CURRICULUM DIVISION, HEC

Prof. Dr. Mukhtar Ahmed          Chairman, HEC
Prof. Dr. Arshad Ali             Executive Director, HEC
Mr. Muhammad Raza Chohan         Director General (Academics)
Dr. Muhammad Idrees              Director (Curriculum)
Mr. Hidayatullah Kasi            Deputy Director (Curriculum)
Mr. Rabeel Bhatti                Assistant Director (Curriculum)
Mr. Muhammad Faisal Khan         Assistant Director (Curriculum)
COURSE CONTENTS

1. Introduction
2. Frame Work for BS (4-years) in Statistics Layout
3. Model Scheme of Studies for BS (4-years) in Statistics
4. Aims and Objectives
5. List of General Courses
6. Elective Courses
7. Detail of Courses
8. Recommendations
9. Compulsory Courses
10. MS/M.Phil Statistics (2-years programme)
11. PhD (Statistics)
   Admission Requirement

Composed by: Mr. Zulfiqar Ali, HEC, Islamabad
PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic program are required to undergo to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/evaluation. 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 regularly 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 indigenous needs and international standards, HEC NCRCs have developed unified framework/templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering.

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 http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx

(Muhammad Raza Chohan)
Director General (Academics)
CURRICULUM DEVELOPMENT

STAGE-I

CURRI. UNDER CONSIDERATION

COLLECTION OF EXP NOMINATION UNI, R&D, INDUSTRY & COUNCILS

CONS. OF NCRC.

PREP. OF DRAFT BY NCRC

STAGE-II

CURRI. IN DRAFT STAGE

APPRaisal OF 1ST DRAFT BY EXP

FINALIZATION OF DRAFT BY NCRC

STAGE-III

FINAL STAGE

PREP. OF FINAL CURRI.

PRINTING OF CURRI.

STAGE-IV

FOLLOW UP

QUESTIONNAIRE

COMMENTS

IMPLE. OF CURRI.

ORIENTATION COURSES BY LI, HEC

BACK TO STAGE-I

Abbreviations Used:
NCRC. National Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
LI Learning Innovation
R&D Research & Development Organization
HEC Higher Education Commission
CONS: Constitution
CURRICULUM DEVELOPMENT CYCLE

1. Preliminary Meeting/Preparation of Draft
2. Selection of Relevant Members
3. Formulation of NCRC
4. Circulation of Draft for feedback (Local/Foreign)
5. Dissemination (Website/Hard copies)
6. Convening of Final NCRC
7. Composing/Printing
8. Nominations from all Stakeholders
**Introduction:**

This list of the participants who attended the meeting of National Curriculum Revision Committee (NCRC) meeting for the discipline of Statistics is as under below:

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Position</th>
<th>Institution</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Irshad Ahmad Arshad</td>
<td>Chairman / Professor,</td>
<td>Department of Statistics, Allama Iqbal Open University, H-8, Islamabad.</td>
<td>Convener</td>
</tr>
<tr>
<td>2.</td>
<td>Dr. Faisal Maqbool Zahid</td>
<td>Associate Professor</td>
<td>Department of Statistics, Government College University, Faisalabad.</td>
<td>Secretary</td>
</tr>
<tr>
<td>3.</td>
<td>Dr. Saud Ahmed Khan</td>
<td>Assistant Professor,</td>
<td>Department of Econometrics &amp; Statistics, Pakistan Institute of Development Economics, Quaid-i-Azam Campus, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>4.</td>
<td>Dr. Muhammad Aslam</td>
<td>Professor,</td>
<td>Department of Mathematics &amp; Statistics, Riphah International University, Sector I-14, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>5.</td>
<td>Dr. Irshad Ahmad Arshad</td>
<td>Chairman / Professor,</td>
<td>Department of Statistics, Allama Iqbal Open University, H-8, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>6.</td>
<td>Dr. Tanweer ul Islam</td>
<td>Assistant Professor,</td>
<td>Department of Economics, School of Social Science &amp; Humanities, NUST, Sector H-12, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>7.</td>
<td>Dr. Zahid Asghar</td>
<td>Associate Professor,</td>
<td>Department of Statistics, Quaid-i-Azam University, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>8.</td>
<td>Dr. Bahrawar Jan</td>
<td>Deputy Director General,</td>
<td>Pakistan Bureau of Statistics, Statistics House, 21-Mauve Area, Sector G-9/1, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>No.</td>
<td>Name</td>
<td>Position</td>
<td>Institution</td>
<td>Member</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>9.</td>
<td>Dr. Rana Abdul Wajid</td>
<td>Professor / Dean &amp; Director</td>
<td>Faculty of Basic Sciences, Centre for Mathematics &amp; Statistical Sciences, Lahore School of Economics, Burki Road, Lahore.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Dr. Muhammad Azam</td>
<td>Associate Professor</td>
<td>Department of Statistics &amp; CS, University of Veterinary &amp; Animal Sciences, Lahore</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Dr. Muhammad Mohsin</td>
<td>Chairman / HoD</td>
<td>Department of Statistics, COMSATS Institute of Information Technology, Defence Road, Off Raiwind Road, Lahore.</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Ms. Munaza Zafar Bajwa</td>
<td>Assistant Professor</td>
<td>Department of Statistics, Kinnaird College for Women, 93-Jail Road, Lahore.</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Dr. Sharoon Hanook</td>
<td>Chairperson / Assistant Professor</td>
<td>Department of Statistics, Room # S-438, Forman Christian College, Ferozpur Road, Lahore.</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Dr. Muhammad Amanullah</td>
<td>Professor</td>
<td>Department of Statistics, Bahauddin Zakariya University, Multan.</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Dr. Muhammad Hanif</td>
<td>Associate Professor</td>
<td>Department of Mathematics &amp; Statistics, PMAS Arid Agriculture University, Murree Road, Rawalpindi.</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Dr. Shahid Kamal</td>
<td>Professor / Dean</td>
<td>College of Statistical &amp; Actuarial Science, University of the Punjab, Quaid-i-Azam Campus, Lahore.</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Dr. Muhammad Yaseen</td>
<td>Assistant Professor</td>
<td>Department of Mathematics &amp; Statistics, University of Agriculture, Faisalabad.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Position</td>
<td>Institution</td>
<td>Role</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>18.</td>
<td>Dr. Fayyaz Ahmad</td>
<td>Assistant Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>University of Gujrat, Gujrat.</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Dr. Syed M. Shakil Ali Ghazali</td>
<td>Chairman / Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The Islamia University of Bahawalpur, Bahawalpur.</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Prof. Dr. Muhammad Hussain Tahir</td>
<td>Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The Islamia University of Bahawalpur, Bahawalpur.</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Dr. Uzma Nawaz</td>
<td>Chairperson / Associate Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The Women University Multan, LMQ Road, Katchery Chowk, Multan.</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Dr. Mir Ghulam Hyder Talpur</td>
<td>Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>University of Sindh, Jamshoro.</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Prof. Dr. Mumtaz Hussain Mahar</td>
<td>Dean / Professor</td>
<td>Faculty of Physical Sciences</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Department of Statistics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shah Abdul Latif University, Khairpur.</td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Prof. Dr. Velo Suthar</td>
<td>Professor / Chairman</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sindh Agriculture University, Tandojam.</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Dr. Amjad Ali</td>
<td>Assistant Professor</td>
<td>Faculty of Basis &amp; Social Sciences</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Department of Statistics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Islamia College, Peshawar.</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Dr. Asma Gul</td>
<td>Assistant Professor</td>
<td>Department of Statistics</td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shaheed Benazir Bhutto Women University, Charsadda Road, Peshawar.</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Name</td>
<td>Title/Position</td>
<td>Affiliation</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Prof. Dr. Qamruz Zaman</td>
<td>Professor</td>
<td>Faculty of Physical &amp; Numerical Sciences, Department of Statistics, University of Peshawar, Peshawar.</td>
<td>Member</td>
</tr>
<tr>
<td>28.</td>
<td>Dr. Farhat Iqbal</td>
<td>Associate Professor</td>
<td>Department of Statistics, University of Balochistan, Quetta.</td>
<td>Member</td>
</tr>
<tr>
<td>29.</td>
<td>Dr. Muhammad Zubair Khan</td>
<td>Assistant Professor</td>
<td>Faculty of Arts &amp; Basic Sciences, Department of Statistics, BUITEMS, Quetta.</td>
<td>Member</td>
</tr>
<tr>
<td>30.</td>
<td>Dr. Aamir Saghir</td>
<td>Assistant Professor</td>
<td>Department of Statistics, Mirpur University of Science &amp; Technology (MUST), Mirpur (AJK).</td>
<td>Member</td>
</tr>
<tr>
<td>31.</td>
<td>Dr. Muhammad Idrees</td>
<td>Director (Curriculum)</td>
<td>Higher Education Commission, Islamabad</td>
<td>Coordinator</td>
</tr>
<tr>
<td>32.</td>
<td>Mr. Rabeel Bhatti</td>
<td>Assistant Director (Curriculum)</td>
<td>Higher Education Commission, Islamabad</td>
<td>Coordinator</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS

After thorough discussion, the participants of the National Curriculum Revision Committee in Statistics 2017 formulated the following recommendations for uniform and effective implementation of the HEC policies at national level.

1. Departments of Statistics in the universities should make efforts to interact with national and international statistical organizations such as PBS, industry and other users of statistics in the public and private sector.

2. Internship should be funded by the HEC and/or other funding agencies, and offered to the students.

3. All universities’ departments should develop and maintain an internship / career services department to facilitate the internship students of Statistics.

4. The teaching of most of the courses requires the use of statistical packages. In this regard HEC should take positive steps to spare sufficient funds for purchasing the licensed statistical software (e.g., SPSS, Stata, Minitab etc.) for all universities.

5. Since there is a shortage of highly qualified statisticians in Pakistan. Therefore, allocating extra quota for statistics students to pursue higher education is needed.

6. The committee strongly recommends the creation of “Department of Biostatistics” for teaching and research guidance at all medical colleges/universities and the posts of biostatisticians in all hospitals/other institutions.

7. Practicum conducted during the course work should be in the form of case studies. The data published by different organizations may be used in such case studies.

8. A course on Statistics may be added in curriculum of FSc (Pre-Medical & Pre-Eng.) to prepare students for their professional education.

9. The department of Statistics in each university may establish a statistics consultancy center to attract potential researchers. HEC should provide technical and financial support to these research cells.

10. Refresher courses for the faculty should be regularly arranged by the HEC.

11. HEC should support universities for the development of computer labs, departmental libraries, students and staff participation in seminars, workshops, and conferences.

12. The department websites should be updated on a regular basis so that research interests of the faculty may become public.

13. PGD (Post Graduate Diploma) / Short courses should be offered by the universities/department of Statistics to the non-statisticians.
14. Professional ethics should be an integral part of the training of students at both the undergraduate and graduate level.

15. Since 4 year BS Programme is equivalent to old M.Sc. Programme in Statistics, therefore, the relevant recruitment rules for the post of BPS-17 may be amended by the concerned departments (FPSC, Establishment Division) and B.S. (Four year Programme) may be added in the eligibility criteria for the posts.

