

**CURRICULUM
OF
BS STATISTICS**

(2026)



**RAWALPINDI WOMEN UNIVERSITY,
RAWALPINDI**

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1. Program Objectives and Outcomes

The department's vision, mission, and the program objectives and learning outcomes of the Bachelor of Science degree in Statistics are as follows:

Vision:

Delivering quality education in Statistics and Data Analytics that cultivates critical thinking, innovation and empowers women to address emerging challenges across professional domains.

Mission:

To cultivate academic excellence, encourage impactful research, and equip graduates with robust statistical and analytical skills through innovation, collaboration, practical application, and sustainable professional development.

Program Objectives:

The program objectives of the Bachelor of Science degree in Statistics, are to:

1. Equip students with fundamental and advanced statistical knowledge to address global trends and challenges.
2. Cultivate ability to apply probability theory, statistical principles and methods to practical problems across disciplines.
3. Equip students with software skills for data-driven analysis and policymaking.
4. Train students to effectively communicate statistical finding to technical and non-technical audiences.
5. Instill ethical awareness and professional standards in statistical practice.
6. Foster data practices and lifelong learning for professional and academic growth.

Program Learning Outcomes:

By the completion of Bachelor of Science degree in Statistics, the graduates will be able to:

1. Demonstrate a comprehensive understanding of fundamental and advanced concepts in Statistics and their relevance to contemporary global trends.
2. Demonstrate an understanding of statistical principles, probability theory, and methodologies to solve real-world problems across diverse disciplines.
3. Use statistical techniques and software tools to collect, analyze, and interpret complex data, providing actionable insights for policymaking.
4. Communicate statistical results, visualizations, and interpretations to technical and non-technical audiences.
5. Apply ethical principles and professional standards in the collection, analysis, and dissemination of the data.
6. Demonstrate readiness for advanced studies or professional growth by engaging in continuous learning and staying updated with emerging trends and technologies in statistics.

2. Admission Criteria for BS Statistics

- For 1st semester: 12 years of education or equivalent level with passing marks.
- For Lateral entry: 14 years of education or equivalent level with passing marks along Statistics or Mathematics.

3. Division and Distribution of Courses for BS Statistics

Sr. #	Categories	No. of Courses	Credit Hours
1	General Education Courses	15	34
2	Major Courses	30	84
3	Interdisciplinary / Allied Courses	04	12
4	Field Experience / Internship	01	03
5	Capstone Project	01	03

- Total Credit Hours 136
- Duration 4 Years
- Semester Duration 16 - 18 Weeks
- Semesters 8
- Course Load Per Semester 15 - 18 Credit Hours

4. Scheme of Studies for BS Statistics (Regular Batch)

Semester	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
First	STA-107	Introduction to Statistics	Major	Nil	3
	MTH-110	Quantitative Reasoning-I	General Education	Nil	3
		Natural Science	General Education	Nil	2
		Natural Science (Lab)	General Education	Nil	1
	ENG-110	Functional English	General Education	Nil	3
	CS-107	Application of Information and Communication Technologies	General Education	Nil	2
	CS-107L	Application of Information and Communication Technologies (Lab)	General Education	Nil	1
		IDS-I	Interdisciplinary/Allied	Nil	3
	Total				18
Second	STA-122	Introduction to Probability & Probability Distributions	Major	Nil	3
	STA-125	Introduction to Sampling Theory	Major	Nil	3
		IDS-II	Interdisciplinary/Allied	Nil	3
	UHQ-101/ ETH-103	Understanding of Holy Quran - I /Ethics-I	General Education	Nil	1
	STA-112	Quantitative Reasoning-II	General Education	Nil	3
	ENG-111	Expository Writing	General Education	Nil	3
	PAK-104	Pakistan Studies	General Education	Nil	2
	Total				18
Third	STA-202	Basic Statistical Inference	Major	Nil	3
	STA-209	Exploratory Data Analysis and Visualization	Major	Nil	3
		Arts & Humanities	General Education	Nil	2
	ISL-101/ ETH-101	Islamic Studies / Ethics	General Education	Nil	2

	UHQ-102/ ETH-104	Understanding of Holy Quran-II/ Ethics-II	General Education	Nil	1
	PAK-103	Ideology and Constitution of Pakistan	General Education	Nil	2
	STA-406	Official Statistics	Major	Nil	3
	Total				16
Fourth	STA-210	Introduction to Regression and Analysis of Variance	Major	Nil	3
	STA-211	Data Wrangling	Major	Nil	3
	STA-203	Statistical Packages	Major	Nil	3
	STA-306	Non-Parametric Methods	Major	Nil	3
		Social Science	General Education	Nil	2
	CCE-497	Civic and Community Engagement	General Education	Nil	2
	MGT-108	Entrepreneurship	General Education	Nil	2
	Total				18
Fifth	STA-312	Probability Distributions	Major	Nil	3
	STA-312L	Probability Distributions (Lab)	Major	Nil	1
	STA-313	Sampling Techniques	Major	Nil	3
	STA-314	Design and Analysis of Experiment	Major	Nil	3
	STA-314L	Design and Analysis of Experiment (Lab)	Major	Nil	1
	STA-407	Biostatistics	Major	Nil	3
		IDS-III	Interdisciplin ary/Allied	Nil	3
	Total				17
Sixth	STA-315	Statistical Inference	Major	Nil	3
	STA-304	Regression Analysis	Major	Nil	3
	STA-304L	Regression Analysis (Lab)	Major	Nil	1
		Elective-I	Major	Nil	3
		Elective-II	Major	Nil	3
		IDS-IV	Interdisciplin ary/Allied	Nil	3
	Total				16
Seventh	INT-499	Internship	Mandatory	Nil	3
	STA-420	Statistical Programming Using R and Python	Major	Nil	3
	STA-403	Research Methodology	Major	Nil	3
	STA-405	Statistical Quality Control	Major	Nil	3
		Elective-III	Major	Nil	3

		Elective-IV	Major	Nil	3
	Total				18
Eighth	CP-498	Capstone Project	Mandatory	Nil	3
	STA-423	Applied Multivariate Analysis	Major	Nil	3
		Elective-V	Major	Nil	3
		Elective-VI	Major	Nil	3
		Elective-VII	Major	Nil	3
	Total				15
	Total Credit Points=				136

5. Scheme of Studies for BS Statistics (Lateral Entry Annual System)

Semester	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
Fifth	STA-209	Exploratory Data Analysis and Visualization	Major	Nil	3
	STA-312	Probability Distributions	Major	Nil	3
	STA-312L	Probability Distributions (Lab)	Major	Nil	1
	STA-313	Sampling Techniques	Major	Nil	3
	STA-314	Design and Analysis of Experiment	Major	Nil	3
	STA-314L	Design and Analysis of Experiment (Lab)	Major	Nil	1
	STA-407	Biostatistics	Major	Nil	3
		IDS-I	Interdisciplinary/Allied	Nil	3
	Total				20
Sixth	STA-203	Statistical Packages	Major	Nil	3
		General Education	General Education	Nil	2
	STA-315	Statistical Inference	Major	Nil	3
	STA-304	Regression Analysis	Major	Nil	3
	STA-304L	Regression Analysis (lab)			1
		Elective-I	Major	Nil	3
		Elective-II	Major	Nil	3
		IDS-II	Interdisciplinary/Allied	Nil	3
	Total				21
Summer	INT-499	Internship	Mandatory	Nil	3
	Total				3
Seventh		IDS-III	Interdisciplinary/Allied	Nil	3
	STA-406	Official Statistics	Major	Nil	3
	STA-420	Statistical Programming Using R and Python	Major	Nil	3
	STA-403	Research Methodology	Major	Nil	3
	STA-405	Statistical Quality Control	Major	Nil	3
		Elective-III	Major	Nil	3
		Elective-IV	Major	Nil	3
	Total				21
Eighth	STA-306	Non-Parametric Methods	Major	Nil	3
	STA-211	Data Wrangling	Major	Nil	3
	CP-498	Capstone Project	Mandatory	Nil	3
	STA-423	Applied Multivariate Analysis	Major	Nil	3

		Elective-V	Major	Nil	3
		Elective-VI	Major	Nil	3
		Elective-VII	Major	Nil	3
	Total				21
Total Credit Points=					86

Note: Scheme of students for BS (Lateral entry) (2028-2030) & onwards is same as Scheme of Studies of BS (4-year) (2026-2030) regular program with some additional courses mentioned below:

ADDITIONAL COURSES TO BE TAUGHT DURING THE PROGRAM				
Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
STA-209	Exploratory Data Analysis and Visualization	Major	Nil	3
STA-406	Official Statistics	Major	Nil	3
STA-203	Statistical Packages	Major	Nil	3
STA-306	Non-Parametric Methods	Major	Nil	3
STA-211	Data Wrangling	Major	Nil	3
	IDS	Interdisciplinary/Allied	Nil	3
	GE	General Education	Nil	2
Total Credit Points=				20

*Students without having mathematical background in BSc will take Interdisciplinary/Allied course of Mathematics.

6. Scheme of Studies for BS Statistics (Lateral Entry Semester System)

Semester	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
Fifth		Deficient-I		Nil	3
	STA-312	Probability Distributions	Major	Nil	3
	STA-312L	Probability Distributions (Lab)	Major	Nil	1
	STA-313	Sampling Techniques	Major	Nil	3
	STA-314	Design and Analysis of Experiment	Major	Nil	3
	STA-314L	Design and Analysis of Experiment (Lab)	Major	Nil	1
	STA-407	Biostatistics	Major	Nil	3
		IDS-III	Interdisciplinary/ Allied	Nil	3
	Total				20
Sixth		Deficient-II		Nil	2
	STA-315	Statistical Inference	Major	Nil	3
	STA-304	Regression Analysis	Major	Nil	3
	STA-304L	Regression Analysis (Lab)	Major	Nil	1
		Elective-I	Major	Nil	3
		Elective-II	Major	Nil	3
		IDS-IV	Interdisciplinary/ Allied	Nil	3
	Total				18
Seventh	INT-499	Internship	Mandatory	Nil	3
	STA-420	Statistical Programming Using R and Python	Major	Nil	3
	STA-403	Research Methodology	Major	Nil	3
	STA-405	Statistical Quality Control	Major	Nil	3
		Elective-III	Major	Nil	3
		Elective-IV	Major	Nil	3
	Total				18
Eight	CP-498	Capstone Project	Mandatory	Nil	3
	STA-423	Applied Multivariate Analysis	Major	Nil	3
		Elective-V	Major	Nil	3
		Elective-VI	Major	Nil	3
		Elective-VII	Major	Nil	3
	Total				15

Total Credit Points=	71
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Note: Scheme of students for BS (Lateral entry) (2028-2030) & onwards is same as Scheme of Studies of BS (4-year) (2026-2030) regular program with some additional courses mentioned below:

ADDITIONAL COURSES TO BE TAUGHT DURING THE PROGRAM				
Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
	Deficient-I		Nil	3
	Deficient-II		Nil	2
Total Credit Points=				5

7. List of Major Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	STA-107	Introduction to Statistics	Nil	3
2	STA-122	Introduction to Probability and Probability Distribution	Nil	3
3	STA-125	Introduction to Sampling Theory	Nil	3
4	STA-202	Basic Statistical Inference	Nil	3
5	STA-209	Exploratory Data Analysis and Visualization	Nil	3
6	STA-406	Official Statistics	Nil	3
7	STA-203	Statistical Packages	Nil	3
8	STA-210	Introduction to Regression and Analysis of Variance	Nil	3
9	STA-306	Non-Parametric Methods	Nil	3
10	STA-211	Data Wrangling	Nil	3
11	STA-312	Probability Distributions	Nil	3
12	STA-312L	Probability Distributions (Lab)	Nil	1
13	STA-313	Sampling Techniques	Nil	3
14	STA-314	Design and Analysis of Experiment	Nil	3
15	STA-314L	Design and Analysis of Experiment (Lab)	Nil	1
16	STA-407	Biostatistics	Nil	3
17	STA-315	Statistical Inference	Nil	3
18	STA-304	Regression Analysis	Nil	3
19	STA-304L	Regression Analysis (Lab)	Nil	1
20	STA-420	Statistical Programming Using R and Python	Nil	3
21	STA-403	Research Methodology	Nil	3
22	STA-405	Statistical Quality Control	Nil	3
23	STA-423	Applied Multivariate Analysis	Nil	3

8. Course Outlines for Major Courses

Introduction to Statistics

BS-Statistics

Course Code: STA-107

Credit Hours: 03

Pre-requisite: Nil

Objectives

To provide students basic understanding of statistical methods and its applications in various fields. This course focuses on descriptive statistics and its applications.

Learning Outcomes

- Student will understand the basic statistical concepts and able to explain measures of central tendency and dispersion.
- Students will be able to present the data using suitable graph, chart, and diagram.
- Students will be able to calculate and explain the difference between measure of absolute and relative dispersion.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.

Course Outline

Unit 1. Introduction to Statistics and Presentation of data

Basic definitions, characteristics, limitations, and uses of statistics. Types of data. Classification and tabulation of data. Frequency distribution. Stem and leaf display. Graphical presentation. Diagrams and graphs.

Unit 2. Measure of Central Tendency

Definitions and types of averages. Criteria of good average. Arithmetic mean and its properties (ungrouped & grouped data). Geometric mean (ungrouped & grouped data). Harmonic mean (ungrouped & grouped data). Mode (ungrouped & grouped data). Median and quantiles (ungrouped & grouped data).

Unit 3. Measures of Dispersion

Range, quartile deviation and their coefficients. Mean deviation and coefficient of mean deviation. Variance and standard deviation. Coefficients of variation. Trimmed and winsorized measures.

Unit 4. Measure of Symmetry and Skewness

Moments about arbitrary value and mean. Concept of symmetry and skewness. Moment ratios. Measures of skewness and kurtosis.

Unit 5. Regression and Correlation Analysis

Regression and its application. Residual plot. Simple Correlation, its application and properties. Rank correlation. Association.

Unit 6. Index Numbers

Construction and uses of index numbers, unweighted 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/Reference Material

1. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson.
3. [Illowsky](#), B., & Dean, S. (2022). *Introductory statistics*. Open Stax Textbooks.
4. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
5. Walpole, R.E., Myers, R.H., Myers, S.L., & Ye, K. (2017). *Probability and statistics for engineers and scientists*, (7th ed.). Pearson.

Introduction to Probability & Probability Distributions

BS-Statistics

Course Code: STA-122

Credit Hours: 03

Pre-requisite: Nil

Objectives

The purpose of the course is to provide understanding of basic concepts of probability, conditional probability, independence, and dependence of events. This course is designed to familiarize students with some of the most encountered random variables, particularly the Binomial and Normal random variables, and make them able to apply the concepts of random variables to scientific applications.

Learning Outcomes

- Student must be able to understand the basic concepts of probability, conditional probability, independence, and dependent events.
- They should be capable to independently explain random variables, discrete & continuous random variables, and their probability distributions.
- Students should be able to apply the concepts of random variables to scientific applications.

Course Outline

Unit 1. Probability

Introduction to probability. Importance & scope of probability in different fields of life. Basic terminologies of probability (sample space, mutually & not-Mutually exclusive events etc.). Fundamental rules of probability and their applications. Conditional probability. Independent & dependent events. Bayes rule & its applications.

Unit 2. Random Variables

Introduction to random variables. Concept of random experiments with applications. Discrete random variables. Probability mass function & its properties. Continuous random variable. Probability density function (pdf) and its properties. Mathematical expectation & variance of random variables. Bivariate frequency tables, joint & marginal probabilities.

Unit 3. Discrete Probability Distributions

Uniform distribution, function, properties, and applications. Bernoulli distribution, Bernoulli function, its properties and applications. Binomial distribution, its function, properties and applications. Hypergeometric distribution, its function properties and applications. Difference between Hypergeometric and Binomial distribution. Poisson probability distribution, function, properties and applications in real life. Poisson process.

Unit 4. Geometric and Negative Binomial Distributions

Geometric distribution, its function, properties and applications. Negative binomial probability distribution, its function, properties and applications. Relation between geometric and negative binomial distribution.

Unit 5. Continuous Probability Distributions

Uniform distribution, function, properties and applications. Introduction to normal distribution & density function. Standard normal variable and standard normal distribution. Properties of normal distribution. Applications of normal distribution from real life problems. Use of inverse area in normal distribution. Normal approximation to binomial distribution and its applications. Normal approximation to poisson distribution and its applications.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J.L. (2020). *Probability with STEM applications*, (3rd ed.). John Wiley and Sons.
2. Illowsky, B., & Dean, S. (2022). *Introductory statistics*. Open Stax Textbooks.
3. Madenhall, W.M., Sincich, T.L., & Boudreau, N.S. (2016). *Statistics for engineers and sciences*. CRC Press.
4. Mood, A.M., Graybill, F.A., & Boes, D.C. (1997). *Introduction to the theory of statistics*. New York: McGraw Hill.
5. Walpole, R.E., Myers, R.H., Myers, S.L., & Ye, K. (2017). *Probability and statistics for engineers and scientists*. (7th ed.). Pearson.

Introduction to Sampling Theory

BS-Statistics

Course Code: STA-125

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to introduce students to the fundamental concepts of sampling, including population, sample, sampling unit, and sampling frame. It enables students to distinguish between various sampling methods and equips them with the skills to calculate and justify sample sizes in practical scenarios. Additionally, the course provides a solid foundation in understanding the sampling distributions of key statistics such as the mean, variance and proportion.

Learning Outcomes

- Understand basic sampling theory related to sample, types of sampling and sampling frame.
- Identify and comprehend different sampling plans.
- Compute sample size in various practical scenarios.
- Understand sampling distributions of popular statistics including sample mean, variance, proportion etc.

Course Outline

Unit 1. Introduction

Introduction and scope of sampling in statistics and research. Basic definitions: population, sample, sampling unit, sampling frame, parameter, statistic. Advantages of sampling survey over census. Types of errors: sampling and non-sampling errors. Overview of the role of sampling in estimation and inference.

Unit 2. Sampling Techniques

Classification of sampling methods. Probability Sampling: Simple Random Sampling, Stratified Sampling, Systematic Sampling, Cluster and Multistage Sampling. Non-Probability Sampling: Convenience Sampling, Judgmental and Quota Sampling. Comparison, advantages and limitations of sampling designs.

Unit 3. Sampling Distribution

Concept and importance of sampling distributions, Properties of sampling distribution of: Sample means, Sample proportions and Sample variances. Biased and unbiased estimators and their implications. Sampling distribution of: the difference between two sample means and the difference between two sample proportions. Central Limit Theorem (CLT) and its applications in inference.

Unit 4. Sample Size Determination

Importance and objectives of sample size calculation. Factors affecting sample size: confidence level, variability, precision, and population size. Sample size formulas for: Estimating means (known/unknown variance), Estimating proportions, Finite population correction. Practical examples and applications. Sample size for comparative studies and decision-making.

Unit 5. Overview of national sample survey of Pakistan.

Critical study of national sample surveys conducted in Pakistan, census of agriculture Pakistan, Pakistan demographic survey (PDS) and national population and housing census.

Recommended Books/Reference Material

1. Arnab, R. (2017). *Survey sampling theory and applications*. Elsevier Science.
2. Chaudhary, A., & Stemger, H. (2005). *Survey sampling theory and methods*. London: Chapman & Hall.
3. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
4. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
5. Cochran, W.G. (1977). *Sampling technique*, (3rd ed.). John Wiley & Sons.
6. Ferguson, T.S. (2017). *A course in large sample theory*. London: Chapman & Hall.
7. Hall, W.J., & Oakes, D. (2023). *A course in the large sample theory of statistical inference*. CRC Press.
8. Lohr, S. L. (2021). *Sampling: Design and analysis* (3rd ed.). London: Chapman & Hall.
9. Sarndal, C.E., Swensson, B., & Wretman, J. (2003). *Model assisted survey sampling*. Springer.
10. Singh, R., & Mangat, N.S. (2013). *Elements of survey sampling*. Springer.
11. Singh, S. (2003). *Advanced sampling theory with applications: How Michael 'selected' Amy* (Vols. 1–2). Springer.
12. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Basic Statistical Inference

BS-Statistics

Course Code: STA-202

Credit Hours: 03

Pre-requisite: Nil

Objectives

The aim of the course is that the students should understand the general principles that constitutes the foundation of theory of inferential statistics. The course outline is designed to familiarize students with estimation procedure, properties and application. Furthermore, the students will learn the methods of hypothesis testing for various parameters to draw inferences about them.

Learning Outcomes

- Students shall be able to understand statistical estimation techniques, including point estimation and interval estimation
- They will derive the appropriate estimators for parameters using best estimation procedure.
- Students will also understand the use of the appropriate distribution for interval estimation and hypothesis testing.
- They will be familiar to apply the appropriate inferential procedure to handle the practical situations.

Course Outline

Unit 1. Introduction to Statistical Inference

Role of probability in inference, types of inference, population vs sample, parameters and statistics.

Unit 2. Estimation: Point Estimation

Introduction to inferential statistics. Basic definitions relating estimation and point estimation. Methods of finding point estimators (method of moments, method of maximum likelihood and method of least squares). Desirable properties of a good estimator (unbiasedness, consistency, sufficiency and efficiency).

Unit 3. Estimation: Interval Estimation

Basic definitions relating interval estimation. Interval estimation of population mean. Large and small sample confidence intervals for population mean. Interval estimation regarding two population means. Large and small sample confidence intervals for difference between two population means using independent samples (assuming equal / not equal variances). Confidence interval estimate for mean difference using paired samples. Interval estimate for population proportions & difference between two population proportions. Estimating sample size.

Unit 4. Testing of Hypothesis (z & t Distributions)

Nature of hypothesis testing and types of errors. Estimation of type I & type II errors. Hypothesis testing for population mean. Hypothesis testing for difference between two population means. Independent samples with large and small sample size (assuming equal / not equal variances). Hypothesis testing for two populations mean using paired samples. Hypothesis testing for population proportions & difference between two population proportions using independent samples.

Unit 5. Inference about Variances

Confidence interval estimate for population variance & ratio of two population variances. Hypothesis testing for population variance & ratio of two population variances.

Recommended Books/Reference Material

1. Bacci, S., & Chiandotto, B. (2021). *Introduction to statistical decision theory*. Routledge.
2. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory, (Part I)*. Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory, (Part II)*. Pakistan: Ilmi Kitab Khana.
4. Clark, G.M., & Cooke, D. (1998). *A basic course in statistics*, (4th ed). London: Arnold.
5. Illowsky, B., & Dean, S. (2022). *Introductory statistics*. Open Stax Textbooks.
6. Walpole, R.E., Myers, R.H., & Myers, S.L. (2007). *Probability and statistics for engineers and scientists*, (7th ed). New York: Prentice Hall.

Exploratory Data Analysis and Visualization

BS-Statistics

Course Code: STA-209

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to develop students' ability to explore and visualize data effectively. It emphasizes the design, interpretation, and critique of both static and interactive data visualizations using tools such as R/Python or Power BI. The course enables students to produce high-quality visual reports for statistical analysis and real-world decision-making.

Learning Outcomes

- Apply principles of effective data visualization to communicate statistical insights clearly.
- Design and interpret various types of charts and graphs, including bar charts, scatter plots, histograms, and heat maps using R/ Python/ Power BI, etc.
- Implement interactive and dynamic visualizations for exploratory data analysis. Analyze and critique data visualizations for accuracy, bias, and misleading representations.
- Integrate data visualization techniques in real-world statistical reports and presentations.

Course Outline

Unit 1. Foundations of EDA and Visualization

Purpose and scope of Exploratory Data Analysis, importance of visualization in statistics, Principles of effective data visualization (clarity, accuracy, minimalism). Data types and appropriate visual encodings. Overview of visualization tools: R (ggplot2), Python (seaborn, matplotlib), Power BI.

Unit 2. Designing and Interpreting Charts and Graphs

Categorical data visualization: bar charts, pie charts. Numerical data visualization: histograms, boxplots, dot plots. Bivariate and multivariate visualizations: scatter plots, bubble charts, heat maps. Use of color, shape, and size to encode information. Hands-on practice using real-world datasets in R/Python/Power BI.

Unit 3. Interactive and Dynamic Visualization

Concepts of interactivity and user engagement. Interactive visualization tools: Plotly, Shiny (R)/Dash (Python)/Power BI dashboards. Creating dynamic filters, sliders, tooltips, and drilldowns. Animating data over time. Building interactive dashboards for data exploration.

Unit 4. Critiquing and Improving Data Visualizations

Identifying poor or misleading visualizations. Misuse of scales, colors, and chart types. Ethical considerations and data integrity in visuals. Visualization critique exercises: real-world examples from media, reports, and dashboards. Redesigning flawed graphics.

Unit 5. Visualization for Communication and Reporting

Storytelling with data: narrative structure and flow. Integrating charts into statistical reports and presentations. Formatting and layout for professional reporting. Final Project: Exploratory data analysis and interactive visualization report.

Recommended Books/Reference Material

1. Cairo, A. (2016). *The truthful art: Data, charts, and maps for communication*. New Riders.
2. Microsoft Corporation. (n.d.). *Power BI documentation*. Retrieved from <https://learn.microsoft.com/en-us/power-bi/>
3. Tufte, E. R. (2001). *The visual display of quantitative information* (2nd ed.). Graphics Press.
4. Wickham, H., & Golemund, G. (2017). *R for data science: Import, tidy, transform, visualize, and model data*. O'Reilly Media.
5. Wilke, C. O. (2019). *Fundamentals of data visualization: A primer on making informative and compelling figures*. O'Reilly Media.

Official Statistics

BS-Statistics

Course Code: STA-406

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will come to know about such organizations in which data is collected, analysed and reported so that they can know about importance and scope of statistics. Project will be given to students based on visit of major statistical organizations.

Learning Outcomes

- Students will be able to understand the official, demographic and social statistics.

- Students will come to know the scope and organization of official statistics.
- Students will be able to understand the planning and administration statistics.
- Students will be able to understand different national statistics.
- Students will be able to use different statistical data sources in Pakistan such as NADRA, PBS etc.

Course Outline

Unit 1. Introduction

Introduction to official statistics and its scope, design and planning of a statistical investigation. Role of sampling in generation of statistics, sampling plans and survey designs. Sources of errors, types of errors, method of their control.

Unit 2. Data Processing

Data processing, presentation, and publication of statistics. Official statistics, statistical systems and standards, sources of official statistics, their role, working and publication. Setup of official organizations in Pakistan, their role, working & publication, statistics division.

Unit 3. Official Organizations

Pakistan Bureau of Statistics. Agriculture census organization. Population census organization. Ministry of food, agriculture and livestock. National database and registration authority (NADRA).

Unit 4. International Standards

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. Visit to an organization.

Unit 5. Income Distribution

Measurement of income distribution. Prices and price mechanisms. Deflation and inflation of series, industrial quantum index. National sample surveys and censuses conducted in Pakistan.

Recommended Books/Reference Material

1. Hansen, M.H., & Tepping, B.J. (1969). *Progress and problems in survey methods and theory illustrated by the work of the United States Bureau of the Census*. US Census Bureau.
2. Kish, L. (1965). *Survey sampling*. John Wiley and sons.
3. Ministry of National Food Security and Research.
4. National Database and Registration Authority (NADRA).
5. Pakistan Bureau of Statistics (PBS).
6. Pakistan Institute of Development Economics (PIDE).
7. State Bank of Pakistan (SBP).

Statistical Packages

BS-Statistics

Course Code: STA-203

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire understanding about the importance of statistical packages. The purpose is to introduce packages to fulfil the demand for data analysis that can be done using menu-based statistical software. Students will develop skills in data manipulation, performing statistical analyses, generating visualizations, and interpreting outputs.

Learning Outcomes

- Students shall be able to use the statistical packages to present the data.
- Students will be capable of analyzing and evaluating the resulting performance.
- They will be able to illustrate the statistical models and the results of statistical surveys graphically.
- Students will be able to troubleshoot common issues in statistical software and refine data analysis techniques for accuracy.

Course Outline

Unit 1. Introduction to SPSS

Overview of SPSS interface and file types. Importing/exporting data from Excel. Variable view and data view. Data coding and labeling. Basic descriptive statistics. Saving files and output navigation.

Unit 2. Analysis of Data Using SPSS

Qualitative and quantitative data presentation. SPSS functions related to probability distributions. SPSS modules. Simple graphing in SPSS. Analysis using SPSS syntax programming. Implementation of analytical methods such as hypothesis testing, interval estimation, regression and analysis of variance.

Unit 3. Introduction to R

Installing R and R Studio, Understanding R interface and script files. Import/export data using readr, readxl, foreign, Data types, vectors, data frames and factors.

Unit 4. Data Analysis and Visualization in R

Data manipulation using dplyr, tidyr. Descriptive and inferential statistics in R. Hypothesis testing using t.test, aov, lm. Correlation, regression, and diagnostics. Data visualization using ggplot2 and plotly. Writing and documenting R scripts.

Unit 5. Comparison and Integration

Comparison of SPSS and R in handling. Missing data. Statistical modeling. Report generation. Integrating R output into reports. Project-based application (real dataset).

Recommended Books/Reference Material

1. Amork, N.M. (2013). *IBM SPSS statistics 24 core system user's guide*. International Business Machine Corporation.
2. Denis, D.J. (2020). *Univariate, bivariate, and multivariate statistics using R: Quantitative tools for data analysis and data science*. John Wiley & Sons.
3. George, D., & Mallery, P. (2020). *IBM SPSS Statistics 23 Step by Step: A simple guide and reference*, (14th ed.). Routledge.
4. Gray, C.D., & Kinnear, P.R. (2012). *IBM SPSS statistics 19 made simple*. Psychology Press.
5. Peng, R. D. (2016). *R Programming for data science*. Leanpub.

Introduction to Regression and Analysis of Variance

BS-Statistics

Course Code: STA-210

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire understanding about the importance of statistical modelling tools. The main purpose of the course is to provide foundation for two major concepts in Statistics: Regression analysis, one and two way analysis of variance. With the basic theory of regression analysis as starting point, the modelling of simple and multiple linear relations between explanatory and response variables, are studied. The focus is on both theoretical foundations and practical application using real-world data.

Learning Outcomes

- Student will be able to understand relationships between variables through correlation and regression.
- Student will be able to understand the theory of linear regression models, including simple and multiple regression.
- Student will be able to apply linear regression techniques to model and analyze relationships between dependent and independent variables.
- Student will be able to demonstrate the concept of one-way and two-way analysis of variance.
- Student will be able to evaluate the goodness-of-fit of regression models using metrics such as R-squared, adjusted R-squared, and residual analysis.

Course Outline

- Unit 1. Simple Regression and Correlation**
Simple correlation between variables. Rank correlation. Introduction of simple linear regression model properties. Interpretation of regression coefficients. Estimation of regression parameters by method of least squares and corresponding variance estimates. Coefficient of determination, its interpretation and standard error of estimate. Measure of association. Hypothesis testing of regression parameters.
- Unit 2. Diagnostics for Simple Linear Regression**
Coefficient of determination (R^2), adjusted R^2 and model comparison, residual analysis and diagnostics.
- Unit 3. Multiple Linear Regression**
Extension to multiple regression, model formulation and assumptions. Interpretation of regression coefficients.
- Unit 4. Inference and Evaluation in Multiple Regression**
Significance testing for individual predictors, overall F-test for model fit, confidence and prediction intervals, practical interpretation of regression output.
- Unit 5. One-Way Analysis of Variance (ANOVA)**
Introduction to ANOVA and assumptions, partitioning of total variation, F-test and interpretation of ANOVA table, post-hoc comparisons (LSD, Bonferroni, Tukey).
- Unit 6. Two-Way Analysis of Variance (ANOVA)**
Two-way classification with replication, main effects and interaction effects, construction and interpretation of two-way ANOVA table.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Clarke, G.M., & Kempson, R.E. (1997). *Introduction to the design & analysis of experiments*. Edward Arnold.
4. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
5. Montgomery, D.C. (2005). *Design and analysis of experiments*. John Wiley and Sons.
6. Wooldridge, J.M. (2006). *Introductory econometrics*, (4th ed.). Thomson South-Western.
7. Wooldridge, J.M. (2020). *Introductory econometrics: A modern approach*. Cengage Learning Publisher.

Non-Parametric Methods

BS-Statistics

Course Code: STA-306

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to provide an understanding of the application of non-parametric tests and their uses in research. This course enables the students to apply non-parametric tests on the data where the assumptions of parametric tests are invalid.

Learning Outcomes

- Understand the effectiveness and need of non-parametric methods in comparison to parametric techniques.
- Understand the principles and applications of non-parametric statistical methods, including their advantages.
- Apply non-parametric tests and resampling techniques on real-world datasets.

Course Outline

Unit 1. Test of Goodness of Fit

Chi-square procedure, Chi-square goodness of fit test, Chi-square test of independence. The Kolmogorov-Smirnov one-sample statistic. Applications of the Kolmogorov-Smirnov one-sample statistics. Lilliefors's test for normality and Shapiro-Wilks test for normality.

Unit 2. Test for Randomness

Tests based on the total number of runs, tests based on the length of the longest run. Runs up and down. Test based on ranks, distribution tests and rank transformation.

Unit 3. One-Sample and Paired-Sample Procedures

Sign test for the median. Modified sign test. Rank-order statistics treatment of ties in rank tests. Wilcoxon signed-rank test, real life examples and applications of the run, Wilcoxon and Kolmogorov-Smirnov tests.

Unit 4. The General Two-Sample Problems

Wald-Wolfowitz runs test. Kolmogorov-Smirnov two-sample test. Median test, Mann-Whitney U-test. Siegel-Tukey test.

Unit 5. 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.

Recommended Books/Reference Material

1. Cline, G. (2019). *Nonparametric statistical methods using R*. Edtech.
2. Conover, W.J. (1999). *Practical nonparametric statistics*, (3rd ed.). John Wiley and Sons.
3. Corder, G.W., & Foreman, D.I. (2014). *Nonparametric statistics: A step-by-step approach*. John Wiley & Sons.
4. Gibbons, J.D., & Chakraborti, S. (2020). *Nonparametric statistical inference*. CRC Press.
5. Sheskin, D.J. (2020). *Handbook of parametric and nonparametric statistical procedures*, (5th ed.). CRC Press.

Data Wrangling

BS-Statistics

Course Code: STA-211

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to equip students with essential skills in data wrangling as a foundational step in the data analysis pipeline. It introduces the key concepts and challenges of collecting, cleaning, and transforming raw data from diverse sources. Students will learn to apply techniques such as handling missing values, outlier detection, and feature engineering to enhance data quality. The course ultimately enables students to deliver clean, consistent, and analysis-ready datasets for real-world statistical applications.

Learning Outcomes

- Students will understanding and explain the key concepts, challenges, and importance of data wrangling in the data analysis pipeline.
- Students will gain understanding to collect, clean, and preprocess raw data from various sources using appropriate tools.
- Students will be able to apply data transformation techniques, including handling missing data, outlier detection, and feature engineering, to improve data quality.
- Students will be able to integrate data preprocessing techniques into a reproducible data analysis pipeline, ensuring clean and ready-to-analyze datasets for statistical modeling.

Course Outline

Unit 1. Introduction to Data Wrangling

Importance of data wrangling in the data science workflow. Types and sources of data (structured, unstructured, APIs, web). Common data quality issues and challenges.

