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

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

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

Reading


Note:

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

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
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Nutrition and Respiration
Reproduction and Development

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

Reading


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

1. In under-graduate scheme of studies, PBG-501, PBG-503, PBG-505, PBG-507, PBG 508 and PBG-509 were declared as core courses for students majoring in Plant Breeding and Genetics which will be taught at all agricultural universities and colleges. However, other courses on different crops may be changed according to regional specific agricultural requirements.

2. All agricultural universities and colleges should adopt semester system and NCRC (HEC) approved curricula of PBG.

3. The courses PBG-701, PBG-702, PBG-703 and PBG-704 were decided as core courses in the scheme of studies of Plant Breeding and Genetics at post-graduate level and these courses will be taught in every agricultural university/college of the country.

4. Members of the committee showed concern about the change in the nomenclature of the PBG degree being offered in few universities of the country. The members after thorough discussion recommended that uniformity in nomenclature of the degree must be ensured and maintained.

5. PBG faculty should avail the HEC facility in procurement of softwares relevant to PBG and Learning Management System for strengthening research and academics.

6. Workshops/trainings sponsored by HEC were strongly recommended to ensure regular updating of teaching faculty about new developments in their area of expertise.

7. Visits to National/International Research Institutes were emphasized to abreast students and faculty members of newly emerging techniques in Plant Breeding and Genetics.