16. The department of Statistics in each university should make concrete efforts for establishing university-industry linkages for MS level research.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr Hr</th>
<th>Subject</th>
<th>Cr Hr</th>
<th>Subject</th>
<th>Cr Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. English I</td>
<td>3</td>
<td>1. Introduction to Psychology</td>
<td>3</td>
<td>Introductory Statistics</td>
<td>3-4</td>
</tr>
<tr>
<td>2. English II</td>
<td>3</td>
<td>2. Introduction to Logic</td>
<td>3</td>
<td>Introduction to Probability &amp; Probability Distributions</td>
<td>3-4</td>
</tr>
<tr>
<td>3. English III</td>
<td>3</td>
<td>3. Fundamentals of Economics</td>
<td>3</td>
<td>Basic Statistical Inference</td>
<td>3-4</td>
</tr>
<tr>
<td>4. Communication Skill</td>
<td>3</td>
<td>4. International Relations</td>
<td>3</td>
<td>Linear Algebra</td>
<td>3-4</td>
</tr>
<tr>
<td>5. Pakistan Studies</td>
<td>2</td>
<td>5. Basics of Sociology</td>
<td>3</td>
<td>Introduction to Regression and Analysis of Variance</td>
<td>3-4</td>
</tr>
<tr>
<td>6. Islamic Studies / Ethics</td>
<td>2</td>
<td>6. Introduction to Environmental Sciences</td>
<td>3</td>
<td>Exploratory Data Analysis and Visualization</td>
<td>3-4</td>
</tr>
<tr>
<td>8. Calculus-II</td>
<td>3</td>
<td>8. Business Administration</td>
<td>3</td>
<td>Sampling Techniques-I</td>
<td>3-4</td>
</tr>
<tr>
<td>9. Introduction to Computer</td>
<td>3</td>
<td>9. (Entrepreneurship)</td>
<td>OR</td>
<td>Statistical Packages</td>
<td>3-4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
<td>Cr Hr</td>
<td>21</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Major courses including research project/internship</td>
<td>Elective Courses within the major</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>----------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-13 courses</td>
<td>4 courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36-42 Credit hours</td>
<td>12 Credit Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subject</strong></td>
<td><strong>Cr Hr</strong></td>
<td><strong>Subject</strong></td>
<td><strong>Cr Hr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Regression Analysis</td>
<td>4</td>
<td>1. Operations Research</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Design &amp; Analysis of Experiment-I</td>
<td>4</td>
<td>2. Stochastic Process</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Sampling Techniques-II</td>
<td>4</td>
<td>4. Introduction to Time Series Analysis</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Econometrics</td>
<td>4</td>
<td>5. Research Methodology</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Statistical Inference-1</td>
<td>3</td>
<td><strong>OR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Multivariate Analysis-I</td>
<td>3</td>
<td><strong>from the list of elective courses.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Multivariate Analysis-II</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Statistical Inference-II</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.`Official Statistics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Research Project / Internship</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>46</strong></td>
<td><strong>12</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester / Year</td>
<td>Name of Subject</td>
<td>Credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>Introductory Statistics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pakistan Studies</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>English-I (Functional English)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calculus-I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>Introduction to Probability Distributions</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Islamic Studies/Ethics</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>English-II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calculus-II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-III</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-IV</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>Basic Statistical Inference</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>English-III</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to Computer and its Applications</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-V</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-VI</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth</td>
<td>Exploratory Data Analysis and Visualization</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to Regression and Analysis of Variance</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication Skills</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Linear Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General-VII</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth</td>
<td>Probability Distribution-1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sampling Technique-I</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design &amp; Analysis of Experiment-I</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regression Analysis</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statistical Packages</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sixth</td>
<td>Probability Distribution-II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sampling Techniques-II</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design &amp; Analysis of Experiment-II</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Econometrics</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Official Statistics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Aims and Objectives:

The major aims and objectives of the curriculum of Statistics are to adapt the curriculum to meet the international standards.

1. To provide a sound footing of the subject matter of statistical theory with applications, so that the students can pursue higher degrees and research in the field of statistics.

2. To train the students in the use of statistical software and techniques of data collection and analysis so that they can compete in the job market.

3. To involve the students in research project so that they can be better trained in the field of research.

4. To develop a solid foundation for the effective operational and strategic decisions based on statistical theory and methodology in almost every discipline.

* LIST OF GENERAL COURSES FOR STATISTICS

Seven courses are to be selected from the following list of courses, according to available facilities and faculty of the universities.

1. Business Administration (Entrepreneurship)
2. Human Resource Management
3. Environmental Sciences
4. Principles of Management & Marketing
5. Basic Financial Management

Note: 4 credit hours courses must include Lab. /Practical.
6. History of Human Civilization
7. Introduction to Biology
8. Foreign Language other than English
9. Introduction to Physics
10. Advanced Calculus
11. Introduction to Genetics
12. Introduction to Geography

or any other subject depending upon the expertise available.

** Elective Courses for BS (4-Year) Programme for Statistics

1. Operations Research
2. Stochastic Process
3. Reliability Analysis
4. Decision Theory
5. Robust Methods
6. Survival Analysis
7. Bio-Statistics
8. Data Mining
9. Actuarial Statistics-I
10. Actuarial Statistics-II
11. Mathematical Models and Simulation
12. Categorical Data Analysis
13. Numerical Methods
14. Bayesian Inference
15. Statistical Quality Control,

or any other subject depending upon the expertise available.
DETIAL OF COURSES

The proposed outlines of the BS (4-YEAR) programme in Statistics are as follows:

STAT- 101: Introductory Statistics

Learning Objectives:
- To have introduction of statistics as a field of knowledge and its scope and relevance to other disciplines of natural and social sciences.
- To equipped and prepare students for advance courses in the field of statistics.
- To achieve the capability of critical thinking about data and its sources; have idea about variables and their types and scale measures.
- Be able to calculate and interpret descriptive statistics (able to classify, tabulate, describe and display data using software).

Learning Outcomes:
- Acquire the basic knowledge of the discipline of Statistics.
- Understand and differentiate between the types of data and variables.
- Evaluate and Interpret basic descriptive statistics. Display and Interpret data graphs.

Course Contents:

Index numbers: construction and uses of index numbers, un-weighted index numbers (simple aggregative index, average of relative price index numbers), weighted index numbers (Laspayer’s, Paasche’s and Fisher’s ideal index numbers), Consumer price index (CPI) and Sensitive Price Indicators

Recommended Books:
   https://sites.google.com/site/introstats4muslims/textbook
   https://sites.google.com/site/introstats4muslims/excel.

STAT- 102: Introduction to Probability & Probability Distributions

Learning Objectives:
- Understand basic concepts of probability, conditional probability, independence etc.
- Be familiar with some of the more commonly encountered random variables, particularly the Binomial and Normal random variable.
- Be able to calculate first two moments of common random variables i.e. means and variances.
- Be able to apply the concepts of random variables to scientific applications. Computation of uncertainty using probability techniques.

Learning Outcomes:
- Acquire the basic knowledge of probability and probability distribution.
- Understand the concepts of basic techniques of measuring the uncertainty problem.
- Analyze the problem of genetics finance and telecommunications by using probability techniques.

Course Contents:

Recommended Books:
STAT- 202: Basic Statistical Inference

Learning Objectives:
- To understand basic techniques of sampling and estimation, their properties and application
- To select a sample from a given population and use it to make inferences about the population and its parameter
- To test, deduce and infer the validity of different types of hypotheses and models built on the basis of the raw data collected in diverse problem situations.

Learning Outcomes:
- Acquire the knowledge of the sampling distributions and their properties.
- Derive the appropriate estimators for parameters using best estimation procedure.
- Use appropriate sampling distributions for interval estimation and hypotheses testing.
- Apply appropriate inferential procedures to handle the practical situations.

Course Contents:
Sampling and sampling distribution of sample mean, proportion, difference between means and difference between proportions; Point and interval estimate properties of good point estimator; Testing of hypothesis for population mean, difference between population means and population proportion and difference between two population proportions, difference between means for paired data; Single population variance, ratio of two variances; Non-parametric methods: The sign test, Wilcoxon’s signed rank test, Mann-Whitney U test, Median test, Run test, Kolmogorov-Smirnov test, Kruskal-Wallis test, Median test for k-samples, Friedman test.

Pre-Requisite- STAT-102
Recommended Books:

**STAT-204 Linear Algebra**

Course Objectives:
- To develop the ability to solve problems using the techniques of linear algebra
- To Understand Euclidean vector spaces, their inherent arithmetic and algebraic structure, and the accompanying geometry that arise
- Acquire facility working with general vector spaces, linear transformations, coordinate vectors, and the changing of bases.
- To analyze the structure of real-world problems and plan solution strategies. Solve the problems using appropriate tools.

Learning Outcomes:
- Interpret the Use of vector equations and linear transformations and its application in image processing and Control theory, etc
- Apply mathematical concepts in problem-solving through integration of new material and modeling
- Analyze/interpret quantitative data verbally, graphically, symbolically and numerically.

Course Contents:

Recommended Books:

STAT- 203: Introduction to Regression and Analysis of Variance

Course Objectives:
- To provide foundations of regression analysis.
- To provide basic knowledge and art of statistical data analysis
- To predict and draw inference about the parameters of the parameters of population.

Learning Outcomes:
- Explore more adequately the connection between theory of regression.
- Analysis of real world problems.
- Prediction of dependent variable.

Course Contents:
Relationship between variables, Simple linear regression model, Estimation of parameters by method of least squares and corresponding variance estimates, Testing and confidence intervals for least squares estimators, mean prediction and individual prediction. Multiple linear regression with two regressors, coefficient of multiple determination, Partial and multiple correlation up to three variables. Inference of simple, partial and multiple correlation coefficients, Analysis of variance for one-way classification and two-way classification. Decomposition of total sum of squares, Multiple comparison tests; least significant difference and Duncans multiple range test, Tukey test and Least significant difference test.

Pre-Requisite: STAT-101
Recommended Books:

STAT-401: Exploratory Data Analysis and Visualization (EDAV)

Learning Objectives:
- to provide solid understanding of the process of Exploratory Data Analysis
- to educate students in data exploration, analysis, and visualization
- to train students in industry standard tools for data analysis and visualization

Learning outcomes:
- describe exploratory data analysis and visualization concepts
- describe data analysis and visualization models and algorithms
- describe applicability of different data analysis and visualization models techniques to solve real-world problems
- acquire and pre-process data
- apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization

Course Contents:
Exploratory Data Analysis: Explore, Visualize, Analyze, Repeat. Selective data collective and data exploration. Data visualization and Data analysis (using Excel/Tableau/R/STATA/SPSS etc).

Recommended Books:
2. Tukey, J. (1977) Exploratory Data Analysis
STAT- 204: Statistical Packages

Course Objectives:
- To understand basics of data analysis through Minitab, SPSS and R.
- To learn visualization of data through Minitab, SPSS and R.
- To learn basic programming in R.

Learning Outcomes:
- Understand the data presentation and analysis using Minitab and SPSS.
- Learn basic programming in R for statistical data analysis.
- Describe concepts as they are implemented in real world data.

Course Contents:
Introduction to statistical packages and programming languages, Introduction to Minitab, data manipulation, graphical representation, qualitative and quantitative data analysis and programming.

Introduction to SPSS, data manipulation, descriptive statistics, function related to probability distributions, SPSS modules, graphical representation of data, tabulation and transformation of variables.

Introduction to R, language essentials; expression and objects, functions and arguments, vectors, missing values, matrices and arrays, factors, data frames, indexing, conditional selection, indexing of data frames, sorting, Data entry; reading from text files, the data editor, interfacing to other programs. Descriptive statistics and graphics.

Note: Use of any other statistical package based upon the availability of the Software.