Unit 2. Data Collection and Importing

Reading data from CSV, Excel, JSON, databases, and web APIs. Working with data from multiple sources. Introduction to R (readr, tidyr) and Python (pandas) for importing data.

Unit 3. Data Cleaning

Handling missing data: deletion and imputation methods. Identifying and treating outliers. Standardizing and validating data values.

Unit 4. Data Transformation

Reshaping data (wide ↔ long formats). Merging and joining datasets. Feature extraction and mathematical and statistical transformation. Dealing with duplicates and inconsistencies. Date-time date manipulation. Encoding categorical variables.

Unit 5. String and Text Manipulation

Basic string operators. Parsing and cleaning string data. Splitting and combining strings. Regular expressions in data wrangling. Text standardization and normalization. Tokenization and frequency analysis. Handling categorical text data.

Unit 6. Automating, Reproducible Workflows and Case Studies

Writing reproducible scripts in R or Python. Using functions, loops and pipelines (e.g., dplyr pipes or method chaining in pandas). Documenting and saving cleaned datasets. Preparing datasets for regression, classification and time series analysis.

Recommended Books/Reference Material

1. Boehmke, B.C. (2021). *Hands-on data wrangling with R*. CRC Press.
2. Boehmke, B.C., & Reich, B.N. (2022). *Data wrangling with R and RStudio*. Springer.
3. Kazil, J., & Jarmul, K. (2022). *Data wrangling with python: Creating actionable data from raw sources (2nd ed.)*. O'Reilly Media.
4. Layton, R. (2020). *Data preprocessing with Python*. Apress.
5. Molin, S. (2021). *Python for data cleaning and wrangling*. Packt Publishing.
6. Ogilvie, B. (2023). *Practical data wrangling: Expert techniques for taming data*. Pragmatic Bookshelf.

Probability Distributions

BS-Statistics

Course Code: STA-312

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to provide students with a comprehensive understanding of probability theory, focusing on both discrete and continuous probability distributions. It is

designed to develop student's ability to model uncertainty, analyze random phenomena, and apply probabilistic concepts to real-world problems.

Learning Outcomes

- Students will be able to understand the fundamental concepts of discrete and continuous probability distributions.
- Students will be able to derive properties for major probability distributions.
- Students will be able to apply transformations of random variables (single and joint) and understand the resulting distributions.
- Students will be able to demonstrate the application of order statistics in probability modeling.

Course Outline

Unit 1. Introduction to Random Variables and Probability Distributions

The basic concepts of probability distributions, random variables, their types and the functions that describe their behavior. An overview of probability mass and density functions, distribution and cumulative distribution functions, relationships between multiple variables through joint, marginal, and conditional distributions. The concept of independence between random variables. Transformations of random variables in both univariate and bivariate contexts.

Unit 2. Mathematical Expectation and Generating Functions

Expected value, variance and higher-order moments. Expectation of a function of a random variable and conditional expectation. Probability generating function (PGF), moment generating function (MGF) and characteristic function. Relationship between moments and cumulants.

Unit 3. Discrete Probability Distributions

Bernoulli and Binomial distributions with their definitions, properties and applications. Hypergeometric distribution with its probability function and mean/variance. Poisson distribution including derivation, the Poisson process and applications. Geometric and negative binomial distributions with focus on properties and differences. The formulation and examples of the multinomial distribution.

Unit 4. Continuous Probability Distributions I

Uniform distribution, exponential distribution and lognormal distribution with properties and applications. The normal distribution including its properties, standard form and approximations to binomial and poisson distributions.

Unit 5. Continuous Probability Distributions II

Beta and gamma distributions, including beta type I and II, their properties, distribution functions, cumulants, and moments. Laplace, rayleigh, and weibull

distributions with derivations, properties, and applications. Chi-square, Student's t, and F-distributions with derivations, moments and applications.

Unit 6. Multivariate Distributions and Order Statistics

Bivariate distributions including joint, marginal and conditional distributions. It further examines the bivariate normal distribution with derivation, correlation structure, and properties. Order statistics, r^{th} and s^{th} order statistics.

Recommended Books/ Reference Material

1. Carlton, M.A., & Devore, J.L. (2020). *Probability with STEM applications*, (3rd ed.). Wiley.
2. Chaudhry, S.M., & Kamal, S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Gupta, S.C., & Kapoor, V.K. (2020). *Fundamentals of mathematical statistics*. India: Sultan Chand & Sons.
4. Hogg, R.M., & Craig, A.T. (1995). *Introduction to mathematical statistics*. New Jersey: Prentice Hall.
5. Illowsky, B., Dean, S. (2023). *Introductory statistics*. United States: Independently Published.
6. Khan, M. K. (1996). *Probability with applications*. Pakistan: Maktiba Ilmi.
7. Mood, A.M., Graybill, F.A., & Boes, D.C. (1997). *Introduction to the theory of statistics*. New York: McGraw Hill.
8. Rabinowitz, L. (2018). *Elementary probability with applications*. CRC Press.
9. Sekhon, E. (2025). *Understanding probability*. Educohack Press.

Probability Distributions (Lab)

BS-Statistics

Course Code: STA-312L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The course aims to provide students with hands-on experience in applying the theoretical concepts of probability distributions using statistical software. It focuses on developing practical skills for visualizing, simulating, and analyzing random variables and distributions using tools such as R, Python, Excel, or SPSS.

Learning Outcomes

- Students will be able to simulate discrete and continuous probability distributions using statistical software.

- Students will be able to estimate distribution parameters using empirical data and evaluate goodness-of-fit.
- Students will be able to analyze real world datasets using probability models and report findings effectively.

Course Outline

1. Basic operations in R/Python/Excel for data handling. Simulating random variables. Generating and plotting distribution and density functions. Understanding pseudorandom number generation.
2. Simulating Bernoulli, Binomial, Poisson, Geometric, Hypergeometric, Negative Binomial, and Multinomial distributions. Visualization through bar plots and empirical PMFs. Calculating expected values and variances.
3. Simulation and visualization of Uniform, Normal, Exponential, and Lognormal distributions. Histograms, density curves, and Q-Q plots. Using empirical data to compare theoretical and observed distributions.
4. Exploration of Gamma, Beta (Type I and II), Chi-square, Student's t, F, Laplace, Rayleigh and Weibull distributions. Applications in survival and reliability analysis. Moment estimation and transformation techniques.
5. Generating bivariate normal and other joint distributions. Plotting 3D surfaces and contour plots.

Recommended Books/ Reference Material

1. Gupta, S.C., & Kapoor, V.K. (2020). *Fundamentals of mathematical statistics*. India: Sultan Chand & Sons.
2. Hogg, R.M., McKean, J. W., & Craig, A.T. (2019). *Introduction to mathematical statistics*. Pearson.
3. Kabacoff, R. (2022). *R in action: Data analysis and graphics with R and tidyverse* (3rd ed.). Manning Publications
4. McKinney, W. (2022). *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
5. Mood, A.M., Graybill, F.A., & Boss, D.C. (1997). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.

Sampling Techniques

BS-Statistics

Course Code: STA-313

Credit Hours: 03

Pre-requisite: Nil

Objectives

The purpose of the course is that the students will understand the importance of sampling in research and decision-making. They will be able to identify the differences between probability

and non-probability sampling methods and apply suitable techniques such as simple random, stratified, cluster, multiphase and multistage sampling. They will learn how to estimate population parameters using ratio, regression and product estimators. Students will also be able to plan, carry out, and present the results of an independent sample survey.

Learning Outcomes

- Use and implement random and non-random sampling with their properties.
- Estimate population total, mean and variance, etc. for different sampling plans.
- Distinguish among ratio, regression, and product estimators for different sampling designs and its applications.
- Students will be able to Plan and conduct an independent survey for any given situation. Arrange, compile and analyze the survey data. Interpret and generalized the results.

Course Outline

Unit 1. Introduction

Introduction to sampling and its importance in research, difference between census and sampling, objectives and advantages of sampling. Basic terms: population, sample, sampling frame, unit, and parameter. Probability sampling and non-probability sampling. Types of probability sampling.

Unit 2. Simple Random Sampling

Simple random sampling. Description and properties of simple random sampling for mean, total and proportion. Sample size determination under different conditions in sampling for proportion and continuous data.

Unit 4. Stratified Random Sampling

Introduction: description and notations. Properties of stratified random sampling, formation of strata. Properties of the estimates. Different methods of allocation of sample size. Relative precision of stratified random and simple random sampling.

Unit 5. Ratio, Regression and Product Estimates

Ratio, product and regression estimate in simple random sampling. Ratio and regression estimate in stratified random sampling.

Unit 6. Systematic and Cluster Sampling

Systematic sampling: linear and circular systematic sampling. Cluster sampling: intraclass correlation and ANOVA method.

Recommended Books/Reference Material

1. Arnab, R. (2017). *Survey sampling theory and applications*. Elsevier Science.
2. Chaudhary, A., & Stemger, H. (2005). *Survey sampling theory and methods*. Chapman & Hall.
3. Cochran, W.G. (1977). *Sampling technique*, (3rd ed.). John Wiley and Sons.
4. Ferguson, T.S. (2017). *A course in large sample theory*. London: Chapman & Hall.

5. Hall, W.J., & Oakes, D. (2023). *A course in the large sample theory of statistical inference*. CRC Press.
6. Lohr, S. L. (2021). *Sampling: Design and analysis* (3rd ed.). Landon: Chapman & Hall.
7. Sarndal, C.E., Swensson, B., & Wretman, J. (2003). *Model assisted survey sampling*. Springer.
8. Singh, R., & Mangat, N.S. (2013). *Elements of survey sampling*. Netherlands: Springer.
9. Singh, S. (2003). *Advanced sampling theory with applications: How Michael 'selected' Amy* (Vols. 1–2). Springer.
10. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Design and Analysis of Experiments

BS-Statistics

Course Code: STA-314

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course provides the basics of experimental designs and their uses in different disciplines. The course outlines are designed to provide basic and advanced learning of investigation for conclusions through planning and designing of experiments. The purpose is 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

- Students will be able to understand the basic concepts of experimental designs and principles with different treatment structures and applications. They will also understand incomplete block designs.
- Students will be able to understand factorial experiments and fractional factorial designs.
- Students will understand Nested and split-plot designs.
- Students will be capable to understand basic concepts of response surface methodology.

Course Outline

Unit 1. Principles and Basic Experimental Designs

Principles of design: randomization, replication, control, types of experimental units and treatments. Completely randomized design (CRD), structure, assumptions, analysis of variance, and interpretation. Estimation of the model parameters. Checking the normality assumptions.

Unit 2. Randomized Complete Block Design

Introduction to randomized complete block design (RCBD). Layout, assumptions, analysis of variance and interpretation. Estimation of the model parameters. Multiple comparisons: LSD and Tukey. Checking the normality assumptions.

- Unit 3. Latin Squares and Incomplete Block Designs**
 Latin square design, structure and analysis. Graeco-Latin square design, layout and analysis. Incomplete block designs (IBDs): necessity and application. Balanced incomplete block designs (BIBDs): incidence matrix, ANOVA.
- Unit 4. Factorial Designs**
 Basic definitions and principles for a 2^2 factorial design. Interaction plots and main effect plots. Structure, assumptions and ANOVA for a 2^2 design. Advantages of factorial designs. Extension to 2^3 factorial design and the general 2^k design. Confounding the 2^k factorial design in two blocks. Confounding the 2^k factorial design in four blocks.
- Unit 5. Fractional Factorial Designs**
 Limitations of full factorials in large systems. Constructing 2^{k-p} designs. Aliasing, confounding, and defining relations. The one-half fraction of 2^k design. The one-quarter fraction of 2^k design. Resolution III, IV, and V designs.
- Unit 6. Nested and Split-Plot Designs**
 Nested design: Concept of nesting vs. crossing. Applications in multi-stage experiments. Hierarchical data structures. ANOVA models for nested factors. Split-plot-Designs: Whole plots vs. subplots. Structure, restricted randomization. Error terms and ANOVA modeling. Applications in agriculture, industry.
- Unit 7. Response Surface Methodology**
 Optimization motivation and introduction to RSM. First-order models and steepest ascent. Second-order models: Central Composite Designs (CCD), Box–Behnken Designs. Visual tools: contour and surface plots. Model fitting and interpretation.

Recommended Books/Reference Material

1. Cochran, W.G., & Cox, G.M. (1992). *Experimental design*. John Wiley & sons.
2. Cox, D.R., & Reid, N. (2000). *The theory of the design of experiments*. Chapman and Hall.
3. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
4. Herzong, M.H., Francis, G., & Clarke, A. (2020). *Understanding statistics and experimental design: How to not lie with statistics*. Springer.
5. Mason, R.L., Gunst, R.F., & Hess, J.L. (2003). *Statistical design and analysis of experiments, with applications to engineering and science*. John Wiley & sons.
6. Montgomery, D.C. (2005). *Design and analysis of experiments*. John Wiley & sons.
7. Stephens, M.P. (2024). *Statistical design and analysis of experiments*. Purdue University Press.

Design and Analysis of Experiments (Lab)

BS-Statistics

Course Code: STA-314L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The course is designed to apply all the basic concepts of experimental design which have been taught in course Design and Analysis of Experiment with the help of Statistical packages. The course is designed 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

- Students will apply and interpret basic experimental designs including CRD, RCBD, and Latin Square design through statistical packages.
- Students will gain knowledge to construct and analyze factorial and fractional factorial experiments through statistical packages.
- Students will understand and implement incomplete block designs, nested, and split-plot designs, and response surface models for process optimization.

Course Outline

1. Introduction to DOE and software environment (R/SPSS), data entry, ANOVA, diagnostics.
2. CRD, RCBD and LSD: layout, blocking effect, simulate data, perform one-way and two-way ANOVA, plotting treatment means and diagnostics.
3. Generating IBD and BIBD structures, ANOVA for incomplete block designs, real data examples in agriculture/medicine
4. Constructing factorial and fractional factorial layouts, identifying significant factors using ANOVA and plots by Using R packages (`FrF2`, `DoE.base`) or SPSS.
5. Designing nested experiments (e.g., schools within districts), designing and analyzing split-plot agricultural/industrial layouts, interpreting variance components and F-tests.
6. Fitting and interpreting RSM models using R or SPSS, visualizing interaction and quadratic effects. Final mini-project: design, analysis, and interpretation of a multi-factor experiment.
7. Response surface design, balanced incomplete block designs (BIBD), Statistical analysis of the BIBD.

Recommended Books/Reference Material

1. Box, G., Hunter, W.G., & Hunter, S. (2021). *Statistics for experimenters: Design, innovation, and discovery* (2nd ed.). John Wiley & sons.

2. Cox, D.R., & Reid, N. (2000). *The theory of the design of experiments*. Landon: Chapman & Hall.
3. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
4. Herzong, M.H., Francis, G., & Clarke, A. (2020). *Understanding statistics and experimental design: How to not lie with statistics*. Springer.
5. Lawson, J. (2021). *Design and analysis of experiments with R*. CRC Press.
6. Mason, R.L., Gunst, R.F., & Hess, J.L. (2003). *Statistical design and analysis of experiments, with applications to engineering and science*. John Wiley & sons.
7. Montgomery, D.C. (2005). *Design and analysis of experiments*. John Wiley & sons.
8. Stephens, M.P. (2024). *Statistical design and analysis of experiments*. Purdue University Press.

Biostatistics

BS-Statistics

Course Code: STA-407

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire the understanding of different types of data, particularly categorical data. It also familiarizes students with biological data and how to handle with it. Furthermore, this course aims in analyzing and interpreting the results obtained from the data from various health and biological fields.

Learning Outcomes

- Apply the concepts of statistics in health and biomedical sciences.
- Understand sampling strategies in biomedical sciences.
- Apply statistical methods in the analysis of biological and health-related data.
- Demonstrate integration of statistical techniques with data analysis tools and methodologies to extract actionable insights from biological and health datasets.

Course Outline

Unit 1. Introduction

Definition of biostatistics, types of variables. Observations in biological, health and medical sciences. Uniqueness in terms of behavior of variables their domain and units.

Unit 2. Basic Concepts and Applications

Categorical, numerical and censored data. Populations, target populations and sampled population. Role of sampling in biostatistics.

Unit 3. Introduction to Probability Distributions

Distributional behavior of biological variables. Application of binomial and poisson distributions in biostatistics. Application of normal distribution in biostatistics.

Unit 4. Categorical Analysis

Size of samples of various types of studies. Proportions, rates and ratios; incidence, prevalence and odds. Role of transformation for analysis of biological variables. Probit and Logit model, Probit and Logit transformations.

Unit 5. Estimation and Statistical Inference

Point and interval estimation. Introduction of confidence interval and hypothesis testing. Confidence interval in simple and composite hypothesis testing.

Recommended Books/Reference Material

1. Daniel, W.W., & Cross, C.L. (2018). *Biostatistics: A foundation for analysis in the health sciences*. John Wiley & Sons.
2. Glover, T., & Mitchell, K. (2015). *An introduction to biostatistics*, (3rd ed.). Waveland Press.
3. Gurumani, N. (2021). *An introduction to biostatistics*. India: MJP Publishers.
4. Merrill, R.M. (2021). *Principles and applications of biostatistics*. Jones & Bartlett Learning.
5. Zar, J.H. (2018). *Biostatistical analysis*. Pearson.

Statistical Inference

BS-Statistics

Course Code: STA-315

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to provide a foundational understanding of the theory underlying statistical analysis, with a particular focus on estimation and inference. It introduces students to the principles of statistical inference for population parameters using a general decision-theoretic framework. The course covers key concepts in point and interval estimation, as well as hypothesis testing, enabling students to develop a sound understanding of statistical reasoning and its application in real-world data analysis.

Learning Outcome

- Understand the properties of point estimators.
- Apply methods for point estimation, including Maximum Likelihood Estimation (MLE) and Method of Moments, and evaluate their properties such as unbiasedness and efficiency.

- Understand the best critical region, uniformly most powerful test, likelihood ratio test, and sequential probability test.
- Conduct hypothesis tests for population parameters, including testing for means, variances, and proportions, using classical statistical techniques.
- Construct and interpret confidence intervals for various statistical parameters, understanding their relationship with the level of significance and margin of error.

Course Outline

Unit 1. Introduction and Methods of Estimations

Introduction to inferential statistics. Estimation: point & interval estimation. Estimation of parameters. Likelihood function. Method of maximum likelihood. Properties of maximum likelihood estimators. Invariance property of maximum likelihood estimators. Method of moments. Method of least square. Baye's method. Minimum Chi-square method.

Unit 2. Properties of Good Point Estimator

Unbiasedness, efficiency, minimum variance unbiased estimator, consistency, mean square error and sufficiency: conditional sufficiency and factorization method.

Unit 3. Uniformly Minimum Variance Unbiased Estimator (UMVUE)

Crammer Rao inequality, Row Blackwell and Laymann Scheffe.

Unit 4. Interval Estimation

Pivotal and other methods of finding confidence interval. Confidence interval in large samples. Shortest confidence interval. Optimum confidence interval. Bayesian confidence interval.

Unit 5. Testing of Hypotheses

Simple and composite hypotheses, critical regions. Power functions. Neyman-Pearson lemma. Uniformly most powerful tests. Randomized tests, unbiased tests. Likelihood tests and properties of tests.

Unit 6. Generalized Likelihood Ratio Test

Generalized likelihood ratio test procedure. Deriving tests of hypothesis concerning parameters of continuous distribution.

Unit 7. Sequential Probability Ratio Tests

Sequential probability ratio tests (SPRT), properties of SPRT. ASN function. OC function.

Recommended Books/Reference Material

1. Deshmukh, S., & Kulkarni, M. (2021). *Asymptotic statistical inference: A basic course using R*. Singapore: Springer.

2. Hogg, R.V., & Craig, A.T. (1996). *Introduction to mathematical statistics*. New Jersey: Prentice Hall.
3. Illukkumbura, A. (2020). *Introduction to hypothesis testing*. Independently Published.
4. Mood, A.M., Graybill, F.A., & Boes, D.C. (1997). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
5. Niewiadomska, B.M., & Bartoszyński, R. (2020). *Probability and statistical inference*. John Wiley and Sons.
6. Rao, C.R. (2009). *Linear statistical inference and its applications*. John Wiley & Sons.

Regression Analysis

BS-Statistics

Course Code: STA-304

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course provides students with a strong foundation in linear regression modeling, including estimation, inference, and diagnostics. It emphasizes understanding model assumptions, detecting violations, and applying corrective measures. Students will gain hands-on experience with real-world data using statistical software for analysis and model selection.

Learning outcomes

- Students will be able to conduct inference for linear regression models and properties of least square estimators.
- Students will be able to apply different diagnostic measures of the linear regression model.
- Students will gain understanding of consequences and remedial measures in case of violation of basic assumptions.
- Students will be able understand model selection criteria.

Course Outline

- Unit 1. Introduction to Linear Regression and Assumptions of the Classical Model**
Simple linear regression: model, interpretation, and assumptions, Multiple linear regression: formulation and matrix approach. Classical linear regression model assumptions (CLRM): linearity, independence, homoscedasticity and normality. Estimation by ordinary least squares (OLS). Properties of OLS estimators: unbiasedness, efficiency, consistency.
- Unit 2. Inference and Goodness-of-Fit in Linear Regression**
Hypothesis testing in linear regression, t-test for coefficients, F-test for overall significance. Coefficient of determination (R^2) and adjusted R^2 . Analysis of variance (ANOVA) for regression. Confidence and prediction intervals.

Unit 3. Violation of Assumptions and Remedial Measures

Generalized least squares. Consequences of violating CLRM assumptions: heteroscedasticity (Breusch-Pagan, White test). Multicollinearity. Autocorrelation (Durbin-Watson test). Non-normality of errors. Remedial measures: transformations (e.g., Box-Cox). Weighted least squares.

Unit 4. Regression Diagnostics and Model Adequacy Checking

Residual analysis: residual plots and assumptions check. Detection of: outliers, leverage points. Influential observations (Cook's distance). Variance inflation factor (VIF) and multicollinearity. Assumption checking using graphical and formal methods.

Unit 5. Model Selection, Extensions and Applications

Criteria for model selection: AIC, BIC, Adjusted R^2 . Best subset selection. Stepwise regression (forward, backward, both).

Recommended Books/Reference Material

1. Dobson, A.J., & Barnett, A. (2018). *An introduction to generalized linear models*, (4th ed.). Chapman & Hall.
2. Fox, J. (2022). *Applied regression analysis and generalized linear models* (4th ed.). Sage Publications.
3. Gujarati, D. (2004). *Basic econometrics*. New York: John Wiley & Sons.
4. Kutner, M. H., Nachtsheim, C. J., & Neter, J. (2022). *Applied linear regression models* (5th ed.). McGraw-Hill Education.
5. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). *Introduction to linear regression analysis* (6th ed.). New York: John Wiley & Sons
6. Roberts, A., & Roberts, J.M. (2020). *Multiple regression: A practical introduction*. Sage Publications.
7. Seber, G. A. F., & Lee, A. J. (2021). *Linear regression analysis* (2nd ed.). New York: John Wiley & Sons

Regression Analysis (Lab)

BS-Statistics

Course Code: STA-304L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course is designed to complement the theoretical course content with practical, hands-on experience using statistical software (R or SPSS or Python). The lab work will help students apply regression techniques on real and simulated data, perform diagnostics, interpret results, and develop strong data analysis skills.

Learning outcomes

- Students will be able to perform regression analysis using software tools.
- Students will be trained in residual diagnostics and model adequacy checking.
- Students will be able to conduct inference for linear regression models and properties of least square estimators.
- Students will be able to apply different diagnostic measures of the linear regression model.
- Students will gain understanding of consequences and remedial measures in case of violation of basic assumptions.
- Students will be able apply model selection criteria.

Course Outline

1. **Introduction to Regression in Software:** Introduction to dataset structure and importing data. Scatterplots and correlation analysis. Fitting simple linear regression (SLR) models. Interpreting slope, intercept, and R^2 . Software Focus: R (`lm()`), Python (`statsmodels.OLS`), SPSS (Linear Regression menu).
2. **Multiple Linear Regression and OLS Estimation:** Creating multiple linear regression models. Using matrix operations for OLS estimation (optional for advanced). Interpreting coefficient output and summary tables.
3. **Inference in Regression:** Conducting t-tests and F-tests using regression output. Constructing confidence and prediction interval. Comparing models with adjusted R^2 . :ANOVA table for regression using `anova()` function in R.
4. **Detecting Assumption Violations:** Simulating heteroscedasticity, multicollinearity, autocorrelation. Breusch-Pagan and White tests (`bptest()` in R).Durbin-Watson test (`durbinWatsonTest()` in R or SPSS output).Creating plots of residuals vs fitted, QQ plots.
5. **Remedial Measures:** Applying Box-Cox transformation (`boxcox()` in R). Using weighted least squares (`gls()` or `lm()` with weights). Dealing with multicollinearity: VIF calculation and interpretation (`car::vif()` in R).Applying standardization and centering techniques.
6. **Regression Diagnostic:** Plotting standardized residuals, leverage plots. Identifying influential points using Cook's distance. Building influence plots using R or Python visualizations. Applying VIF, DFFITS, DFBETAS for detailed diagnostics.
7. **Model Selection Techniques:** Best subset selection (leaps package in R). Forward, backward, and stepwise regression (`stepAIC()` from MASS). Comparing models using AIC, BIC, adjusted R^2 . Visualizing model fit comparisons.

Recommended Books/Reference Material

1. Fox, J. (2022). *Applied regression analysis and generalized linear models* (4th ed.). Sage Publications.
2. Gujarati, D. (2004). *Basic econometrics*. New York: John Wiley & Sons.
3. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). *Introduction to linear regression analysis* (6th ed.). New York: John Wiley & Sons
4. Kabacoff, R. I. (2022). *R in action: Data analysis and graphics with R* (3rd ed.). Manning.
5. Kutner, M. H., Nachtsheim, C. J., & Neter, J. (2022). *Applied linear regression models* (5th ed.). McGraw-Hill Education.
6. Roberts, A., & Roberts, J.M. (2020). *Multiple regression: A practical introduction*. Sage Publications.
7. Seber, G. A. F., & Lee, A. J. (2021). *Linear regression analysis* (2nd ed.). New York: John Wiley & Sons.
8. Yau, N. (2021). *Data science with Python and R*. O'Reilly Media.

Statistical Programming Using R and Python

BS-Statistics

Course Code: STA-420

Credit Hours: 03

Pre-requisite: Nil

Objectives

The purpose of the course is to introduce a statistical programming to fulfil the demand for specific data analysis that cannot be done using menu-based statistical software. The course is designed to give introduction to R and Python programming. The student learns how to import and export data, to handle different data types, create and use scripts, store data and results, create and save graphical illustrations. Furthermore, the course provides an overview of the implemented analytical methods.

Learning Outcomes

- Students will be able to create programs in the programming languages R and Python using basic programming concepts, including algorithms, data structures, flow control, etc.
- Students will be able to use different R packages and Python libraries for data manipulation and cleaning tasks and visualize data effectively.
- Students will be skilful to work with real-world datasets by applying both R and Python tools to analyze, interpret, and evaluate statistical results performance. For different statistical tasks, developing a practical understanding of the strengths and limitations of each language.

Course Outline

Unit 1. Introduction to Programming and Tools

Role of programming in statistics. Overview of R and Python ecosystems. Setting up R, RStudio, Anaconda, and Jupyter. Writing and running basic scripts. Variables, data types, operators. Control structures (if, loops). Functions and file.

Unit 2. Data Structures and Data Handling

Core data structures in R: vectors, lists, arrays, matrices, matrix operations, data frames, for loops, while loops, repeat loops. Core data structures in Python: lists, dictionaries, arrays, looping, DataFrames. Reading and writing data (CSV, Excel). Handling missing or inconsistent data.

Unit 3. Data Cleaning and Manipulation

Data wrangling with R (`dplyr`, `tidyr`). Data wrangling with Python (`pandas`, `numpy`). Filtering, transforming, grouping, merging. Reshaping and aggregating datasets.

Unit 4. Exploratory Data Analysis (EDA) and Visualization

Summary statistics and distributions. Univariate and multivariate plots. R: `ggplot2`. Python: `matplotlib`, `seaborn`. Customizing, saving, and integrating visualizations.

Unit 5. Statistical Analysis and Modeling

For statistical analysis, use following R Tools: `stats` package (`t.test()`, `aov()`, `lm()`), `broom`, and **Python Tools:** `scipy.stats`, `statsmodels`, `scikit-learn` (basic usage). Descriptive and inferential statistics. Hypothesis testing and confidence intervals. Linear regression (simple & multiple). ANOVA and model comparison. Model diagnostics.

Unit 6. Advanced Modelling Techniques

Logistic regression for classification. Introduction to regularization Techniques (Ridge, Lasso and Elastic Net). Cross validation, model selection and evaluation.

Unit 7. Final Project and Review

Group or individual comprehensive data analysis project: end-to-end data analysis. Peer review and code feedback. Final presentations. Course review and future directions.

Recommended Books/Reference Material

1. Denis, D.J. (2020). *Univariate, bivariate, and multivariate statistics using R: Quantitative tools for data analysis and data science*. John Wiley & Sons.
2. Foster, M. (2020). *Python for data analysis: The ultimate beginner's guide to learn programming in Python for data science with Pandas and NumPy, master statistical analysis, and visualization*: Independently Published.
3. McNulty, K. (2021). *Handbook of regression modeling in people analytics: With examples in R and Python*. CRC Press.

4. Mueller, J.P. (2023). *Beginning programming with Python for dummies*. John Wiley & Sons.
5. Thulin, M. (2021). *Modern statistics with R: From wrangling and exploring data to inference and predictive modelling*. BoD-Books on Demand.
6. Xanthidis, D., Manolas, C., Xanthidou, O.K., & Wang, H.I. *Handbook of computer programming with Python*. (2022). CRC Press.

Research Methodology

BS-Statistics

Course Code: STA-403

Credit Hours: 03

Pre-requisite: Nil

Objectives

The primary objective of this course is to develop a research orientation among students and to acquaint them with fundamentals of research methods. This course develops understanding of the basic framework of research process and various research designs and techniques. The students will be able to conduct independent research in future because of practical part of the course.

Learning Outcomes

- Students will gain the understanding of the fundamental principles of research methodology, encompassing various research types, designs and pertinent procedures.
- Students will be able to use various data collection tools.
- Students will be able to develop a questionnaire and check its validity and reliability.
- Students will be able to understand research ethics and report writing.

Course Outline

Unit 1. Introduction

Definition & types of research. Quantitative and qualitative research. Plagiarism and ethics of research.

Unit 2. Designing a Survey

Selection of problem, choice of the most important variables, choice of population and sample design. Search for references, formation of hypothesis. Surveys to test hypothesis objectivity, planning of experiment and steps in experimentation. Selection of topic for practical survey.

Unit 3. Mode of Data Collection and Other Choices

Modes of data collection, choice of suitable mode, levels of significance. Survey of literature on selected topic, collection of references from various sources. Designing questionnaire.

Unit 4. Analysis of Data and Preparation of Report

Data analysis to determine functional / causal relationship between variables. Interpretation of results. Components of scientific report and various methods of data collection / arrangement of primary and secondary data for selected practical survey.

Unit 5. Preparation and Publication of Reports

Publication procedures, steps for preparation of scientific report. Qualitative research, content analysis, preparation of own report and presentations of prepared report.

Recommended Books/Reference Material

1. Mahrool, F. (2020). *Research methodology. A guide for a literature review: A short description*. GRIN Verlag.
2. Panneerselvam, R. (2013). *Research methodology*. India: Prentice Hall.
3. *Research Methodology: A handbook for beginners*. (2017). Notion Press.
4. Saris, W.E., & Gallhofer, I.N. (2014). *Design, evaluation, and analysis of questionnaires for survey research*. John Wiley & Sons.
5. Singh, Y.K. (2011). *Fundamental of research methodology and statistics*. New Age International.
6. Thomas, C.G. (2021). *Research methodology and scientific writing*. Springer.

Statistical Quality Control

BS-Statistics

Course Code: STA-405

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is to provide students with the fundamental concepts, techniques, and tools of statistical quality control (SQC). Emphasis is placed on control charts, process capability analysis and acceptance sampling for monitoring and improving the quality of products and processes.

Learning Outcomes

- Students will be able to understand the fundamental principles, techniques and tools of statistical quality control.
- Students will be able to monitor statistical processes using various control charts.
- Students will be able to observe consumer's and producer's risk using different acceptance sampling plans.

Course Outline

- Unit 1. Introduction to Quality and Statistical Quality Control**
Concept of quality control and quality assurance. Total quality management (TQM). Statistical methods for quality improvement. Statistical quality control (SQC). Probability plots and basic methods of statistical process control.
- Unit 2. Control Charts for Variables**
Construction and interpretation of $\bar{X}$ -charts, R-charts, and s-charts. Estimating process mean and variability. Identifying out-of-control conditions and rational subgroups.
- Unit 3. Control Charts for Attributes**
p-chart, np-chart, c-chart, and u-chart; assumptions and calculations.
- Unit 4. Process Capability Analysis**
Definition and calculation of process capability indices (C_p , C_{pk} , C_{pm}). Specification limits and interpreting capability results.
- Unit 5. Cumulative Sum and Exponentially Weighted Moving Average Control Charts**
Design and application of CUSUM charts. EWMA charts for detecting small shifts in process mean and comparison with Shewhart charts.
- Unit 6. Acceptance Sampling**
Basic concepts of acceptance sampling, types of sampling plans (single, double, multiple), operating characteristic (OC) curves, average outgoing quality (AOQ), producer's and consumer's risks.

Recommended Books/Reference Material

1. Chandra, M.J. (2001). *Statistical quality control*. CRC Press.
2. Gupta, B.C. (2021). *Statistical quality control: Using Minitab, R, JMP and Python*. John Wiley & Sons.
3. Miltag, H.J., & Rinne H. (1993). *Statistical methods of quality assurance*. Landon: Chapman & Hall.
4. Montgomery, D.C. (2020). *Introduction to statistical quality control*. John Wiley & Sons.
5. Ryan, T.P. (1989). *Statistical methods for quality improvement*. John Wiley & Sons.

Applied Multivariate Analysis

BS-Statistics

Course Code: STA-423

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to enable students to understand multivariate data and methodology for multivariate analysis. This course enables students to handle large size data, its analysis as well as interpretation of results by using real world problems of multivariate data.

Learning Outcomes

- Students will be able to apply multivariate regression and Statistical inference for multivariate data.
- Students will understand multivariate statistical techniques for dimension reduction such as principal component analysis and factor analysis.
- Students will gain understanding of using discriminant analysis and clustering techniques.

Course Outline

Unit 1. Introduction to Multivariate Analysis

Overview of multivariate data and multivariate analysis. Types of multivariate techniques dependence vs interdependence). Data structures and types of variables. Matrix algebra basics for multivariate analysis. Assumptions in multivariate analysis.

Unit 2. Multivariate Normal Distribution and Inference

Multivariate normal distribution: definition and properties. Estimation of the mean vector and covariance matrix. Hypothesis testing for mean vector (Hotelling's T^2). Confidence regions and simultaneous intervals. Assessing multivariate normality.

Unit 3. Multivariate Regression Analysis

Concept and model formulation of multivariate regression. Estimation and interpretation of parameters. Hypothesis testing in multivariate regression. Model diagnostics and multicollinearity. Applications and case studies.

Unit 4. Principal Component Analysis (PCA)

Motivation and objectives of PCA. Derivation and computation of principal components. Eigenvalues and eigenvectors. Interpretation and selection of components. Applications of PCA in real data.

Unit 5. Factor Analysis

Differences between PCA and factor analysis. Common factor model and assumptions. Estimation methods: principal component vs maximum likelihood. Factor rotation (orthogonal and oblique). Interpretation and applications.

Unit 6. Discriminant Analysis

Purpose and types (linear and quadratic discriminant analysis). Assumptions and estimation of discriminant functions. Classification rules and performance evaluation. Comparison with logistic regression. Practical examples.

Unit 7. Cluster Analysis

Objectives of cluster analysis. Hierarchical clustering methods (single, complete, average linkage). Non-hierarchical methods (k-means, k-medoids). Choosing the number of clusters. Interpretation and validation of clustering results.

Recommended Books/ Reference Material

1. Afifi, A.A., May, S., & Clark, V.A (2003). *Computer aided multivariate analysis (4th ed.)*. California: Chapman & Hall.
2. Afifi, A.A., May, S., Donatello, R. A., & Clark, V.A. (2021). *Practical multivariate analysis*. John Wiley & Sons.
3. Anderson, T.W. (2003). *An introduction to multivariate statistical analysis*. John Wiley & Sons.
4. Backhaus, K., Erichson, B., Gensler, S., Weiber, R., & Weiber, T. (2021). *Multivariate analysis*. Springer.
5. Cleff, T. (2019). *Applied statistics and multivariate data analysis for business and economics*. Springer.
6. Denis, D.J. (2020). *Univariate, bivariate, and multivariate statistics using R: Quantitative tools for data analysis and data science*. John Wiley & Sons.
7. Härdle, W.K., Simar, L., & Fengler, M.R (2024). *Applied multivariate statistical analysis*. Springer.
8. Johnson, W. (2015). *Applied multivariate statistical analysis*. Pearson.
9. Morrison, F. (1990). *Multivariate statistical methods*. New York: McGraw-Hill.

9. List of Major within Elective Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	STA-424	Statistical Tools for Data Science	Nil	3
2	STA-425	Statistics for Deep Learning	Nil	3
3	STA-426	Statistical Methods for Data Mining	Nil	3
4	STA-427	Statistical Machine Learning	Nil	3
5	STA-428	Artificial Intelligence	Nil	3
6	STA-429	Big Data Analytics	Nil	3
7	STA-430	Digital Analytics	Nil	3
8	STA-431	High-Dimensional Data Analysis	Nil	3
9	STA-432	Epidemiology	Nil	3
10	STA-415	Survival Analysis	Nil	3
11	STA-401	Categorical Data Analysis	Nil	3
12	STA-433	Analysis of Repeated Measurements	Nil	3
13	STA-434	Design and Analysis of Medical Studies	Nil	3
14	STA-435	Structural Equation Models	Nil	3
15	STA-436	Pharmaceutical Statistics	Nil	3
16	STA-437	Clinical Trials	Nil	3
17	STA-438	Financial Econometrics	Nil	3
18	STA-439	Time Series Analysis and Forecasting	Nil	3
19	STA-440	Actuarial Statistics	Nil	3
20	STA-412	Reliability Analysis	Nil	3
21	STA-441	Predictive Modeling	Nil	3
22	STA-410	Operations Research	Nil	3
23	STA-409	Bayesian Statistics	Nil	3
24	STA-411	Stochastic Processes	Nil	3
25	STA-442	Spatial Statistics	Nil	3
26	STA-443	Population Studies and Demographic Techniques	Nil	3
27	STA-444	Robust Statistics	Nil	3
28	STA-445	Environmental Statistics	Nil	3
29	STA-446	Functional Data Analysis	Nil	3

10. List of Elective Courses within the Selected Specialization

SPECIALIZATION 1: DATA SCIENCE			
Course Code	Course Title	Pre-Requisite	Credit Hour
STA-424	Statistical Tools for Data Science	Nil	3
STA-425	Statistics for Deep Learning	Nil	3
STA-426	Statistical Methods for Data Mining	Nil	3
STA-427	Statistical Machine Learning	Nil	3
STA-428	Artificial Intelligence	Nil	3
STA-429	Big Data Analytics	Nil	3
STA-430	Digital Analytics	Nil	3
STA-431	High-Dimensional Data Analysis	Nil	3
SPECIALIZATION 2: BIOSTATISTICS			
STA-432	Epidemiology	Nil	3
STA-415	Survival Analysis	Nil	3
STA-401	Categorical Data Analysis	Nil	3
STA-433	Analysis of Repeated Measurements	Nil	3
STA-434	Design and Analysis of Medical Studies	Nil	3
STA-435	Structural Equation Models	Nil	3
STA-436	Pharmaceutical Statistics	Nil	3
STA-437	Clinical Trials	Nil	3
SPECIALIZATION 3: FINANCIAL STATISTICS			
STA-438	Financial Econometrics	Nil	3
STA-439	Time Series Analysis and Forecasting	Nil	3
STA-440	Actuarial Statistics	Nil	3
STA-412	Reliability Analysis	Nil	3
STA-441	Predictive Modeling	Nil	3
STA-435	Structural Equation Models	Nil	3
STA-430	Digital Analytics	Nil	3
STA-429	Big Data Analytics	Nil	3

11. Course Outlines for Major within Elective Courses

Statistical Tools for Data Science

BS-Statistics

Course Code: STA-424

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will be introduced with fundamental statistical techniques essential for data science and develop students' ability to perform exploratory data analysis (EDA). This will equip students with the skills to handle real-world data using statistical softwares and teach the interpretation of statistical results in the context of data-driven decision-making. This course also prepare students for advanced data science courses through strong statistical foundations and software implementation.

Learning Outcomes

- Students will be able to apply basic to intermediate statistical techniques for analyzing data.
- Use R or Python to perform statistical computations and visualizations.
- Conduct and interpret hypothesis tests, regression analysis, and model diagnostics.
- Carry out exploratory data analysis (EDA) and draw meaningful conclusions.
- Communicate data insights using appropriate statistical terminology and graphics.

Course Outline

Unit 1. Introduction to Data Science and Exploratory Data Analysis

Background of data Science. What is data science? And its importance. Challenges in data science. Scope of data science. Role of statistics in data science, Types of data structured, unstructured and tidy) and levels of measurement.

Unit 2. Data Collection and Management

Methods of data collection, data ware housing and management. Data quality and data cleaning: handling missing values, outliers, duplicates. Data transformation: filtering, grouping, merging, reshaping. Creating new variables and concept of tidy data. Data governance and ethics. Importing data (CSV, Excel, web sources).

Unit 3. Exploratory Data Analysis

Importance of exploratory data analysis (EDA). Review of statistical summaries: mean, median, SD, quartiles. Visual summaries: bar charts, box plots, histograms, scatter plots. Correlation and causation. Identifying pattern and trends.

Unit 4. Statistical Inference for Data Science

Review of sampling distributions and Central Limit Theorem. Confidence intervals for mean/proportion. Hypothesis testing (t-tests, chi-square tests, ANOVA) and Visual inference using simulation and bootstrapping.

Unit 5. Regression and Model Diagnostics

Machine learning fundamentals, types of machine learning (supervised, unsupervised and reinforcement). Model selection criteria, overfitting, underfitting. Cross validation techniques. Importance of feature selection, Evaluation metrics for classification, evaluation metrics for regression. Bias variance trade off.

Recommended Books/Reference Material

1. Blum, A., Hopcroft, J., & Kannan, R. (2020). *Foundations of data science*. India: Cambridge University Press.
2. Nandi, G., & Sharma, R. K. (2020). *Data science fundamentals and practical approaches: Understand why data science is the next*. India: Bpb Publications.
3. Rogel-Salazar, J. (2020). *Advanced data science and analytics with Python*. CRC Press.
4. Selvam, M.M., Srivastava.S., Murugan,R.T., & Gayathri.(2024) *Foundations of data science*. RK Publication.
5. Spector, A. Z., Norvig, P., Wiggins, C., & Wing, J. M. (2022). *Data science in context: foundations, challenges, opportunities*. United Kingdom: Cambridge University Press.
6. Wickham, H., & Grolemund, G. (2023). *R for data science*, (2nd ed.). O'Reilly.

Statistics for Deep Learning

BS-Statistics

Course Code: STA-425

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces students to the statistical foundations of deep learning, including probability, inference, and optimization. It explains key phenomena like overfitting, generalization, and uncertainty using tools such as regularization and Bayesian methods. Students will gain both theoretical insight and practical skills to build and evaluate deep learning models statistically.

Learning Outcomes

- Students will understand and apply core statistical concepts such as probability, estimation, and inference in the context of deep learning.
- Students will be able to analyse the training behaviour and generalization of deep neural networks using statistical tools.
- Students will Interpret and evaluate deep learning models using techniques like regularization, uncertainty quantification, and model calibration.

- Students will be able to apply dimensionality reduction and representation learning concepts to understand latent structures in data.

Course Outline

Unit 1. Introduction to Deep Learning

What is learning? What is deep learning? Overview of brain and neuron. What is artificial intelligence? Types of deep learning. Difference between machine learning and deep learning. Advantages and disadvantages of deep learning. The role of statistics in deep learning models. Challenges of using deep learning models. Statistical foundations for deep Learning.

Unit 2. Optimization and Learning Dynamics

Gradient descent, stochastic gradient descent (SGD) and their statistical interpretation. Backpropagation as an application of the chain rule. Learning rate, momentum, and convergence properties. Neural tangent kernel (NTK) and wide network training dynamics.

Unit 3. Introduction to Neural Network

Introduction to neural network, Multilayer perceptron, Back propagation learning. Unsupervised learning with deep network, autoencoders. Training data; maximum likelihood based cost, cross entropy, MSE cost; feed-forward networks; MLP, sigmoid units; neuroscience inspiration. Output vs hidden layers; linear vs nonlinear networks.

Unit 4. Convolutional Neural Network

1D & 2D convolution, filters and feature maps. Pooling, fully connected layers, batch normalization. ConvNet architectures: AlexNet, VGG, GoogleNet, ResNet, Inception, U-Net. Transfer learning and multi-class classification.

Unit 5. Unsupervised & Generative Deep Learning

Dimensionality reduction & representation learning: PCA, autoencoders: basic architecture and motivation, denoising autoencoders for robust feature learning, sparse autoencoders and regularization, stacked autoencoders for deep representation learning. Generative models: (GANs), Variants such as adversarial autoencoders (AAE) and CycleGANs and image segmentation and retrieval.

Recommended Books/Reference Material

1. Charniak, E. (2019). Introduction to deep learning. United Kingdom: MIT Press.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT Press.
3. Murphy, K. P. (2022). *Probabilistic machine learning: An introduction*. MIT Press.
4. Rasmussen, C. E., & Williams, C. K. I. (2006). *Gaussian processes for machine learning*. MIT Press.
5. Roberts, D. A., Yaida, S., & Hanin, B. (2022). *The principles of deep learning theory*. Cambridge University Press.

Statistical Methods for Data Mining

BS-Statistics

Course Code: STA-426

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire the understanding about data mining and develop skills to apply statistical models for pattern discovery, prediction, and decision-making in large datasets. Bridge the gap between statistics and machine learning, emphasizing the role of statistical reasoning in data mining. Equip students with practical knowledge of implementing statistical methods using software tools like R or Python.

Learning Outcomes

- Students will gain understanding about the basic concepts of data mining and different type of data warehouses.
- Students will be to apply appropriate statistical techniques to explore, analyze, and model complex datasets.
- Students will gain understanding about the application of data reduction techniques on real life data.
- Students will be able to use statistical software tools (e.g., R or Python) to conduct data mining tasks and interpret outputs.

Course Outline

Unit 1. Introduction to Data Mining

Why data mining, kind of data and pattern to be mined. Technologies used for data mining. Application of data mining and its issue.

Unit 2. Data Pre-Processing

Data preprocessing, data cleaning, data integration, data reduction, data transformation and data discretization. Data warehouse modeling.

Unit 3. Regression and Classification Models

Linear and logistic regression, Model diagnostics and regularization (Ridge, Lasso), Discriminant analysis (LDA/QDA) and Evaluation metrics: confusion matrix, ROC, AUC, etc.

Unit 4. Cluster Analysis

Cluster analysis, partitioning methods, hierarchal methods, clustering high dimensional data, clustering graph and network data.

Unit 5. Dimension Reduction and Association Rules

Principal component analysis (PCA), Factor analysis and feature selection, Association rule mining (Apriori algorithm) support, confidence, lift, and applications.

Recommended Books/Reference Material

1. Berson, A., & Smith, S. J. (1997). *Data warehousing, data mining, and OLAP*. McGraw-Hill.
2. Dinov, I. D., & Velez, M. V. (2021). *Data science: time complexity, inferential uncertainty, and space-time analytics*. De Gruyter.
3. Grus, J. (2015). *Data science from scratch: First principles with Python*. O'Reilly Media.
4. Han, J., Pei, J., & Tong, H. (2022). *Data mining: Concepts and techniques*. Morgan Kaufmann.
5. Kantardzic, M. (2019). *Data mining: Concepts, models, methods, and algorithms*. John Wiley and Sons.
6. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2023). *Data mining: Practical machine learning tools and techniques* (4th ed.). Morgan Kaufmann.

Statistical Machine Learning

BS-Statistics

Course Code: STA-427

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire understanding of principles, algorithms, and applications of machine learning from the point of view of modeling and prediction. They will also learn the science of analyzing an algorithm's statistical properties and performance guarantees.

Learning Outcomes

- Students will gain understanding of methodology with theoretical foundations and computational aspects.
- Students will be able to understand the art of designing good learning algorithms and the science of analyzing an algorithm's statistical properties and performance guarantees.
- Write simple code in R or Python to build and test ML models.

Course Outline

Unit 1. Introduction

Introduction to machine learning. Prediction approaches. Statistical decision theory. Supervised versus unsupervised learning. Training vs testing data sets. Statistical models accuracy.

Unit 2. Linear Methods for Regression and Classification

Linear regression models. Linear discriminant analysis. Bayes theorem for classification. Logistic regression and K-nearest neighbors.

Unit 3. Resampling Methods

Validation set approach, bootstrap and model complexities. Bias-variance decomposition. Optimism of training error rate and test error.

Unit 4. Model Inference and Averaging

Maximum likelihood methods. Bayesian methods. Relationship between bootstrap and bayesian inference. Polynomial regression.

Unit 5. Linear Model Selection and Regularization

Subset selection, shrinkage methods, dimension reduction methods. Consideration in high dimensions data and regression with high dimension data.

Recommended Books/Reference Material

1. Bishop, C.M. (2013). *Pattern recognition and machine learning: All "just the facts 101" material*. Springer.
2. Bishop, C.M. (2023). *Pattern recognition and machine learning*. Springer.
3. Hastie, T., Tibshirani, R., & Friedman, J. (2013). *The elements of statistical learning: data mining, inference, and prediction*. Springer.
4. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An introduction to statistical learning with applications in R*. Springer.
5. Roelants, P. (2023). *Statistical learning with Math and Python*. Manning.
6. Wasserman, L. (2006). *All of nonparametric statistics*. Springer.

Artificial Intelligence

BS-Statistics

Course Code: STA-428

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces students to core concepts in Artificial Intelligence (AI) with a focus on data-driven reasoning, statistical modeling, and algorithmic learning. It aims to bridge traditional statistical analysis with modern AI tools, preparing students to apply intelligent systems in real-world, data-centric environments.

Learning Outcomes

- Students will understand and explain fundamental AI concepts and methodologies.
- Students will be able to model and solve decision problems using search, logic, and probabilistic reasoning.

- Students will gain understanding of machine learning and statistical models and their usage in real-world data contexts.
- Students will design, implement, and interpret AI models using Python or R.

Course Outline

Unit 1. Introduction to Artificial Intelligence

History and evolution of AI, definitions. Applications, and ethical considerations. Symbolic AI vs. statistical AI. Role of AI in data science and statistics. AI vs machine learning vs statistical modeling. Types of AI: reactive, limited memory, theory of mind, self-aware. Applications in healthcare, education, business, climate.

Unit 2. Search and Problem Solving

Problem Solving: State-space, Actions, and Goals. Uninformed Search: BFS, DFS, UCS. Informed Search: A*, Greedy. Optimization Techniques: Hill Climbing, Simulated Annealing. Applications: Scheduling, Route Planning, Resource Allocation.

Unit 3. Knowledge Representation and Reasoning

Logical agents. Propositional logic. Inference in propositional logic. Predicate (First-order) Logic. Inference in first-order logic. Knowledge representation. Knowledge-based Systems. Probabilistic reasoning: Bayesian networks, Naive Bayes.

Unit 4. Statistical Learning and Data-Driven AI

Supervised learning: regression, classification. Unsupervised learning: clustering, dimensionality reduction. Decision trees, Naive Bayes, k-NN. Statistical metrics: confusion matrix, ROC, precision-recall. Implementation in Python/R using real statistical data.

Unit 5. AI in the Real World and Ethical Dimensions

Case studies: NLP (sentiment analysis) and image recognition. AI in healthcare, agriculture, social media and climate models. Explainable AI and interpretability. Bias, fairness and transparency in AI. The future of AI in statistics and policy research.

Recommended Books/Reference Material

1. Alpaydin, E. (2020). *Introduction to machine learning*, (4th ed.). MIT Press.
2. Chollet, F. (2021). *Deep learning with Python*, (2nd ed.). Manning Publications
3. Flach, P. (2012). *Machine learning: The art and science of algorithms that make sense of data*. Cambridge University Press.
4. Géron, A. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems*, (2nd ed.). O'Reilly Media.
5. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT Press.

6. Joshi, P. (2017). *Artificial intelligence with Python*. Germany: Packt Publishing.
7. Russell, S. J., & Norvig, P. (2020). *Artificial intelligence: A modern approach*, (4th ed.). Pearson.

Big Data Analytics

BS-Statistics

Course Code: STA-429

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will learn to manage, process, analyze, and interpret large-scale data using statistical methods. Students will explore distributed data systems, scalable algorithms, and machine learning techniques suited for high-dimensional data. Real-world data from health, finance, social sciences, and e-commerce will be used. Emphasis will be on applying theoretical concepts through hands-on projects using tools like R, Python, Spark, and SQL.

Learning Outcomes

- Students will understand the characteristics, challenges, and opportunities presented by big data.
- Students will learn scalable statistical methods and algorithms for data analysis.
- Students will gain understanding of how to use programming tools and platforms to process and visualize big data.
- Students will be able to apply statistical thinking to real-world, large-scale data problems in industry and research.

Course Outline

Unit 1. Foundations of Big Data and Statistical Thinking

Introduction to big data: definitions, 5Vs (Volume, Variety, etc.). Role of statistics in big data analysis. Comparison: traditional statistics vs. big data methods. Big data architecture overview (data lake, data warehouse).

Unit 2. Statistical Data Handling and Preprocessing

Data acquisition, storage, and retrieval from large sources. Cleaning and pre-processing large datasets. Data summarization using distributed computing. Handling missing data and outliers at scale. Importing and exporting large datasets (CSV, JSON, Parquet). Variable encoding (label, one-hot, binary). Normalization and standardization. Feature engineering and transformation.

Unit 3. Statistical Models and Machine Learning at Scale

Regression and classification in high-dimensional data. Curse of high dimensionality. Regularization: Ridge, Lasso. Decision Trees, Random Forests,

and XGBoost. Clustering: Scalable k-means, DBSCAN. Model evaluation metrics: AUC, RMSE, Precision/Recall.

Unit 4. Big Data Tools and Ecosystem

Big data storage systems: hadoop distributed file system (HDFS). NoSQL databases: MongoDB, cassandra. Data Lakes vs. Data Warehouses. Distributed computing frameworks. Data acquisition from web, social media, cloud, and IoT sources

Unit 5. Data Visualization, Ethics and Applications

Interactive data visualization with Power BI, Tableau Public, ggplot2, and plotly. Dashboards for big data reporting. Case studies: Health surveillance, E-commerce, Social media, Government data. Data privacy, ethical implications, and fairness in big data analysis.

Recommended Books/Reference Material

1. Dasu, T., & Johnson, T. (2003). *Exploratory data mining and data cleaning*. Wiley-Interscience.
2. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An introduction to statistical learning: With applications in R*, (2nd ed.). Springer.
3. Marz, N., & Warren, J. (2015). *Big data: Principles and best practices of scalable real-time data systems*. Manning Publications.
4. Matter, U. (2023). *Big data analytics*. Landon: Chapman & Hall.
5. Sardar, T. H., & Pandey, B. K. (2024). *Big data computing*. CRC Press.
6. White, T. (2015). *Hadoop: The definitive guide*, (4th ed.). O'Reilly Media.

Digital Analytics

BS-Statistics

Course Code: STA-430

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces students to the principles, tools, and techniques used to collect, measure, analyze, and interpret digital data generated through websites, mobile applications, and online platforms. Students learn how to track user behavior, evaluate digital performance, and generate actionable insights for data-driven decision-making using modern analytics platforms and visualization tools.

Learning Outcomes

- Students shall be able to understand the fundamentals of digital analytics and data-driven decision making
- Students will be capable of analyzing user behavior using analytics tools.

- They will be able to interpret key performance indicators (KPIs) and metrics.
- Students will be able to Design dashboards and reports for stakeholders and Apply ethical and privacy considerations in digital data usage.

Course Outline

Unit 1. Foundations of Digital Analytics

Introduction to digital analytics. Evolution of web and digital analytics. Role of analytics in organizations. Data-driven decision making. Digital analytics ecosystem. Types and sources of digital data. Owned, earned, and paid media.

Unit 2. Digital Data Collection & Tracking

Data collection mechanisms. Cookies, sessions, and user identification. Client-side vs server-side tracking. Page views and event tracking. Tag management systems. Tracking implementation challenges.

Unit 3. Metrics, KPIs & Performance Measurement

Metrics vs dimensions. Traffic and acquisition metrics. Engagement metrics Conversion metrics KPI development. Goal tracking. Funnel analysis and benchmarking.

Unit 4. Audience & Behavioral Analytics

Audience segmentation. Behavioral analytics concepts. Engagement and session analysis. User behavior interpretation.

Unit 5. Data Processing & Integration

Data cleaning and preprocessing. Handling missing and inconsistent data. Sampling and bias. Data integration concepts. Introduction to APIs. ETL basics for digital analytics.

Unit 6. Customer Journey, Visualization & Reporting

Customer journey analytics. Attribution models. Cohort and retention analysis. Data visualization principles. Dashboard design. Data storytelling. Analytics reporting and communication.

Unit 7. Optimization, Ethics & Emerging Trends

A/B testing and experimentation. Conversion rate optimization (CRO). Experiment evaluation. Data ethics and privacy principles. Consent and regulatory concepts. AI and future trends in digital analytics.

Recommended Books/Reference Material

1. Clifton, B. (2012). *Advanced Web Metrics with Google Analytics*. John Wiley & Sons.
2. Dougherty, J. & Ilyankou, I. (2021). *Hands-On Data Visualization*. O'Reilly Media.
3. Feroz, A.K., Khan, G.F. & Sponder, M. (2024). **Digital Analytics for Marketing**. Routledge.
4. Kaushik, A. (2009). *Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity*. John Wiley & Sons.
5. Provost, F & Fawcett, T. (2013). *Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking*. O'Reilly Media.

High Dimensional Data Analysis

BS-Statistics

Course Code: STA-431

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course equip students with the theoretical understanding and practical skills needed to analyze and interpret high-dimensional data, where traditional methods often fail due to the large number of variables. It emphasizes techniques such as dimension reduction, variable selection, and penalized regression to handle complex datasets effectively. Students will gain hands-on experience using modern statistical software to apply these methods across various domains like genomics, text analysis, and finance.

Learning Outcomes

- Students will be able to understand and address challenges in high-dimensional data settings.
- Students will gain understanding of key techniques for dimension reduction and variable selection. They will implement penalized regression and classification models.
- Students will be able to perform multiple hypothesis testing in high dimensions.
- Students will efficiently use statistical software to analyze high-dimensional data from real-world applications.
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Course Outline

Unit 1. Foundations of High Dimension Data

Introduction, definition examples of high-dimensional data (Genomics, Text, Image) differences between $p \gg n$ and $p < n$ problems. Curse of dimensionality and challenges. Why high-dimensional data analysis matters? Challenges and complexities in high-dimensional data. Data visualization in high dimensions. Review of multivariate statistics and linear models. Real-world applications and example. Ethical considerations in data analysis.

Unit 2. Variable Selection and Penalized Regression

Motivation for variable selection in high dimensions. Subset selection (forward, backward, stepwise). Ridge regression. Lasso regression. Elastic net. comparison of methods. Support vector machines (SVM). k-NN and decision trees in high dimensions.

Unit 3. Dimension Reduction Techniques

Principal component analysis (PCA), Multidimensional scaling (MDS), Factor analysis. Non-linear methods: t-SNE, UMAP (overview). Sparse PCA.

Unit 4. Multivariate Analysis in High Dimensions

Multivariate regression and analysis of variance (ANOVA). Canonical correlation analysis (CCA). Partial least squares (PLS). MANOVA and multivariate classification. Multivariate time series analysis.

Unit 5. Big Data and High-Dimensional Data Analysis

Challenges of big data in high dimensions. Distributed computing frameworks. Scalable algorithms for high-dimensional data. Real-time analysis of streaming high-dimensional data. Genomic data analysis (microarrays, RNA-seq). Text mining and natural language processing.

Recommended Books/Reference Material

1. Bühlmann, P., & Van de Geer, S. (2011). *Statistics for high-dimensional data: Methods, theory and applications*. Springer.
2. Giraud, C. (2021). *Introduction to high-dimensional statistics*, (2nd ed.). Landon: Chapman and Hall.
3. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An introduction to statistical learning: With applications in R*, (2nd ed.). Springer
4. Sobczak-Michalowska, B., Borah, A., & Polkowski, M. (2024). *Applications of synthetic high-dimensional data*. IGI Global.
5. Wright, J., & Ma, Y. (2022). *High-dimensional data analysis with low-dimensional models: Principles, computation, and applications*. Cambridge University Press.

Epidemiology

BS-Statistics

Course Code: STA-432

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to provide students with a thorough understanding of the principles and methods used in epidemiology. It focuses on the measurement of disease occurrence, identification of risk factors, and evaluation of health related interventions using statistical approaches.

Learning Outcomes

- Students will be able to understand key concepts and terminology in epidemiology.
- Students will be able to measure and interpret disease frequency and association.
- Students will be able to design and analyze epidemiological studies.
- Students will be able to apply statistical tools to real-world public health data.

Course Outlines

Unit 1. Introduction to Epidemiology

Definition and scope of epidemiology, historical developments, role of epidemiology in public health, types of epidemiologic studies.

Unit 2. Measures of Disease Frequency

Incidence, prevalence, cumulative incidence, incidence rate, mortality and survival rates, standardization of rates.

Unit 3. Epidemiologic Study Designs

Overview of descriptive and analytical studies, cross-sectional, case-control and cohort studies. Randomized controlled trials. Study design selection.

Unit 4. Measures of Association and Impact

Risk difference, risk ratio and odds ratio. Attributable risk and population attributable risk. Interpretation in various study designs.

Unit 5. Bias, Confounding and Effect Modification

Types and sources of bias: selection, information, and recall; strategies to reduce bias and confounding; stratification and interaction.

Unit 6. Screening and Diagnostic Tests

Principles of screening; validity and reliability of screening tests; sensitivity, specificity, predictive values; ROC curves and test evaluation.

Unit 7. Epidemiologic Data Analysis and Software

Use of statistical software (e.g., R or SPSS) for epidemiologic analysis; analyzing contingency tables, logistic regression, survival data; interpreting statistical results in epidemiologic contexts.

Recommended Books/ Reference Material

1. Bonita, R., Beaglehole, R., Kjellström, T. (2006). *Basic epidemiology* (2nd ed.). World Health Organization.
2. Friis, R. H., Sellers, T. A. (2020). *Epidemiology for public health practice* (6th ed.). Jones & Bartlett Learning.
3. Merrill, R. M. (2020). *Introduction to epidemiology* (7th ed.). Jones & Bartlett Learning.
4. Rothman, K. J. (2012). *Epidemiology: An introduction* (2nd ed.). Oxford University Press.

5. Rothman, K. J., Greenland, S., Lash, T. L. (2021). *Modern epidemiology* (4th ed.). Wolters Kluwer.

Survival Analysis

BS-Statistics

Course Code: STA-415

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will develop the understanding of identifying characteristics of survival data and their implications in both observational and experimental biomedical and public health studies, as well as in industrial applications. Furthermore, students can understand the principles and methods for the analysis of time-to event data.

Learning Outcomes

- Students will be able to understand the basic concepts and ideas of survival analysis.
- Students will be able to derive properties and methods for standard survival time distributions.
- Students will be able to perform and interpret simple non-parametric survival analyses using software.
- Students will be able to apply and interpret semi-parametric regression models for survival data using software.

Course Outline

Unit 1. Introduction to Survival Analysis

Survival data, censoring, covariates, basic distribution theory, survival function, hazard function. Special distributions: exponential, extreme value, Weibull, gamma and log logistic distributions with special reference to survival analysis. ML inference for parametric model with single sample.

Unit 2. Nonparametric Procedures

Non-parametric estimation of survival function. Life table method, product-limit method, diagnostic plots, K-sample non-parametric tests.

Unit 3. Estimation of Survival Function

Kaplan-Meier estimator, Nelson-Aalen estimator and the kernel density estimator. Ramlau-Hansen estimator and comparisons of k independent survival functions by means of the generalized log-rank test.

Unit 4. Computational Methods Including the EM

The proportional hazards model, the likelihood function, the partial likelihood function, identification of significant covariates, estimation of the survivorship function with covariates.

Unit 5. Multi-parameter Analysis Using Large Sample
Algorithms, analysis of grouped data and multi-parameter models.

Recommended Books/Reference Material

1. Collett, D. (2023). *Modelling survival data in medical research*. Routledge.
2. Hosmer, D.W., Lemeshow, S., & May, S. (2011). *Applied survival analysis: Regression modeling of time-to-event data*. John Wiley & Sons.
3. Klein, J.P., & Moeschberger, M.L. (2013). *Survival analysis: Techniques for censored and truncated data*. Springer.
4. Machin, D., Cheung, Y.B., & Parmar, M. (2006). *Survival analysis: A practical approach*. John Wiley & Sons.
5. O'Quigley, J. (2021). *Survival analysis: Proportional and non-proportional hazards regression*. Springer.

Categorical Data Analysis

BS-Statistics

Course Code: STA-401

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to introduce basic concepts of categorical data and common statistical models used for analysis of categorical data. It enables students to recognize different types of categorical data and use appropriate methodology for such data.

Learning Outcomes

- Students will become familiar with the concept of categorical data handling.
- Students will gain understanding of the fundamentals of generalized model fitting and apply inference techniques to different generalized models.

Course Outline

Unit 1. Introduction: Distributions and Inference for Categorical Data
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.

Unit 2. Introduction to Generalized Linear Models

Introduction to generalized linear models. Generalized linear model for binary data. Moments, likelihood and inference for generalized linear models. Fitting of generalized linear models.

Unit 3. Logistic Regression

Logistic regression model building, checking and applying. Methods for analysing matched case-control data, exact methods and conditional logistic regression. Alternative link functions for binary outcome and diagnostics.

Unit 4. Models for Multinomial Responses

Multinomial response models for nominal data. Multinomial response models for ordinal data. Poisson regression model and Poisson regression for rates.

Unit 5. Log Linear Models for Contingency Tables

Log linear models for Two-way tables. Log linear models for independence and interactions in three-way tables. Inference for Log linear models. Log linear model fitting.

Recommended Books/Reference Material

1. Agresti, A. (2012). *Categorical data analysis*, (3rd ed.). John Wiley & Sons.
2. Chap, T.L. (1998). *Applied categorical data analysis*. John Wiley & Sons.
3. Hosmer, D.W., & Lemeshow, S. (2004). *Applied logistic regression*. John Wiley & Sons.
4. Liu, X. (2022). *Categorical data analysis and multilevel modeling using R*. Sage Publications.
5. Ronald, C. (1997). *Log-linear models and logistic regression*, (2nd ed.). Springer.
6. Tang, W., He, H., & Tu, X. M. (2023). *Applied categorical and count data analysis*. CRC Press.

Analysis of Repeated Measurements

BS-Statistics

Course Code: STA-433

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is to provide students with the conceptual understanding and practical tools for analyzing data where multiple measurements are collected on the same experimental units over time or under different conditions. The course emphasizes appropriate modeling strategies, interpretation, and application in real-world scenarios.

Learning Outcomes

- Students will be able to identify and understand the structure of repeated measurements data.
- Students will be able to perform repeated measures ANOVA and interpret results appropriately.
- Students will be able to model longitudinal data using linear mixed effects models and generalized estimating equations.

Course Outline

Unit 1. Introduction to Repeated Measurements

Definition and structure of repeated measures data. Types of repeated designs. Challenges of correlated data and the need for specialized methods.

Unit 2. Overview of Traditional Approaches

Separate analyses at each time point, paired t-tests, and analysis of change scores. Strengths and limitations of summary measures.

Unit 3. Repeated Measures ANOVA

One-way and two-way repeated measures ANOVA. Assumptions including sphericity. Mauchly's test and corrections (Greenhouse-Geisser, Huynh-Feldt).

Unit 4. Multivariate Approach to Repeated Measures

Using MANOVA for repeated measures. Wilks' Lambda, Pillai's Trace. Comparison to univariate methods.

Unit 5. Linear Mixed Effects Models (LMM)

Modeling subject-specific effects. Random intercept and slope models. Covariance structures. Estimation using REML and ML.

Unit 6. Generalized Estimating Equations (GEE)

Marginal modeling for non-normal outcomes (binary, count). Working correlation structures. Application in public health and clinical data.

Unit 7. Model Selection and Assumption Checking

Assessing model fit, checking assumptions, handling missing data. Strategies for model comparison and residual diagnostics.

Recommended Books/ Reference Material

1. Fitzmaurice, G. M., Laird, N. M., & Ware, J. H. (2012). *Applied longitudinal analysis*. John Wiley & Sons.
2. Hand, D. J., Taylor, C. (1987). *Multivariate analysis of variance and repeated measures: a practical approach for behavioural scientists*. Japan: Taylor & Francis.
3. Islam, M. A., Chowdhury, R. I. (2018). *Analysis of repeated measures data*. Springer.
4. Rizopoulos, D. (2012). *Joint models for longitudinal and time-to-event data: With applications in R*. CRC press.

5. Schreiber, J., Turk, M. T. (2022). *Statistics and data analysis literacy for nurses*. Springer.
6. Vonesh, E. C., Chinchilli, V. M. (2020). *Linear and Nonlinear models for the analysis of repeated measurements*. Taylor & Francis Group.

Design and Analysis of Medical Studies

BS-Statistics

Course Code: STA-434

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces the fundamental principles and practical aspects of designing, conducting, and analyzing medical and health-related studies. Students will learn about different types of study designs, data collection methods, and statistical techniques used in medical research, with an emphasis on ethical and practical considerations in real-world settings.