Recommended Books:

STAT- 301: Probability Distributions- I

Course Objectives:
- This course is designed to give students a conceptual knowledge of discrete random variables and probability theory.
- This course provides the fundamentals of probability theory in different disciplines.
• This course helps to model the uncertain behavior from the real life scenario.

**Learning Outcomes:**
• Understand the basic concepts and applications of probability.
• Investigate the nature of stochastic process and apply suitable probability distributions for the random variable generated from such process.
• Find probabilities using probability distributions.
• Use probability concepts and laws in decision analysis.

**Course Contents:**
Distribution function, Probability mass and density functions. Location, scale, and shape parameters. Joint and conditional distributions for two and more random variables, Marginal and conditional distributions, stochastic independence, Mathematical expectation and its properties, Conditional expectation, variance and moments, Probability generating, Moment generating and characteristic functions with their properties. Factorial Moments, Cummulants, L moments and their relationships. Probability distributions: Bernoulli, Binomial, Hypergeometric, Poisson, Negative binomial, Geometric, discrete uniform, Multinomial distribution. Normal approximation to binomial, Poisson and Hypergeometric distribution.

**Pre-Requisite: STAT-102**

**Recommended Books:**

**STAT- 303: Sampling Techniques-I**

**Course Objectives:**
• To introduce the concept and scope of sampling.
• To determine the sample size for conducting a survey.
To learn ratio and regression estimations.
To understand the concept of simple and stratified random sampling techniques.

Learning Outcomes:
- Use and implement of sampling designs.
- Apply the simple random sampling and the stratified random sampling appropriately in real world problems.
- Estimate the population parameters by using simple and stratified random sampling techniques.

Course Contents:
Introduction of Sampling, advantages of sampling, requirements of a good sample, bias, sampling and non-sampling errors, Steps and problems involved in planning and conduct of census and their sources, sample surveys, Selection and estimation procedures. Description and properties of simple random sampling, Sampling for proportions and percentages, Estimation of variances, standard errors and confidence limits, Sample size determination under different conditions, Description and properties of stratified random sampling, Formation of strata, Different methods of allocation of sample size, Ratio and regression estimates in simple and stratified random sampling

Pre-Requisite: STAT-201

Recommended Books:
and
*Various publications of Pakistan Bureau of Statistics (PBS).

STAT- 307: Regression Analysis

Course Objectives:
- To understand the basic assumptions of regression analysis.
- To handle the problems arising from the violation of assumptions.
- To understand the estimation techniques of parameters.
- To give the concept of nonlinear regression analysis.
Learning Outcomes:
- Students would have enough knowledge of regression analysis.
- Students will be able to understand the concept of basic assumption of regression and how to overcome these problems.
- It developed the skills of students to analyze the real phenomena of regression models.

Course Contents:

Pre-Requisite: STAT-203

Recommended Books:

STAT-305: Design and Analysis of Experiments-I

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

Learning Outcomes:
- Understand the basic concepts and applications of experimental design.
- Decide appropriate design for given scenario.
- Analyze the data generated from different designs and interpret the results.
Course Contents:
Introduction to experimental design and its terminology; Planning and designing of experiment and research; Aspects of experimental design, basic principles of experimental design, fixed and random effects. Analysis of variance, estimation of model parameters. Checking model adequacy, Inference beyond ANOVA multiple comparisons, Contrast analysis, orthogonal polynomial contrasts and trend analysis. Basic experimental designs; completely randomized design, randomized complete block design and Latin square design. Relative efficiency of these designs. Incomplete block designs (IBD), balanced incomplete block designs (BIBD) and partially balanced incomplete block designs (PBIBD). Intra-block and Inter-block analysis of IBD.

Pre-Requisite:  STAT-203

Recommended Books:

STAT- 310:  Non-Parametric Methods

Rationale of non-parametric methods, Chi-Square Procedures: Chi-Square Goodness of fit Test, Chi-Square test of independence, Location estimates for single sample: The sign test, modified sign test, Wilcoxon signed rank test, confidence interval based on these tests. Runs test for randomness. Anderson-Darling test.

Distribution tests and rank transformation, Kolmogrov’s test, Lilliefor’s test and Shapiro-Wilks test for normality. Tests and estimation for two independent samples; the median test, Wilcoxon Mann – Whitney test. The Siegel – Tukey test, the squared rank test for variance, Smirnov test, Tests for paired samples, Kruskal – Wallis test, Friedman test, multiple comparison with the Friedman test, Cochran’s test for binary responses Spearman’s rank correlation coefficient, Kendall’s rank correlation coefficient. Theil’s regression method

Pre-Requisite:  STAT-202
Recommended Books:
3. Lehman, E.L. (1973), *Nonparametric Statistical Methods, based on Ranks*, Holden-Day San Francisco

STAT- 302: Probability Distributions - II

Course Objectives:
- This course is designed to give students a conceptual knowledge of continuous random variables and probability theory.
- This course provides the fundamentals of probability theory in different disciplines.
- This course helps to model the uncertain behavior from the real life scenario.

Learning Outcomes:
- Understand the basic concepts and applications of probability.
- Investigate the nature of stochastic process and apply suitable probability distributions for the random variable generated from such process.
- Find probabilities using probability distributions.
- Use probability concepts and laws in decision analysis.

Course Contents:
Overview of the continuous random variables, Uniform, Beta, Lognormal, Exponential, Gamma, Laplace, Rayleigh and Weibull distributions with their properties; Bivariate Normal distribution and its properties, Distributions of functions of random variables: Chi-square, t and F distributions, their derivations and properties. Central limit and Chebyshev's theorems, Weak and Strong Laws of large numbers and their applications, Order statistics, Distributions of r-th and s-th order statistics.

Pre-Requisite: STAT-301

Recommended Books:

**STAT- 304: Sampling Techniques-II**

**Course Objectives:**
- To understand the concept of systematic, cluster, multistage and multiphase sampling techniques.
- Comparison among different sampling techniques.
- To learn ratio and regression estimations.
- To understand the non-response, their sources, and randomized response technique.

**Learning Outcomes:**
- Use and implement of systematic and cluster sampling designs.
- Apply the multistage and multiphase sampling appropriately in real world problems.
- Estimate the population parameters by using systematic and cluster sampling techniques.

**Course Contents:**
Systematic sampling, Cluster Sampling. Efficiency of systematic sampling compared with simple random sampling, stratified random sampling and cluster sampling. Sub sampling, proportion to size (PPS)-Sampling, Double Sampling, Multistage and Multiphase sampling, Thomson Hurwitz estimator, Comparison of different sample designs; non-response, their sources and bias and Randomized response.

**Note:** Practical's of this course shall include visits of the students to various national statistical organizations and a report submitted to this effect.

**Pre-Requisite:** STAT-303

**Recommended Books:**

*Various publications of Pakistan Bureau of Statistics (PBS).

STAT- 308: Economometrics

Course Objectives:
- The purpose of this course is to introduce students to the main concepts and tools used in econometrics.
- In particular, to learn when and how to apply regression analysis. Learn the basic assumptions and techniques used to run estimations and make inferences in the context of a linear equation framework.
- To learn to recognize specification and data problems. Also additional tools to handle time series data.
- Each topic will be approached with a mix of intuitive explanations, theoretical characterization and proofs.
- And practical applications, including interpretation of regression output.

Learning outcomes:
- Conduct basic statistical and econometric analysis. Explain and interpret econometric results.
- Explain econometric concepts and results intuitively, conduct independent data analysis and inquiry using the tools of statistics and econometrics.
- Conduct Research with econometrics, derive econometric results mathematically

Course Contents:

Recommended Books:

STAT- 306: Design and Analysis of Experiments-II

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

Learning Outcomes:
- Understand the basic concepts and applications of experimental design.
- Decide appropriate design for given scenario.
- Analyze the data generated from different designs and interpret the results.

Course Contents:
Introduction to factorial experiments, simple, main and interaction effects. Hidden replication. $2^k$ and $3^k$ series and mixed level factorial experiments and their analysis. Analysis of Covariance (ANCOVA). Confounding in factorial experiments, complete and partial confounding; Single replication of factorial experiments. Fractional factorial experiments. Introduction of response surface methods; first and second order designs, central composite designs, fitting of response surface models and estimation of optimum response, split plot design and its variations.

Pre-Requisite: STAT-305

Recommended Books:
Meaning of vital statistics, registrations of Birth and death in Pakistan. Uses of vital statistics, short comings of vital statistics, rates and ratios (Sex ratio, child women ratio, birth and death ratio, population growth rate, classification of natal rates, death rates or mortality rates, crude death rate, specific death rate, infant mortality rate, case fatality rate, fertility rates, crude birth rate, specific birth rate, standardized death rate, reproduction rates, morbidity or sickness rates, marriage rates, divorce rates etc. general; fertility rate, total fertility rate.)

Basic concepts of demography, Sources of demographic data: The population and housing census, Registration of vital events. Demographic surveys, Components of population growth, composition of population and vital events, Types and sources of errors, Data quality testing procedures, testing the accuracy of age and sex distribution, Fertility and mortality measures, Estimation from incomplete Data

Construction of complete and abridged life tables, Different types of life tables, Graphs of \( I_x \), \( q_x \) and \( e_x \), Description and uses of life table columns.

**Recommended Books:**

10. Pakistan Demographic Survey (2007), Govt. of Pakistan.

**STAT- 312: Population Models**

Stationary population models, Population estimates and projections, Intercensal estimates, Population projections through various methods. Theory of demographic transition, Stable and stationary population models, their applications and uses, Malthusian and post Malthusian theories of growth, Consequences of world population growth & population explosion; State of Population in Pakistan, Development of demographic profile in Pakistan, Recent demographic parameters. Current and future demographic activities in Pakistan

**Recommended Books:**
10. Pakistan Demographic Survey (2007), Govt. of Pakistan.

STAT- 401: Statistical Inference-I

Course Objectives:
- To introduces students to the basic theory behind the development and assessment of statistical analysis.
- To understand the techniques in the areas of point and interval estimation, as well as hypothesis testing.
- To apply the statistical techniques to real data and draw conclusions.

Learning Outcomes:
- Explain the notion of a parametric model and point estimation of the parameters of those models. Explain and apply approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
- Assess the plausibility of pre-specified ideas about the parameters of a model by examining the area of hypothesis testing.
- Explain and apply the idea of non-parametric statistics, wherein estimation and analysis techniques are developed that are not heavily dependent on the specifications of an underlying parametric model.
- Understand the computational issues related to the implementation of various statistical inferential approaches.

Course Contents:

Pre-Requisite: STAT-302

Recommended Books:
STAT- 402: Statistical Inference-II

Course Objectives:
- To develop an advanced-level understanding and working knowledge of statistical inference.
- To provide an introduction to the rudiments of statistical inference for population parameters based on a general decision theoretic framework covering estimation and test of hypothesis.
- To introduce some nonparametric methods and their applications.

Learning Outcomes:
- A foundation for understanding probability-based statistical inference material presented in other courses.
- The understanding of the concepts of testing, size and power of a test.
- The understanding of and derivation of the properties of tests based on different criterion functions.

Course Contents:
Interval Estimation: Pivotal and other methods of finding confidence interval, confidence interval in large samples, shortest confidence interval, optimum confidence interval. Bayes’ Interval estimation


Pre-Requisite: STAT-401

Recommended Books:
STAT- 403: Multivariate Analysis

Course Objectives:
- This course provides the fundamental knowledge of multivariate data and its applications in different fields of life.
- This course will introduce the students different multivariate techniques through real world problems.
- This course will develop the skill in students to estimate the parameters and drive inference in multivariate cases.