Learning Outcomes

- Students will understand various study designs used in medical and public health research, including experimental and observational studies.
- Students will be able to design valid and ethical medical studies, considering issues of bias, confounding, and randomization.
- Students will be able to apply appropriate statistical methods for analyzing data from medical studies.

Course Outline

Unit 1. Introduction to Medical Research and Study Design

Role of statistics in medical research. Types of medical studies: observational vs. experimental. Key concepts: population, sample, exposure, outcome, bias. Overview of study design phases (design, implementation, analysis, reporting).

Unit 2. Observational Study Designs

Cross-sectional studies: design, use, limitations. Case-control studies: matching, odds ratio, recall bias. Cohort studies: prospective vs. retrospective, risk ratio. Confounding and effect modification.

Unit 3. Experimental Study Designs

Clinical trials and randomized controlled trials (RCTs). Randomization techniques and blinding. Placebo and control groups. Ethical issues in medical experimentation. CONSORT guidelines for reporting trials.

Unit 4. Sample Size and Power Calculations

Importance of sample size and statistical power. Calculations for comparing means, proportions, and time-to-event outcomes. Type I and Type II errors. Practical tools and software for sample size estimation.

Unit 5. Data Collection and Management in Medical Studies

Questionnaire design and data collection methods. Data entry, coding, and cleaning. Missing data: causes and handling methods. Data security and ethical considerations.

Unit 6. Statistical Analysis of Medical Data

Comparing groups: t-tests, ANOVA, chi-square tests. Association and risk: odds ratios, relative risks. Logistic regression for binary outcomes. Survival analysis basics: Kaplan-Meier curves, log-rank test. Adjusting for confounders using regression models.

Unit 7. Interpretation, Reporting and Critical Appraisal

Interpreting p-values, confidence intervals, and effect sizes. Reporting results according to STROBE and CONSORT guidelines. Common pitfalls in analysis and interpretation. Critical reading of medical literature and study limitations. Writing a basic study report or abstract for a medical journal.

Recommended Books/Reference Material

1. Armitage, P., Colton, T., & Newcombe, R. G. (2021). *Statistical methods in medical research* (5th ed.). John Wiley & Sons.
2. Chen, D.G. (2022). *Clinical trial data analysis using R*. CRC Press.
3. Chow, S.C. (2023). *Design and analysis of clinical trials: concepts and methodologies*. John Wiley & Sons.
4. McDonald, S., & Marshall, T. (2021). *Modern medical statistics: A practical guide*. Oxford University Press.
5. Rajagopalan, R. (2023). *Essentials of biostatistics and research methodology* (3rd ed.). Jaypee Brothers Medical Publishers.
6. Rosner, G.L., Parmigiani, G., & Smith, M.A. (2021). *Bayesian thinking in biostatistics*. CRC Press.

Structural Equation Models

BS-Statistics

Course Code: STA-435

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to introduce students to the fundamental principles of Structural Equation Modeling (SEM), including path diagrams, latent and observed variables, and model estimation. Students will learn to apply SEM techniques using statistical software to explore relationships

among variables, test theoretical models, and interpret model fit. The course emphasizes conceptual understanding and hands-on application over mathematical derivations.

Learning Outcomes

- Understand the components and purpose of structural equation models.
- Develop and interpret basic path diagrams and confirmatory factor analysis (CFA) models.
- Apply SEM to real-world problems using user-friendly statistical software.
- Evaluate and modify SEM models based on fit indices and theoretical relevance.
- Conduct small-scale SEM analyses independently for undergraduate research projects.

Course Outline

- Unit 1. Introduction to Structural Equation Model (SEM)**
Definition and scope of SEM. Importance of SEM in social and behavioral sciences. Basic terms: observed and latent variables, measurement and structural models. Differences between SEM and regression analysis. Applications of SEM in education, psychology, and health sciences.
- Unit 2. Review of Basic Concepts**
Review of correlation, covariance, and regression analysis. Introduction to path diagrams. Understanding model parameters, residuals, and error terms. Role of multiple indicators and measurement error.
- Unit 4. Path Analysis**
Development of simple path models using observed variables. Direct, indirect, and total effects. Recursive vs. non-recursive models. Introduction to model identification in simple cases. Drawing and interpreting path diagrams.
- Unit 5. Confirmatory Factor Analysis (CFA)**
Concept of latent variables and measurement models. Specification and estimation of CFA models. Comparison of CFA with Exploratory Factor Analysis (EFA). Factor loadings, measurement errors, and reliability. Basic goodness-of-fit indices for CFA.
- Unit 6. Structural Models and Estimation**
Combining measurement and structural models. Estimation of SEM parameters using software like R, SPSS or Python. Understanding standardized coefficients, model assumptions, and interpretation of results. Application of SEM in undergraduate project data.
- Unit 7. Model Fit and Modification**
Evaluation of model fit: Chi-square, Root Mean Square Error of Approximation, Comparative Fit Index, Tucker-Lewis Index and Standardized Root Mean Square Residual. Use of modification indices for model improvement. Parsimony in

modeling. Practical strategies for model refinement while preserving theoretical structure.

Unit 8. Application and Project.

Introduction to SEM software: AMOS (GUI-based), R (lavaan package). Interpreting fit output from AMOS or R. Project: Analyze a small dataset and report findings

Recommended Books/Reference Material

1. Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd ed.). Guilford Press.
2. Byrne, B. M. (2016). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (3rd ed.). Routledge.
3. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). *Multivariate data analysis* (8th ed.). Cengage Learning.
4. Hoyle, R. H. (2023), *Handbook of structural equation modeling* (2nd ed.). Guilford Press.
5. Kline, R. B. (2023). *Principles and practice of structural equation modeling* (5th ed.). Guilford Press.
6. Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of statistical software*, 48(2), 1–36. <https://doi.org/10.18637/jss.v048.i02>
7. Whittaker, T. A., & Schumacker, R.E. (2022). *A beginner's guide to structural equation modeling* (5th ed.). Routledge.

Pharmaceutical Statistics

BS-Statistics

Course Code: STA-436

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces the statistical methods used in the pharmaceutical industry for drug discovery, development, clinical trials, and post-marketing surveillance. Emphasis is placed on study design, regulatory considerations, and the application of statistical techniques to pharmaceutical data.

Learning Outcomes

- Students will be able to understand the role and importance of statistics in pharmaceutical research and regulatory processes.
- Students will be able to apply statistical techniques to drug formulation, quality control, and clinical trials.
- Students will be skillful to design and analyze pharmaceutical experiments using principles of biostatistics and inferential statistics. They will use statistical software (R/SPSS) for pharmaceutical data analysis.

- Students will be capable to interpret and report statistical findings in a pharmaceutical context using regulatory guidelines.

Course Outline

Unit 1. Introduction to Pharmaceutical Statistics

Importance of statistics in the pharmaceutical industry. Overview of the drug development process. Types of pharmaceutical studies (preclinical, clinical, post-marketing). Regulatory bodies: FDA, EMA, ICH and statistical guidelines.

Unit 2. Descriptive Statistics and Data Types

Types of pharmaceutical data: continuous, categorical, ordinal. Measures of central tendency and variability. Frequency distributions and graphical representation. Data management and quality assurance in pharmaceutical research.

Unit 3. Experimental Design in Pharmaceutical Research

Basic principles of design of experiments (DoE). Randomization, replication, and blocking. Factorial designs and response surface methodology. Applications in formulation and process optimization.

Unit 4. Inferential Statistics and Hypothesis Testing

Estimation and confidence intervals. One-sample and two-sample tests (t-tests, chi-square). ANOVA and multiple comparisons. Non-parametric methods relevant to pharmaceutical data.

Unit 5. Statistical Quality Control in Manufacturing

Control charts for variables and attributes. Process capability analysis. Acceptance sampling. Validation of analytical methods and equipment.

Unit 6. Clinical Trials and Statistical Methods

Phases of clinical trials and their statistical requirements. Randomized controlled trials: design and analysis. Survival analysis and time-to-event data. Intention-to-treat vs per-protocol analysis. Sample size and power calculations.

Unit 7. Regulatory Statistics and Data Reporting

ICH E9 and related statistical guidelines. Statistical principles for reporting clinical trial data. Common technical document (CTD) format. Reproducibility, data integrity, and audit trails. Use of software (SPSS/R) for reporting.

Recommended Books/Reference Material

1. Bolton, S., & Bon, C. (2020). *Pharmaceutical statistics: Practical and clinical applications (6th ed.)*. Landon: Chapman and Hall.
2. Kar, A. (2020). *Applied pharmaceutical analysis*. New Academic Science.
3. Kay, R. (2021). *Statistical thinking for non-statisticians in drug regulation (2nd ed.)*. John Wiley & sons.

4. Kelly, M.O., & Ratitch, B. (2021). *Statistical methods for drug safety*. Landon: Chapman & Hall.
5. Matsui, S. (2021). *Design and analysis of clinical trials for predictive medicine*. Springer.

Clinical Trials

BS-Statistics

Course Code: STA-437

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces the statistical methods used in the pharmaceutical industry for drug discovery, development, clinical trials, and post-marketing surveillance. Emphasis is placed on study design, regulatory considerations, and the application of statistical techniques to pharmaceutical data.

Learning Outcomes

- Students will be able to explain the phases, objectives, and essential components of clinical trials, including relevant ethical and regulatory frameworks.
- Students will be able to compare and apply different clinical trial designs, including randomization techniques and sample size estimation.
- Students will be skilful to identify and manage potential sources of bias and variability in clinical trials to ensure study validity and reliability.
- Students will be capable to analyze, interpret, and communicate clinical trial data using appropriate statistical methods and reporting standards.

Course Outline

Unit 1. Introduction to Clinical Trials, Ethics and Regulatory Guidelines

Purpose and importance of clinical trials in medical research. Phases of clinical trials: Key components: protocol, endpoints, trial arms. Stakeholders: sponsors, investigators, regulators. Ethical principles: autonomy, beneficence, justice. Role of Institutional Review Boards (IRBs).

Unit 2. Clinical Trial Designs

Types of designs: parallel, crossover, factorial, cluster. Superiority, equivalence, and non-inferiority trials. Blinding and control arms: single, double, placebo. Choosing an appropriate design for a trial objective.

Unit 3. Randomization and Sample Size Estimation

Purpose and types of randomization: simple, block, stratified. Allocation concealment. Sample size calculation principles: power, effect size, significance level. Tools and software for sample size planning.

Unit 4. Bias and Variability in Clinical Trials

Types of bias: selection, performance, detection, attrition. Confounding and interaction. Methods to minimize and adjust for bias. Trial protocol deviations and compliance issues.

Unit 5. Statistical Analysis of Clinical Trial Data

Intention-to-treat (ITT) vs per-protocol (PP) analysis. Common statistical tests: t-test, chi-square, ANOVA. Time-to-event (survival) analysis: Kaplan-Meier curves, log-rank test. Adjusting for covariates: ANCOVA, regression models.

Unit 6. Reporting and Interpretation of Trial Results

CONSORT guidelines for transparent reporting. Interpreting effect sizes, confidence intervals, and p-values. Clinical vs statistical significance. Writing a statistical report and summary of findings.

Recommended Books/Reference Material

1. Chen, M.H., & Carlin, B.P. (2021). *Bayesian design and analysis of clinical trials*. London: Chapman & Hall.
2. Chen, D.G. (2022). *Clinical trial data analysis using R*. CRC Press.
3. Chow, S.C. (2023). *Design and analysis of clinical trials: concepts and methodologies*. John Wiley & Sons.
4. Kay, R. (2021). *Statistical thinking for non-statisticians in drug regulation (2nd ed.)*. John Wiley & sons.
5. Kelly, M.O., & Ratitch, B. (2021). *Statistical methods for drug safety*. London: Chapman & Hall.
6. McDonald, S., & Marshall, T. (2021). *Modern medical statistics: A practical guide*. Oxford University Press.
7. Matsui, S. (2021). *Design and analysis of clinical trials for predictive medicine*. Springer.

Financial Econometrics

BS-Statistics

Course Code: STA-438

Credit Hours: 03

Pre-requisite: Nil

Objectives

The course enhances skills in applying econometric methods to business research using R or Python. It covers regression, diagnostics, structural equations, and categorical data models. Students will analyze cross-sectional, time series, and panel data using real datasets. Hands-on coding in R or Python reinforces theoretical concepts through practical application.

Learning outcomes

- Apply econometric techniques to real-world business research problems.
- Build and interpret econometric models using R or Python.

- Perform data analysis, estimation, and forecasting independently.
- Translate econometric theory into practical application using code and datasets.

Course Outline

Unit 1. Introduction and Foundations of Econometrics

What is Econometrics? Importance and methodology. Types, sources, and structure of data (cross-sectional, time series, panel). Hands-on: Data importing and exploration in R (readr, dplyr) or Python (pandas).

Unit 2. Simple and Multiple Regression Analysis

Simple linear regression model and OLS estimation, OLS assumptions and properties. Estimation and hypothesis testing. Effects of changing measurement units and interpreting regression output. Multiple regression and model estimation with two or more variables. Incorporating nonlinearities, interaction terms, and lagged variables. Hands-on: Running linear models using lm (R) or statsmodels.OLS (Python).

Unit 3. Regression Diagnostics and Functional Forms

Regression on standardized variables. Summary statistics and correlation matrices. Transforming variables (log, exponential). Using logs, ratios, percentages in models. Dealing with missing data. Hands-on: diagnostic plots and data transformation in R/Python.

Unit 4. Multicollinearity, Heteroscedasticity, and Autocorrelation

Multicollinearity: causes, consequences, detection (VIF), and remedies. Heteroscedasticity: tests (Breusch-Pagan, White), consequences, and solutions. Serial correlation: detection methods (Durbin-Watson, LM Test), causes, and treatments (GLS, transformation). Hands-on: use of car, lmtest, sandwich (R) or statsmodels.stats (Python).

Unit 5. Simultaneous Equation Models (SEMs)

Concept of exogenous and endogenous variables. Identification problems in SEMs. Indirect Least Squares (ILS). Two-Stage Least Squares (2SLS). Three-Stage Least Squares (3SLS). Hands-on: SEM estimation using systemfit, AER(R) or linearmodels.iv (Python).

Unit 6. Panel Data Models

Pooled OLS and least squares dummy variable (LSDV) models. Fixed effects and random effects models. One-way and two-way error components. Hausman test for model selection. Hands-on: panel data analysis using plm (R) or linearmodels.PanelOLS (Python).

Unit 7. Limited Dependent Variable Models

Binary outcome models: logit and probit. Ordinal models: Ordered logit and probit. Censored regression: tobit model. Post-estimation tests for discrete choice models.

Hands-on: glm, MASS::polr, AER::tobit in R or statsmodels.discrete.discrete_model in Python.

Unit 8. Forecasting and Time Series Models

Introduction to forecasting in business. Seasonal variation and seasonal index construction. Forecast evaluation metrics (RMSE, MAPE). Stationarity and unit root tests (ADF). Cointegration and error correction models (ECM). Time series models: ARMA, ARIMA, VAR, VECM. Hands-on: forecasting using forecast, urca, vars (R) or statsmodels.tsa, pmdarima, arch (Python).

Recommended Books/Reference Material

1. Baltagi, B. H. (1999). *Econometrics*, (2nd ed.). Springer.
2. Dobson, A.J., & Barnett, A. (2018). *An introduction to generalized linear models*, (4th ed.). London: Chapman & Hall.
3. Draper, N.R. & Smith, H. (2004). *Applied regression analysis*. John Wiley & Sons.
4. Fox, J. (2022). *Applied regression analysis and generalized linear models* (4th ed.). Sage Publications.
5. Gujarati, D. (2004). *Basic econometrics*. John Wiley & Sons.
6. Hansen, B. (2022). *Econometrics*. United Kingdom: Princeton University Press.
7. Kutner, M. H., Nachtsheim, C. J., & Neter, J. (2022). *Applied linear regression models* (5th ed.). McGraw-Hill Education.
8. McNulty, K. (2021). *Handbook of regression modeling in people analytics: With examples in R and Python*. CRC Press.
9. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). *Introduction to linear regression analysis*, (6th ed.). John Wiley & Sons
10. Roberts, A., & Roberts, J.M. (2020). *Multiple regression: A practical introduction*. Sage Publications.
11. Seber, G. A. F., & Lee, A. J. (2021). *Linear regression analysis*, (2nd ed.). John Wiley & Sons.

Time Series Analysis and Forecasting

BS-Statistics

Course Code: STA-439

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will acquire understanding about the basic notions, theory, models and methods for solutions, in time series analysis. The course covers models for time dependent data. Models for stationery and non-stationery models.

Learning Outcomes

- Students will be able to understand the notions expectation, covariance function and spectral distribution for time series.
- Students will be able to define and explain stationery and non-stationery time series and models.
- Students will be able to independently define ARMA, ARIMA and SARIMA models.
- Students will be able to derive and estimate expectation, covariance function for time series, analyse their connections, and derive the uncertainty of the estimates.

Course Outline

Unit 1. Introduction, Fundamental Concepts and Trends

Introduction of time series. Time series plots and model building strategy. Time series and stochastic process. Mean, variance and covariance derivation. Stationarity, deterministic versus stochastic trends. Estimation of a constant mean. Regression methods, reliability and efficiency of regression estimates. Interpreting regression output and residual analysis.

Unit 2. Smoothing Techniques, ACF, PACF, Standard Errors and Linear Processes

Exponential smoothing techniques. Auto-correlation and auto-covariance. Estimation of auto-correlation function (ACF) and partial autocorrelation function (PACF). Standard errors. General linear processes. Moving average processes. Autoregressive processes.

Unit 3. Models for Stationery Time Series

The mixed autoregressive moving average model. Invariability. ARMA and mixed models. ARMA (p, q) processes. The ACF and PACF of an ARMA (p, q) process. Calculation of the ACVF. The autocorrelation functions. The partial autocorrelation functions.

Unit 4. Spectral Analysis

Periodicity and the periodogram, cumulative periodogram. Spectral analysis and the spectrum. Wold's Theorem, aliasing. Convergence of the spectra, Spectra for ARMA processes. Processes with continuous spectra.

Unit 5. Non- Stationery Models

Stationarity through differencing. General ARIMA notation. General ARIMA models. Constant terms in ARIMA models. Minimum mean square forecasting. Seasonal ARIMA models. Forecasting with SARIMA models, diagnostics and prediction.

Unit 6. Practical in R/Python

Creating, plotting and smoothing time series in R/ python. Smoothing using polynomials, removing trend, and the ACF, PACF and periodogram in R/ python. Simulating AR, MA and ARMA processes. Simulating ARIMA and SARIMA

processes, recognizing stationarity and non-stationarity. Identifying ARIMA and SARIMA models, estimation, diagnostics and forecasting.

Recommended Books/Reference Material

1. Brockwell, P.J., & Davis, R.A. (2016). *Introduction to time series and forecasting*, (3rd ed.). Springer Publication.
2. Chan, K.S., & Cryer, J.D. (2008). *Time series analysis with applications in R*. Springer.
3. Diebold, F.X. (1998). *Elements of forecasting*. USA: South-Western College Pub.
4. Diebold, F.X., Kilian, L., & Nerlove, M. (2006). *Time series analysis. In macroeconometrics and time series analysis*. London: Palgrave Macmillan UK.
5. Vishwas, B., & Patel, A. (2020). *Hands-on time series analysis with Python*. Apress.
6. Woodward, W.A., Sadler, B.P., & Robertson, S. (2022). *Time series for data science: Analysis and forecasting*. CRC Press.

Actuarial Statistics

BS-Statistics

Course Code: STA-440

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to equip students with statistical techniques used in actuarial modeling and risk assessment. This course emphasizes survival models, life tables, risk theory, credibility theory, and applications of statistical inference in actuarial science.

Learning Outcomes

- Students will be able to understand and apply survival models and life tables.
- Students will be able to use statistical methods in insurance and pension mathematics.
- Students will be able to evaluate risk using credibility theory and ruin theory.

Course Outlines

Unit 1. Introduction to Actuarial Statistics

Introduction of the foundational concepts of actuarial science, including the nature of insurance and pension systems. Basic actuarial models and the importance of probability and statistics in actuarial applications.

Unit 2. Survival Models and Life Tables

Survival functions, hazard rates, and force of mortality. Construction and interpretation of life tables.

Unit 3. Insurance and Annuity Models

Mathematical modeling of life insurance and annuities. It includes calculation of present values, net single premiums, and net annual premiums. Various insurance products such as whole life, term life and endowment policies, along with temporary, life, increasing, and decreasing annuities.

Unit 4. Risk Models and Loss Distributions

Modeling claim amounts and frequency in insurance. Topics include individual and aggregate risk models, common loss distributions (exponential, gamma, Pareto), and their statistical properties. Use of probability models to estimate expected losses and premiums.

Unit 5. Credibility Theory

Basics of credibility theory used in insurance rate setting. The unit covers the rationale behind credibility, the Buhlmann model and the concept of full and partial credibility. Practical applications in claim forecasting and premium calculation.

Unit 6. Estimation and Model Fitting in Actuarial Work

Methods of parameter estimation relevant to actuarial models, including the method of moments and maximum likelihood estimation. It includes discussion on model validation, goodness-of-fit testing, and construction of confidence intervals for actuarial parameters using sample data.

Unit 7. Statistical Tools and Software for Actuarial Applications

Use of statistical software (such as R or Excel) for analyzing actuarial data. Students will work with simulated and real-life insurance datasets to calculate life table functions, model loss distributions and fit actuarial models using estimation techniques.

Recommended Books/ Reference Material

1. Allen, E. T., Melone, J. J., & Rosenbloom, J. S. (1984). *Pension planning: pensions, profit sharing, and other deferred compensation plans*. United States: R.D. Irwin.
2. Atkinson, M. E., & Dickson, D. C. M. (2000). *An introduction to actuarial studies*. United Kingdom: Edward Elgar Pub.
3. Booth, P., Chadburn, R., Haberman, S., James, D., Khorasanee, Z., Plumb, R. H., & Rickayzen, B. (2020). *Modern actuarial theory and practice*. CRC Press.
4. Dickson, D. C. M., Hardy, M. R., & Waters, H. R. (2020). *Actuarial mathematics for life contingent risks*. United Kingdom: Cambridge University Press.
5. Dickson, D. C. M. (2005). *Insurance risk and ruin*. United Kingdom: Cambridge University Press.
6. Humphreys, N. A., & Koshevnik, Y. (2021). *Probability and statistics for actuaries*. United States: Cognella Academic Publishing.
7. McQuire, P., & Kume, A. (2023). *R programming for actuarial science*. John Wiley & Sons.
8. Wuthrich, M. V., & Merz, M. (2022). *Statistical foundations of actuarial learning and its applications*. Springer.

Reliability Analysis

BS-Statistics

Course Code: STA-412

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will develop the understanding of reliability modeling and the ability to analyze complete and censored reliability data with and without covariates. Furthermore, they will develop knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability.

Learning Outcomes

- Students will be able to analyze the interference between strength and stress, or life data for estimating reliability.
- Students will be able to apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects.
- Students will be able to specify life test plans for reliability validation.

Course Outline

Unit 1. Introduction

Basic concepts of reliability. Examples of real-life applications. Structural reliability.

Unit 2. Lifetime Distributions Application

Lifetime distributions (failure models). Hazard rate; gamma, Weibull, gumball, log-normal and inverse Gaussian distribution.

Unit 3. Fatigue Rate Models and Estimation

Stochastic fatigue rate models. Point and interval estimation. Fatigue life model.

Unit 4. Reliability Testing

Testing reliability hypothesis. Monte-Carlo, distribution free and Baye's method in reliability.

Unit 5. 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/Reference Material

1. Elsayed, E.A. (2012). *Reliability engineering*. John Wiley & Sons.

2. Gertsbakh, I. (2012). *Reliability theory: With applications to preventive maintenance*. Springer.
3. Jardine, A.K.S., & Tsang, A.H.C. (2021). *Maintenance, replacement, and reliability: theory and applications*. CRC Press.
4. O'Connor, P., & Kleyner, A. (2012). *Practical reliability engineering*. John Wiley & Sons.
5. Pochampally, K.K., & Gupta, S.M. (2021). *Reliability analysis with Minitab*. CRC Press.

Predictive Modelling

BS-Statistics

Course Code: STA-441

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is to introduce students to the principles and practices of predictive modeling using statistical and machine learning techniques. It emphasizes model selection, evaluation, and application to real-world datasets, particularly in risk analysis, finance, and actuarial contexts.

Learning Outcomes

- Students will be able to understand and apply predictive modeling techniques such as regression, classification, and tree-based models.
- Students will be able to assess model accuracy and validity using appropriate metrics and validation strategies.
- Students will be able to implement predictive models using statistical software.

Course Outlines

Unit 1. Introduction to Predictive Modeling

Overview of predictive analytics. Key concepts: supervised vs. unsupervised learning, model performance, overfitting, bias-variance trade-off. Applications in business, healthcare, and actuarial domains.

Unit 2. Data Preprocessing and Feature Engineering

Data cleaning, transformation, and normalization. Handling missing data. Feature selection and extraction. Dummy variables and interaction terms.

Unit 3. Linear and Logistic Regression

Simple and multiple linear regression models. Assumptions and diagnostics. Logistic regression for binary classification. Interpretation of coefficients. Model assessment using AIC, BIC, confusion matrix, ROC curves.

Unit 4. Tree-Based Models

Decision Trees, Random Forests, and Gradient Boosting Machines (GBM). Tree construction, pruning, ensemble methods, variable importance, and model tuning.

Unit 5. Model Evaluation and Selection

Cross-validation techniques, train-test split, resampling methods. Model performance metrics (RMSE, MAE, accuracy, precision, recall, F1-score). Model selection strategies.

Unit 6. Regularization Methods

Ridge Regression, Lasso, and Elastic Net. Dealing with multicollinearity and overfitting. Application to high dimensional data.

Unit 7. Applications in Insurance and Risk Modeling

Use of predictive models in actuarial science. Claims frequency and severity models. Applications to underwriting, fraud detection, and customer retention.

Recommended Books/ Reference Material

1. Bruce, P., Bruce, A., & Gedeck, P. (2020). *Practical statistics for data scientists*. O'Reilly.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2017). *The elements of statistical learning*. Springer.
3. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An introduction to statistical learning*. Springer.
4. Kuhn, M., & Johnson, K. (2019). *Applied predictive modeling*. Springer.
5. Kuhn, M., & Johnson, K. (2019). *Feature engineering and selection: A practical approach for predictive models*. London: Chapman & Hall.

Spatial Statistics

BS-Statistics

Course Code: STA-442

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is to introduce students to statistical methods for analyzing data that are spatially referenced. The course focuses on spatial data visualization, spatial dependence, point pattern analysis, areal data modeling, and geostatistical techniques including variogram modeling and kriging. Applications are drawn from environmental sciences, public health, geography, and resource management.

Learning Outcomes

- Students will be able to identify and differentiate spatial data structures including point-referenced, areal, and point pattern data.

- Students will be able to apply methods to assess spatial autocorrelation and spatial structure in data.
- Students will gain practical experience in point pattern analysis and lattice data modeling.
- Students will develop the ability to construct and interpret variograms.

Course Outlines

Unit 1. Introduction to Spatial Statistics

Introduction of the core concepts of spatial statistics. Spatial and non-spatial data, and categorization of spatial data into three main types: point-referenced data, areal (lattice) data, and point patterns.

Unit 2. Spatial Data Visualization and Mapping

Methods for visualizing spatial data and identifying patterns using maps and graphical tools. Coordinate systems, spatial resolution, and thematic mapping including choropleth and heat maps. Basic Geographic Information System (GIS) tools and the use of R for spatial data visualization are introduced.

Unit 3. Spatial Autocorrelation and Dependence

Concept of spatial dependence and methods for measuring spatial autocorrelation. The construction and interpretation of empirical semi variograms.

Unit 4. Point Pattern Analysis

Analysis of spatial point patterns. Concepts such as complete spatial randomness (CSR), spatial intensity functions, and types of point processes (e.g., Poisson process). Quadrat counts, nearest-neighbor analysis, and Ripley's K-function to assess clustering or regularity in spatial point data.

Unit 5. Analysis of Areal Data (Lattice Data)

Spatial data aggregated over predefined geographic areas. Analyses of areal data using spatial weights matrices and autoregressive models such as the conditional autoregressive (CAR) and simultaneous autoregressive (SAR) models. Practical examples include disease mapping and socio-economic data analysis.

Unit 6. Geo statistics and Kriging

Continuous spatial variation and the key tools of geo statistics. Theoretical and empirical variograms, spatial trend modeling, and covariance functions. Kriging methods: simple, ordinary, and universal kriging.

Recommended Books/ Reference Material

1. Bartlett, M. S. (2013). *The statistical analysis of spatial pattern*. Netherlands: Chapman & Hall.
2. Cressie, N. (2015). *Statistics for Spatial Data*. John Wiley & Sons
3. Fischer, M. M., & Wang, J. (2011). *Spatial data analysis: Models, methods and techniques*. Germany: Manfred M. Fischer.

4. Griffith, D. A. (2022). *Advanced introduction to spatial statistics*. United Kingdom: Edward Elgar Publishing.
5. Moraga, P. (2023). *Spatial statistics for data science: theory and practice with R*. CRC Press.
6. Wikle, C. K., Zammit-Mangion, A., & Cressie, N. (2019). *Spatio-temporal statistics with R*. CRC Press.

Population Studies and Demographic Techniques

BS-Statistics

Course Code: STA-443

Credit Hours: 03

Pre-requisite: Nil

Objectives

The primary objective of this course is to introduce the basics of vital statistics and demography to the students. This course develops understanding of rates and ratios related to vital events, and the methods of testing and estimation of vital events.

Learning Outcomes

- Students will be able to independently explain the concept of vital statistics and demography.
- Students will be able to calculate and analyse various rates and ratios of vital events.
- Students will be capable to perform the data quality testing procedures.
- They will be able to estimate from incomplete data.

Course Outline

Unit 1. Introduction

Meaning of vital statistics. Registrations of birth and death in Pakistan. Uses of vital statistics. Shortcomings of vital statistics.

Unit 2. 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 and Total fertility rate.

Unit 3. Demography

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.

- Unit 4. Testing**
Data quality testing procedures. Testing the accuracy of age and sex distribution. Fertility and mortality measures.
- Unit 5. Estimation**
Estimation from incomplete data. Construction of complete and abridged life tables. Different types of life tables. Graphs of l_x , q_x and e_x . Description and uses of life table columns.
- Unit 6. Practical Exercises**
Analyzing demographic data sets, building and interpreting demographic models, policy analysis exercises, future trends in population dynamics, population aging, urbanization, global population projections.

Recommended Books/Reference Material

1. Goerres, A., & Vanhuysse, P. (2021). *Global political demography: The politics of population change*. Palgrave Macmillan.
2. Grow, A. & Bavel, J.V. (2016). *Agent-based modelling in population studies: Concepts, methods, and applications*. Springer.
3. Haupt, A., Kane, T.T., & Haub, C. (2011). *PRB's population handbook*, (6th ed.). Population Reference Bureau.
4. Keyfitz, N. (2013). *Applied mathematical demography*. Springer .
5. GOP(2007). *Pakistan demographic survey*.
6. Rukanuddin, A.R., & Farooqi, M.N.I. (1988). *The state of population in Pakistan – 1987*. NIPS, Islamabad.
7. Schoen, R. (2020). *Analyzing contemporary fertility*. Springer International Publishing.

Bayesian Statistics

BS-Statistics

Course Code: STA-409

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will develop a sound understanding about Bayesian Statistics. In addition to computational aspects, it emphasizes differences between the classical and Bayesian approaches, formulation of Bayesian models, data and prior distributions.

Learning Outcomes

- Students will be able to apply basic techniques of Bayesian statistics for decision making.
- Students will be able to understand different simulation techniques to handle complex posterior distribution.
- Students will be able to demonstrate the application of Bayesian statistics in different models.

Course Outline

Unit 1. Introduction to Basic Elements

Conditional probability, decision, rules and risk. Randomized decision rules. Decision principles. Criticism of classical statistics. The likelihood principle. Choosing the decision principle. Sufficient Statistics.

Unit 2. Prior Information and Distributions

Subjective probability. Prior information. Subjective determination of the prior density. Non-informative priors. Methods of elicitation of prior distributions.

Unit 3. Posterior Distributions

Definition and determination. Conjugate families. Predictive distributions. Improper priors. The loss function. The posterior means and medians (under loss functions). Variances of univariate and bivariate posterior distributions.

Unit 4. Non-Informative Priors

Definition and concept of non-informative priors. Elicitation of non-informative priors.

Unit 5. Bayesian Inference

Credible regions. Hypothesis testing. Bayes factor. The highest density region. Posterior probability of the hypothesis.

Recommended Books/Reference Material

1. Berger, J.O. (2010). *Statistical decision theory and bayesian analysis*. Springer.
2. Bernardo, J.M., & Smith, A.F.M. (2009). *Bayesian theory*. John Wiley & Sons.
3. Oijen, M.V. (2020). *Bayesian compendium*. Springer.
4. Reich, B.J., & Ghosh, S.K. (2021). *Bayesian statistical methods*. CRC Press.
5. Watanabe, S. (2020). *Mathematical theory of bayesian statistics*. Routledge.

Operations Research

BS-Statistics

Course Code: STA-410

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is to develop the understanding about techniques of operations research. Addition to basic skills and knowledge of operations research, also enables the students to practical application of operations research on industrial data. Furthermore, enables students to use effectively relevant statistical software for data analysis.

Learning Outcomes

- Students will be able to identify and develop operations research models from the verbal description of the real system.
- Students will be able to understand the mathematical tools that are needed to solve optimization problems.
- Students will be able to demonstrate the usage of statistical software for solving problem and analyzing the relevant data.

Course Outline

Unit 1. Introduction of Operation Research

Historical study of operation research. Types of OR models. Linear programming. Methods to solve LP models.

Unit 2. Graphical Methods and Mathematical Computations

Graphical solution of two variables and its standard form. Mathematical computations.

Unit 3. Simplex Method & Duality Theory

The simplex methods. Degeneracy and cycling. Artificial variables. Duality, the dual simplex method. Primal and dual form.

Unit 4. Sensitivity Analysis and Transportation

Sensitivity analysis. Transportation problem. Methods of solving transportation. Assignment problem.

Unit 5. Network Analysis

PERT/ CPM techniques. Queuing models. Methods of solving queuing models.

Recommended Books/Reference Material

1. Bronson, R., & Naadimuthu, G. (1997). *Operations research*, Schaum's Outlines. New York: McGraw Hills.
2. Eiselt, H.A., & Sandblom, C.L. (2022). *Operations research: A model-based approach*. Springer Nature.
3. Gross, D. (2008). *Fundamentals of queueing theory*. John Wiley & Sons.
4. Gupta, P.K., & Hira, D.S. (2022). *Introduction to operations research*. India: S. Chand Publishing.
5. Taha, H.A. (2013). *Operations research: An introduction*. Pearson.

Stochastic Processes

BS-Statistics

Course Code: STA-411

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will learn the ability to analyze certain aspects of these stochastic processes. Furthermore, enables the students to understand the usage of Markov chains in discrete and continuous time.

Learning Outcomes

- Students will be able to 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 Outline

Unit 1. Introduction

Generating functions. Laplace transforms. Differential equations.

Unit 2. Stochastic Processes

Types of stochastic process. Stationary process. Random walk. The random walk in one and two dimensions.

Unit 3. Markov Chains and Processes

Transition probabilities. Classification of states and chains. Markov processes of discrete and continuous state space.

Unit 4. Poisson Process and Renewal Phenomena

Pure birth and death processes. Random process. Wiener process. Diffusion equations for the wiener process. Definition of renewal process and related concepts. Introduction to brownian motion.

Unit 5. Queuing Systems

Queuing processes, poisson arrivals and exponential service time. General service time distributions. Variations and extensions. Basic principle of atomic spectroscopy. Use of atomic spectra for detection and determination of elements. Flame as a source of atomization and excitation. Instrumentation involved in FES. FES applications and limitations.

Recommended Books/Reference Material

2. Durrett, R. (2018). *Essentials of stochastic processes*. Springer.
3. Gall, J.F.L. (2022). *Measure theory, probability, and stochastic processes*. Springer.
4. Kao, E. P. (2019). *An introduction to stochastic processes*. Courier Dover Publications.
5. Pinsky, M., & Karlin, S. (2010). *An introduction to stochastic modeling*. Academic press.
6. Pogorui, A., Swishchuk, A., & Dagnino, R.M. (2021). *Random motions in markov and semi-markov random environments 1: Homogeneous random motions and their applications*. John Wiley & Sons.
7. Ross, S.M. (2006). *Stochastic process*, John Wiley & Sons.

Robust Statistics

BS-Statistics

Course Code: STA-444

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will develop the understanding of both basic and advanced analytical tools for robust models such as multivariate linear regression and estimators. Emphasis on theoretical understanding of concepts as well as the application of key methodologies used in different research fields.

Learning Outcomes

- Students will be able to explain the importance, techniques and biases of estimators in context.
- Students will be able to explain the concept of outliers in regression model and other influential observations.
- Students will be able to construct and interpret various statistical hypothesis tests.

Course Outline

Unit 1. Introduction to Robustness

Objective function. M-estimator of location. E-estimator and its functions. R-estimator and its functions.

Unit 2. M- Estimators and Robust Estimator Influence function

Redescending M-estimators. The breakdown point of robust estimator influence function. M-estimator for scale.

Unit 3. Error and Sensitivity

Gross error sensitivity. Sensitivity analysis. Contaminated normal distribution. Comparisons of usual and robust estimators.

Unit 4. Jackknife Resampling and Simulation

Monte Carlo simulation. Evaluation of breakdown point by simulation.

Unit 5. Outliers and Influential Observations

Introduction of outliers and influential observations. Outlier detections methods. Outliers in regression analysis.

Recommended Books/Reference Material

1. Hampel, F.R., Ronchetti, E.M., Rousseeuw, P.J., & Stahel, W.A. (2011). *Robust statistics: The approach based on influence functions*. John Wiley & Sons.
2. Huber, P.J., & Ronchetti, E.M. (2011). *Robust statistics*. John Wiley & Sons.
3. Jurecková, J., Pícek, J., & Schindler, M. (2021). *Robust statistical methods with R*, (2nd ed.). Routledge.
4. Maronna, R.A., Martin, R.D., Yohai, V.J., & Salibián, B.M. (2019). *Robust statistics: Theory and methods (with R)*. John Wiley and Sons.
5. Wilcox, R.R. (2021). *Introduction to robust estimation and hypothesis testing*. Academic press.

Environmental Statistics

BS-Statistics

Course Code: STA-445

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to introduce students to the fundamental statistical methods required to conduct and interpret statistical analyses in the context of environmental issues and challenges. Students will develop an understanding of key concepts such as measurement, descriptive statistics, graphical techniques, basic probability, correlation, and regression, all of which are essential for analyzing environmental data. In addition, the course aims to provide a solid foundation in inferential statistical methods, including hypothesis testing, the construction of confidence intervals, and the calculation and interpretation of effect sizes, thereby equipping students with the tools to make evidence-based conclusions in environmental science.

Learning Outcomes

- Students will gain a systematic understanding of advanced topics and current developments in statistical theory and methods relevant to environmental data.
- Students will learn to apply statistical techniques to key issues in environmental sciences, with an emphasis on analyzing and quantifying changes in environmental conditions.
- Students will develop a strong conceptual foundation in statistical approaches used in ecology and conservation, including the ability to distinguish among commonly applied methods in these fields.

Course Outlines

- Unit 1. Role of Statistics in Environmental Science**
Significance and application of statistics in addressing environmental challenges. Types of environmental data, sources of variability, uncertainty, and the role of statistical modeling in pollution control, climate studies, and resource management.
- Unit 2. Environmental Sampling and Risk Analysis**
Exploration of various sampling designs relevant to environmental data collection such as random, stratified, systematic, and composite sampling. Risk assessment principles, including exposure analysis and environmental hazard quantification.
- Unit 3. Statistical Methods and Regression in Environmental Studies**
Descriptive statistics, visualization techniques, correlation, and linear regression models for environmental data. Advanced topics include quantile regression and spatial linear regression, focusing on applications in air quality, water contamination, and ecological trends.
- Unit 4. Time Series Analysis and Forecasting**
Introduction to stationary processes, auto-covariances, and spectral analysis of environmental time series. ARMA (Autoregressive Moving Average) models for modeling environmental variables such as temperature, rainfall, and pollution levels.
- Unit 5. Spatial and Censored Data Analysis**
Spatial statistical methods for environmental systems, including interpolation, spatial correlation, and regression. Analysis of censored data, common in detection limits for pollutants.
- Unit 6. Change Point and Non-Stationary Process Analysis**
Statistical methods for detecting structural changes or shifts in environmental processes over time. Change point analysis, non-stationary modeling, and methods for identifying abrupt environmental trends due to natural or anthropogenic influences.
- Unit 7. Statistical Monitoring of Environmental Systems**
Techniques for monitoring and control of environmental processes. Control charts, trend detection methods, and early warning systems for environmental changes.

Recommended Books/ Reference Material

1. Barnett, V. (2005). *Environmental statistics: Methods and applications* (2nd ed.). John Wiley & Sons.
2. Chandler, R., & Scott, M. (2011). *Statistical methods for trend detection and analysis in the environmental sciences*. John Wiley & Sons.
3. Davis, J. (2023). *Introduction to environmental data science*. CRC Press.

4. Dormann, C. (2021). *Environmental data analysis: An introduction with examples in R*. Springer.
5. Manly, B. F. J. (2008). *Statistics for environmental science and management* (2nd ed.). CRC Press.
6. Millard, S. P. (2013). *EnvStats: An R package for environmental statistics*. John Wiley & Sons.

Functional Data Analysis

BS-Statistics

Course Code: STA-446

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces the fundamental concepts and methods of Functional Data Analysis (FDA), where data arise in the form of functions, curves, or trajectories. Students will explore tools for visualizing, smoothing, modeling, and interpreting functional data using basis functions such as splines and Fourier series. The course emphasizes statistical techniques for functional regression, principal component analysis, and clustering. Students will gain hands-on experience with FDA using R software.

Learning Outcomes

- Students will understand and explain the fundamental principles of functional data and distinguish it from traditional multivariate data.
- Students will be able to apply basis function methods (e.g., Splines, Fourier) to represent and smooth functional datasets.
- Students will be able to perform and interpret functional principal component analysis (FPCA) and functional regression models.
- Students will be able to analyze, classify, and cluster functional data using appropriate statistical and computational techniques.

Course Outline

Unit 1. Introduction to Functional Data

Introduction of functional data. Examples from healthcare, finance and environmental studies. Comparison with multivariate data analysis.

Unit 2. Data Representation and Smoothing

Discretization vs. continuous representation. Basis functions: B-splines, fourier, polynomial bases. Smoothing techniques and noise reduction.

Unit 3. Functional Descriptive Statistics

Functional mean, variance, and covariance. Functional boxplots and visualization techniques. Confidence bands for functional data.

- Unit 4. Functional Principal Component Analysis (FPCA)**
Motivation and applications. Eigen functions and variance decomposition. Dimension reduction using FPCA.
- Unit 5. Functional Linear Models, Clustering and Classification**
Functional predictors and scalar responses. Scalar-on-function and function-on-function regression. Parameter estimation and interpretation. Distance measures for functions. Clustering using FPCA scores. Functional discriminant analysis.
- Unit 6. Case Studies and Software Implementation**
Applications using real-world datasets. FDA in R using `fda`, `refund`, and `fdapace` packages. Final mini-project using domain-specific data.

Recommended Books/Reference Material

1. Aneiros, G., Rodríguez-Casal, A.M., & Vieu, P. (2020). *Functional and high-dimensional statistics and related fields*. Springer.
2. Ferraty, J.C. (2020). *Applied functional data analysis: Methods and case studies*. Springer.
3. Ramsay, J.O., Hooker, G., & Graves, S. (2021). *Functional data analysis with R and MATLAB*. Springer.
4. Kokoszka, P., & Reimherr, M. (2021). *Introduction to functional data analysis: Theory and practice*. CRC Press.
5. Ramsay, J.O., & Hooker, G. (2019). *Functional data analysis in medicine and health sciences*. Springer.

12. List of Mandatory Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	INT-499	Internship	Nil	3
2	CP-498	Capstone Project	Nil	3

13. Course Outlines for Mandatory Courses

Internship

BS-Statistics

Course Code: INT-499

Credit Hours: 03

Pre-requisite: Nil

Objectives

The internship course in statistics provides students with a hands-on opportunity to apply theoretical concepts learned in the classroom to real-world settings. Through practical experience, interns gain insights into the functioning of governmental organizations or non-governmental entities. The internship offers a platform for students to develop and enhance critical skills such as research, analysis, and communication, while navigating the complexities of environments. Under the guidance of experienced mentors, interns engage in tasks that contribute to their understanding of statistics for implementation, processes, and analysis. This experiential learning opportunity not only prepares students for future careers but also fosters a deeper appreciation for the practical challenges and nuances of data science. Overall, the internship course serves as a bridge between academic knowledge and real-world applications, equipping students with the practical skills.

Capstone Project

BS-Statistics

Course code: CP-498

Credit hour: 3

Prerequisite: Nil

Objectives

It will enable the student to understand importance and applications of statistics in real life.

Learning Outcomes

A capstone project allows students to bring together the concepts, principles and methods that they have learned in their course of study and to apply their knowledge and acquired competencies to address the real-world problems.

Course Contents

The capstone project (preferably undertaken after the sixth semester) shall be supervised and graded by a faculty member as per the rules prescribed by the university. This shall be a mandatory degree award requirement of 3 credit hours with course code of CP-498 for all students enrolled in the program.

14. List of General Education Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	PAK-103	Ideology and Constitution of Pakistan	Nil	2
2	ENG-110	Functional English	Nil	3
3	MTH-110	Quantitative Reasoning-I	Nil	3
4	ENG-111	Expository Writing	Nil	3
5	ISL-101/ETH-101	Islamic Studies / Ethics	Nil	2
6	STA-112	Quantitative Reasoning-II	Nil	3
7	MGT-108	Entrepreneurship	Nil	2
8	CS-107	Application of Information and Communication Technologies	Nil	2
9	CS-107L	Application of Information and Communication Technologies (Lab)	Nil	1
10	CCE-497	Civic and Community Engagement	Nil	2
11	PAK-104	Pakistan studies	Nil	2
12	UHQ-101/ETH-103	Understanding of Quran - I / Ethics-I	Nil	1
13	UHQ-102/ETH-104	Understanding of Quran - II / Ethics-II	Nil	1
Arts and Humanities Pool Courses				
1	BFA-119	History of Ancient Civilizations	Nil	2
2	BFA-129	Art and Humanities	Nil	2
3	BFA-118	Digital Art	Nil	2
4	BFA-116	Calligraphy	Nil	2
5	BFA-117	Introduction to Painting	Nil	2

6	BFA-120	Photography	Nil	2
7	ENG-218	Creative Writing	Nil	2
Social Sciences Pool Courses				
1	SOC-104	Introduction to Social Sciences	Nil	2
2	ENG-134	Introduction to Linguistics	Nil	2
3	MCM-106	Language, Communication and Power	Nil	2
4	MCM-104	AI in Media	Nil	2
Natural Sciences Pool Courses				
1	SCI-101	Natural Sciences	Nil	2
2	SCI-101L	Natural Sciences (Lab)	Nil	1
3	CS-108	Introduction to Programming	Nil	2
4	CS-108L	Introduction to Programming (Lab)	Nil	1
5	CS-118	Programming Fundamentals	Nil	2
6	CS-118L	Programming Fundamentals (Lab)	Nil	1

15. Course Outlines for General Education Courses

Ideology and Constitution of Pakistan

Course Code: PAK-103

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistan citizens to enable them function in a socially responsible manner.

Learning Outcomes

- Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.
- Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
- Explain about the guiding principles on rights and responsibilities of Pakistani citizens are enshrined in the Constitution of Pakistan 1973.

Course Outline

- Unit 1. Introduction to the Ideology of Pakistan:**
Definition and significance of ideology. Historical context of the creation of Pakistan (with emphasis on socio-political. Religious and cultural dynamics of British India between 1857 till 1947). Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah etc. Contributions of women and students in the freedom movement or separate homeland.
- Unit 2. Two-Nation Theory**
Evolution of the Two-Nation Theory (Urdu-Hindi controversy. Partition of Bengal. Simla Deputation 1906, Allama Iqbal Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940). Role of communalism and religious differences.
- Unit 3. Introduction to the Constitution of Pakistan:**
Definition and importance of a constitution. Ideological factors that shaped the Constitution(s) of Pakistan. Overview of constitutional developments in Pakistan.
- Unit 4. Constitution and State Structure**

Structure of government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. Eighteenth Amendment and its impact of federalism.

Unit 5. Fundamental Rights, Principles of Policy and Responsibilities

Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles R-28). Overview of Principles of Policy (Articles 29-40). Responsibilities of the Pakistani citizen.

Unit 6. Constitutional Amendments

Procedures for amending the Constitution. Notable constitutional amendments and their implications.

Recommended Books/Reference Material

1. Ahmed, A. S. (1997). *Jinnah, Pakistan and Islamic Identity: The Search for Saladin*. Routledge.
2. Aziz, K. K. (2002). *The Making of Pakistan: A Study of Nationalism*. Sang-e-Meel Publishers.
3. Choudhury, G. W. (1969). *Constitution-Making in Pakistan: The Dynamics of Political*. Columbia: University of British.
4. Cohen, S. P. (2004). *The Idea of Pakistan*. Washington: Brookings Institution Press.
5. Hussain, M. (2020). *The Parliament of Pakistan*. London: Oxford University press.
6. Iqbal, J. (2005). *Ideology of Pakistan*. Sang-e-Meel.
7. Jalal, A. (2014). *The Struggle for Pakistan: A Muslim Homeland and Global Politics*. Belknap Press: An Imprint of Harvard University Press.
8. Khan, H. (2020). *Constitutional and Political Development of Pakistan*. London: Oxford University Press.
9. Mahmood, S. (2003). *Pakistan: Political Roots and Development*. Sterling: University of Michigan.
10. Mujahid, S. u. (2001). *Ideology of Pakistan*. Progressive Publishers.
11. Qureshi, I. H. (1965). *The Struggle for Pakistan*. Karachi: University of Karachi Press.
12. Sayeed, K. B. (1960). *Pakistan: The Formative Phase*. London: Oxford University Press
13. Talbot, I. (2015). *Pakistan: A New History*. London: Oxford University Press.
14. *The Constitution of Pakistan 1973*. Original text. Retrieved from website: National Assembly: https://na.gov.pk/uploads/documents/1333523681_951.pdf
15. Ziring, L. (2000). *Pakistan in the Twentieth Century: A Political History*. London: Oxford University Press.

Functional English

Course Code: ENG-110

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and communication aspects including professional writing, public speaking, and everyday conversation. Ensuring that students are equipped in both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.

Learning Outcomes

- Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure
- Comprehend a variety of literary non-literary written and spoken texts in English.
- Effectively express information, ideas and opinions in written and spoken English.
- Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.

Course Outline

Unit 1. Introduction

Ice breaking Activities. Types and modes of Communication. Intrapersonal, Intrapersonal and group Communication.

Unit 2. Rules for Structure of Sentences

Types of sentences on the basis of function (Declarative, Interrogative, Imperative, Exclamatory and structure (simple, compound, complex). Synthesis of sentences. Punctuation and Spellings. Vocabulary, lexical and functional categories.

Unit 3. Concept of Time and Tense (present, past, future)

Discussion: General topics and everyday conversation. Concept of Voice: active and passive voice. Functional use of Voice in different situations.

Unit 4. Direct and Indirect Reporting

Discussion regarding description of things persons, places, pictures, events etc. Salutation & Greeting, Introduction, asking and answering questions.

Unit 5. Practicing Everyday Conversation

Request and Permission, Agreement and Disagreement. Apologizing, Expressing likes and Dislikes, expressing opinion. Expressing approval, Disapproval.

Unit 6. Articulating Expression

Expressing appreciation, regret, and indifference. Expressing certainty, uncertainty, and obligation. Expressing suggestion, warning, Expressing possibility, impossibility & logical conclusion.

Unit 7. Art of Inviting

Accepting, declining invitation. Expressing & inquiring about preferences. Stating intentions and Making Plans. Giving directions. Instructing people how to do things.

Unit 8. Discussing Past and Present

Future prospects. Talking about the past.

Recommended books/ Reference material

1. Azar, B. S. (2003). *Fundamentals of English grammar*. Longman.
2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2010). *Communication: Principles for a lifetime* (p. 483). Boston, MA: Allyn & Bacon.
3. Eastwood, J. (1994). *Oxford guide to English grammar*. Oxford University Press.
4. Floyd, K., & Cardon, P. (2023). *Business and Professional Communication*. McGraw-Hill US Higher Ed USE.)
5. Kortmann, B. (2020). *English linguistics: essentials*. Springer.
6. Langan, J. (2001). *College writing skills with readings*. New York.
7. Murphy, R. (2003). *English grammar in use*. Cambridge: Cambridge University Press.
8. Sharma, Gajendra Dutt (2023) *A Comprehensive Resource Book of Functional English*, OEP, New Delhi.
9. Thomson, A. J., & Martinet, A. V. (2015). *A practical English grammar*. New York: Oxford University Press.
10. Wren, P. C., & Martin, H. (2000). *English grammar and Composition*. New Delhi: S Chand & Company Ltd.

Quantitative Reasoning-I

Course Code: MTH-110

Credit Hours: 03

Pre-requisite: Nil

Objectives

Quantitative Reasoning-I is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics to develop students' abilities to

analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

Learning Outcomes

By the end of this course,

- The students shall have fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately.
- Understanding of fundamental mathematical concepts. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

Course Outline

Unit1. Numerical Literacy

Number system and basic arithmetic operations. Units and their conversions, dimensions, area, perimeter and volume. Rates, ratios, proportions and percentages. Types and sources of data; Measurement scales. Tabular and graphical presentation of data. Quantitative reasoning exercises using number knowledge.

Unit 2. Fundamental Mathematical Concepts

Basics of geometry (lines, angles, circles, polygons etc. Relations, functions, and their graphs. Exponents, factoring and simplifying algebraic expressions. Algebraic and graphical solutions of linear and quadratic equations and inequalities. Quantitative reasoning exercises using fundamental mathematical concepts.

Unit 3. Mathematical Modeling and Analyses

Introduction to deterministic models. Use of linear functions for modeling in real-world situations. Modeling with the system of linear equations and their solutions. Elementary introduction to derivatives in mathematical modeling. Linear and exponential growth and decay models. Quantitative reasoning exercises using mathematical modeling.

Unit 4. Introduction to Logic

Introduction and importance of logic. Inductive, deductive and abductive approaches of reasoning. Propositions, arguments (valid, invalid), logical connectives.

Unit 5. Truth Tables and Logical Reasoning Concepts

Truth tables and propositional equivalences. Logical fallacies. Venn Diagrams. Predicates and quantifiers. Quantitative reasoning exercises using logical reasoning concepts and techniques.

Recommended Books/Reference Material

1. Bennett, J., & Briggs, W.L and Badalamenti. A. (2019). *Using and understanding mathematics: A quantitative reasoning approach*. Pearson.
2. Mesquita, E.B., and Fowler, A. (2021). *Thinking clearly with data: A guide to quantitative reasoning and analysis*. Princeton University Press.
3. Rosen, K. H. (2007). *Discrete mathematics and its applications*. The McGraw Hill Companies.
4. Schröder, B. (2010). *Fundamentals of mathematics*. John Wiley & Sons.
5. Zaslow, E. (2020). *Quantitative reasoning: Thinking in numbers*. Cambridge University Press.

Expository Writing

Course Code: ENG-111

Credit Hours: 03

Pre-requisite: Nil

Objectives

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation building pre-requisite course, Functional English, this course will enhance students' basic skills of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

Learning Outcomes

- Understand the essentials of the writing process integrating pre-working, drafting, editing and proofreading to produce well-structured essays.
- Uphold ethical practices to maintain originality in expository writing.

Course Outline

Unit 1. Introduction to Expository Writing

Understanding expository writing (definition, types, purpose and applications). Characteristics of effective expository writing (clarity, coherence and organization). Introduction to paragraph writing.

Unit 2. The Writing Process

Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.). Drafting (three stage process of drafting techniques). Revising and editing (ensuring correct grammar, Clarity, coherence, conciseness etc.). Proofreading (fine-tuning of the draft). Peer review and feedback (providing and receiving critique).

Unit 3. Essay Organization and Structure

Introduction and hook (engaging readers and introducing the topic). Thesis statement (crafting a clear and focused central idea). Body Paragraphs (topic sentences, supporting evidence and transitional devices). Conclusion (types of concluding paragraphs and leaving an impact). Ensuring cohesion and coherence (creating seamless connections between paragraphs)

Unit 4. Types of Expository Writing

Description, Illustration, Classification. Cause and effect (exploring causal relationships and outcomes). Process analysis (explaining step-by-step procedures). Comparative analysis (analyzing similarities and differences).

Unit 5. Writing for Specific Purposes and Audiences

Different types of purposes (to inform, to analyze, to persuade, to entertain etc.). Writing for academic audiences (formality, objectivity, and academic conventions). Writing for public audiences (engaging, informative and persuasive language). Different tones and styles for specific purposes and audiences.

Unit 6. Ethical Considerations

Ensuring original writing (finding credible sources, evaluating information etc.). Proper citation and referencing (APA, MLA, or other citation styles). Integrating quotes and evidences (quoting, paraphrasing, and summarizing). Avoiding plagiarism (ethical considerations and best practices).

Recommended books/ Reference material

1. Axelrod, R. B., & Cooper, C. R. (2010). *The St. martin's guide to writing*. Macmillan.
2. Faigley, L., Selzer, J., Enoch, J., & Wible, S. (2009). *Good reasons with contemporary arguments*. Pearson Longman.
3. Floyd, K., & Cardon, P. (2023). *Business and professional communication*. McGraw-Hill US Higher Ed USE.
4. Graff, G., Birkenstein, C., & Maxwell, C. (2014). *They say, I say: The moves that matter in academic writing* (p. 245). Gildan Media Corp Book Publisher.
5. Johnson-Sheehan, R., Paine, C., & Paine, C. (2010). *Writing today*. Pearson.
6. Keizer, E. (2015). *A functional discourse grammar for English*. Oxford University Press.
7. Rosenwasser, D., & Stephen, J. (2011). *Writing analytically*. Cengage Learning Press.
8. Straaijer, R. (2018). Modern English usage from Britain to America: Bryan Garner follows Henry Fowler from A Dictionary of Modern American English Usage to Garner's Modern English Usage. *English Today*, 34(4), 39-47.
9. Wachal, R. S. (2000). The Elements of Style, by William Strunk, Jr., and EB White; and A Dictionary of Modern American Usage, by Bryan A. Garner. *American speech*, 75(2), 199-207.
10. Williams, J. M., & Bizup, J. (2022). *Lessons in clarity and grace*. Pearson.

Islamic Studies

Course Code: ISL-101

Credit Hours: 02

Pre-Requisites: Nil

Objectives

Students will be able to demonstrate enhanced knowledge of Islamic Fundamentals, beliefs, practices, historical development, spiritual values and Ethical Principles. Describe Basic sources of Islamic Law and their application in daily life. Also, Identify and discuss contemporary issues being faced by the Muslim world Including Social Challenges, Gender Role and Interfaith dialogue.

Learning Outcomes

- Evaluate and discuss their understanding about the beliefs, history and Ethical values of Islam.
- Be able to apply and relate the Articles of faith in their life according to present world.
- Be able to analyze the importance of Quran and Sunnah in their life and also to refute many relating misconceptions
- Engage in Discussions and write about Contemporary issues specifically related to Women.

Course Outline

Unit 1. Introduction to Islam

Definition of Islam and its core Beliefs (Tawheed, Akhirat and Risalat), Pillars of Islam and their significance (Tawheed, Prayers, Fasting, Zakat & Hajj), The Holy Quran (Introduction, Revelation & Compilation), Sunnah & Hadith (Introduction, Revelation & Compilation).

Unit 2. Seerah of the Holy Prophet pbuh

Life of Prophet pbuh in Makkah, Life of Holy Prophet pbuh in Medina, Diverse roles of Holy Prophet pbuh (individual, leader, peacemaker, educator etc).

Unit 3. Islamic History and Civilization

World before Islam, The Rashidun Caliphate and its expansion, Contributions of Muslim Scientists and Philosophers.

Unit 4. Islamic Jurisprudence

Fundamental sources of Islamic Jurisprudence, Major Schools of Islamic Jurisprudence, Significance & principle of Ijtihad.

Unit 5. Family & Society in Islam

Status and Rights of Women in Islam, Marriage, Family & Gender roles in Muslim Society, Family values and Structure in Muslim Society.

Unit 6. Islam & Modern world

Relevance of Islam in Modern World. (Islamophobia. Interfaith dialogue & Multiculturalism), Islamic viewpoint towards socio-cultural and technological changes.

Recommended Books/Reference Material

1. Ahmed, Dr. A. (1996). *Women & social justice: An islamic paradigm*. The Islamic Foundation UK
2. Ahmed, K. (1971) *Islami nazria e hayat*, Karachi University press.
3. Ahmed, K. (1980). *Islam, Its meaning & message*. The Islamic Foundation UK.
4. Al-Mubarikpuri, M. S. (2002), *Al Raheeq ul Makhtoom (The Sealed Nector)*, Dar ul Salam.
5. Al-Suhaym, Dr. M.B., A. (2006) *Islam, Its foundation & concepts*, Darussalam
6. An Introduction to Islamic Theology by John Renard.
7. Bokhari, A.S, Zafar, M.D., Prof. Shakir, A.S. (2021). *A textbook of Islamic Education*. Akram Printing Press, Lahore.
8. Hussain, M. *The Five Pillars of Islam: A Framework for Islamic Values and Character building*, Kube Publishing, The Islamic Foundation UK
9. Maududi, Abul A. (2008). *Islamic Civilization Foundations, Beliefs & Principles*. Kube Publishing, Islamic Foundation UK
10. Maududi, Abul. A. (2007). *Towards understanding Islam*. The Islamic foundation UK
11. Phillip, Dr. A. A., B. (2018) *Islamic Studies*. International Islamic Publishing House.
12. Prof. Dr. Chaudary, M.N., Prof. Malik, M.A (2022). *Tafheem e Islamiyat*. Qureshi Brothers Publishers, Lahore.

Ethics

Course Code: ETH-101

Credit Hours: 2

Pre-Requisite: Nil

Objectives

Upon successful completion of the course, students will be able to know the basics of ethics & morality and develop ethical approach, identify the concept of ethics in different religions & relate the ethical values with their lives business ethics and journalism ethics etc.

Learning Outcomes

- Students will be able to demonstrate their understanding about the meaning of ethics and morality.
- Analyze the Similarities and Differences between ethical teachings of various religions.
- Develop sense of belongingness to the ethical values as a student, being member of the society etc.

Course Outline

Unit 1. Meaning and Scope of Ethics

Meaning and Definition of Ethics and Morality, Difference between Ethics and Morality, Relation of Ethics with: Religion, Science, Law.

Unit 2. Historical development of Morality

Instinctive Moral Life, Customary Morality. Reflective Morality.

Unit 3. Moral Theories, Moral Ethics and Society

Hedonism (Mill), Intuitionism (Butler), Kant's Moral Theory, Freedom and Responsibility, Tolerance, Justice, Punishment.

Unit 4. Moral Teaching of Major Religions

Judaism, Christianity, Islam, Islam and Minorities.

Unit 5. Professional Ethics

Medical Ethics, Ethics of Student, Ethics of Teacher, Business Ethics.

Recommended Books/ Reference Material

1. R. Shafer-Landau. (2020). *The fundamentals of ethics*. (5th ed.).
2. S. Blackburn. (2021). *Ethics: A very short introduction*. (2nd ed.).
3. S. Liautaud, L. Sweetingham. (2022). *The power of ethics: How to make good choices in a complicated world*.
4. S. M. Cahn, P. Markie. (2019). *Ethics: History, theory, and contemporary issues*. (7th ed.).

Quantitative Reasoning-II

Course Code: STA-112

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis, estimation and testing of hypothesis. It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

Learning Outcomes

- Student will understand the basic statistical concepts and have basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts and equation etc.
- Understand basic quantitative modeling and analyses.
- Ability to critically evaluate quantitative information to make evidence based decision through appropriate statistical tools.

Course Outline

- Unit 1. Introduction of Statistic and Data Condensation**
Types and sources of data. Measurement scales. Population and sample. Tabular and graphical presentation of data. Quantitative reasoning exercises using fundamental statistical concepts.
- Unit 2. Measure of Central Tendency and Dispersion**
Measure of central tendency. Measure of dispersion. Data interpretation. Quantitative reasoning exercises using statistical concepts.
- Unit 3. Probability and Probability Distributions**
Basic probability theory. Rules of counting (multiplicative, permutation, combinations). Introduction to random variables and their probability distributions. Quantitative reasoning exercises using probability theories and distribution concepts.
- Unit 4. Regression and Correlation Analysis**
Introduction to probabilistic models. Bivariate analysis. Scatter plots. Simple linear regression model. Correlation analysis. Quantitative reasoning exercises using statistical modelling.
- Unit 5. Estimation and Testing of Hypothesis**
Basics of estimation and confidence interval. Testing of Hypothesis (z-test; t-test). Statistical inference in decision making. Quantitative reasoning exercises using estimation and Statistical inference concepts and techniques.

Recommended Books/Reference Material

1. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana
3. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson Education.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.

6. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
7. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.
8. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientists*, (6th ed.). New York: Prentice Hall.

Entrepreneurship

Course Code: MGT-108

Credit Hours: 02

Pre-requisite: Nil

Objective

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge, skills, abilities, enabling them to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting a business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business, market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation.

Learning Outcomes

By the end of this course, students shall have:

- Knowledge of fundamental entrepreneurial concepts, skills and process.
- Understanding on different personal, social and financial aspects associated with entrepreneurial activities.
- Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on export businesses;
- Ability to apply knowledge, skills and competencies acquired in the course to develop a feasible business plan.

Course Outline

Unit 1. Introduction to Entrepreneurship

Definition and concept of entrepreneurship. Why to become an entrepreneur? Entrepreneurial process. Role of entrepreneurship in economic development.

Unit 2. Entrepreneurial Skills

Characteristics and qualities of successful entrepreneurs (including stories of successes and failures). Areas of essential entrepreneurial skill and ability such as creative and critical thinking, innovation and risk taking abilities etc.

- Unit 3. Opportunity Recognition and Idea Generation**
Opportunity identification, evaluation and exploitation. Innovative idea generation techniques for entrepreneurial ventures.
- Unit 4. Marketing and Sales**
Target market identification and segmentation. Four P's of Marketing. Developing a marketing strategy. Branding.
- Unit 5. Financial Literacy**
Basic concepts of income, savings and investments. Basic concepts of assets, liabilities and equity. Basic concepts of revenue and expenses. Overview of cash-flows. Overview of banking products including Islamic modes of financing. Sources of funding for startups (angel financing, debt financing, equity financing etc.).
- Unit 6. Team Building for Startups**
Characteristics and features of effective teams. Team building and effective leadership for startups.
- Unit 7. Regulatory Requirements to Establish Enterprises in Pakistan:**
Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.). Intellectual property rights and protection. Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms. Taxation and financial reporting obligation.

Suggested Practical Activities (Optional)

As part of the overall learning requirements, students shall be tasked with creating and presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise shall allow them to apply the knowledge, skills and competencies acquired in the course to develop a feasible business plan.

Recommended Books/ Reference Material

1. Barringer, B. R., & Ireland, R. D. (2016). *Successfully launching new ventures*.
2. Gupta, S. (2020). *Fundamentals of entrepreneurship by Sanjay Gupta (eBook): SBPD Publications*. SBPD publications.
3. Hägg, G., & Kurczewska, A. (2022). *Entrepreneurship education: Scholarly progress and future challenges (p. 101)*. Taylor & Francis.
4. Pruthi, S., & Mitra, J. (2023). *Global entrepreneurship & innovation*. Sage.
5. Ries, E. (2022). *The lean startup: how today's entrepreneurs use continuous innovation to create radically successful businesses*. New York : Crown Business,.
6. Singh, K. K. (2023). *Women entrepreneurship*. Gaurav book center.

Application of Information and Communication Technologies

Course Code: CS-107

Credit Hours: 2

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various DOMAINS in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- **Define** various types and components of computer including input/output devices, memory, storage media.
- **Describe** different types of software from operating systems to system utilities and productivity apps.
- **Describe** the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media.

Course Outline

Unit 1. Technology

Types of Computers, Mobile & Game Devices, Data and Information, The Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy, Health Concerns, Environmental Issues, Programs and Apps, Operating Systems, Applications, Installing and Running Programs, Developing Programs and Apps, Communications and Networks, Wired and Wireless Communications, Networks, Technology Uses, Government, Finance, Retail, Entertainment, Health Care, Science, Travel, Publishing, Manufacturing, Technology Users.

Unit 2. Online Web

The Internet, Websites and Media, The Internet, Evolution of the Internet, connecting to the Internet, Internet Service Providers, How Data Travels the Internet, IP & MAC Addresses and Domain Names, The World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Mobile Computers and Desktops, Laptops, Tab and Other Mobile Computers, Handheld Computers, Desktops and All-in-Ones, Servers, Terminals, Point-of-Sale Terminals, Wearable Devices, Game Devices, Embedded Computers. Inside the Case, The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory, Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

Role of the Operating System, Obtaining Software, Installing Software, Categories of Programs and Apps, Multimedia and Interest Applications, Communications Applications, File, Disk, and System Management Tools.

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure. Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering. What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization. Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended Books/Reference Material

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016). *Shelly cashman series discovering computers & Microsoft office 365 & office 2016: A fundamental combined approach*. Cengage Learning.
2. Hafez, K., Skinner, A., & Grüne, A. (2022). *Foundations of global communication: A conceptual handbook*. Routledge.
3. Hawkrige, D. (2022). *New information technology in education*. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2016). *Managing and using information systems: A strategic approach*. John Wiley & Sons.
5. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). *Managing and using information systems: A strategic approach*. John Wiley & Sons.