Learning Outcomes:
- Understand the basic concepts and applications of multivariate techniques.
- Unable to decide which multivariate technique to be used for the given scenario.
- Analyze the multivariate data and interpret the results correctly.

Course Contents:

Pre-Requisite: STAT-305

Recommended Books:
STAT- 402: Statistical Inference-II

Interval Estimation: Pivotal and other methods of finding confidence interval, confidence interval in large samples, shortest confidence interval, optimum confidence interval. Bayes’ Interval estimation


Pre-Requisite: STAT-401

Recommended Books:

STAT- 422: RESEARCH PROJECT / INTERNSHIP

Note: A separate and independent research project/internship will be assigned and completed by each student. At the end of the project/internship, it will be mandatory for each student to submit his/her project/research/internship report for evaluation.
STAT- 405: Research Methodology

Course Objectives:
- To understand some basic concepts of research and its methodologies
- To identify appropriate research problems
- To select and define appropriate research problems and parameters
- To organize and conduct research in more appropriate manner

Learning Outcomes:
- Understand general definition of research design
- Solve the problems in the fields of qualitative and quantitative research
- Plan and conduct research using an appropriate research design, keeping in view the ethical issues in the research
- Critically review and develop a complete research project

Course Contents:

NOTE: Studying and reviewing standard survey questionnaires and preparation of a sample questionnaire and a scientific report.

Pre-Requisite: STAT-304

Recommended Books:

STAT-406: Operations Research

Course Objectives:
- To introduce students to the techniques of operations research.
- To provide students with basic skills and knowledge of operations research and its application in industry.
- To introduce students to practical application of operations research with emphasis on the industrial data.
- To effectively use relevant statistical software for data analysis.

Learning Outcomes:
- Identify and develop operations research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimization problems.
- Apply operations research techniques to summarize the industrial data.
- Demonstrate the usage of statistical software for solving problem and analyzing the relevant data.

Course Contents:
History and definition of Operations Research (OR), Types of OR models, Introduction to linear programming, Formulation of LP model, Graphical solution of two variables, Standard Form, Simplex method, Duality theory; Sensitivity Analysis, Primal and dual form, Transportation Problem, Assignment problem. Network Analysis, PERT/CPM techniques, Queuing Models.

Recommended Books:
STAT- 407: Stochastic Processes

Course Objectives:
- This course aims to provide an understanding of stochastic processes and the ability to analyze certain aspects of these processes.
- Accordingly, the course starts by reviewing probability theory, conditional probability, independence and certain properties of random variables, and continues by examining stationary processes.
- Furthermore, Markov chains in discrete and continuous time as well as Possion processes are investigated in detail.

Learning Outcomes:
- Define probability models, concept and properties of random variables, random processes, Markov processes and Markov chains,
- Explain properties and functions of random processes with stochastic mathematical models, - formulate discrete and continuous time random processes, stationary random processes.
- Devise solutions with probability models for Poisson processes, discrete and continuous time Markov chains.

Course Contents:

Recommended Books:
STAT- 408: Reliability Theory

Course Objectives:
- To learn to analyze complete and censored reliability data with and without covariates.
- To learn some key methods in reliability modeling.
- To learn the probability and statistical methods covered in the Reliability Analysis.
- To have the working knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability.

Learning Outcomes:
- Analyze the interference between strength and stress, or life data for estimating reliability
- Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects.
- Specify life test plans for reliability validation.

Course Contents:
Basic concepts of reliability, Structural reliability, Life time distributions (Failure models): Hazard rate; Gamma, Weibull, Gumball, Log-Normal and Inverse Gaussian Distribution. Stochastic fatigue-rate models, Point and interval estimation, Fatigue-life model

Testing reliability hypothesis, Monte-Carlo simulations, distribution-free and Bayes’ methods in reliability, System reliability; series and parallel systems, Failure models, (k-out-of-m) New-better-than used models. Inferences for these models, Accelerated life testing

Recommended Books:
Course Objectives:
- Learn basic analysis of time series data.
- Compute and interpret ACF/PACF and a sample spectrum.
- Derive the properties of ARIMA models and choose an appropriate ARIMA model for a given set of data and fit the model using an appropriate package.
- Compute forecasts for a variety of linear methods and models.

Learning Outcomes:
- Demonstrate understanding of the concepts of time series and their application to various fields of sciences.
- Apply ideas to real time series data and interpret outcomes of analyses and forecast.
- Use various advanced time series econometric methods, estimation methods and related econometric theories.
- Interpret time series models' estimates and analyze the results.

Course Contents:
Time series analysis: concepts and components, Stochastic Process, Stationary Time-Series, Exponential smoothing techniques, auto-correlation and auto-covariance, estimation of auto-correlation function (ACF) and Partial autocorrelation function (PACF) and standard errors, Periodogram, spectral density functions, comparison with ACF, Linear stationary models: Auto Regressive Moving Average (ARMA) and mixed models, Non-stationary models, general ARIMA notation and models, minimum mean square forecasting. ARIMA Seasonal Models

Recommended Books:
STAT- 411: Robust Methods

Course Objectives:
- The objectives of this course is to provide an introduction to both basic and advanced analytical tools for robust models. This course also aims to promote a critical perspective on the use of statistical informations.
- Beginning with simple statistical methods, the course builds to more robust analytical techniques such as multivariate linear regression and estimators.
- Emphasis is placed on theoretical understanding of concepts as well as the application of key methodologies used in different research fields.

Learning Outcomes:
- Explain the importance, techniques and biases of estimators in context
- Explain the concept of outliers in regression model and other influential observations
- Construct and interpret various statistical hypothesis tests.

Course Contents:
Introduction to Robustness, Objective function, M-estimator of location, E-estimator, R-estimator and W-estimator, Redescending M-estimator’s The Breakdown point of Robust estimator Influence function. M-estimator for scale, Jackknife Resampling, Outliers and influential observations, Outliers in Regression analysis

Recommended Books:

STAT- 412: Official Statistics

Course Objectives:
- To understand the official, demographic and social statistics.
- To understand the scope and organization of official statistics,
- To understand the planning and administration statistics.
Learning Outcomes:
- The versatility to work effectively in a broad range of analytic, scientific, government, financial, technical and other positions.
- A broad overview of the fundamental issues underlying the organization of official statistics.
- To recognize the importance of statistical thinking.

Course Contents:
Introduction to official statistics, statistical systems and international standards, set up of national and provincial statistical organizations in Pakistan, its role in development of statistics, working and publications.

Sources of official statistics, National Database Registration Authority (NADRA) and its role, Economic Statistics producers, International classification and standards.

Use of Statistics in administration and planning concepts and evaluation of GDP, GNP, NNP, balance of Trade and payments. Measurements of income distribution, prices and price mechanisms. Deflation and Inflation of series, Industrial quantum index, National sample surveys and census conducted in Pakistan.

Note: Visit of major Statistical Organizations should be a part of the course. Alternatively, the department may invite experts from various statistical organizations.

Suggested Reports:
   *Various Publications of PBS, State Bank of Pakistan, Ministry of Finance, etc.

STAT- 413: Survival Analysis

Course Objectives:
- To introduce the basic concepts of survival analysis
To describe and explain how survival analysis can be applied in different fields
To learn the usage of appropriate statistical software for survival data analysis

**Learning Outcomes:**
- Understand the basic concepts and ideas of survival analysis
- Derive properties and methods for standard survival time distributions
- Perform and interpret simple non-parametric survival analyses using software
- Apply and interpret semi-parametric regression models for survival data using software

**Course Contents:**
Introduction to survival analysis with some important basic definition of statistical quantities, terminologies and notation of survival and hazard function, Censored Data and its three types, truncation; importance and scope of the survival analysis.

Describing the probability distributions of the survival and hazard functions. Basic layout of the survival problem both manually and computer based presentation of survival data. Computation of the descriptive measures for survival data both graphically and empirically.

Estimation of the survival function, survival probabilities. Estimation of the survival functions from possibly censored samples by means of the Kaplan-Meier estimator, the Nelson-Aalen estimator and the kernel density estimator or the Ramlau-Hansen estimator and comparisons of k independent survival functions by means of the generalized log-rank test and related alternative approaches.

The Proportional Hazards Model, the likelihood function, the Partial Likelihood Function, identification of Significant Covariates, estimation of the Survivorship Function with Covariates.

Cox's semi-parametric models. Evaluation of the assumptions of Cox proportional hazard model. Introduction to estimation of Stratified Cox's procedures for single and multiple variable adequacy Assessment of the Proportional Hazards Model.

**Recommended Books:**

**STAT- 414: Biostatistics**

**Course Objectives:**
- To discuss and explain what biostatistics is and how it is used in Biological Sciences
- To recognize and give examples of different types of data arising in Biological Sciences
- To use statistical techniques to summarize the Biological data
- To apply statistical software to analyze and evaluate Biological data

**Learning Outcomes:**
- Understand the diverse applications of statistical tools in biological science.
- Demonstrate an understanding of the central concepts of modern statistical theory in Biological Sciences.
- Acquire the understanding of the appropriate usage of software for Biological sciences.
- Analyze and communicate the results of statistical analysis accurately and effectively.

**Course Contents:**
Introduction to the basic concepts and terminology of Biostatistics, types of variables, populations, target populations and sampled population: Role of sampling in biostatistics, Sample size estimation. Contingency table analysis, Fisher’s exact test, 2x2 tables, Three way tables, rxc test for independence, Simpson’s paradox, Confounding, G-Test. Proportions, rates and ratios; incidence, prevalence, Odds Ratio, Relative Risk, Rate Ratio, Sensitivity and specificity. Distributional behavior of biological variables (Binomial, Poisson and Normal), Role of transformation for analysis of biological variables, Probit and Logit transformations and their analysis

**Recommended Books:**


**STAT- 415: Data Mining**

Introduction to databases including simple and relational databases, data warehouses, Review of classification methods from multivariate analysis; classification, decision trees: classification and regression trees. Clustering methods from both statistical and data mining viewpoints; vector quantization. Unsupervised learning from univariate and multivariate data; dimension reduction and feature selection. Supervised learning from moderate to high dimensional input spaces; introduction to artificial neural networks and extensions of regression models.

**Recommended Books:**


Course Objectives:
- To develop understanding of the mathematical concepts and techniques that are used by actuaries to model stochastic processes of both assets and liabilities.
- To learn about various types of insurance and pension schemes.

Learning Outcomes:
- Basic Mathematics involved in Actuarial Computations.
- Insurance, Types and Applications in Pakistan.
- Understanding the Life Contingencies and Actuarial Notations.

Course Contents:
Interest Rate Theory: Simple interest rate, Compound interest rate, Discount interest rate, Force of Interest, Real and Money Interest. Annuities: Description of annuities, Term annuity, Deferred annuity, Non-level annuities, Continuous annuities. Introduction to Actuarial Science, Role of Actuaries: Business, Finance, Stock Markets, Banks and other Financial Institutions. The role of Actuaries in Government Departments: SECP, State Bank, Employee Benefits Management. Insurance and Assurance, Types of Insurance: Life Insurance, Health Insurance, Motor Insurance, Businesses and Pension Fund. Islamic Mode of Insurance / Takaful. Life Insurance Contract: Define simple insurance contracts and devolve the formulae for mean and variance of the present values of the payments under these contracts, Whole life assurance, Term assurance, Pure endowment assurance, endowment assurance and critical ill-health assurance including assurances where the benefits are deferred also derive their mean and variances Define the symbols $A_x, A_x^{n}, A_x^{n}, A_x^{n}$ and their select and continuous equivalents.

Recommended books:

STAT- 417: Actuarial Statistics – II

Course Objectives:
- Developing an understanding of the mathematical concepts and techniques that are used to model and value cash flows contingent on survival, death and other uncertain events.
- Building mathematical foundations of life insurance and superannuation models.

Learning Outcomes:
- Understanding the Life Tables, Types and Computations.
- Understanding the Theories of Mortality, Analytical Laws and Projections.
- Develop and analyze the pension and benefit strategies that are equitable and meet the needs of diverse communities.

Course Contents:
Life Tables: Describe the life table functions, express life table probabilities in term of the actuarial related functions used both in assurances and annuities. Evaluation of assurances and annuities: derive the relations between assurance and annuities and their select and continuous equivalents. Net premiums and provisions: ultimate and select mortality; net premiums and net premium provisions, random future loss, prospective and retrospective provisions, Derive Thiele’s equation, Death strain at risk, expected death strain, actual death strain, mortality benefits, Simple annuities and assurances involving two lives. Mortality: Theories of Mortality, analytical laws of mortality, techniques of projections of population mortality. Pension Theory: Structure and design of pension funds, Basic actuarial aspects of pension plans, Actuarial assumptions and actuarial cost methods, periodic gain and loss analyses, Relative merits of cost methods, sensitivity analysis.

Recommended books:

STAT- 418: Mathematical Modeling and Simulation

Course Objectives:
- To understand the mathematical models using simulation
- To understand the simulation approaches to problem solving, on a diverse variety of disciplines.
- To check the validity of models.

Learning Outcomes:
- Recognize the connections between simulated and real data.
- Familiar with a variety of simulated examples where mathematical models helps accurately explain physical phenomena.
- Able to independently expand their mathematical or statistical expertise when needed, or for interest’s sake.

Course Contents:
Monte Carlo methods: Different methods of generating random numbers, generation of random variables, acceptance and rejection techniques from various distributions. Comparison of algorithms to generate random variables, generating random variables from failure rates. Generation from multinomial distribution/Monte Carlo integration, Gibbs sampling and other resampling techniques, Variance reduction techniques: importance sampling for integration, control and antithetic variables.

Recommended Books:

STAT- 419: Categorical Data Analysis

Course Objectives:
- To understand the basic concepts of categorical data analysis
• To recognize different types of categorical data and use appropriate methodology for categorical data
• To conduct statistical analysis using existing software and properly interpret the computer output.

**Learning Outcomes:**
• Implement basic categorical methods and combine them for the sampling estimation
• Obtain estimators, evaluate standard errors, construct confidence intervals and making statistical inference according to the categorical analysis techniques
• Apply the principles of lifelong learning to any new challenges arise with categorical data
• Demonstrate the knowledge to characterize, analyze and solve a wide range of problems related to the categorical data

**Course Contents:**
A brief history of categorical data analysis, Principles of likelihood-based inference, Sampling distributions for contingency tables, Measures of association for 2x2 tables, Testing independence in contingency tables, Exact inference for two-way tables, Inferences for three-way tables.

Introduction to generalized linear models, Logistic regression, Model building, Alternative link functions for binary outcome, Diagnostics, Receiver Operating Characteristic (ROC) Curve Analysis. Exact methods and conditional logistic regression, Methods for analyzing matched case-control data, Multinomial response models for nominal data, Multinomial response models for ordinal data.

Poisson regression model, Poisson regression for rates, Log linear models for contingency tables

**Recommended Books:**
STAT- 422: Bayesian Inference

Course Objectives:
- The aim of this course is to introduce the modern approach to Bayesian statistics,
- This course is emphasizing the computational aspects and the differences between the classical and Bayesian approaches.
- This course will help in formulating appropriate Bayesian models, including data and prior distributions.

Learning Outcomes:
- Understanding basic techniques of Bayesian statistics for decision making
- Using different simulation techniques to handle complex posterior distribution
- Knowing the application of Bayesian statistics in different models

Course Contents:
Introduction to Bayesian Inference, goals of Bayesian Inference, Conditional Probability, Conditional independence, Prior distribution and its different types, Posterior distribution, its mean, median (Bayes estimators under loss functions) and variances. Posterior Inference based on one parameter e.g. binomial, Poisson etc. Posterior inference based on normal distribution: Posterior predictive distributions, Bayesian Hypotheses Testing: Bayes factor; The highest density region; Introduction to Monte Carlo method, Discrete approximations.

Recommended Books:
Course Objectives:
- This course is designed to provide a conceptual and practical knowledge of techniques for quality control.
- This course is structured to monitor the process control via control charts.
- This course is designed to determine most appropriate sample size needed to accept or reject a lot of material.

Learning Outcomes:
- Design attribute and variable acceptance sampling plans for the industrial purpose.
- To construct various types of attribute and variable sampling plans using statistical software.
- Draw attribute and variable control charts to be implemented in different scenarios exist in industry.
- To construct various types of attribute and variable control charts to be implemented in different scenarios exist in industry.

Course Contents:

Recommended Books:
RECOMMENDATIONS:

The following recommendations were made by the committee to enhance the teaching and learning of Statistics:

17. Departments of Statistics in the universities should make efforts to interact with national and international statistical organizations such as PBS, industrial and other spheres of public and private sectors where voluminous statistical data is awaiting data mining and future/current policy developments.

18. Internship should be funded by the HEC and/or other funding agencies, and offered to the students.

19. All universities departments should develop and maintain an internship / career services department to facilitate the internship students of Statistics.

20. The teaching of most of the courses requires the use of statistical packages. In this regard HEC should take positive steps to spare sufficient funds for purchasing the licensed statistical software (e.g., SPSS, Stata, Minitab, SAS, EViews, Matlab, Mathematica, Statistix etc.) for all universities.

21. The subject of Statistics should be categorically considered under the umbrella of social sciences.

22. The committee strongly recommends the creation of “Department of Biostatistics” for teaching and research guidance at all medical colleges/universities and the posts of biostatisticians in all hospitals/other institutions.

23. Practicum conducted during the course work should be in the form of case studies. Different data collection agencies/organizations should be encouraged to share/ disseminate the data among the Statistics departments of universities for having useful analysis and predictions from this valuable information.

24. A course on Statistics may be added in curriculum of FSc (Pre-Medical and Pre-Eng.) to prepare students for their professional education.

25. The department of Statistics in each university may establish a statistics consultancy center to attract potential researchers. HEC should provide technical and financial support to these research cells.

26. Refresher courses for the faculty with a special focus on the faculty of affiliated colleges of the universities should be regularly arranged by the HEC.

27. HEC should support universities for the development of computer labs, departmental libraries, students and staff participation in seminars, workshops, and conferences.
28. HEC should provide financial support for publishing the research work in well reputed impact factor international journals.

29. Statistics as major subject must be the eligibility criteria for the jobs requiring statistical expertise like statistical officers in different department.

30. The department websites should be updated on a regular basis so that research interests of the faculty may become public.

31. Short courses / Post Graduate Diploma (PGD) should be offered by the universities/department of Statistics to the non-statisticians/researchers in other disciplines.

32. Professional ethics should be an integral part of the training of students at both the undergraduate and graduate level.

33. The department of Statistics in each university should make concrete efforts for establishing university-industry linkages for MS/MPhil/PhD level research.
COMPULSORY COURSES IN ENGLISH FOR BS
(4 YEAR) IN BASIC & SOCIAL SCIENCES

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
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

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 norther, 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)
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 Holy Quran
1) Verses of Surah Al-Baqra 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 Holy 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

Recommended Books:
1) Hameed ullah Muhammad, “Emergence of Islam”, IRI, Islamabad
2) Hameed ullah Muhammad, “Muslim Conduct of State”
3) Hameed ullah Muhammad, ‘Introduction to Islam
4) Mulana Muhammad Yousaf Islahi,”
6) Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
9) Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001)
Note: One course will be selected from the following three 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:


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:
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-coordinate 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:
COURSE FOR NON-STATISTICS MAJOR IN SOCIAL SCIENCES

Title of subject : Introduction of Statistics  
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 Statistics and prepare the students not majoring in Statistics

Objectives : After completion of this course the student should be able to:
- Understand the use of the essential tools of basic Statistics;
- Apply the concepts and the techniques in their respective disciplines.

Unit 1. What is Statistics?

Unit 2. Presentation of Data
Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Historigram, Ogive for Discrete Variable, Types of frequency curves, Exercises.

Unit 3. Measures of Central Tendency
Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and Mode, Relative Merits and Demerits of various Averages. Properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection, Exercises

Unit 4. Measures of Dispersion
Introduction, Absolute and relative measures, Range, Quartile Deviation, The Mean Deviation, The Variance and standard deviation,
Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios, Exercises.

**Unit 5. Probability and Probability Distributions**
Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

**Unit 6. Sampling and Sampling Distributions**
Introduction, sample design and sampling frame, bias, sampling and non-sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions, Exercises.

**Unit 7. Hypothesis Testing**
Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis, Exercises.

**Unit 8. Testing of Hypothesis- Single Population**
Introduction, testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

**Unit 9. Testing of Hypotheses-Two or more Populations**
Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table, Exercises

**Unit 10. Testing of Hypothesis-Independence of Attributes**
Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes, Exercises

**Unit 11. Regression and Correlation**
Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation, Correlation, Coefficient of linear correlation, its estimation, and interpretation of $r$ and $R^2$. Multiple regression and interpretation of its parameters, Examples

**Recommended Books:**
MS/M.Phil. STATISTICS  (2 Years programme)

MS/M.Phil. Statistics will contain a total of 36 Credit Hours out of which 24(12+12) will comprise course work in the first two semesters (1\textsuperscript{st} year of study) and final two semesters will be for thesis / research equivalent to 12 Credit Hours.

**Detail of Credit Hours is as follows:-**

<table>
<thead>
<tr>
<th>Semester</th>
<th>No. of Subjects</th>
<th>Credit Hours</th>
<th>Total Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st}</td>
<td>4</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>2\textsuperscript{nd}</td>
<td>4</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>3\textsuperscript{rd} + 4\textsuperscript{th}</td>
<td>Thesis / Research Work</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**Total Credit Hours for MS Statistics** 30

**Courses:**

- STAT-701 Advanced Probability Theory
- STAT-702 Linear Models
- STAT-703 Advanced Statistical Inference
- STAT-704 Advanced Regression Analysis
- STAT-705 Advanced Design of Experiments
- STAT-706 Advanced Multivariate Analysis
- STAT-707 Regression Models for Count Data
- STAT-708 Time Series Analysis and Forecasting
- STAT-709 Advanced Categorical Data Analysis
- STAT-710 Logical Reasoning and Research Methods
- STAT-711 Survey Sampling
- STAT-712 Longitudinal Data Analysis
- STAT-713 Survival Data Analysis
- STAT-714 Applied Stochastic Models
- STAT-715 Spatial Data Analysis
- STAT-716 Advanced Distribution Theory
- STAT-717 Inference in Stochastic Processes
- STAT-718 Advanced Bayesian Inference
- STAT-719 Optimization Techniques
- STAT-720 Ecological Statistics
STAT-721 Statistical Methods for Clinical Trials  
STAT-722 Bayesian Inference  
STAT-723 Financial Stochastic Models  
STAT-724 Statistical Genetics  
STAT-725 Generalized Linear Models  
STAT-726 Meta Analysis  
STAT-727 Decision Trees  
STAT-728 Generalized Linear Mixed Models  
STAT-729 Advanced Operations Research  
STAT-730 Multilevel Modeling  
STAT-731 Environmental Statistics  
STAT-732 Advanced Statistical Methods in Quality Control  
STAT-733 Applied Smoothing Techniques  
STAT-734 Convergence in Probability  
STAT-735 Meta Analysis  
STAT-736 Structural Equation Models  
STAT-737 Causal Inference

Note: All courses can be offered depending upon the availability of faculty.