Application of Information and Communication Technologies (Lab)

Course Code: CS-107L

Credit Hours: 1

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various DOMAINS in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- **Define** various types and components of computer including input/output devices, memory, storage media.
- **Describe** different types of software from operating systems to system utilities and productivity apps.
- **Describe** the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media.

Course Outline

Unit 1. Technology

Introduction to the lab equipment and SOPs of the labs. Introduction to computer hardware and system information. Introduction to the Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy.

Unit 2. Online Web

IP & MAC Addresses and Domain Names, The World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Inside world: The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory,

Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

File, Disk, and System Management Tools. MS office.

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure. Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering. What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization. Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended Books/Reference Material

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016). *Shelly cashman series discovering computers & Microsoft office 365 & office 2016: A fundamental combined approach*. Cengage Learning.
2. Hafez, K., Skinner, A., & Grüne, A. (2022). *Foundations of global communication: A conceptual handbook*. Routledge.
3. Hawkrigde, D. (2022). *New information technology in education*. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2016). *Managing and using information systems: A strategic approach*. John Wiley & Sons.
5. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). *Managing and using information systems: A strategic approach*. John Wiley & Sons.

Civic and Community Engagement

Course Code: CCE-497

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with fundamental knowledge about civics, citizenship and community engagement. In this course the students will learn about the essential of civil society, government, civic responsibilities, inclusivity and effective ways to participate in shaping the society which will help them apply the theoretical knowledge to the real-world situation to make a positive impact on their communities.

Learning Outcomes

By the end of this course, student will be able to:

- Demonstrate fundamental understanding of civics, government, citizenship and civil society.
- Understand the concept of community and recognize the significance of community engagement for individuals and groups.
- Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence.

Course Outline

Unit 1. Civics and Citizenship

Concepts of civics, citizenship, and civic engagement. Foundations of modern society and citizenship. Types of citizenship: active, participatory, digital etc.

Unit 2. State, Government and Civil Society

Structure and function of government in Pakistan. The relationship between democracy and civil society. Right to vote and importance of political participation and representation.

Unit 3. Rights and Responsibilities

Overview of fundamental rights and liberties of citizens under constitution of Pakistan 1973. Civic responsibilities and duties. Ethical consideration in civic engagement (accountability, non-violence, peaceful dialogue, civility etc.).

Unit 4. Community Engagement

Concept, nature and characteristics of community. Community development and social cohesion. Approaches to effective community engagement. Case studies of successful community driven initiatives.

Unit 5. Advocacy and Activism

Public discourse and public opinion. Role of advocacy in addressing social issues. Social action movements.

Unit 6. Digital Citizenship and Technology

The use of digital platform for civic engagement. Cyber ethics and responsible use of social media. Digital divides and disparities (access, usage, socio-economic, geographic etc.) and their impact on citizenship.

Unit 7. Diversity, Inclusion and Social Justice

Understanding diversity in society (ethnic, cultural, economic, political etc.). Youth, women and minorities engagement in social development. Addressing social inequalities and injustices in Pakistan. Promoting inclusive citizenship and equal rights for social harmony and peaceful co-existence.

Suggested Practical Activities (Optional)

Apart of the overall learning requirements, the course may have one or a combination of the following practical activities

1. **Community Storytelling:** Students can collect and share stories from community members. This could be done through oral histories, interviews or multimedia presentations that captured the lived experiences and perspectives of diverse individuals.
2. **Community Event Planning:** Student can organize a community event or workshop that addresses a specific issue or foster community interaction. This could be a health fair, environmental cleanup, cultural festival or educational workshop
3. **Service Learning:** Student can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time, and skills to address a particular community need, such as tutoring, mentoring or supporting vulnerable population.
4. **Cultural Exchange Activities:** Student can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances and presentations that promote cross cultural understanding.

Recommended Books/Reference Material

1. Džankić, J., & VINK, M. P. (2022). Citizenship & migration.
2. Kymlicka, W. and Norman, W. (2010). *Citizenship in diverse societies*. University Press, United Kingdom.
3. Mackert, J., & Turner, B. S. (2017). The Transformation of citizenship, Volume 2. Boundaries of Inclusion and Exclusion.
4. Mattson, K. (2017). *Digital citizenship in action: Empowering students to engage in online communities*. International Society for Technology in Education, United Kingdom.
5. McGraw-Hill Education, (2009). *Civics today: Citizenship, economics, & you*. United States: Student Edition .
6. Weinstock, D. (2017). Citizenship and cultural diversity. The Oxford Handbook of Citizenship.
7. Youniss, J. and Levine, J. (2009). *Engaging young people in civic life*. Ukraine: Vanderbilt University Press.

Pakistan Studies

Course Code: PAK-104

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical, and cultural dimensions. It delves into the diverse landscapes, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is

to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Learning Outcomes

After studying this course, the student will be able to:

- Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan.
- Understand the society and culture of Pakistan.
- Understand and explain the socio-economic developments in Pakistan.
- Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Course Outline

- Unit 1. Introduction to Pakistan**
Geographical location and significance. Historical background: Ancient civilizations in the region. Factors leading to the creation of Pakistan.
- Unit 2. Political History of Pakistan**
Formative phase. Military interventions and democratic transitions.
- Unit 3. Geography of Pakistan**
Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas. River systems: Indus River and its tributaries. Climatic regions of Pakistan.
- Unit 4. Society and Culture of Pakistan**
Socio-cultural diversity. Languages and literature of Pakistan.
- Unit 5. Economic Development of Pakistan**
Agriculture and industrial sectors of Pakistan. Economic challenges of Pakistan
- Unit 6. Contemporary Issues**
Foreign relations of Pakistan. Security challenges: terrorism, extremism, and regional conflicts. Environmental problems and sustainable development (SDGs). Media and social change.

Recommended Books/Reference Material

1. Burke, S. M. (1973). *Pakistan's foreign policy: An historical analysis*. Oxford University Press.
2. Hayat, S. (2008). *Pakistan studies: A book of readings*. Oxford University Press.
3. Horton, P. B., & Hunt, C. L. (1984). *Sociology* (6th ed.). McGraw-Hill.
4. Husain, I. (2003). *Economic development of Pakistan*. Oxford University Press.
5. Jahangir, U. (2004). *Physical geography of Pakistan*. Caravan Book House.

6. Jalal, A. (1985). *The sole spokesman: Jinnah, the Muslim League, and the demand for Pakistan*. Cambridge University Press.
7. Khan, A. J. (Ed.). (2005). *Pakistan's cultural heritage: Socio-economic and technological aspects*. Lok Virsa Publishing House.
8. Khan, F. K. (2001). *A geography of Pakistan: Environment, people, and economy*. Oxford University Press.
9. Khan, H. (2001). *Constitutional and political history of Pakistan* (2nd ed.). Oxford University Press.
10. Kokab, R. U. (2014). *Separatism in East Pakistan: A study of failed leadership*. Lahore: Fiction House.
11. Qureshi, I. H. (1965). *The struggle for Pakistan*. University of Karachi.
12. Rahman, T. (1996). *Language and politics in Pakistan*. Oxford University Press.
13. Rumi, R. (2016). *Being Pakistani: Society, culture and the arts*. HarperCollins India.
14. Saeed, A., & Sarwar, K. M. (1947). *Trek to Pakistan*. Ferozsons.
15. Sayeed, K. B. (1968). *Pakistan: The formative phase, 1857–1948*. Oxford University Press.
16. Sayeed, K. B. (1980). *Politics in Pakistan: The nature and direction of change*. Praeger.
17. Talbot, I. (2009). *Pakistan: A modern history* (2nd ed.). Hurst & Company.
18. Wolpert, S. (1984). *Jinnah of Pakistan*. Oxford University Press.
19. Zaidi, S. A. (2005). *Issues in Pakistan's economy* (2nd ed.). Oxford University Press.
20. Ziring, L. (1997). *Pakistan in the twentieth century: A political history*. Oxford University Press.

Understanding of Quran-I

Course Code: UHQ-101

Credit Hours: 1

Pre-Requisites: Nil

Objectives

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcomes

This course will enable the students to:

- Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
- Acquire a strong foundation for understanding long verses of the Quran with clarity.
- Comprehend Quranic vocabulary, particles (operative & non operative particles),

- compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plurals through hundreds of Quranic sentences.
- Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
 - Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
 - Understand at least 30 to 40 % of each page of the Holy Quran.

Course Outline

- Unit 1. Simple Quranic Words**
Muallim ul Quran: Book 1: Unit: Lesson 1-19
- Unit 2. Words that Comes Before (The simple Quranic words)**
Muallim ul Quran: Book 1: Unit#2: Lesson 1-13
- Unit 3. Quranic Words in Terms of their Relationship and Characteristics**
Muallim ul Quran: Book 1: Unit#3: Lesson 1-10
- Unit 4. Singular Pronouns**
Muallim ul Quran: Book 2: Unit#4: Lesson 1-17
- Unit 5. Singular pronouns and Demonstrative Pronouns**
Muallim ul Quran: Book 2: Unit#5: Lesson 1-23
- Unit 6. Present Tense**
Muallim ul Quran: Book 3: Unit#6: Lesson 1-5

Recommended Books/ Reference Material

1- بشير، دكتور. عبيد الرحمن - معلم القرآن - اسلام آباد: دار العلم، ٢٠٢٤. جلد ١، ٢ &

Ethics-I

Course Code: ETH-103

Credit hours: 1

Pre-Requisites: Nil

Objectives

Upon successful completion if the course, students will be able to know the basics of ethics, & know how develop Ethical approach. Also Analyze the importance of ethic and Ethical values for a human being. And identify the Semitic & Non-Semitic Religions. Moreover, Develop the concept of Ethics in Semitic & Non-Semitic religions. Also, Analyze the similarities and Differences between Ethical teachings of various religions.

Learning Outcomes

- Students will be able to demonstrate their understanding about the concept of ethics & ethical approach.
- Analyze the difference between the concept of Ethics in Sematic and Non-Sematic religions.

Course Outline

- Unit 1. Introduction and Importance of Ethics and Basic Ethical Principles**
Definition of ethics, importance of ethics, beneficence, non-maleficence, autonomy, justice as basic ethical behaviors.
- Unit 2. Theories of Moral Standards**
Moral standards as law, moral standards as pleasure, moral standards as perfection. (Theories of Various Philosopher such as Kant, Spencer, John S. Mackenzie etc).
- Unit 3. The Concept of Ethics in Major Religions- Christianity, Judaism**
Introduction of the religion, its basic concepts and major ethical teachings.
- Unit 4. The Concept of Ethics in Major Religions- Hinduism and Buddhism**
Introduction of the religion, its basic concepts and major ethical teachings.
- Unit 5. The concept of Ethics in Major Religions- Islam**
Introduction of the religion, its basic concepts and major ethical teachings.

Recommended Books/ Reference Material

Books

1. Davis, N.K. (2023). *Elements of Ethics*, Legare Street Press.
2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). *Introducing Ethics-a Graphic Guide*, Icon Books Ltd.Uk.
5. اخلاق اور فلسفہ اخلاق، سیوہاروی، حفظ الرحمن، ندوۃ المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

Websites & Articles

1. Articles on Ethics www.infotrac-college.com
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7 ,2017 from amacad.org
3. Business Ethics Magazine www.business-ethics.com/annual.htm
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July 2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>

7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics www.gloablethics.org
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). "Philosophical Foundations for Global Journalism Ethics" Journal of Mass Media Ethics:20(1)

Understanding of Quran-II

Course Code: UHQ-102

Credit Hours: 1

Pre-Requisites: Nil

Objectives

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcome

This course will enable the students to:

- Directly comprehend hundreds of Quranic sentences & verses.
- Understand at least 80 to 85 % of each page of the holy Quran.
- Understand common verses across different Quranic topics.
- Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
- Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
- Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Course Outline

Unit 1. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 1: Lesson 1-9

Unit 2. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 2: Lesson 1-7

Unit 3. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 3: Lesson 1-9

Unit 4. Past Tense

Muallim ul Quran: Book 5: Unit#7: Chapter 4: Lesson 1-5

Unit 5. Past Tense and Passive Voice
Muallim ul Quran: Book 5: Unit#7: Chapter 5 – 9

Unit 6. Imperative Verbs for Singulars
Muallim ul Quran: Book 6: Unit#8: Lesson 1-8

Recommended Books/ Reference Material

1- بشير، دكتور. عبید الرحمن - معلم القرآن - اسلام آباد: دار العلم، ۲۰۲۴. جلد ۳، ۴، ۵، ۶

Ethics-II

Course Code: ETH-104

Credit hours: 1

Pre-Requisites: Nil

Objectives

Upon successful completion of the course, students will be able to have better understanding of ethics in various walks of life like in workplace, in business, journalism etc. Moreover, they will be able to be familiarize with Contemporary World's Ethical Issues. And, try to develop answers about them.

Learning Outcomes

- Students will be able to demonstrate their understanding about the importance of ethics in their lives today.
- Identify Contemporary World's Ethical Issues.
- Create problem solving for these contemporary Ethical issues.

Course Outline

Unit 1. Professional Ethics and Bioethics
Meaning of work/professional ethics, professional ethics and human values, elements of professional ethics: person attitude, beliefs about work, positive attributes (honesty, integrity, dedication, commitment, responsibility, and interpersonal relationship) genetic engineering, organ donation, cloning and head transplant.

Unit 2. Ethical Conduct in Business Ethics and its Important
Types of business ethics, common business ethical challenges. Conflict of interest, honesty and integrity, whistle blowing, loyalty vs truth.

Unit 3. Journalism
Principles of ethical journalism: truth and accuracy, independence, fairness & impartiality, humanity and public accountability.

Unit 4. Environmental Ethics

Core principles of environmental ethics: justice & sustainability, sufficiency & compassion, solidarity & public participation, pollution prevention. Current issues of environmental ethics: pollution, the depletion of natural resources, loss of biodiversity, destruction of ecosystem, global climate change.

Unit 5. Social Inequalities

Meaning of social inequalities, issues related to social inequality. Difference in source of income, health care, freedom of speech, gender inequality, toxic workplace culture, education, political representation and participation.

Unit 6. Social Media Ethics

Facebook, YouTube, WhatsApp, Instagram, TikTok, Snapchat, LinkedIn, X. Current ethical issues in social media: plagiarism, fake news, harassment, photo ethics, post without caution, inappropriate behavior privacy.

Recommended Books/ Reference Material**Books**

1. Davis, N.K. (2023). *Elements of Ethics*, Legare Street Press.
2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). *Introducing Ethics-a Graphic Guide*, Icon Books Ltd.Uk.
5. اخلاق اور فلسفہ اخلاق، سیوہاروی، حفظ الرحمن، ندوة المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

Websites & Articles

1. Articles on Ethics www.infotrak-college.com
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7, 2017 from amacad.org
3. Business Ethics Magazine www.business-ethics.com/annual.htm
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July 2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics www.globolethics.org
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). "Philosophical Foundations for Global Journalism Ethics" *Journal of Mass Media Ethics*:20(1)

History of Ancient Civilizations

Course Code: BFA-119

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will compare and analyze how accomplishments made by ancient civilizations during their transition continue to affect our world today. They will also develop understanding about how geography played a crucial role in the development of early civilizations.

Learning Outcomes

- Through understanding, students will be equipped to respect the diversity of contemporary society.
- Upon learning that the environment was a deciding element in the emergence of ancient complex societies, students will be able to realize and uphold a sense of communal, environmental responsibility.

Course Outline

Unit 1. The Aesthetic Evolution of Humanity

Explore the journey from prehistoric expressions to civilized artistic stance through the lens of human aesthetic development. Examine how art defines humanity's unique cultural identity through the anthropology of ornamentation. Study primitive and prehistoric cultural periods and witness humanity's first civilized stance in the Indus Valley. Students will use AI image generation tools to recreate prehistoric cave paintings based on research, then compare their AI-assisted recreations with actual archaeological findings to understand stylistic elements and cultural significance.

Unit 2. Mesopotamian and Egyptian Civilizations

Investigate the artistic foundations of early river valley civilizations, examining how geographic determinism shaped their distinctive artistic expressions. Analyze architectural innovations like ziggurats and pyramids as responses to spiritual needs and environmental conditions. Study hieroglyphics and cuneiform as artistic communication systems. Virtual museum tours enhanced by AI-powered guides that can answer questions about specific artifacts. Students complete an Egyptian-themed pot painting assignment incorporating authentic symbolism identified through AI analysis of historical examples.

Unit 3. Classical Greek Innovations

Examine how Greek geography fostered city-state development and artistic competition. Analyze the evolution of architectural orders, sculptural naturalism, and narrative painting techniques. Explore how Greek aesthetic principles continue to influence contemporary design, architecture, and visual storytelling.

Unit 4. Roman Artistic Achievement and Legacy

Study how Roman engineering and artistic innovations built upon Greek foundations while developing distinctive characteristics. Examine architecture as expressions of imperial power and public infrastructure. Analyze realistic portraiture as political communication and the development of narrative relief sculpture. Students design digital mosaics using AI collaboration tools that suggest color combinations based on authentic Roman palette analysis. The AI assistant provides historical context about mosaic techniques and helps students understand the mathematics behind tesserae arrangement.

Unit 5. Buddhist Art of the Sub-Continent

Investigate how Buddhism's spread created distinctive artistic traditions across diverse geographic regions. Compare architectural and sculptural styles from Sanchi, Bharut, Gandhara, and Ajanta. Analyze how artistic syncretism reflected cultural exchange along trade routes. Examine how Buddhist artistic expressions communicated philosophical concepts across language barriers. Students conduct a study of signs and symbols in Buddhist art, using AI pattern recognition to identify recurring motifs across different regions and time periods. An AI-assisted timeline tool helps visualize how symbols evolved as Buddhism adapted to different cultural contexts.

Recommended Books/Reference Material

1. Blattner. (2012). *World civilizations and cultures*. Mark Twain Media.
2. Brown. (2023). *Indian architecture*. United States: Palmer Press.
3. Edwards. (2023). *Ancient civilizations of history - trivia adventures*.
4. Kleiner, S. (2016). *Gardner's art through the ages*, (15th ed.). United States: Thomson Wadsworth.

Art and Humanities

Course Code: BFA-129

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will develop critical understanding and analysis of art through varied perspectives. They will enhance their knowledge to make informed aesthetic judgments and differentiate between genuine pieces of art and imitations. The course aims to cultivate sensitive perception paired with analytical reasoning about artistic elements.

Learning Outcomes

- Students will develop a systematic understanding of art elements, progressing from basic components (dot, line, shape) to complex compositions enhanced by color.

- Students will acquire the ability to identify and analyze stylistic elements that contribute to artistic individuality.
- Students will demonstrate enhanced perceptual sensitivity paired with logical analysis of artistic components.
- Students will build confidence in making aesthetic judgments based on established critical frameworks.

Course Outline

Unit 1. Foundations of Art Criticism and Appreciation

Explore the distinctions and relationships between criticism, appreciation, and history in approaching artistic works. Examine various forms of artistic expression including visual arts, performing arts, and applied arts with special emphasis on visual arts. Study fundamental frameworks for engaging with art meaningfully and developing a personal critical voice. Students will use AI visual recognition tools to analyze compositional elements in masterworks across different periods, helping them identify critical patterns and approaches used by established art critics throughout history.

Unit 2. The Multi-dimensional Framework of Art Analysis

Investigate the comprehensive framework for art appreciation through six key dimensions: Subject (thematic content), Function (purpose), Medium (materials), Organization (compositional structure), Style (individual expression), and Judgment (critical evaluation). Examine how these dimensions interconnect to create meaningful artistic experiences. Explore varied sources of artistic subject matter including nature, mythology, religion, and history.

Unit 3. Artistic Medium and Technical Execution

Study the intimate relationship between artists and their chosen media, examining how material selection influences artistic expression and technical execution. Analyze how medium-specific techniques develop across artistic movements and how critical judgments must account for medium constraints and possibilities. Students will experiment with AI tools that simulate different artistic media, allowing them to understand technical challenges and expressive possibilities of various materials without requiring specialized studio equipment. They'll compare their AI-generated experimental works with historical examples to deepen their understanding of medium-specific artistry.

Unit 4. Compositional Organization and Visual Elements

Examine diverse organizational plans in visual composition including symmetrical, pyramidal, vertical, and radial arrangements. Analyze how artists create centers of interest and direct viewer attention through strategic organization of visual elements. Study the fundamental elements of visual arts (line, shape, color, texture, space) and principles of design (balance, rhythm, proportion, emphasis). Students will use AI composition analysis tools to create interactive maps of visual flow in masterworks, revealing hidden structural patterns. They'll then apply these insights

to reorganize famous compositions through AI manipulation, exploring how organizational changes impact viewer experience and artistic meaning.

Unit 5. Cultural Contexts and Critical Judgment

Explore the complex relationships between art and broader cultural domains including beauty, religion, nature, history, and conceptual thought. Investigate how artistic styles develop within cultural contexts and reflect historical movements. Examine frameworks for critical judgment based on sincerity, scope, levels of meaning, truth, and magnitude. Students will engage with an AI-powered cultural simulation tool that contextualizes artworks within their original environments, demonstrating how cultural factors influenced artistic decisions. Working with this tool, students will develop critical essays that evaluate artworks through historically appropriate critical frameworks, enhanced by AI-generated visual comparisons that illustrate stylistic evolution across cultures and time periods.

Recommended Books/Reference Material

1. Sporre, D. J. (2015). *Perceiving the arts: An introduction to humanities* (10th ed.). Prentice Hall.
2. Davies, S. (2018). *Definitions of art*. Cornell University Press.
3. Barrett, T. (2023). *Criticizing art: Understanding the contemporary* (4th ed.). Mayfield Publishing.
4. Danto, A. C. (2022). *After the end of art: Contemporary art and the pale of history*. Princeton University Press.

Digital Art

Course Code: BFA-118

Credit Hours: 02

Pre-requisite: Nil

Objectives

This comprehensive course introduces students to essential digital art and design tools, focusing on Adobe Photoshop, Adobe Illustrator and Canva. Students will develop foundational skills in both raster and vector-based design, preparing them to create professional artwork for print and digital platforms. The course emphasizes practical application of art and design principles and incorporates contemporary AI tools to enhance creativity.

Learning Outcomes

- Students will be able to demonstrate proficiency in using relevant softwares
- Apply digital art techniques for both print and interactive media
- Implement effective visual communication strategies through digital media
- Create cohesive brand identities and marketing materials

- Work effectively with both raster and vector graphics
- Solve technical and aesthetic challenges in digital art production
- Explore AI-assisted digital art creation methods

Course Outline

Unit 1. Digital Imaging Foundations

Introduction to Photoshop and Illustrator interfaces; Understanding raster vs. vector graphics; File types and formats for different media; Tool options and interface navigation; Basic selection and transformation techniques; Working with the pen tool for precision vector work; Creating and managing layers. "Style Exploration Lab" - Students will use AI image generation tools to explore various artistic styles, then recreate selected elements manually in Photoshop and Illustrator to understand the underlying techniques.

Unit 2. Digital Composition and Design

Advanced selection techniques; Working with layers and masks in Photoshop; Creating and manipulating vector shapes in Illustrator; Understanding color theory and color modes for digital and print; Typography fundamentals for digital media; Layout principles for effective visual communication. "Composition Assistant" - Students will generate AI-based compositions as inspiration, then analyze the compositional principles at work and create their own refined versions with proper design principles.

Unit 3. Visual Graphics and Branding

Logo design principles and techniques; Creating vector graphics for brand identity; Digital illustration techniques; Building a cohesive visual identity; Preparing files for different media platforms; Managing design assets across applications. "Brand Persona Generator" - Using AI tools to develop brand personality concepts that students will then translate into visual branding elements using Illustrator.

Unit 4. Digital Media Applications

Designing for print versus digital platforms; Creating effective advertisements; Introduction to digital marketing concepts; Social media graphics and assets; Preparing and exporting files for various media; Building a basic portfolio of digital work. "Marketing Mockup Maker" - Students will use AI tools to generate marketing concepts, then develop finished digital media pieces based on the most promising ideas.

Recommended Books/Reference Material

1. Bakhromovna, K. Z. (2023). Innovative process of computer graphics. *European Journal of Innovation in Nonformal Education*, 3(4), 45–49.
2. Cetinic, E., & She, J. (2022). Understanding and creating art with AI: Review and outlook. *ACM Transactions on Multimedia Computing, Communications, and*

- Applications (TOMM)*, 18(2), 1–22. <https://doi.org/10.1145/3490490> (Add DOI if available; example shown)
3. Chaffey, D., & Smith, P. R. (2022). *Digital marketing excellence: Planning, optimizing and integrating online marketing* (6th ed.). Taylor & Francis.
 4. Kelby, S. (2023). *How do I do that in Photoshop?* Rocky Nook.
 5. Pattinson, J. (2018). *A beginner's guide for Adobe Photoshop, Adobe Illustrator, Adobe InDesign basics*. Amazon Digital Services.
 6. Paul, C. (2023). *Digital art* (4th ed.). Thames & Hudson.

Calligraphy

Course Code: BFA-116

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course will develop understanding to the students about fundamental principles, techniques, and tools of calligraphy; to enable them to recognize and differentiate between various calligraphic styles; and to develop an understanding of the historical, cultural, and artistic contexts in which calligraphy has evolved.

Learning Outcomes

- Students will be able to explain the basic principles, techniques, and tools used in calligraphy.
- Students will be able to identify and distinguish between various calligraphic styles.
- Students will identify and interpret historical, cultural and artistic context of calligraphy.

Course Outline

Unit 1. Introduction to Calligraphy

Understanding of the calligraphy history includes its origins, evolution and notable calligraphy styles. To introduce kalam making, other tools and essential materials / supplies i.e. nib pens, ink, paper.

Unit 2. Foundations of Hand Lettering

To develop different letter forms includes basic letter, anatomy and construction, also focus on the in depth Study of individual Alphabet focusing of its proportions, spacing and connection. Understanding about stokes and movement, in-depth study of individual of Alphabet focusing on its proportions, spacing and connection.

Unit 3. Calligraphy Styles and Techniques

A brief introduction of Calligraphic styles, Khat Nastaleeq, Thuluth, Naskh, Diwani, Kufic, Muhaqqaq. Techniques, gilding, illumination and marbelling.

Unit 4. Calligraphic Styles and Techniques: Kufic Style

History, Eastern Kufic, Western Kufic and Floral Kufic.

Unit 5. Calligraphy in Practice

Applying calligraphic skills to real-world projects both manually and digitally by using AI tools (words, logos, signage, verses etc.).

Recommended Books/Reference Material

1. Abi Fares, H. S., & Samir, N. (2023). *Mouneer Al-Shaarani: Against the grain: Exploring the scope of the Arabic letter*. Khatt Books.
2. Akin-Kivanc, E. (2020). *Muthanna / Mirror writing in Islamic calligraphy: History, theory, and aesthetics*. Indiana University Press.
3. Ekhtiar, M. D. (2018). *How to read Islamic calligraphy*. The Metropolitan Museum of Art.
4. Mansour, N. (2017). *Amshaq al-Khatt al-Muhaqqaq*. The Royal Hashemite Documentation Centre.

Introduction to Painting

Course Code: BFA-117

Credit Hours: 02

Pre-requisite: Nil

Objectives

In this course, students will be introduced to the foundational elements of painting, such as shape, form, and composition. They will learn to apply these principles through the study and depiction of still life, natural landscapes, and the human figure. Emphasis will be placed on developing a strong observational practice and translating visual experiences into painted form.

Learning Outcomes

- Students will demonstrate a clear understanding of the basic elements and principles of painting.
- Students will acquire the skills necessary to create original paintings using foundational techniques.
- Students will enhance their ability to keenly observe and interpret their surroundings through visual analysis and artistic expression.

Course Outline

Unit 1. Single Object Observation

In this unit, students will engage in the observation and drawing of single objects, focusing on the accurate balance of space, proportion, light, and shadow on a drawing sheet or canvas. Objects such as fruits, vegetables, and similar items will be used for practice. Additionally, students will develop an understanding of color values by creating paintings of colorful still life compositions. As part of the

coursework, students are required to complete a minimum of two oil paintings on canvas (1 x 1.5 feet each): one featuring vegetables and fruits, and another centered on flowers.

Unit 2. Nature Study

Students will conduct close-up studies of natural subjects, focusing on plants, stems, roots, foliage, and flowers. They will complete 2–3 detailed studies on small-sized canvases (approximately 6 x 6 inches and 1 x 1 foot). In addition, students will explore landscape painting using a variety of mediums, including pastels, watercolors, and oil paints, to further develop their skills in color application, composition, and the depiction of natural environments.

Unit 3. Facial Features Study

In this unit, students will learn to draw and paint individual facial features — including the nose, eyes, lips, and ears — observed under both natural and artificial light conditions. Each feature will be studied separately through close-up renderings on individual canvases. Students are required to complete four separate studies, each on a 6 x 6 inch canvas, focusing on accurately capturing the form, structure, and lighting of each feature.

Unit 4. Mix Media

In this unit students will make paintings by exploring different mediums and texture e.g., defining techniques of painting of old masters like, fresco, tempera or gauche or may merge with contemporary techniques like stamping, wax painting, impressions etc.

Recommended Books/Reference Material

1. Aquin, S., Banz, S., Subotnick, A., & Hyde, M. (2022). *Nicolas Party*. Phaidon.
2. Karnes, A. (2022). *Women painting women*. Modern Art Museum of Fort Worth.
3. Powers, A. (2022). *Painting people in watercolor*. Echo Point Books & Media.
4. Wollheim, R. (2023). *Painting as an art* (Vol. 33). Princeton University Press.

Photography

Course Code: BFA-120

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course will help students to understand camera functionality and technical settings for creative control. Master the principles of light and its role in photography. Develop compositional skills to create visually compelling images. Learn basic post-processing techniques to enhance photographs. Build a foundation for continued growth in photography.

Learning Outcomes

- Students will understand the basics of light and how their eyes perceive light effects.
- Students will capture what they envision through technical camera control.
- Students will master essential camera features and functions.
- Students will produce a beginning portfolio demonstrating technical and creative skills.
- Students will develop basic editing skills to enhance their photographs.

Course Outline

Unit 1. Know Your Camera (6 hours)

Camera Types and Basic Functions. DSLR vs Mirrorless vs Smartphone. Understanding your specific camera model. Essential accessories and equipment. **Exposure Triangle.** Aperture: controlling depth of field (hands-on exercises). Shutter Speed: freezing vs blurring motion (hands-on exercises). ISO: managing sensitivity and noise (hands-on exercises). Exposure compensation and metering modes. **Focus and White Balance.** Auto vs. manual focus techniques. Focus modes and focusing points. Understanding white balance and color temperature. Common camera issues and troubleshooting.

Unit 2. Composition (6 hours)

Core Compositional Principles. Rule of thirds and grid systems. Leading lines and visual flow. Framing and perspective. Symmetry vs. Asymmetry. **Subject and Background.** Depth of field for landscape photography. Filling the frame effectively. Subject isolation techniques. Background considerations and management. **Advanced Composition.** Breaking the rules purposefully. Using negative space. Creating visual balance. Composition exercises across different genres.

Unit 3. Directions of Light (4 hours)

Fundamental Light Directions. Front lighting: characteristics and applications (studio exercises). Side lighting: creating dimension (studio exercises). Top and bottom lighting: mood and drama (studio exercises). Back lighting: silhouettes and rim lighting (studio exercises). **Creative Applications.** Bulb photography and long exposures. Mixed lighting direction techniques. Problem-solving challenging lighting directions. **Digital Workflow Basics.** File formats and management. Organizing and backing up images. Software options (free and paid).

Unit 4. The Quality of Light (4 hours)

Artificial Light Sources. Tungsten lighting characteristics and challenges. Fluorescent lighting techniques. Flash and strobe basics. LED and continuous lighting options. **Natural Light Qualities.** Hard vs. soft light. Diffused light techniques. Reflected light applications. Light modifiers for natural light. Introduce AI image generators (Midjourney, DALL-E) as conceptual tools for photography planning. Assign projects that combine AI-generated concepts with original

photography. **Essential Adjustments.** Exposure, contrast, and brightness. Color correction and white balance. Cropping and straightening. Basic retouching techniques.

Unit 5. Creative Applications of Light (4 hours)

Outdoor Lighting Scenario. Golden hour photography (morning/evening light. Handling harsh midday sun. Overcast and cloudy day techniques. Night and low-light photography basics. **Genre-Specific Lighting.** Portrait lighting fundamentals. Landscape lighting considerations. Street photography lighting challenges. Action and movement photography. **Creative Editing.** Black and white conversions. Vignettes and borders. Export settings for different uses. Before and after analysis.

Recommended Books/Reference Material

1. Parashar, L. G. (n.d.). *Exploring the world through the lens: A journey into photography. Worldwide International Interdisciplinary Research*, 10.
2. Ross, E. S. (2023). *Insects close up: A pictorial guide for the photographer and collector featuring 125 photographs and drawings*. University of California Press.
3. Safori, A., & Ananbey, A. (2023). The photo manipulation from the perspective of photographers: Study from Jordan. *Mutah Journal of Humanities and Social Sciences (MJHSS)*, 38(2).
4. Shaw, M. (2023). *The beginner's guide to astrophotography: How to capture the cosmos with any camera*. Bruce Birnbaum.
5. Stillman, W. (2023). *The amateur's photographic guide book*. BoD–Books on Demand.

Creative Writing

Course code ENG-218

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course provides an opportunity for students to pursue advanced creative writing work. The purpose of this course is three-fold: 1) to engage students in the careful reading and critical analysis of imaginative/creative literature, thus deepening their understanding of the ways writers use language to provide both meaning and pleasure for their readers, 2) to enable students to create works of literature in various genres, including, but not limited to: short story/fiction, creative nonfiction, drama, and poetry, and 3) to prepare students with the reading, analytical, and writing skills necessary for success in this course.

Learning Outcomes

After completion of this course, students will be able to

- Develop the ability to express ideas, emotions, and narratives creatively through various forms of writing.
- Hone language skills, including vocabulary, syntax, and style, to craft compelling and evocative prose and poetry.

- Develop editing skills to refine and polish written work, emphasizing attention to detail and precision in language.
- Explore and develop a distinctive writer's voice and experiment with different narrative perspectives to enhance storytelling techniques.
- Engage in collaborative exercises and discussions to foster a creative community, gaining insights from peers and expanding creative perspectives.

Course Outline

Unit 1. Narrative Writing

Focus on creative fiction. Characteristics of Good Writing. How to raise timeless voices and timeless themes? Use of narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines. Unit culminates in students producing a ten-page original short story/novella.

Unit 2. Poetic Versification

Figurative language, imagery, sensory details, point of view, rhyme, meter. Symbols. Personification. Working with similes. The Magic of Metaphors. Expanding Metaphors. Generating Fresh Imagery.

Unit 3. Memoir and Autobiography

Reflective Writing, literature by doing. Students create a personal memoir of a unique and memorable event or time in their lives.

Unit 4. Literary Critique (Film/Novel review)

Word Choices. Precise language. Poetic forms Adventure story character, setting, plot, style and playwriting.