Detail of Courses

STAT- 701: Advanced Probability Theory

Course Objectives:
- To impart a conceptual knowledge of random variables and probability theory.
- To use the advanced probability theory in mathematical statistics.
- To strengthen the theoretical basis for future research.

Learning Outcomes:
- Understanding the advanced concepts of probability theory.
- Learning and developing the mathematical theories.
- Acquiring the solution oriented research skills using mathematical statistics.

Course Contents:
An overview of measure theory, fields and sigma-fields, limits of sequences of subsets, sigma-field generated by a class of subsets, Borel fields, Probability, measure on a sigma-fields, probability space, continuity of a probability measure. Real and vector-valued random variables, distribution functions, discrete and continuous random variables, decomposition of c.d.f, transformation of random variables, independence of r.v.s, Borel zero-one law, Expectation of a real r.v. and of a complex-valued r.v. Linear properties of expectations, characteristic functions, their simple properties, uniqueness
theorem. Convergence of a sequence of r.v.s., convergence in distribution, convergence in probability, Kolmogorov strong law of large numbers (without proof), monotone convergence theorem and dominated convergence theorem, continuity theorem for characteristic functions. Lindeberg’s CLT and its particular cases.

Recommended Books:

STAT- 702: Linear Models

Course Objectives:
- To provide sound knowledge of theory of standard statistical models and their properties
- To understand the theory of estimation and significance testing
- To be able critical understanding of model fitting

Learning Outcomes:
- A good understanding of the theory of standard statistical models, their properties and significance testing.
- Fit and fix random and mixed effect models.
- Carry out comparative analysis of various parameter estimation techniques.

Course Contents:
Recommended Books:

STAT- 703: Advanced Statistical Inference

Course Objectives:
- To provide sound knowledge of theory of statistical inference.
- To enable the scholars to communicate the purposes of the analyses, the findings from the analysis, and the implications of those findings.
- To optimize the model fitting using various estimation techniques.

Learning Outcomes:
- Have a foundation for understanding probability-based statistical inference.
- Be able to apply various techniques to minimize variance and bias and have the knowledge of variance-bias tradeoff.
- Be able to apply parameter optimization algorithms for model fitting.

Course Contents:
Objective of statistical analysis and theory, criteria for the choice of families of models, the likelihood, sufficient statistics, some general principles of statistics inference, significance tests: discrete problems, composite alternatives, Local power, Multidimensional alternatives, composite null hypothesis, similar Region, invariants tests, Distribution–free and randomization tests: permutation tests, Rank test, Randomization tests, distance tests, Interval estimation: Scalar parameter, scalar parameter with nuisance parameters, Vector parameter, confidence region, Point estimation: General considerations on bias and variance, Cramer–Rao inequality, Achievement of minimum variance and remove of bias, estimates of minimum mean squared error, Robust estimation, Asymptotic theory: Introduction, maximum likelihood estimates, large sample parametric significance tests, Robust inference for location parameters.
Recommended Books:

**STAT- 704: Advanced Regression Analysis**

**Course Objectives:**
- To provide advanced knowledge on multiple regression and robust regression
- To understanding and application of model selection techniques
- To understand the concept of resampling techniques

**Learning Outcomes:**
- To compute and interpret the results of multivariate regression analysis
- To carry out analysis of residual and perform diagnostic tests
- To perform bootstrapping and cross validation
- To carry out model selection using backward, forward and stepwise selection approaches

**Course Contents:**
Brief review of multiple regression by least-squares, Outliers: Analysis of residuals, Influence measure, identifying influential observations, Diagnostics Tests, Robust regression, Tests for normality, choosing a regression model using various computational techniques: All possible regressions, forward selection, backward elimination and stepwise regressions. Re-Sampling techniques: Jackknifing, bootstrapping and cross-validation.

Recommended Books:
STAT- 705: Advanced Design of Experiments

Course Objectives:
- To provide the knowledge of advanced experimental designs and their uses in different disciplines.
- To provide basic and advanced skills of investigation for conclusions through planning and designing of experiments.
- To train students through innovative instruction in design theory and methodology that will help them in understanding the significance of experimental design in statistics and across the universal disciplines.

Learning Outcomes:
- Skill to encounter the principles of randomization, replication and blocking, and their application
- Ability to explore the general theory of complete and incomplete block designs and understand this theory sufficiently to find appropriate designs for specific applications
- Proficiency to evaluate designs using common optimality criteria and use them to critically compare competing designs
- Expertise in using statistical software to analyze common forms of experiments

Course Contents:
Incomplete block designs (IBD), balanced incomplete block designs (BIBD) and partially balanced incomplete block designs (PBIBD). Intra-block and Inter-block analysis of IBD. Resolvable block designs. Square lattice designs, rectangular lattice designs, generalized lattice designs. Latinized block designs, row-column designs, Latin square design. Factorial experiments: single and fractional replication. Response surface methodology, first and second order response surface designs. Optimal designs and optimality criteria, robust parameter designs and Taguchi methods.

Recommended Books:


**STAT-706: Advanced Multivariate Analysis**

**Course Objectives:**
- To impart the conceptual and advanced knowledge of multivariate data.
- To teach various advanced techniques to handle the challenges presented by these data.
- To develop sound knowledge of multivariate theories and its application in different fields.

**Learning Outcomes:**
- Understanding of the link between multivariate techniques and corresponding univariate techniques.
- Recognition of the variety of advanced multivariate techniques and their proficient applications.
- Development of the skill to summarize, analyze and interpret the multivariate data.

**Course Contents:**
Review of multivariate methods, distance, quadratic form, Eigen analysis, spectral decomposition, singular-value decomposition. Descriptive statistics for multivariate data, multivariate normal distribution and derivation of its properties, principal component analysis, correspondence analysis, factor analysis, canonical correlation analysis, discriminant analysis, cluster analysis, multidimensional scaling, classification and regression tree (CART), Path analysis. Multivariate linear model: multivariate regression, multivariate analysis of variance (MANOVA) and multivariate analysis of covariance (MANCOVA).

**Recommended Books:**
Course Objectives:
- To understand the count data exclusively other than categorical data.
- To learn the characteristics and existence form of count data in different fields.
- To enhance skills in comprehension and evaluation of statistical methods for count data.
- To learn and apply the various discrete and extended discrete probability distributions in real life count data.

Learning Outcomes:
- Acquire the mathematical basis of Count Regression models.
- Analyze data arising from observational studies.
- Understand the role of statistical modelling in discovering information, making predictions and decision making in a range of applications in distinct fields of natural and social science.

Course Contents:


Recommended Books:
STAT- 708: Time Series Analysis and Forecasting

Course Objectives:
- The objective of this course is to equip students with various forecasting techniques and knowledge on modern statistical methods for analyzing time series data.
- To make the students learnt the theory and application of the three parts: I. Univariate methods; II. Regression methods; III. ARIMA models.

Learning Outcomes:
- The ability to demonstrate an understanding of the principles behind modern forecasting techniques.
- The ability to select an appropriate model, to fit parameter values, and to carry out the forecasting calculation.

Course Contents:
Types of data, components of time series data, Stochastic processes, Stationary and non-stationary processes, Forms and tests of non-stationarity, Purely random processes, Random walk models, Lag operator, Difference equations and their solutions, Smoothing and decomposition methods, Univariate time series analysis (ARMA, ARIMA, Box-Jenkins approach, ARCH,GARCH etc.), Time series modeling and diagnostic checking, State space models and use of Kalman filter, Multivariate time series analysis: Granger causality, Vector Autoregressive Models. Transfer function and intervention analysis, Time series forecasting, Co-integration analysis, Vector error correction model and Johansen approach.

Recommended Books:
STAT- 709: Advanced Categorical Data Analysis

Course Objectives:
- To understand the basic concepts of categorical data analysis
- To recognize different types of categorical data and use appropriate methodology for categorical data
- To conduct statistical analysis using existing software and properly interpret the computer output.

Learning Outcomes:
- Implement basic categorical methods and combine them for the sampling estimation
- Obtain estimators, evaluate standard errors, construct confidence intervals and making statistical inference according to the categorical analysis techniques
- Demonstrate the knowledge to characterize, analyze and solve a wide range of problems related to the categorical data

Course Contents:


Recommended Books:
STAT-710:  Logical Reasoning and Research Methods

Course Objectives:
- To develop the reasoning ability to the students
- To understand the logical structure of arguments
- To emphasis on acquiring a working knowledge of statements, symbolism, logical connectives, logical relations, basic deductive inferences, truth tables and validity.

Learning Outcomes:
- Knowledge of important aspects of critical thinking
- Strong basis in methods of Boolean algebra and truth tables
- Understanding of research problems and questionnaire

Course Contents:
What is logic, Logic as a science and an art, laws of thought, propositions, Arguments, Deductive and inductive Arguments, Validity and truth, Classes and Categorical positions, symbolism and diagrams for categorical syllogism, figures of the syllogism, Venn Diagram Technique for testing syllogism, Symbolic Logic, Negation and disjunction, truth tables, Concept of boolean algebra, Truth trees, decision trees, formulation of research problems and its significance, preparation of research design, components of research design, questionnaires and interviews, preparation of research report, Multidimensional scaling.

Recommended books:

STAT- 711:  Survey Sampling

Course Objectives:
- To understand the different types of errors involved in planning and running surveys
- To know how to minimize the error arises in sampling surveys
- To critically evaluate the quality and data analysis of complex surveys
Learning Outcomes:
- Demonstrate knowledge and understanding of the stages involved in planning and running surveys, knowing the error might arises in each of these and how to minimize.
- Achieve an understanding of the diverse methodological issues arising in sample survey research and the relationships between them.
- Demonstrate knowledge and understanding of the compromises that exist in survey design, and the strengths, weaknesses and suitability of each option.

Course Contents:

Recommended Books:

STAT 712: Longitudinal Data Analysis

Course Objectives:
- To enhance the student’s understanding and informed usage of modern methods in the analysis of longitudinal (repeated measures) data.
- To provide a foundation for research in statistical methods for longitudinal data.
• To understand statistical methods/models, particularly linear/generalized linear mixed models and GEE approaches, for analyzing longitudinal data

Learning Outcomes:
• Understand the advantages of using longitudinal data for research and decision-making.
• Manage longitudinal datasets and prepare these for statistical analysis.
• Understand and apply different approaches that can be used to model multivariate relationships with longitudinal data (e.g. fixed and random effects regression models).
• Analyze and interpret the results of longitudinal data analyses.

Course Contents:

Recommended Books:
STAT-713: Survival Data Analysis

Course Objectives:
- To introduce the basic concepts of survival models
- To learn how time dependent and independent models can be applied in various fields
- To learn the usage of appropriate statistical software for survival analysis

Learning Outcomes:
- Understand the basic concepts and ideas of survival models
- Derive properties and methods for various survival models
- Perform and interpret parametric and non-parametric survival models using an appropriate software
- Use of different statistical software and packages for application of survival techniques.

Course Contents:

Recommended Books:

STAT- 714: Applied Stochastic Models

Course Objectives:
- This course aims to provide an understanding of stochastic processes and the ability to analyze certain aspects of these processes.
- Accordingly, the course starts by reviewing probability theory, conditional probability, independence and certain properties of random variables, and continues by examining stationary processes and Ergodic theorem.
- Furthermore, Markov chains in discrete and continuous time as well as Poisson processes are investigated in detail.

Learning Outcomes:
- Define probability models, concept and properties of random variables, random processes, Markov processes and Markov chains.
- Explain properties and functions of random processes with stochastic mathematical models.
- Formulate discrete and continuous time random processes, stationary random processes.
- Devise solutions with probability models for Poisson processes, discrete and continuous time Markov chains.
Course Contents:

Recommended Books:

STAT- 715: Spatial Data Analysis

Course Objectives:
- To introduce the spatial statistics providing students with necessary background to investigate the geographically represented data.
- To develop a deeper understanding of the three main areas of spatial statistics: geostatistical data, lattice (areal) data and point patterns.
- To develop comprehension in the application of spatial autocorrelation in statistical modeling.
- To develop the perception and basic skills to apply spatial methods in their own research using statistical software and Geographical Information System (GIS).

Learning outcomes:
- Distinguish different types of spatial data and understand how spatial autocorrelation plays a role in statistical modeling.
- Read and discuss new methods in the spatial statistics literature based on an understanding of the basic spatial statistics approaches, principles and main assumptions.
- Determine which spatial methods to use in their own research and implement them.
- Use existing methods to investigate spatial autocorrelation in example data sets provided as exercises.
Course Contents:
Introduction to spatial statistics and data handling, Eigen function analysis of aerial unit configuration, spatial auto-correlation and spectral analysis, models of spatial auto-correlation, higher order autoregressive models, relationship between autoregressive and spectral models Kriging.

Recommended Books:

STAT- 716: Advanced Distribution Theory

Course Objectives:
- To explore the basic concept of classical and modern probability distributions
- To provide knowledge of extension of classical probability distributions
- To gain sound knowledge of the mathematical characteristics of probability distributions

Learning Outcomes:
- Have a strong basis in probability and distribution theory
- A sound knowledge and understanding of the behavior of random variables
- Be able to apply different probability distributions

Course Contents:
Probability measures, expectations, conditioning, functions of random variables, generating functions, characteristic functions, convergence of random sequences, law of large numbers, central limit theory, discrete distributions, continuous distributions, mixing of probability distributions, transformation of discrete and continuous variable, special sampling distributions: central and non-central case.

Recommended books:

**STAT- 717: Inference in Stochastic Processes**

**Course Objectives:**
- This course aims to provide an understanding of inferences in Markov processes and the ability to analyze certain aspects of this process.
- It provides concept of martingale, strong law of large numbers and Central Limit Theorem for martingales.
- Furthermore, it also provides the asymptotic distribution theory about the processes in context.

**Learning Outcomes:**
- To draw the inferences about Markov processes and the ability to analyze certain aspects of this process.
- To analysis of parametric Pure Jump processes and other processes.
- Devise solutions with probability models for Poisson processes, discrete, continuous time Markov chains and other processes. It will be also helpful in current research in this field.

**Course Contents:**
Recommended Books:

STAT-718: Advanced Bayesian Inference

Course Objectives:
- To impart a conceptual and advanced knowledge of Bayesian theory.
- To teach the development of models by using different priors and the estimation of the Bayes estimates.
- To develop the computational skills by using different algorithms to estimate the posterior distributions.
- To enable the students to draw inferences.

Learning Outcomes:
- Understanding basic techniques of Bayesian statistics for decision making.
- Using different simulation techniques to handle complex posterior distribution.
- Knowing the application of Bayesian statistics in different models.

Course Contents:
Bayesian Inference and its ingredients, different types of Prior and their uses, Conditional independence, Exchangeability, Inference based on one parameter model (Binomial and Poisson), Inference based on two parameter model (Normal), Posterior predictive distributions, Introduction to Monte Carlo method, Posterior approximation with Gibbs Sampler (GS), The Metropolis (MA) Algorithm, Bayesian Regression, Generalized linear models, Non-conjugate priors and implementation of the MA, Hierarchical models.

Recommended Books:

**STAT- 719: Optimization Techniques**

**Course Objectives:**
- To understand the advance knowledge of operations research
- To identify and develop operation research model and its applications
- To understand the simulation techniques

**Learning Outcomes:**
- To develop the understanding of the decision analysis, and knowledge about the game theory
- To identify the best path for the network of optimization problem
- To develop the mathematical tools for getting optimum solutions

**Course Contents:**
Definition of Operation Research (OR), nature and scope of operation research, Objectives of OR, Major phases of OR study, development of OR models and its application in various scenarios of business.


Introduction to advance linear programming model (LPM), properties of advance LPM, formulation of advance LPM, simplex method fundamentals, revised simplex method, boundary variables algorithms, duality, parametric linear programming. Introduction to non-linear programming, constraint and unconstrained algorithms.

Integer linear programing, its application and algorithms, Deterministic dynamic programming, recursive nature of computation in DP, forward and backward recursion.

Introduction to Transportation model, comparison between LPM and transportation model, feasible solution by North-west corner method, Least-cost cell method, Vogel’s approximation method, least time model, Sensitivity analysis of transportation model, Assignment model.

Introduction to Decision analysis and games, classification of decisions, steps in decision theory approach, decision making under uncertainty, decision making under risk, criterion of optimism, criterion of pessimism, Hurwicz criterion, regret criterion, Decision making with and without experimentation, Baye’s decision rule, decision trees. Game theory and optimal solution of two person zero sum games, mixed strategy games.

Introduction to simulation, advantages of simulation, types of simulation models, Monte Carlo simulation, Generation of random numbers, Use of computer packages and R programming for operation research study.

**Recommended Books:**

**STAT-720: Ecological Statistics**

**Course Objectives:**
- Introduce the Ecological data in specific reference to a statistical framework.
- To comprehend the common form of ecological data and discuss their associated models.
- Model fitting approaches including the incorporation of heterogeneity with in the given biological system and the integration of different data sources.

**Learning Outcomes:**
- Focus on learning ecological intensive statistics from an applied perspective.
- Evaluate the structure of ecological data, resulting from observational and experimental studies.
- Analysis of ecological data using appropriate statistical techniques.

**Course Contents:**
Introduction to Ecological data, Diversity in ecological data, spatial patterns in community ecological data, Spatial Eigen function analysis: simple ordination Principal component analysis (PCA), Component Analysis (CA), Principal Component Ordination Analysis (PCOA), multivariate regression analysis and Canonical Analysis, permutation test. Introduction to beta diversity in environmental sorting and to community based processes including neural
processes. The cycle of ecological research and the role of Statistical Modeling: framing ecological questions -> ecological hypothesis -> empirical models -> study design -> statistical models -> Ecological Data Collection -> Statistical Modelling => Answer Question else New Question.

**Recommended Books:**

**STAT 721: Statistical Methods for Clinical Trials**

**Course Objectives:**
- To enhance the students’ awareness and informed usage of modern methods in the design and analysis of randomized control trials.
- To improve statistical thinking as applied to clinical research.
- To provide a foundation for research in statistical methods for clinical trials.

**Learning Outcomes:**
- Plan and apply various clinical study designs
- Recognize a research objective that would meet through a clinical trial
- Discuss the relative contributions of clinical judgment and clinical trials in evaluating new medical therapies.
- Apply various characteristics of statistical reasoning to a research objective in a clinical trial setting.

**Course Contents:**
Introduction to clinical trials, types and aspects of clinical trials; definition, phases and protocol: Design of Clinical Studies; Randomized controlled design, crossover design, cluster randomization, equivalence trial, large sample trial: Randomization; fixed randomization, adaptive randomization: Review of Methods of analysis; Randomization tests, stratified analysis, survival analysis: Surrogate endpoints; surrogate versus clinical endpoints, validation of surrogate end points: Statistical planning; sample size determination: Equivalency testing; Testing for the similarity of treatments: Multiple Testing; Multiple comparisons, subgroup analysis, multiple endpoints, covariate adjustment: Statistical Monitoring; methods of repeated testing of hypotheses over time: Noncompliance / Departure from intended treatment; Intent to treat principle, Efficacy analysis.
Recommended Books:

STAT-722: Bayesian Inference

Learning Outcomes:
- Understanding basic techniques of Bayesian statistics for decision making
- Using different simulation techniques to handle complex posterior distribution
- Knowing the application of Bayesian statistics in different models

Course Contents:
Bayesian Inference and its ingredients, different types of Prior and their uses, Conditional independence, Exchangeability, Inference based on one parameter model (Binomial and Poisson), Inference based on two parameter model (Normal), Posterior predictive distributions, Introduction to Monte Carlo method, Posterior approximation with Gibbs Sampler (GS), The Metropolis (MA) Algorithm, Bayesian Regression, Generalized linear models, Non-conjugate priors and implementation of the MA, Hierarchical models.

Recommended books:
STAT- 723: Financial Stochastic Models

Course Objective:
- Understand the properties of financial time series at level and its returns.
- Calculate Value at Risk, understand Trading Strategies, modeling long run relationships in Finance. Understanding of simulation techniques.

Learning Outcomes:
- Have understanding of financial time series data especially financial return series data. Use event-study methodology in applied research
- Test the standard asset pricing models. Investigate market interdependence (in the mean and variance equations)
- Estimate non-linear models
- Forecast financial data using high-level econometric techniques and measure their effectiveness. Explore the spillover effect in financial return series

Course Contents:

Recommended Books:

STAT-724: Statistical Genetics

Course Objectives:
- The importance of Statistical genetics within the Life and Behavioral Sciences.
• The course is focused to provide an introduction to statistical methods for genetic studies.
• The contents has the sufficiency to obtain knowledge on statistical genetics and fathom skills to analyze data from human/animal and plant genetics. A background in statistical methods and applied multivariate analysis at the undergraduate level is assumed with no any necessity of background in genetics.
• To introduce the Microarray Gene Expression data matrix and its evaluation relationship with applied multivariate techniques

Learning Outcomes:
• The ability to evaluate conclusions that are based on genetic data.
• Insight into the mathematical, statistical, and computational basis of genetic analyses that use genome-scale data sets in systems biology settings.
• The study of Microarray Gene Expression data analysis will make the students meet the challenges of large complex data sets and be able to develop ability to contribute to new methodological and computational advances.

Course Contents:
Introduction to Genetics: Genome, Genome Type and Gene Expression, Of Wild-Types and Other Alleles, Aspects of underlying Biology and Physiochemistry (DNA, RNA and transcription).

Introduction to Quantitative Genetics: Estimation of heritability, Quantitative trait Loci (QTLs), Genetic Correlations, Mendalein Disorder, Complex Traits.

Microarray Gene Expression Data: Gene Expression Data Matrix, Screening and Unsupervised Classification (Clustering Analysis) of Gene Data, Supervised Classification of Tissue samples or Discriminant Analysis.

Analysis Microarray Genetic Data: Hand on practice on any two gene expression data sets available on different websites.