Recommended Books/Reference Material

1. Dawson, P. (2004). *Creative writing and the new humanities*. Routledge.
2. Demirbaş, İ., & Şahin, A. (2023). The effect of digital stories on primary school students' creative writing skills. *Education and Information Technologies*, 28(7), 7997-8025.
3. Earnshaw, S. (Ed.). (2014). *Handbook of creative writing*. Edinburgh University Press.
4. Harper, G. (2010). *On creative writing* (Vol. 4). Multilingual Matters.
5. Kaufman, S. B., & Kaufman, J. C. (Eds.). (2009). *The psychology of creative writing*. Cambridge University Press.
6. Maitlo, S. K., Soomro, A. R., & Lashari, A. A. (2023). The Impact of Picture Series Learning on the Creative Writing Skills of ESL Learners. *Global Digital & Print Media Review*, VI, 211-223.
7. May, S. (2007). *Doing creative writing*. Routledge.
8. Morley, D. (2007). *The Cambridge introduction to creative writing*. Cambridge University Press.
9. Syrewicz, C. C. (2023). The motivations that improve the creative writing process: what they might be and why we should study them. *New Writing*, 20(2), 178-200.

Introduction to Social Sciences

Course Code: SOC-104

Credit Hours: 02

Pre-requisite: Nil

Objectives

Introduction to Social Sciences offers a comprehensive overview of the various disciplines within social sciences, exploring their origins, scope, methodologies, applications, and interconnectedness. Students will be introduced to anthropology, sociology, psychology, political science, economics, geography, and history, with an emphasis on their relevance to contemporary Pakistani society. The course encourages critical thinking, interdisciplinary understanding, and the application of social sciences in real-world contexts.

Learning Outcomes

Upon completion of this course, students will be able to:

- Understand the origins and development of social sciences as distinct fields of study.
- Recognize the scope, methodologies, and principles of various social science disciplines.
- Analyze social phenomena from interdisciplinary perspectives.
- Apply social science concepts to understand and address issues relevant to Pakistani society.
- Engage in critical discussions, research, and ethical considerations within social sciences.

Course Outline

- Unit 1. Introduction to Social Science**
Definition and importance of social sciences. Historical development and interconnectedness.
- Unit 2. Anthropology**
Scope, methods and key concepts cultural and biological anthropology.
- Unit 3. Sociology**
Origin and scope of sociology, key concepts. Sociological imagination.
- Unit 4. Psychology**
Introduction to psychology and its branches. Human behavior and mental processes.
- Unit 5. Political Science**
Understanding political systems and governance politics and international relations.
- Unit 6. Social Sciences in Pakistani Society**

Application of social sciences in Pakistani context, social issues, policies and cultural insights.

Unit 7. Research Methods in Social Sciences
Quantitative and qualitative research. Research ethics.

Unit 8. Interdisciplinary Approaches and Future Trends
Integration of social science disciplines. Emerging trends and future challenges.

Recommended Books/Reference Material

1. Colander, D., & Hunt, E. (2022). *Social science: An introduction to the study of society*. Routledge.
2. Gerring, J. (2011). *Social science methodology: A unified framework*. Cambridge University Press.
3. Habermas, J. (2015). *On the logic of the social sciences*. John Wiley & Sons.
4. Sharpes D. K. (2009). *The evolution of the social sciences*. Lexington Books.
5. Williams, M. (2012). *Science and social science: An introduction*. Routledge.

Introduction to Linguistics

Course Code: ENG-134

Credit Hours: 02

Pre-requisite: Nil

Objectives

The course aims to provide knowledge of major concepts in language study, give understanding of different areas of micro- and macro linguistics defined by the linguists and introduce students to major branches of linguistics.

Learning Outcomes

- Understand the basic concepts of linguistics.
- Demonstrate their knowledge of different areas of micro- and macro-linguistics.
- Distinguish and define branches of linguistics.

Course Outline

Unit 1. Understanding Language
Features of Language Human Language system vs. Animal Communication.

Unit 2. Theoretical Branches of Linguistics
Phonetics and Phonology. Morphology and Syntax. Semantics and Pragmatics.

Unit 3. Applied Linguistics
Sociolinguistics: Language in Society. Psycholinguistics: Brain and Language Connection.

Unit 4. Discourse Analysis and Stylistics
Conversational Structure and Strategies. Introduction to Stylistics: Analyzing Language in Literature.

Recommended Books/ Reference Material

1. Bruce, M. (2019). *A Concise Introduction to Linguistics*. Routledge.
2. Crystal, D., & Alan, C. L. (Eds.). (2023). *A dictionary of linguistics and phonetics*. John Wiley & Sons.
3. Finch, G. & Peck, J. (2017). *How to study linguistics: A guide to understanding language*. Bloomsbury Publishing.
4. Kortmann, B. (2020). *English linguistics: essentials*. Springer Nature.
5. Strazny, P. (Ed.). (2013). *Encyclopedia of linguistics*. Taylor & Francis.
6. Yule, G. (2022). *The study of language*. Cambridge university press.

Language, Communication and Power

Course code: MCM-106

Credit hours: 02

Pre-requisite: Nil

Course Objectives

This course introduces students to the powerful role that language and communication play in everyday life. It explores how language can influence how we think, how societies are organized, and how power is maintained or challenged through communication. Students will learn how messages in media, politics, education, and social settings can shape identity, reinforce authority, or promote resistance. The course encourages students to think critically about the language they use and encounter in various real-life situations.

Learning Outcomes

By the end of this course, students will be able to recognize how language is used to express power in different social contexts. They will understand how communication influence's identity, authority, and social relationships. Students will learn to identify persuasive techniques in media and public discourse and will be able to reflect on how language can include or exclude individuals and groups. They will also gain basic skills in analyzing everyday texts and conversations to understand how language shapes meaning and power.

Course Outline

- Unit 1. Understanding Language and Power**
What is language? What is power? How language shapes thinking and society?
- Unit 2. Everyday Communication and Influence**
Language in everyday life: compliments, commands, silence, use language to lead, persuade, or resist.
- Unit 3. Language in Media and Advertising**
Words and images in media, headlines, hashtags, and ads influence on buying behavior of people.
- Unit 4. Identity and Language**
How language expresses gender, culture, and identity, stereotypes and labeling in communication.
- Unit 5. Political Language and Public Speech**
Speeches, slogans, and political messages, language of protest and resistance.
- Unit 6. Online Communication and Social Media**
Language in digital spaces: emojis, memes and algorithms.
- Unit 7. Language, Inclusion, and Discrimination**
Biased language, microaggressions and respect.
- Unit 8. Language analysis**
Analysis of a media message or speech (project).

Recommended Books/ Reference Material

1. Bourdieu, P. (1991). *Language and symbolic power*. Harvard University Press.
2. Cameron, D. (2012). *Verbal hygiene*. Routledge.
3. Fairclough, N. (2001). *Language and power* (2nd ed.). Longman.
4. Gee, J. P. (2014). *An introduction to discourse analysis: Theory and method* (4th ed.). Routledge.
5. Lakoff, G. (2004). *Don't think of an elephant! Know your values and frame the debate*. Chelsea Green Publishing.
6. Van Dijk, T. A. (2008). *Discourse and power*. Palgrave Macmillan.
7. Wodak, R., & Meyer, M. (Eds.). (2015). *Methods of critical discourse studies* (3rd ed.). SAGE Publications.

AI in Media

Course code: MCM-106

Credit hours: 02

Pre-requisite: Nil

Objectives

By the end of the course, students will be able to understand the basics of Artificial Intelligence and its role in the media. They will explore real-world applications of AI in journalism, advertising, and entertainment, and analyze how AI impacts media content, audience behavior, and decision-making. Students will also be able to identify ethical concerns related to AI in media and use basic AI tools in media production and content generation.

Learning Outcomes

The students will be able to explain how AI works and its applications in different media fields. They will evaluate how AI changes the way content is created and distributed, and recognize AI-generated content while assessing its credibility. Additionally, students will use AI tools to assist in writing, video editing, and audience analysis. Finally, they will be able to critically discuss the ethical and legal issues surrounding the use of AI in media.

Course Outline

- Unit 1. Introduction to AI**
What is artificial intelligence? Types of AI (Narrow, General, Generative AI), basics of machine learning & deep learning, and Role of AI in the digital age.
- Unit 2. AI and Core Concepts**
Algorithmic media theory, filter bubbles, echo chambers.
- Unit 3. AI in Journalism**
Topics include: automated news writing (robot journalism), fact-checking and fake news detection using AI, and case studies: BBC, Reuters, etc.
- Unit 4. AI in Advertising and Marketing**
Targeted ads using AI, AI in consumer behavior prediction, and chatbots and virtual assistants in advertising.
- Unit 5. AI in Content Creation**
Text, image, and video generation using AI tools, tools like Chatgpt, DALL·E, runway and Impacts on creative professions.
- Unit 6. AI in Film and Entertainment Industry**
AI in scriptwriting and video editing, deepfakes and virtual actors, and AI in animation and computer-generated imagery.

- Unit 7. Audience Engagement and Data Analytics**
Understanding media audiences using AI, personalized content recommendations (Netflix, YouTube) and social media algorithms.
- Unit 8. Ethics, Challenges and Future of AI in Media**
Deepfake dangers and misinformation, AI bias and data privacy, legal and ethical concerns and future trends of AI in Media.

Recommended Books/ Reference Material

1. Broussard, M. (2019). *Artificial unintelligence: How computers misunderstand the world*. MIT Press.
2. Culkin, J., & Hill, R. (2023). *AI and the media: Ethics, practices, and future trends*. Routledge.
3. McStay, A. (2018). *Emotional AI: The rise of empathic media*. SAGE Publications.
4. Napoli, P. M. (2021). *Social media and the public interest: Media regulation in the disinformation age*. Columbia University Press.
5. Newman, N. (2022). *Journalism, fake news & disinformation: A handbook for journalism education*. UNESCO.
6. O'Neil, C. (2016). *Weapons of math destruction: How big data increases inequality and threatens democracy*. Crown Publishing.
7. Russell, S., & Norvig, P. (2020). *Artificial intelligence: A modern approach* (4th ed.). Pearson.
8. Schwab, K. (2017). *The fourth industrial revolution*. World Economic Forum.
9. Sundar, S. S. (Ed.). (2020). *The handbook of the psychology of communication technology*. Wiley-Blackwell.
10. West, D. M. (2018). *The future of work: Robots, AI, and automation*. Brookings Institution Press.

Natural Sciences

Course Code: SCI-101

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is intended to give students a broad understanding of those sub-disciplines that comprise the natural sciences and to provide students with an understanding of the history, philosophy, and social contributions of science.

Learning Outcomes

The students will be able to understand

- Overview of the philosophical background of natural science development
- Survey of historical events that contributed to the development of natural science
- Description and explanation of the main branches of natural science

Course Outline

Unit 1. Introduction to Natural Sciences

Definition and scope, categorization of natural sciences: Physics, Chemistry, Biology, Earth Sciences and Astronomy, interdisciplinary fields and their importance.

Unit 2. Historical Development of Natural Sciences

The scientific method and its evolution. Major historical events that shaped the natural sciences, significant discoveries and their impact on scientific progress, the role of key figures in the advancement of natural sciences.

Unit 3. Main Branches of Natural Science

Detailed exploration of the main branches: Physics, Chemistry, Biology, Earth Sciences and Astronomy. Key concepts and principles in each branch.

Unit 4. Natural Science and Modern Technology

Relationship between natural sciences and technological advancements, Examples of how natural science drives technological innovation, Impact of technology on scientific research and vice versa.

Unit 5. Natural Science in Modern Society

The role and importance of natural sciences in contemporary society, contributions of natural sciences to societal development, public perception and understanding of natural sciences. Science and society interface: major issues at the interface between science, technology and society.

Recommended Books/Reference Material:

1. Brush, S.G. (1988). *The History of Modern Science: A Guide to the Second Scientific Revolution, 1800-1950*. Iowa State University Press.
2. Bryson, B. (2003). *A Short History of Nearly Everything*. Broadway Books.
3. Cantor, G.N., Christie, J.R.R., Hodge, M.J.S., & Olby, R.C. (Eds.). (2006). *Companion to the History of Modern Science*. Taylor & Francis.
4. Cohen, H.F. (2010). *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*. Amsterdam University Press.
5. Gal, O. (2021). *The Origins of Modern Science: From Antiquity to the Scientific Revolution*. Cambridge University Press.

6. Kuhn, T.S. (1970). *The Structure of Scientific Revolutions*. University of Chicago Press.
7. Zilsel, E., & Zilsel, P. (2013). *The Social Origins of Modern Science*. Springer Netherlands.

Natural Sciences (Lab)

Course Code: SCI-101L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course is intended to give students a broad understanding of those sub-disciplines that comprise the natural sciences and to provide students with an understanding of the history, philosophy, and social contributions of science.

Learning Outcomes

The students will be able to understand

- Overview of the philosophical background of natural science development
- Survey of historical events that contributed to the development of natural science
- Description and explanation of the main branches of natural science.

Course Outline

- Lab rules, PPE use, emergency protocols
- Using balances, rulers, thermometers, graduated cylinders
- pH testing using indicators and pH meter
- Introduction to microscope, viewing plant/animal cells
- Test water turbidity, color, smell, pH
- Use of vernier caliper and screw gauge

Introduction to Programming

Course Code: CS-108

Credit Hours: 2

Pre-requisite: Nil

Objectives

- Computer, its programming languages and its applications in daily life, studies and industries.
- Visual studio tools like compiler, execution C++ etc.
- Latest trends and applications in the field of computing.

Learning Outcomes

Students will learn programming languages and its applications in daily life, studies and industries. Hands on experience of different C/C++ constructs Basic syntax of C/C++.

Course Outline

Unit 1. Introduction

Introduction to operating system, functions and uses of operating system. Introduction to programming, programming tools. Introduction to C++. Intro to tools of C++.

Unit 2. Basics of C++ & Error Handling, Functions

Getting started with C, computer program engineering, and basic structure of C++, components of C++, errors and its types, error handling. Function (prototype, declaration, calling, function body), user & system defined functions, Why use functions, parameters, arguments, passing values between functions, Scope rule of functions, advanced features of functions, call by value and call by reference.

Unit 3. Data Types & Variables Declaration, Strings

Variables initialization, data types in C++, operators, uses of escape sequences, comments, what are strings, more about string.

Unit 4. Loops and Arrays

What are arrays, array initialization, bounds checking, passing array elements to functions, passing an entire array to a function, more the one dimension, initializing A2-Dimensional array, memory map of 2-Demensional array, and three dimensional arrays. Loop (For, While), loop (Do While), nested loops, Arrays (Linear Array), array 2D. Introduction to functions, implementation of functions and structures.

Unit 6. Exception & File Handling

Exception handling, introduction to filing, file handling , files, types of disk I/O, standard input/output, binary mode and text mode and record input/out.

Recommended Books/Reference Material

1. Hanly, J. R., & Koffman, E. B. (2012). *Problem Solving and Program Design in C* (7th ed.). Pearson.
2. Gaddis, T. (2017). *Starting Out with C++ from Control Structures to Objects* (9th ed.). Pearson.
3. Kernighan, B. W., & Ritchie, D. M. (1988). *The C Programming Language* (2nd ed.). Pearson.

Introduction to Programming (Lab)

Course Code: CS-108L

Credit Hours: 1

Pre-requisite: Nil

Objectives

- Computer, its programming languages and its applications in daily life, studies and industries.
- Visual studio tools like compiler, execution C++ etc.
Latest trends and applications in the field of computing.

Learning Outcomes

Students will learn programming languages and its applications in daily life, studies and industries. Hands on experience of different C/C++ constructs basic syntax of C/C++.

Course Outline

Unit 1. Introduction to Programming Tools

Installation of programming tool, configuration, programming syntax, variable declaration and initialization.

Unit 2. Basics of C++ and Functions

variables, data type , operators, uses of escape sequences, function, user and system defined functions, parameters, arguments, passing values between functions, call by value and call by reference, recursion and fibonacci series.

Unit 3. Conditional Statements

If statement, multiple statements within if, if-else statement, nested if-else's), conditional structure (if, if else), if-else-if, switch statement.

Unit 4. Loops and Arrays

Loops structure (while, do while, for loop), break statement, continue statement, goto statement, case control structure, decisions using switch, linear array, array initialization, passing array elements to functions. Passing an entire array to a function, more the one dimension, initializing a 2-dimensional array, three dimensional arrays.

Unit 6. Pointers, Exception and File Handling

Pointer and array, pointers and strings, double indirection, pointers to pointers. Exception handling, file handling, files, standard input/output, binary mode and text mode, record input/out.

Recommended Books/Reference Material

1. Hanly, J. R., & Koffman, E. B. (2012). *Problem Solving and Program Design in C* (7th ed.). Pearson.

2. Gaddis, T. (2017). *Starting Out with C++ from Control Structures to Objects* (9th ed.). Pearson.
3. Kernighan, B. W., & Ritchie, D. M. (1988). *The C Programming Language* (2nd ed.). Pearson.

Programming Fundamentals

Course Code: CS-118

Credit Hours: 02

Pre-requisite: Nil

Objectives

The objective of course is to introduce a disciplined approach to Problem solving methods and algorithm development. The aim is to teach the syntax and vocabulary of a modern programming language like C++. The significant philosophies and logical programming, including models or I/O, processing, and all related terminology will be taught. Simple programs will be constructed, using a number of different logical, calculation and algorithm.

Learning Outcomes

- Understand fundamental concepts of structured programming along with problem solving techniques and analytical thinking.
- Analyze problem requirements to recognize what type of data and processes are involved in solution.
- Apply basic concepts to alter and expand short programs and algorithms. Writing pseudo-codes and simple program development using standard control structures and functions.
- Design module-based approach to gratify those requirements, and organize program code for implementation.

Course Outline

Unit 1. Introduction, Declarations, Control Structures

Analyzing, implementation, testing and debugging, Object oriented programming languages, What is C, Getting Started with C, Computer Program Engineering, Decision Control structure (if statement, Multiple Statements within if, if-else statement, Nested if-else's), logical operators Hierarchy and conditional operators.

Unit 2. Loops, Statements, Functions

Loops structure (while, do while, for loop), break statement, continue statement, goto statement, case control structure, Decisions using switch, Function (prototype, declaration, calling, function body), User & system defined functions, Why use functions, Parameters, arguments, Passing values between functions, Scope rule of functions, Advanced features of functions, Call by value and call by reference, Recursion , Fibonacci series, Recursion vs. iteration.

Unit 3. Arrays & Pointers

What are arrays, Array initialization, Bounds checking, Passing array elements to functions, Passing an entire array to a function, More the one dimension, Initializing A 2-Dimensional array, Memory map of 2-Dimensional array, Three Dimensional arrays, puppeting on string, What are strings, More about string., Pointers overview, Return data from function, Pointer and array, Pointers and strings, Double indirection ,Pointers to pointers , Pointer and array, Pointers and strings, Double indirection.

Unit 4. Searching and Sorting

Searching Algorithms, Sorting Algorithms, Graphics in C.

Unit 5. Structures & File Handling

Why use structures, Declaring a structures, Accessing structures elements, How structures elements are stored, Array of structures, Additional features of structures, Uses of structures, Unions, Unions of structures, Structures and pointers, Files, Types of Disk I/O, Standard Input/output, Binary Mode and Text Mode, Record Input/Out, Random access, Error condition, System-level Input/output.

Recommended Books/Reference Material

1. Bin Uzayr, S. (2022). Mastering C++ Programming Language: A Beginner's Guide. CRC Press.
2. Deitel, H., & Deitel, P. C. (2021). How to program. Pearson.
3. Deitel, P., & Deitel, H. (2022). C++ 20 for Programmers: An Objects-Natural Approach. Pearson.
4. Doyle, B. (2014). C# Programming: from problem analysis to program design. Cengage Learning.
5. Gaddis, T. (2008). Starting Out with Programming Logic and Design, 2/e. Pearson Education India.
6. Gregoire, M. (2021). Professional C++. John Wiley & Sons.
7. Hanly, J. R., & Koffman, E. B. (2007). Problem solving and program design in C. Pearson Education India.
8. Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.

Programming Fundamentals (Lab)

Course Code: CS-118L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course helps the students to understand basic knowledge of visual studio and computer programs and capable of designing different C language programs and flowcharts.

Learning Outcomes

- **Implement** fundamental knowledge and understanding of computer programming using C Language program constructs .
- **Demonstrate** the use of software tool, Microsoft Visual Studio for program development in C Language .
- **Apply** the knowledge of C programming to develop small-to-moderate scale software applications and use Visual Studio software tool for program testing and debugging .
- **Execute** module-based approach to gratify those requirements, and organize program code for implementation .

Course Outline

Unit 1. Introduction to Framework

Installation of visual studio, Variable Declaration and Initialization, Programming Syntax, Decision Control structure (if statement, Multiple Statements within if, if-else statement, Nested if-else's).

Unit 2. Loops, Statements, Functions

Loops structure (while, do while, for loop), break statement, continue statement, goto statement, case control structure, Decisions using switch, Function, User & system defined functions, Parameters, arguments, Passing values between functions, Call by value and call by reference, Recursion , Fibonacci series.

Unit 3. Arrays & Pointers

Array initialization, Bounds checking, Passing array elements to functions, Passing an entire array to a function, More the one dimension, Initializing A 2-Dimensional array, Three Dimensional arrays, Puppeting on string, Return data from function, Pointer and array, Pointers and strings, Double indirection, Pointers to pointers.

Unit 4. Searching and Sorting

Searching Algorithms, Sorting Algorithms, Graphics in C.

Unit 5. Structures & File Handling

Declaring a structures, Accessing structures elements, How structures elements are stored, Array of structures, Uses of structures, Unions, Unions of structures, Structures and pointers, Files, Standard Input/output, Binary Mode and Text Mode, Record Input/Out.

Recommended Books/Reference Material

1. Bin Uzayr, S. (2022). Mastering C++ Programming Language: A Beginner's Guide. CRC Press.
2. Deitel, P., & Deitel, H. (2022). C++ 20 for Programmers: An Objects-Natural Approach. Pearson.

3. Doyle, B. (2014). C# Programming: from problem analysis to program design. Cengage Learning.
4. Gaddis, T. (2008). Starting Out with Programming Logic and Design, 2/e. Pearson Education India.
5. Gregoire, M. (2021). Professional C++. John Wiley & Sons.
6. Hanly, J. R., & Koffman, E. B. (2007). Problem solving and program design in C. Pearson Education India.
7. Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.
8. Weisfeld, M. (2008). The object-oriented thought process. Pearson Education.
9. Wu, C. T. (2006). An Introduction to object-oriented programming with Java TM. McGraw-Hill Incorporated.

16. List of Interdisciplinary /Allied Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	MTH-121	Calculus-I	Nil	3
2	MTH-122	Calculus-II	MTH-121	3
3	MTH-104	Calculus and Analytical Geometry	Nil	3
4	MTH-311	Linear Algebra	Nil	3
5	MTH-207	Software Packages	Nil	2
6	MTH-207L	Software Packages (Lab)	Nil	1
7	CS-114	Database Management Systems and Applications	Nil	2
8	CS-114L	Database Management Systems and Applications (Lab)	Nil	1
9	IT-311	Cyber Security	Nil	2
10	IT-311	Cyber Security	Nil	1
11	CS-406	Cloud Computing	Nil	3
12	CS-115	Introduction to Artificial Intelligence	Nil	2
13	CS-115L	Introduction to Artificial Intelligence (Lab)	Nil	1

17. Course Outlines for Interdisciplinary /Allied Courses

Calculus-I

Course Code: MTH-121

Credit Hours: 03

Pre-requisite: Nil

Objectives

Calculus serves as the foundation of advanced subjects in all areas of mathematics. This is the first course of Calculus. The objective of this course is to introduce students to the fundamental concepts of limit, continuity, differential and integral calculus of functions of one variable.

Learning Outcomes

- The students will be able to understand the concepts of limit and continuity and calculate derivatives.
- The students will be able to identify the concept of integration.

Course Outline

Unit 1. Preliminaries

Solving linear and quadratic equations, division of polynomials, synthetic division, roots of polynomials, Viète relations descartes rule of signs, solving linear inequalities, linear and nonlinear inequalities with absolute value, domain and range of a function, examples: polynomial, rational, piecewise defined functions, absolute value functions. sum, product, quotient and compositions, graphs of functions: linear, quadratic, piecewise functions. Equation of a straight-line slope and intercept of a line, parallel and perpendicular lines. Solution of system of linear equations. Nonlinear systems, at least one quadratic equation.

Unit 2. Limits and Continuity

Limit of a function, graphical approach, properties and theorems of limits, limits of polynomials and rational and transcendental functions, limits at infinity, infinite limits, one-sided limits, continuity.

Unit 3. Derivatives

The derivative as a function, the derivative as a rate of change, derivatives of products, quotients and negative powers, derivatives of trigonometric, polynomials, rational, exponential, logarithmic functions, chain Rule, implicit differentiation, higher derivatives, Leibnitz theorem.

Unit 4. Applications of Derivatives

Increasing and decreasing functions, first derivative test, convexity and point of inflection, the second derivative test, inverse of functions and their derivatives.

Unit 5. Integration

Riemann sums and the definite integral, properties of integral, the fundamental theorem of calculus, the substitution rules.

Recommended Books/Reference Material

1. Anton, H. Bivens, I.C., and Davis, S. (2021). *Calculus*. John Wiley & Sons.
2. Ayres, F., and Mendelson, E. (2009). *Calculus*. Schaum's outlines.
3. Hughes-Hallett, D., Gleason, A.M., and McCallum, W.G. (2020). *Calculus: single and multivariable*. John Wiley & Sons.
4. Stewart, J., Clegg, D.K., and Watson, S. (2020). *Calculus: early transcendentals*. Cengage Learning.
5. Thomas, G. B., Finney, R. L., Weir, M. D., & Giordano, F. R. (2003). *Thomas' calculus*. Reading: Addison-Wesley.

Calculus-II

Course Code: MTH-122

Pre-requisite: MTH-121

Credit Hours: 03

Objectives

This is second course of Calculus. As a continuation of Calculus-I, it focuses on techniques of integration and applications of integrals. The course also aims at introducing the students to infinite series, parametric curves and polar coordinates.

Learning Outcomes

Upon successful completion of this course;

- The students will be able to learn integration techniques,
- They will be able to understand conic sections and polar curves also be able to test convergence and divergence.

Course Outline

Unit 1. Techniques of Integration

Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts, substitution. Integration by partial fractions. Improper Integrals, gamma functions.

Unit 2. Applications of Integrals

Area between curves, average value. Volume. Area of a surface of revolution. Arc length. Applications to Economics, Physics, Engineering and Biology.

Unit 3. Infinite Series

Sequences and series. Convergence and absolute convergence. Divergence test, integral test, p-series test, comparison test, limit comparison test, alternating series

test, ratio test., root test. Power series, convergence of power series. Taylor and Maclaurin's series approximations by Taylor polynomials.

Unit 4. Conic Sections, Parametrized Curves

Curves defined by parametric equations. Calculus with parametric curves. Tangent, areas, arc length.

Unit 5. Polar Coordinates

Polar Curves. Tangents to polar curves. Areas and arc length in polar coordinates.

Recommended Books/Reference Material

1. Anton, H., Bivens, I. C., Davis, S. (2022). *Calculus: Single variable*. John Wiley & Sons.
2. Fehribach, J. D. (2023). *Sequences and series in calculus*. Germany: De Gruyter.
3. HughesHallett, D., Gleason, A. M., McCallum, W. G. (2020). *Calculus: Single and multivariable*. John Wiley & Sons.
4. Stewart, J., Clegg, D.K., and Watson, S. (2020). *Calculus: Early transcendentals*. Cengage Learning.
5. Thomas, G. B., Finney, R. L., Weir, M. D., & Giordano, F. R. (2003). *Thomas' calculus*. Reading: Addison-Wesley.

Linear Algebra

Course Code MTH-311

Credit Hours 03

Prerequisite Nil

Objectives

Linear algebra is the study of vector spaces and linear transformations. The main objective of this course is to help students learn in a rigorous manner, the tools, and methods essential for studying the solution spaces of problems in mathematics, engineering, the natural sciences, and social sciences and develop mathematical skills needed to apply these to the problems arising within their field of study and to various real-world problems.

Learning Outcomes

By the end of this course, students will be able to:

- Understand the theory of matrices, vector spaces and linear transformations.
- Apply linear algebra techniques to solve systems of linear equations.
- Analyze eigenvalues, eigenvectors, and their applications in various fields, including machine learning.

Course Outline

Unit 1. Matrices and its Solutions

Matrices. Operation on matrices. Echelon and reduced echelon form. Inverse linear system. Gaussian elimination. Determinants of a matrix, computing higher order determinants.

Unit 2. Vector Space

Vector spaces, subspaces, linear combination and spanning set. Linear dependence and independence. Finite dimensional vector spaces, bases and dimension of a vector space. Operations on subspaces, intersections and sums.

Unit 3. Transformations

Linear transformations, kernel and image of a linear transformation. Isomorphism and composition. Matrix of a linear map, change of basis, invariant subspaces and direct sums.

Unit 4. Eigen Values and Eigen Vectors

Eigenvalues, Eigen vectors, diagonalization, and orthogonal diagonalization.

Unit 5. Inner Product Spaces

Inner product spaces, norms and Cauchy inequality.

Recommended Books/Reference Material

1. Shapiro, H. (2015). *Linear algebra and matrices*. AMS, Providence, Rhode Island.
2. Strang, G. (2022). *Introduction to linear algebra*. Wellesley-Cambridge Press.
3. Aggarwal, C.C., Aggarwal, L.F., and Lagerstrom-Fife. (2020). *Linear algebra and optimization for machine learning*. Springer.
4. Hill, R. O. (2014). *Elementary linear algebra*. Academic Press.
5. W. K. Nicholson, (2021), *Linear algebra with applications*. Lyryx Learning Inc.

Software Packages

Course Code: MTH-207

Pre-Requisites: Nil

Credit Hours 02

Objectives

The purpose of this course is to teach students the use of mathematical software like MATLAB and MATHEMATICA for solving computationally-difficult problems in mathematics. The student shall become well versed in using at least one mathematical software and shall learn a number of techniques that are useful in calculus as well as in other areas of mathematics.

Learning Outcomes

- The students must be able to utilize the software to solve computationally difficult problems in calculus and other areas of mathematics at the end of the course.
- The students will be able to learn the application tools of software.

Course Outline

Unit 1. Basics in MATLAB and Arrays

MATLAB environment, arithmetic operations, display formats, built-in functions. Defining scalar variables, commands for managing variables, write and save script files, creating vectors and matrices, transpose operator, array addressing, colon, adding deleting array elements.

Unit 2. Mathematical Operations and Script Files

Addition, subtraction, multiplication, division of arrays, element by element operations, random numbers generation. MATLAB applications examples, output commands, save and load commands, integration, derivation, summation of finite series, equation solving, polynomial commands roots etc.

Unit 3. Two Dimensional Plots and User-Defined Functions

Lot command, f-plot command, multiple plots in same graph, formatting plots, histograms, polar plots, multiple figure window, creating function file, structure of function file, saving function file, user-defined function use. Anonymous functions, sub functions.

Unit 4. Loops

Relational and logical operators, conditional statements, the switch case statement, loops nested loops.

Unit 5. Mathematica

Running Mathematica and numerical calculations, Algebraic Calculations, equation solving, integration, derivation, summation of finite series.

Recommended Books/Reference Material

1. Lee, H. (2021). *Programming and engineering computing with MATLAB*. Canada: SDC Publications.
2. Maftunzada, S. A. L. (2023). *Splines interpolation analysis using Maple package*. Advanced Technologies and Computer Science, (1), 4-9.
3. Nomura, S. (2022). *Complex variables for engineers with Mathematica*. Springer.
4. Villalobos Alva, J. (2021). *Beginning Mathematica and wolfram for data science: Applications in data analysis, machine learning, and neural networks*. United States: Apress.
5. Villalobos Alva, J., & Villalobos Alva, J. (2021). Introduction to Mathematica. *Beginning Mathematica and Wolfram for Data Science: Applications in Data Analysis, Machine Learning, and Neural Networks*, 1-43.

Software Packages (Lab)

Course Code: MTH-207L

Pre-Requisites: Nil

Credit Hours: 01

Objectives

The purpose of this course is to teach students the use of mathematical software like MATLAB and MATHEMATICA for solving computationally-difficult problems in mathematics. The student shall become well versed in using at least one mathematical software and shall learn a number of techniques that are useful in calculus as well as in other areas of mathematics.

Learning Outcomes

The students must be able to use MATLAB in different areas of mathematics at the end of this course.

Course Outline

Unit 1. Introduction to MATLAB

Creating and saving script file. MATLAB syntax. Variable declaration and initialization. Creating vectors and matrices. Variables, Data type. Arithmetic operations.

Unit 2. Mathematical Operations

Arithmetic operation with arrays. Random number generation. Function. User and system defined functions. Sub functions. Parameters, arguments. Passing values between functions. Call by value and call by reference. Integration and Differentiation. Summation of series. Quadratic equation solution.

Unit 3. Conditional Statements

If statement. Multiple Statements within if. if-else statement, Nested if-else's). Conditional Structure (if, if else). if-else-if, switch statement.

Unit 4. Loops

Loop's structure (while, do while, for loop). break statement continue statement. goto statement. case control structure. Decisions using switch.

Unit 5. Two Dimensional Plots

Plot generation. Polar plots. Histogram formation. Using plot tools.

Unit 6. Mathematica

Numerical calculations. Algebraic calculations. Integration and differentiation. Summation of finite series. Solution of equations.

Recommended Books/Reference Material

2. Lee, H. (2021). *Programming and engineering computing with MATLAB 2021*. Canada: SDC Publications.
3. Maftunzada, S. A. L. (2023). Splines interpolation analysis using Maple package. *Advanced Technologies and Computer Science*, (1), 4-9.
4. Nomura, S. (2022). *Complex variables for engineers with Mathematica*. Switzerland: Springer.
5. Villalobos Alva, J., & Villalobos Alva, J. (2021). Introduction to Mathematica. *Beginning Mathematica and Wolfram for Data Science: Applications in Data Analysis, Machine Learning, and Neural Networks*, 1-43.
6. Villalobos Alva, J. (2021). *Beginning Mathematica and wolfram for data science: applications in data analysis, machine learning, and neural networks*. United States: Apress.

Database Management Systems and Applications

Course Code: CS-114

Credit Hours: 02

Pre-requisite: Nil

Objectives

This module introduces the basic concepts of databases and database management systems. Help students understand benefits that can be attained by using both Relational Database Management System and NoSQL. It Enable students to become comfortable in designing databases and schemas, plus writing both simple and complex queries (SQL and XPath) to manipulate database.

Learning Outcomes

- **Explain** fundamental database concepts.
- **Design** conceptual, logical and physical database schemas using various data models.
- **Identify** functional dependencies & resolve database anomalies by normalizing database tables.

Course Outline

Unit 1. Introduction to Database Approach, Database System Models

Data, Processing & Information, The Role of Data in Business, Meta Data & Meta Meta Data, The Database , Evaluation of Database, Types of Files, Traditional File Processing Systems, Database Approach, Advantages & Disadvantages, Components of the DBMS Environment, Centralized Database, Personal Computer Database, Client/Server database, Distributed Database, Teleprocessing, Concept and Evaluation Of Database Models, Flat file Model, Hierarchical model, Network Model, Relational Model, Object Relational Model, Object Based data Model, ANSI-SPARC Architecture: External Level, Conceptual Level, Internal Level.