Recommended Books:

**STAT- 725: Generalized Linear Models**

**Course Objectives:**
- To understand the concept of generalized linear model
- To improve the student's ability to apply the theory in exploratory data analysis and further in statistical modelling
- To learn multi-category response models in the field of generalized linear models

**Learning Outcomes:**
- Understand and be proficient at theoretical developments in the analysis of linear models, including linear hypothesis testing, analysis of variance, etc
- Apply the results from linear model theory in advanced topics, such as Over-dispersed models, Quasi-likelihood models, generalized and multivariate analysis
- Read statistical papers involving linear model theory on their own

**Course Contents:**

**Recommended Books:**
STAT- 726 : Meta Analysis

Course Objectives:
- To understand basic and advanced methods for meta-analysis with particular emphasis on using the statistical software R for conducting the analyses.
- Use of statistical programming in R for conducting the analyses.
- To understand the systematic review of observational studies based on meta-analysis

Learning Outcomes:
- To learn important aspects of a systematic review
- To learn a systematic review of observational studies based on meta-analysis
- To have an understanding of standard meta-analytic techniques and methodology

Course Contents:
What is meta analysis, why we need systematic reviews and meta-analyses, Systematic review process, Diagnostic tests and accuracy, Fixed and Random Effects in Meta Analysis, Differences in Treatment Effects in Meta Analysis, Forest plots, Funnel plots. Heterogeneity and meta-regression, Power analysis for Meta Analysis, Meta Analysis methods based on p-values, Publication bias, Network meta-analysis and Reporting a systematic review.

Recommended Books:

STAT- 727: Decision Trees

Course Objectives:
- To explain and differentiate classification and regression methods.
To teach the applications of decision tree techniques in classification of data.
To study tree growing, pruning and generating strategy.

**Learning Outcomes:**
- Ability to distinguish between classification and regression methods.
- Use of some suitable software e.g. (SPSS, R, CART, WEKA) for classification of data.
- Understanding of the flow of the decision trees and the application of the decision tree techniques.

**Course Contents:**
Classification, classifier and an overview of classification techniques,
Difference between supervised and un-supervised learning/classifiers,
Decision trees and their generation procedures (tree growing process),
role of evaluation functions to split parent node into two sub-nodes,
Various node splitting evaluation functions (impurity-based and non-impurity-based) including Gini index, Twoing rule and Entropy function. Properties of impurity-based evaluation functions, Selection criterion to split a node, Estimation of error rates and right sized classification trees. Construction of classification trees; evaluating the performance of a classifier: Holdout Method, Random Sub-Sampling, Cross-Validation and Bootstrap Samples

**Recommended Books:**

**Stat-728: Generalized Linear Mixed Models**

**Course Objectives:**
- To provide the basic tools to use linear, generalized, linear mixed and generalized linear mixed models and focuses on understanding the unified theoretical basis for the using GLMM.
- To create responsibility and awareness in user and consumer of GLMM models.
To teach standard linear models, GLMMs and the models beyond GLMMs.
To educate the use of statistical software to model GLMMs.

Learning Outcomes:
- Command on the application of classic statistical models for dependent responses based on random components, including: linear, generalized, linear mixed and generalized linear mixed models.
- Identification of pertinent models for answering the biologic/scientific question of interest
- Identification of the key assumptions related to those statistical models
- Conduction of the analysis using statistical software and drawing conclusions

Course Contents:
Review of linear model (LM); model development; estimation of LM parameters through least squares (LS), generalized least squares (GLS), maximum likelihood (ML) and restricted maximum likelihood (REML); distributional properties in LM; development of test statistics and statistical inference in LM; Introduction to generalized linear model (GLM); components of GLM; properties, score function, hessian matrix and information matrix of exponential family of distributions; estimation of GLM parameters and statistical inference; Introduction to Linear Mixed Model (LLM); estimation of fixed effects and variance components; prediction of random effects; statistical inference in LLM; Introduction to generalized linear mixed model (GLMM); estimation of fixed effects and variance components; prediction of random effects and statistical inference in GLMM

Recommended Books:

STAT- 729: Advanced Operations Research

Course Objectives:
- To introduce students to the advanced techniques of operations research.
• To provide students with skills of simulation and advanced modeling in Operations Research.
• To introduce students to practical application of operations research with emphasis on the industrial data.
• To effectively use relevant statistical software for data analysis.

Learning Outcomes:
• Identify and develop advanced operations research models from the verbal description of the real system
• Understand the mathematical tools that are needed to solve optimization problems
• Apply operations research techniques to summarize the industrial data
• Demonstrate the usage of statistical software for solving problem and analyzing the relevant data

Course Contents:
Recommended Books:

Stat – 730: Multilevel Modeling (3 Cr. Hours)

Course Objectives:
- Introducing theory and practice of multilevel models.
- Learning to develop, implement, interpret and report research involving multilevel analysis.

Learning Outcomes:
- Principles and assumptions underlying multilevel.
- Estimate, confirm the validity of, and interpret such models using the statistical software.
- Apply multilevel models to a research problem according to a well-articulated research strategy.

Course Contents:
Introduction to multilevel models: Short review of regression, multilevel data structure, multilevel models, terminology and subscripts. Two Levels Models: Random intercept, random intercept and random slope (univariate and multivariate), Level-1 and level-2 residuals and assumption checking, Group level coefficients, logistic models (binary, multinomial and ordinal). Three and higher levels multilevel models.

Recommended Books:


STAT-731: Environmental Statistics

Course Objectives:
- To introduce the basic statistical methods necessary to conduct and understand statistical analyses of environmental issues and problems.
- To understand measurement, descriptive statistics, graphs, basic probability, correlation and regression.
- To have knowledge of inferential statistics (hypothesis testing, confidence interval construction, effect size calculation).

Learning Outcomes:
- Systematic advanced treatment of areas of current interest in the statistical theory and methods for environmental data.
- Application of statistical methods to important problems in environmental sciences, with a focus on understanding and quantifying change in environmental sciences or problems of this nature.
- Broad understanding of the conceptual underpinnings of statistics in ecology and conservation. The key distinctions among statistical methods commonly used in ecology and conservation.
- Become aware of a wide range of applications of statistics in environmental management, life sciences & decision making.

Course Contents:

Recommended Books:

**STAT- 732: Advanced Statistical Methods in Quality Control**

**Course Objectives:**
- To provide a conceptual and practical knowledge of techniques for quality control.
- To provide the knowledge and techniques required to improve product quality and process efficiency by identifying and measuring production process variability.
- To determine most appropriate sample size needed to accept or reject a lot of material.
- To monitor the process control via control charts.

**Learning Outcomes:**
- Skill to draw various types of graphs to be used to monitor the industrial process.
- Awareness of design attribute and variable acceptance sampling plans for the industrial purpose.
- Ability to construct various types of attribute and variable sampling plans using statistical software.
- Proficiency to draw attribute and variable control charts to be implemented in different scenarios existing in industry.

**Course Contents:**
Statistical Process Control (SQC), Concepts of Process and Product, Quality of Design, Quality of Conformance, Dimensions of Quality, Importance of SQC in Industry, Acceptance Sampling Plans: Classification of plans (attribute and variable), Types such as Single, Double and Multi-stage sampling plans. Repetitive and multiple dependent state sampling (MDS) plans. Mixed Sampling plans. Control Charts based on Variable and Attribute quality characteristic, Control charts based on EWMA statistic, Process capability Indices Cp, Cpk, Cpm. Six Sigma: Historical Developments, DMAIC principles. Use of various probability distributions in the development of sampling plans and control charts. Optimization procedures and Simulation runs to find plan parameters of sampling plans and average run length in control charts. Friedman test to compare efficiency of sampling plans.

**Recommended Books:**

STAT- 733: Applied Smoothing Techniques

Course Objectives:
- This course provides a general class of techniques for nonparametric estimation of functions.
- Kernel smoothing is a nonparametric approach for estimating the relationship between a response variable and design variables. A major problem for kernel smoothing is the selection of the bandwidth, which controls the amount of smoothing.
- The selected topics for the study are helpful to meet the current research of interests in the field of nonparametric estimation.

Learning Outcomes:
- Transform set of irregular data points as a smooth line.
- Helpful in drawing inference about the nonparametric methods.
- Better understanding of these techniques and models involved in current research.

Course Contents:

Recommended Books:

**STAT-734: Convergence in Probability**

**Course Objectives:**
- This course aims to provide an understanding of weak convergence in metric spaces measure, integral and related spaces.
- Explains the theorems and their properties that will be helpful research in the field of probability.
- Furthermore, it gives the solution of Brownian bridge problems.

**Learning Outcomes:**
- Demonstrate knowledge of and properties of convergence in metric spaces measures.
- Understand the basic principles of Construction of wiener measure, Donsker's theorem and Brownian bridge problems.
- Able to do research in the field of mathematical statistics in order to meet the current research at international level.

**Course Contents:**

**Recommended Books:**

**STAT- 736: Structural Equation Models**

**Course Objectives:**
- To develop a solid conceptual and theoretical understanding and ability to use SEM and its extensions correctly and effectively in research.
- Obtain thorough knowledge of structural equation modelling (SEM) and its special cases path analysis and factor analysis.
- Understanding of the statistical theory on which SEM is based. In addition to the common applications of SEM to cross-sectional, continuous, multivariate normally distributed data.
- How to apply SEM to multi-group data, longitudinal data, non-normal data, and (other) discrete data.

**Learning Outcomes:**
- Understanding of the statistical theory on which SEM is based.
- Students learn when and how to apply SEM and how to interpret SEM results, but they also learn the pitfalls of SEM, and to question the application and results of SEM.
- Students learn to read, understand, and interpret scientific articles in which SEM is applied.

**Course Contents:**
Recommended Books:

STAT-737: Causal Inference

Course Objectives:
- To enhance the student’s understanding of the concepts used in causal inference
- To learn the appropriate use of modern tools for causal inference
- To provide a foundation for research in statistical methods for causal inference
- To place causal inference in the general picture of statistical learning theory

Learning Outcomes:
- Recognize a situation, where causal inference is required
- Apply the causal criteria to the assessment of the exposure outcome association
- Understand the appropriate usage of various statistical methods in causal inference analysis
- Discover the limitations inherent in using causal criteria for causal inference

Course Contents:

**Recommended Books:**
Ph.D. (STATISTICS)

Admission requirement:
For admission into the PhD minimum CGPA 3.0 (out of 4.0 in the Semester System) or First Division (in the Annual System) in M.Phil/M.S/Equivalent is required.

Course Work:
Course work of **18 credit hours** preferably in the first year is required to be completed and followed by a comprehensive examination for granting candidacy as PhD researcher.

Note: Any course(s) from the elective list given before M.Phil/MS curriculum (or any other Ph.D. level course being offered in the respective university), that has not been taken by the student at M.Phil./MS level, can be taken to complete the requirement of **18 credit hours**.

Foreign Expert Evaluation:
The Ph.D. Dissertation must be evaluated by at least two Ph.D. experts from technologically/academically advanced foreign countries in addition to local Committee members.

Open Defense:
An open defense of Dissertation is essential part of PhD Program after positive evaluation.

Research Paper:
Acceptance/publication of at least one research paper in an HEC approved “X” category journal is a requirement for the award of Ph.D. degree (“Y” in case of Social Sciences only).

Plagiarism Test:
The Plagiarism Test must be conducted on the Dissertation before its submission to the two foreign experts.

Copy of PhD Dissertation to HEC:
A copy of Ph.D. Dissertation (both hard and soft) must be submitted to HEC for record in Ph.D. Country Directory and for attestation of the PhD degree by the HEC in future.