Unit 2. Database Design Fact Finding Techniques

Data Modeling, Phases of Database Design, DBMS Selection, Implementation, Testing, Data Administration & Database Administration, Data Administration, Database Administration, Comparison, Database Analysis, Uses of Fact-Finding Techniques, Fact Finding Techniques, Examining Documentation, Interviewing, Observation, Research, Questionnaires, A worked Example, Logical Design, Conceptual Database Design, Introduction to Entity-Relational model, Relationship Types: Degree of Relationship Type.

Unit 3. Specialization/Generalization for EERD

Simple & Composite Attributes, Single Valued & Multi-Valued Attributes, Derived Attributes, Keys, Strong & Weak Entity Types, Attributes on Relationships, Cardinality and Participation Constraint, Super Classes & Sub Classes, Super Class / Sub Class Relationships, Attributes Inheritance, Specialization Process, Generalization Process, Constraints on, Specialization/Generalization, Aggregation, Composition, Normalization: First Normal Form, Second Normal Form: Full Functional Dependency, Third Normal Form: Transitive Dependency, Boyce-Codd Normal Form, Fourth Normal Form, Multi-valued Dependency, Fifth Normal Form (5 NF), Lossless-Join Dependency.

Unit 4. Data Integrity and Overview of SQL

Types of Data integrity (Entity Integrity, Domain Integrity, Referential Integrity, User-defined Integrity), Constraints (PRIMARY KEY Constraint, UNIQUE Constraint, IDENTITY Property, DEFAULT Definition, FOREIGN Key Constraint, CHECK Constraint).

Unit 5. Transaction Management, Deadlocks

File organization and storage structure, Unordered File, Ordered File, Hash Files, Hash Functions, Types of Indexes, Indexed sequential Files, Secondary indexes, Multilevel indexes, B+ trees, Clustered, Non Clustered Indexes, Threats, Counter Measures: Authorization, Views, Backup and Recovery, Integrity, Encryption, RAID, Transaction and Scheduling, Concurrent Execution of Transactions, Serializability, Lock-Based Concurrency Control, Deadlocks, Incremental Log with Deferred Updates, Incremental Log with immediate Updates, Concurrency Control, Deadlock detection, Deadlock prevention, Time stamping, Data Warehousing & Data Mining Concepts.

Recommended Books/Reference Material

1. Date, C. J. (2019). *Database design and relational theory: normal forms and all that jazz*. Apress.
2. Foster, E., & Godbole, S. (2022). *Database systems: A pragmatic approach*. Auerbach Publications.
3. Meier, A., & Kaufmann, M. (2019). *SQL & NoSQL databases*. Springer.
4. Besta, M., Gerstenberger, R., Peter, E., Fischer, M., Podstawski, M., Barthels, C., & Hoefler, T. (2023). Demystifying graph databases: Analysis and taxonomy of data organization, system designs, and graph queries. *ACM Computing Surveys*, 56(2), 1-40.

Database Management Systems and Applications (Lab)

Course Code: CS-114L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This module introduces the basic concepts of databases and database management systems. Help students understand benefits that can be attained by using both Relational Database Management System and NoSql. It Enable students to become comfortable in designing databases and schemas, plus writing both simple and complex queries (SQL and XPath) to manipulate database.

Learning Outcomes

- **Explain** fundamental database concepts.
- **Design** conceptual, logical and physical database schemas using various data models.
- **Identify** functional dependencies & resolve database anomalies by normalizing database tables.

Course Outline

Unit 1. Introduction to DBMS Tools

Overview of DBMS Tools, The Role of Data in Business, Meta Data & Meta Meta Data, The Database Limitations, Database Approach, Centralized Database, Personal Computer Database, Client/Server database, Distributed Database, Teleprocessing, Concept and Evaluation of Database Model, Flat file Model, Hierarchical model, Network Model, Relational Model, Object Relational Model, Object Based data Model

Unit 2. Database Design

Data Modeling, Phases of Database Design, DBMS Selection, Implementation, Testing, Data Administration & Database, Logical Design, Conceptual Database Design, Introduction to Entity-Relational model, Entity Types, Relationship Types: Degree of Relationship Type, Recursive Relationship.

Unit 3. Introduction to SQL

History of SQL, Importance & Environment of SQL, Categories of SQL Commands (DML, DDL, DCL), Create a Database, Creating Tables, Altering Table, Dropping Table, Creating Views, removing views, Restrictions on Views, Updating Views.

Unit 4. Implementation of SQL

The SELECT Clause, The FROM Clause, The WHERE Clause, Relational Operators, Logical Operators, Wildcard Characters, Understanding the NULL values and Expressions, ORDER BY Clause, Aggregate Functions in SQL, The GROUP BY Clause, The HAVING Clause, Sub Query, Types of Sub Query,

Nested Sub query, Single row sub query, Multiple row sub query, Correlated Subquery, Parameters Queries, Multi Table Queries, Joins (Inner join, Outer Join, Left outer join, Right outer join), EXISTS and NOT EXISTS, Combining Results Tables, (UNION, INTERSECTION, EXCEPT), Changing the Content of Tables using Action Queries (The INSERT table Statement, The DELETE table Statement, The UPDATE table Statement).

Unit 5. Implementation to Physical Database Design

Basic concepts, Unordered File, Ordered File, Hash Files, Hash Functions, Types of Indexes, Indexed sequential Files, Secondary indexes, Multilevel indexes, B+ trees, Backup and Recovery, Integrity, Encryption, RAID, Lock-Based Concurrency Control, Deadlocks, Incremental Log with Deferred Updates, Concurrency Control, Deadlock detection & prevention.

Recommended Books/Reference Material

1. Date, C. J. (2019). *Database design and relational theory: normal forms and all that jazz*. Apress.
2. Foster, E., & Godbole, S. (2022). *Database systems: A pragmatic approach*. Auerbach Publications.
3. Meier, A., & Kaufmann, M. (2019). *SQL & NoSQL databases*. Springer.
4. Besta, M., Gerstenberger, R., Peter, E., Fischer, M., Podstawski, M., Barthels, C., & Hoefler, T. (2023). Demystifying graph databases: Analysis and taxonomy of data organization, system designs, and graph queries. *ACM Computing Surveys*, 56(2), 1-40.

Cyber Security

Course Code: IT-311

Credit Hours: 2

Pre-requisite: Nil

Objectives

To develop experts that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets. To develop graduates that can identify, analyze, and remediate computer security breaches.

Learning Outcomes

- **Understand** malware, social engineering, and advanced persistent threats (APTs).
- **Develop** a comprehensive understanding of key cyber security technologies and best practices, including network security, cryptography, identity and access management, and cloud security.
- **Apply** this knowledge to real-world scenarios, such as securing web applications and mobile devices.

Course Outline

Unit 1. Introduction to Cyber security

Introduction to Cybersecurity, Cyber security Importance, Differences between Information security and cyber security, Ethical hacking concepts and scope, Evolution of cyber-attacks, Types of cyber-attacks, Impact of cyber-attacks on individuals and organizations, penetration testing process.

Unit 2. Information Security & Cybersecurity

Virtual Private Networks (VPNs), Cryptography, Symmetric and Asymmetric key encryption, Public key infrastructure (PKI). Information security frameworks, Web and Web application security threats, secure web protocols (HTTPS, SSL/TLS), Cross-site scripting (XSS) and SQL injection attacks, secure coding practices.

Unit 3. Introduction to Security Threats

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Unit 4. Threat Intelligence and Hunting

Identity and access management (IAM) overview, IAM components (authentication, authorization, etc.), Single sign-on (SSO), Identity federation and trust models. Introduction to threat intelligence and hunting, Threat intelligence sources and collection techniques, Threat hunting strategies and tools, Cybersecurity threat sharing and collaboration.

Unit 5. Cyber Security Ethics in Emerging Trends

Cybersecurity governance frameworks, Cybersecurity risk management, Cybersecurity metrics and measurements, Cybersecurity incident response planning. Overview of emerging trends and technologies in cybersecurity, Artificial intelligence and machine learning in cybersecurity, Blockchain and cybersecurity, Internet of Things (IoT) security. Ethics in cybersecurity decision-making, Ethical hacking and penetration testing, Legal and regulatory issues in cybersecurity, Intellectual property and copyright laws in cybersecurity, Liability and responsibility in cybersecurity incidents.

Recommended Books/Reference Material

1. Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The importance of cybersecurity education in school. *International Journal of Information and Education Technology*, 10(5), 378-382.
2. Shoemaker, D., Sigler, K., & Shoemaker, T. (2023). *Teaching Cybersecurity: A Handbook for Teaching the Cybersecurity Body of Knowledge in a Conventional Classroom*. CRC Press.
3. Whitman, M. E., & Mattord, H. J. (2021). *Principles of information security*. Cengage learning.

Cyber Security (Lab)

Course Code: IT-311L

Credit Hours: 01

Pre-requisite: Nil

Objectives

To develop experts that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets. To develop graduates that can identify, analyze, and remediate computer security breaches.

Learning Outcomes

- **Understand** malware, social engineering, and advanced persistent threats (APTs).
- **Develop** a comprehensive understanding of key cyber security technologies and best practices, including network security, cryptography, identity and access management, and cloud security.
- **Apply** this knowledge to real-world scenarios, such as securing web applications and mobile devices.

Course Outline

Unit 1. Introduction to Cybersecurity

Introduction to Cybersecurity, Cyber security Importance, Differences between Information security and cyber security, Ethical hacking concepts and scope, Evolution of cyber-attacks, Types of cyber-attacks, Impact of cyber-attacks on individuals and organizations, penetration testing process.

Unit 2. Information Security & Cybersecurity

Virtual Private Networks (VPNs), Cryptography, Symmetric and Asymmetric key encryption, Public key infrastructure (PKI). Information security frameworks, Web and Web application security threats, secure web protocols (HTTPS, SSL/TLS), Cross-site scripting (XSS) and SQL injection attacks, secure coding practices.

Unit 3. Introduction to Security Threats

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Unit 4. Threat Intelligence and Hunting

Identity and access management (IAM) overview, IAM components (authentication, authorization, etc.), Single sign-on (SSO), Identity federation and trust models. Introduction to threat intelligence and hunting, Threat intelligence sources and collection techniques, Threat hunting strategies and tools, Cybersecurity threat sharing and collaboration.

Unit 5. Cyber Security Ethics in Emerging Trends

Cybersecurity governance frameworks, Cybersecurity risk management, Cybersecurity metrics and measurements, Cybersecurity incident response planning. Overview of emerging trends and technologies in cybersecurity, Artificial intelligence and machine learning in cybersecurity, Blockchain and cybersecurity, Internet of Things (IoT) security. Ethics in cybersecurity decision-making, Ethical hacking and penetration testing, Legal and regulatory issues in cybersecurity, Intellectual property and copyright laws in cybersecurity, Liability and responsibility in cybersecurity incidents.

Recommended Books/Reference Material

1. Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The importance of cybersecurity education in school. *International Journal of Information and Education Technology*, 10(5), 378-382.
2. Shoemaker, D., Sigler, K., & Shoemaker, T. (2023). *Teaching Cybersecurity: A Handbook for Teaching the Cybersecurity Body of Knowledge in a Conventional Classroom*. CRC Press.
3. Whitman, M. E., & Mattord, H. J. (2021). *Principles of information security*. Cengage learning.

Cloud Computing

Course Code: CS-406

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces students to fundamentals of cloud computing and software development for cloud platforms. It covers topics such as cloud basic architecture, virtualization, and architecture of cloud systems, programming for the cloud, resource management, as well as privacy and security issues.

Learning Outcomes

- **Apply** vSphere. OpenStack, Microsoft Azure Cloud
- **Practice** vSphere. OpenStack, o Microsoft Azure Cloud.
- **Contribute** individually or as a team member to work effectively.

Course Outline

Unit 1. Introduction vSphere Virtual Infrastructure

Introduction vSphere Virtual Infrastructure, Overview of vSphere virtual infrastructure Installation of ESXi, Configuring ESXi services. VSphere Virtual Infrastructure. Discuss the latest virtual machine hardware and its features, Explain

the importance of VMware Tools™, Deploy and configure virtual machines and templates, Identify virtual machine disk format. Describe, create, and manage standard switches, Configure virtual switch security and load-balancing policies, explain the importance of VMware Tools™, Describe the virtual switch connection types.

Unit 2. Configuring and Managing Virtual Storage

Introduce storage protocols and storage device types. Create and manage VMFS and NFS datastores, describe the new features of VMFS 6.7. Deploy and configure vCenter Server Appliance, use vSphere Web Client, Backup and restore vCenter Server, vCenter Server permissions and roles. Compute, Storage and Network Management, OpenStack Orchestration Management, Image Management. Use templates and cloning to deploy new virtual machines, Modify and manage virtual machines, Clone a virtual machine, Remove virtual machines from the vCenter Server inventory and datastore.

Unit 3. Introduction to Microsoft Azure Cloud

Azure Foundations ,Azure Portal, Azure CLI, Cloud Shell , Creating a Free Azure Account , Footprint and Structure ,Azure Services ,Web and Mobile , Databases , Data and Analytics ,Security and Identity , Monitoring and Management . Creating Azure Resources. App Service, Azure Container Instances, Azure App Services

Unit 4. Networking – Azure

Creating a Virtual Network Connection, IP Addressing, Azure Active Directory, Create Azure AD Tenant, Create Users and Groups, Self-Service Password Reset, Creating a Storage Account, Add Disk, Disk Caching.

Unit 5. Introduction to Cloud Computing

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Recommended Books/Reference Material

1. Gavanda, M., Mauro, A., Valsecchi, P., & Novak, K. (2019). *Mastering VMware vSphere 6.7: Effectively deploy, manage, and monitor your virtual datacenter with VMware vSphere 6.7*. Packt Publishing Ltd.
2. Ruparelia, N. B. (2023). *Cloud computing*. Mit Press.
3. Toroman, M. (2018). *Hands-on cloud administration in azure: Implement, monitor, and manage important Azure services and components including IaaS and PaaS*. Packt Publishing Ltd.
4. Trofimczuk, D., Ahola, H., & Aunimo, L. (2022). *Case study: Microsoft Azure Cloud experiences in teaching at Haaga-Helia University of Applied Sciences*.

Introduction to Artificial Intelligence

Course Code: CS-115

Credit Hours: 02

Pre-requisite: Nil

Objectives

Artificial Intelligence (AI) is a constantly and actively growing and changing field. In this course, students will learn the basics of modern AI as well as some of the representative applications of AI. This course introduces students to the basic knowledge representation, problem solving, and learning methods of artificial intelligence. Upon completion, students should be able to develop intelligent systems by assembling solutions to concrete computational problems; understand the role of knowledge representation, problem solving, and learning in intelligent-system engineering; and appreciate the role of problem solving, vision, and language in understanding human intelligence from a computational perspective.

Learning Outcomes

- Know various AI search algorithms (tree search, uninformed, informed, and heuristic), understand different types of AI agents, and know how to build simple knowledge-based systems.
- Ability to apply knowledge representation, reasoning, and machine learning techniques to real-world problems.

Course Outline

Unit 1. Introduction

What is AI, Major AI areas, Intelligent Agents: Agents and environments, Rationality? PEAS (Performance measure, Environment, Actuators, Sensors), Environment types, Agent Types, Problem solving through uninformed search: Breadth First Search, Depth First Search, Iterative DFS, Comparison of Search Algorithms.

Unit 2. Problem Solving Through Informed Search, Expert Systems

Problem solving through informed search: Heuristically Informed Methods, Hill Climbing, Beam Search, Best First Search, A*Procedure, Adversarial Search, Min-Max Procedure, Static Evaluation Function, Alpha Beta Pruning, Expert Systems: Knowledge Base Expert System Their Types and Application, Working of Expert Systems with its different components.

Unit 3. Neural Networks, Back Prop Algorithms

Binary Expert Systems: Developing an Expert System, Identifying the problem, forward and Backward Chaining. Neural Network: Introduction to Artificial Neural Networks (ANN), ANN Applications, Topologies of ANN, Single Layer perception (SLP).

Unit 4. Genetic Algorithm, Fuzzy System, Classification

Genetic Algorithm: Introduction to Evolutionary Computing, Genetic Algorithm (GA), Genetic operators (Crossover and Mutation) and its applications. Fuzzy System: Fuzzy Set Theory, Fuzzy Inference, And Classification: Decision Tree, Bayes Classification.

Unit 5. Machine Learning, Introduction to Computer Vision, Mining Frequent Patterns

Machine Learning: Introduction to Learning, Supervised Machine Learning: Unsupervised Learning, K-means Clustering Algorithm, and Introduction to Computer Vision (CV), Pattern Recognition, Mining Frequent Patterns, Association and Correlation.

Recommended Books/Reference Material

1. Finlay, J. (2020). *An introduction to artificial intelligence*. CRC Press.
2. Joshi, P. (2017). *Artificial intelligence with python*. Packt Publishing Ltd.
3. Le, D., Chung, K., Quach, S., & Thaichon, P. (2022). *Introduction to artificial intelligence (AI)*. Artificial Intelligence for Marketing Management.
4. Luger, G. F. (2005). *Artificial intelligence: structures and strategies for complex problem solving*. Pearson.
5. Mehrotra, D. (2019). *Basics of artificial intelligence & machine learning*. Notion Press.
6. Miller, B. N., Ranum, D. L., & Anderson, J. (2019). *Python programming in context*. Jones & Bartlett Learning.

Introduction to Artificial Intelligence (Lab)

Course Code: CS-115L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Study the applications of AI and agent-based approach to AI and First-order predicate calculus, logical reasoning and problem-solving using Prolog language. To study and discuss various techniques and algorithms of AI used in general problem solving, optimization problems, constraint satisfaction problems, and game programming. Familiarize students with various sub-areas of AI, such as expert systems, natural language processing and machine learning.

Learning Outcomes

- **Explain** artificial intelligence, its characteristics and its application areas.
- **Formulate** real-world problems as state space problems, optimization problems or constraint satisfaction problems.
- **Implement** appropriate algorithms and AI techniques to solve complex problems.
- **Develop** an expert system by using appropriate tools and techniques.

Course Outline

Unit 1. Problem Solving

Problem solving (2 jug puzzles, 3 jug puzzles, lion man puzzles, vacuum cleaner puzzle. Implementation of 2 jug puzzles, 3 jug puzzles, lion man puzzles, vacuum cleaner puzzle using DFS and BFS.

Unit 2. Cost Search Algorithm Implementation

Implementation of A* and Uniform cost search algorithms to solve problems. Implementation of different games using game search tree algorithms.

Unit 3. Game Search Algorithm Implementation

Implementation of different games using game search tree algorithm Solution of 8 queen problem using genetic algorithm.

Unit 4. 8 Queen Problem and Prolog Language

Solution of 8 queen problem using genetic algorithm. Learning Prolog language for Logic Practice of Prolog and Lisp.

Unit 5. K Means Clustering Algorithm and Neural Networks

Implementation of K mean clustering algorithm. Implementation of single layer neural network.

Recommended Books/Reference Material

1. Finlay, J. (2020). *An introduction to artificial intelligence*. CRC Press.
2. Joshi, P. (2017). *Artificial intelligence with python*. Packt Publishing Ltd.
3. Le, D., Chung, K., Quach, S., & Thaichon, P. (2022). *Introduction to artificial intelligence (AI)*. Artificial Intelligence for Marketing Management.
4. Luger, G. F. (2005). *Artificial intelligence: structures and strategies for complex problem solving*. Pearson.
5. Mehrotra, D. (2019). *Basics of artificial intelligence & machine learning*. Notion Press.
6. Miller, B. N., Ranum, D. L., & Anderson, J. (2019). *Python programming in context*. Jones & Bartlett Learning.

18. List of Interdisciplinary /Allied Courses for Other Departments

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	STA-101	Statistical Methods	Nil	3
2	STA-102	Introduction to Biostatistics	Nil	3
3	STA-103	Business Statistics	Nil	3
4	STA-104	Mathematical Statistics	Nil	3
5	STA-105	Application of Statistics	Nil	3
6	STA-106	Introduction to Probability and Statistics	Nil	3
7	STA-108	Social Statistics	Nil	3
8	STA-109	Statistical Inference	Nil	3
9	STA-110	Business Statistics-I	Nil	3
10	STA-111	Business Statistics-II	Nil	3
11	STA-112	Quantitative Reasoning-II	Nil	3
12	STA-113	Statistical Reasoning	Nil	3
11	STA-121	Introductory Statistics	Nil	3
12	STA-114	Statistics in Psychology	Nil	3
13	STA-115	Statistics for Chemists	Nil	3
14	STA-116	Scientific Inquiry and Research Methods	Nil	2
15	STA-116L	Scientific Inquiry and Research Methods (Lab)	Nil	1
16	STA-117	Scientific Writing and Research Methods	Nil	3
17	STA-118	Statistics-I	Nil	3
18	STA-119	Statistics-II	Nil	3

19	STA-120	Biostatistics	Nil	2
20	STA-120L	Biostatistics (Lab)	Nil	1
21	STA-316	Data Analysis	Nil	2
22	STA-316L	Data Analysis (Lab)	Nil	1

19. Course Outlines for Interdisciplinary /Allied Courses for Other Departments

Statistical Methods

Course Code: STA-101

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to provide sound base of statistical knowledge and concepts to the students who are not studying subject of Statistics as major. The contents of the course are designed to give knowledge and understanding of the key features which provides base to do statistical research. Furthermore, this course focuses on applications of all concepts using statistical software SPSS.

Learning Outcomes

- Students will understand the basic concepts of statistical methods and able to apply descriptive & inferential statistics on data using SPSS.
- Students will gain understanding about graphical presentation of data and able to draw conclusion from SPSS output.

Course Outline

Unit 1. Introduction to Statistics

Introduction to basic concept of statistics and its related definitions. Classification, tabulation & frequency distribution using SPSS. Diagrams and graph drawing on SPSS.

Unit 2. Measures of Central Tendency and Dispersion

Mean, median and mode and criterion of good average. Measure of dispersion, moment, skewness and kurtosis. Application of all these measures on SPSS.

Unit 3. Introduction to Probability, Regression and Correlation

Definition and concept of correlation & regression, calculation of correlation coefficient using SPSS. Measuring regression coefficients using SPSS, fitting of regression lines on SPSS. Introduction to probability, basic concepts and addition laws.

Unit 4. Estimation

Introduction to normal distribution. Point estimation, interval analysis using SPSS. Interval estimation for mean, difference between mean using SPSS.

Unit 5. Testing of Hypothesis and ANOVA

Introduction to testing of hypothesis, testing of hypothesis for population mean using t and z-test on SPSS. Testing of hypothesis for difference between population means on SPSS. Concept of p-values and analysis of SPSS output. Short description of analysis of variance technique using SPSS.

Recommended Books/Reference Material

1. Amork, N.M. (2013). *IBM SPSS Statistics 24 Core System User's Guide*. International Business Machine Corporation.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
4. George, D., & Mallery, P. (2020). *IBM SPSS statistics 23 step by step: A simple guide and reference*. (14th ed.). Routledge.
5. Illowsky, B., & Dean, S. (2022). *Introductory statistics*. Open Stax Textbooks.
6. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
7. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. London: Pearson.

Introduction to Biostatistics

Course Code: STA-102

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of biological sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course focuses on the basic concepts of probability and probability distributions. Furthermore, the students will learn the methods of hypothesis testing for various parameters to draw inferences about them.

Learning Outcomes

- Students will understand the concept of modern statistical theory and their probabilistic foundation.
- Students will gain understanding about basic probability concepts and probability distributions as an aid to business decision making.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Students should be able to design and analyze an experiment for a real-life problem.

Course Outline

Unit 1. Frequency Distribution

Introduction and importance of biostatistics, limitations, population and sample sizes. Variable types, formation of frequency table from raw data. Summation, notation and statistical inference, data transformation.

Unit 2. Measures of Central Tendency and Dispersion

Arithmetic mean, median, mode. Range, variance, standard deviation, mean deviation.

Unit 3. Probability Distributions

Introduction of Probability, types of probabilities. Random variables, sampling distribution. Binomial, Poisson and Normal distributions, their properties and applications.

Unit 4. Basic Experimental Design

Basic concept and principles of experiments. Observational studies, planning of experiments, replication and randomization. Basic One-way ANOVA: types of sum of squares, how ANOVA works, ANOVA table. Two-way ANOVA. Field plot technique, layout and analysis of completely randomized design, randomized completely block design, latin square, factorial design, Linear combinations, multiple comparisons, treatment comparison.

Unit 5. Mean, Association, Correlation, Regression and Variance Testing

T-Test: Basic idea, Confidence limits of means, significant difference of means. Chi square test: Basic idea, testing goodness of fit to a ratio, testing association (Contingency table). F-Test: Introduction and application in analysis of variance. LSD test, Duncan's New Multiple Range test (for comparison of individual means), Bonferroni test. Correlation and Regression.

Recommended Books/Reference Material

1. Bacci, S., & Chiandotto, B. (2021). *Introduction to statistical decision theory*. Routledge.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
4. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
5. Kuzma, J. W., & Bohnenblust, S. E. (2004). *Basis statistics for the health sciences* (5th ed.). USA: McGraw Hill.
6. Rosner, B. (2010). *Fundamentals of biostatistics*, (7th ed.). John Wiley & Sons.
7. Triola, M. M., Triola, M. F., & Roy, J. (2017). *Biostatistics for biological and health sciences*, (2nd ed.). Pearson.
8. Walpole, R. E. (2002). *Introduction to Statistics*, (7th ed.). New York: Macmillan.
9. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. Pearson.
10. Zar, J. H. (2009). *Biostatistical analysis*, (5th ed.). Pearson.

Business Statistics

Course Code: STA-103

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objectives of the course are to enhance student's competency in application of statistics to solve business management problems and to improve their level of quantitative sophistication for further advanced business analysis. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis.

Learning Outcomes

- Students will be able to condense the business-related data and understand the basic concepts of central tendency and index numbers.
- Students will be able to present the data using suitable graph, chart, and diagram.
- Students will be able to calculate and explain the difference between measure of absolute and relative dispersion.
- Students will gain understanding about basic probability concepts and probability distributions as an aid to business decision making.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.

Course Outline

Unit 1. Data Condensation and Presentation

Basic definitions, descriptive statistics and inferential statistics. Statistics applications in business data. The data array and frequency distribution, relative frequency and cumulative frequency distribution. Graphical representation, Pie chart, Bar chart, Histogram and frequency polygon, Ogive.

Unit 2. Measures of Central Tendency and Dispersion

Means: (Arithmetic, Geometric and Harmonic mean), median and mode for grouped and ungrouped data. Quartiles for grouped and ungrouped data. Range, mean absolute deviation, variance, standard deviation, relative measures of dispersion.

Unit 3. Index Numbers and Sets

Defining an Index number, unweighted and weighted index numbers. Quantity and value indices. Basic sets and subsets, operations on sets. Venn diagram, permutations for all or part of elements of a set, permutation of the objects ranged in circle. Combinations.

Unit 4. Probability

Basic concepts, addition rules of probability. Conditional probabilities. Multiplication rule of probability. Mathematical expectation, expected monetary value. Decision criterion utility and expected utility.

Unit 5. Probability Distribution and Regression Analysis

Types of probability distribution. Random variables. Binomial distribution. Poisson distribution. Normal distribution. Regression and correlation analysis.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J. L. (2020). *Probability with STEM applications*, (3rd ed.). Wiley.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
4. Kazmier, L. J. (2009). *Shaum's outline of business statistics*, (4th ed.). New York: McGraw Hill.
5. Levin, R. I., Rubin, D. S., Siddique, M. H., & Rastogi, S. (2017). *Statistics for management*, (8th ed.). Pearson.
6. Martian, S. K., & Bowen, E. K. (1983). *Statistics for business and economics*. New York: McGraw Hill.
7. Michael J. Evans, M. J., & Rosenthal, J.S. (2010). *Probability and statistics*. Macmillan Learning.
8. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
9. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.

Mathematical Statistics

Course Code: STA-104

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to give students an abstract knowledge towards the formulation of mathematical concepts on random variables, probability and probability distributions. Besides understanding fundamentals of probability theory, it also helps in mathematical modelling of uncertain behaviour from real life situations. This course also provides the concepts advanced topics such as the transformation techniques and key properties of important sampling distribution in hypothesis testing.

Learning Outcomes

- Students will be understand the statistical methods and probability distribution for mathematical problems.
- Students will gain understanding about sampling distribution and their use in hypothesis testing.

Course Outline

Unit 1. Probability and Random Variable

Probability distribution, continuous random variables. Probability density functions, marginal distributions. Conditional Distributions. Expected value of random variable, moments. Moment generating functions.

Unit 2. Discrete Probability Distributions

Derivation and properties of the discrete distribution, bernoulli, binomial, poisson, and hypergeometric distributions.

Unit 3. Continuous Probability Distributions

Exponential, Gamma, uniform, normal distribution; derivation and applications, properties with proofs, real world problems, relations with other distributions.

Unit 4. Identifying New Variable's Distribution

Transformation techniques for one & two variables case; change of variable technique. Distribution function technique. Moment generating function technique.

Unit 5. Sampling Distributions

Sampling distribution of F, t and Chi-Square distribution; derivation, applications and its properties with proofs. Estimation of Variance. Testing of Statistical Hypothesis of means.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J.L. (2020). *Probability with STEM applications*. (3rd ed.). Wiley.
2. Freund, J. E. (1980). *Mathematical statistics* (3rd ed.). New Jersey: Prentice Hall.
3. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson Education.
4. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
5. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
6. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer .

Application of Statistics

Course Code: STA-105

Credit Hours: 03

Pre-requisite: Nil

Objectives

The aim of the course is that the students should understand the general principles that constitute the foundation of theory of inferential statistics. The course outline is designed to familiarize students with basic concepts of probability and probability distributions. Furthermore, the students will learn the methods of hypothesis testing for various parameters to draw inferences about them.

Learning Outcomes

- Students will be capable to explain the random variables, discrete and continuous random variables, and their probability distributions.
- Students will gain understanding to apply the probability distribution on scientific studies and interpret the results of statistical analyses accurately and effectively.
- Students will gain understand concept of the sampling distribution and their use in hypothesis testing.

Course Outline

Unit 1. Probability and Probability Distribution

Introduction to probability and basic definitions, addition laws, multiplication law for independent events. Binomial experiment, binomial probability distribution, properties of binomial distribution. Normal distribution and its properties, calculation of probabilities using standard normal table.

Unit 2. Sampling: Probability Sampling and Non-Probability Sampling

Introduction of sampling techniques, sample design and sampling frame, bias, sampling and non-sampling errors. Sampling with and without replacement. Probability sampling and non-probability sampling.

Unit 3. Estimation

Introduction to Inferential statistics, basic definitions relating estimation, point estimation and interval estimation. Interval estimation of population mean, large and small sample confidence intervals for population mean. Interval Estimation regarding two populations means. Large and small sample confidence intervals for difference between two population means using independent samples (assuming equal variances). Confidence interval estimate for mean difference using paired samples. Interval estimate for population proportions & difference between two population proportions.

Unit 4. Testing of Hypothesis

Introduction of hypothesis testing, Type I & Type II error. Hypothesis testing for population mean, hypothesis testing for difference between two population means: Independent samples with large and small sample size (assuming equal variances). Hypothesis testing for two populations means using paired samples. Hypothesis testing for population proportions & difference between two population proportions. Testing of hypothesis about independence of attributes.

Unit 5. Analysis of Variance (ANOVA)

Concepts of Analysis of variance. One-way ANOVA. Two-way ANOVA.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
4. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to Mathematical Statistics*, (8th ed.). Boston: Pearson.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics* (3rd ed.). New York: McGraw Hill.
6. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
7. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. Pearson.
8. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Introduction to Probability and Statistics

Course Code: STA-106

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. Furthermore, the course focuses on basic principles of probability and probability distributions for discrete and continuous random variables.

Learning Outcomes

- Students will be capable to explain the random variables, discrete and continuous random variables, and their probability distributions.

- Students will gain understanding to apply the probability distribution on scientific studies and interpret the results of statistical analyses accurately and effectively.
- Student will understand the basic statistical concepts and able to calculate and explain measures of central tendency and dispersion.
- Students will be able to present the data using suitable graph, chart, and diagram.

Course Outline

Unit 1. Introduction to Statistics and Presentation of Data

Introduction statistics, important statistical terms, variable, data & data collection. Classification and tabulation of data. Frequency distribution, its construction and other related concepts. Graphical presentation: Simple bar chart, component & multiple bar chart, pie chart, histogram, frequency polygon and ogive.

Unit 2. Measures of Central Tendency

Mean, median & mode for ungrouped and grouped data, quartiles, deciles and percentiles for ungrouped & grouped data.

Unit 3. Measures of Dispersion

Absolute and relative measures of dispersion for ungrouped and grouped data. Moments about mean. Measures of skewness and kurtosis. Moment-ratios.

Unit 4. Probability & Probability Distributions

Introduction to probability theory, types of events. Functions of classical probability with real world problems. Numerical examples of probability. Concept of random variable, discrete and continuous random variables. Binomial probability distribution & its numerical examples.

Unit 5. Discrete and Continuous Probability Distributions

Binomial probability distribution & its numerical examples. Hyper geometric probability distribution & its numerical examples. Poisson probability distribution & numerical examples related to it. Normal distribution, numerical examples with direct & inverse use of area table for standard normal distribution.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J.L. (2020). *Probability with STEM applications*. (3rd ed.). Wiley.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.

6. Scheaffer, R. L., Mulekar, M., & McClave, J. T. (2010). *Probability and statistics for engineers*. Cengage Learning.
7. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
8. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientists*, (6th ed.). New York: Prentice Hall.
9. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. Pearson.

Social Statistics

Course Code: STA-108

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of social sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. Furthermore, the course focuses on basic principles of probability and probability distributions for discrete and continuous random variables, sampling distribution, regression and correlation analysis and testing of hypotheses.

Learning Outcomes

- Student will understand the basic statistical concepts and able to calculate and explain measures of central tendency and dispersion.
- Students will be able to present the data using suitable graph, chart, and diagram.
- Students will gain understanding of the concepts and application of probability-based statistical inference and perform tests of hypothesis.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Student will gain knowledge about both theoretical and practical framework of sample surveys.

Course Outline

Unit 1. Introduction to Statistics and Presentation of Data

Introduction statistics, important statistical terms, variable, data & data collection. Classification and tabulation of data. Frequency distribution, its construction and other related concepts. Graphical presentation: Simple bar chart, component & multiple bar chart, pie chart, histogram, frequency polygon and ogive.

Unit 2. Measures of Central Tendency and Dispersion

Mean, median and mode for ungrouped and grouped data, quartiles, deciles and percentiles for ungrouped & grouped data. Absolute and relative measures of

dispersion for ungrouped and grouped data. Moments about mean. Measures of skewness and kurtosis.

Unit 3. Probability and Probability Distributions

Introduction to probability theory, types of events. Functions of classical probability with real world problems. Numerical examples of probability. Concept of random variable, discrete and continuous random variables. Examples. Discrete and continuous probability distributions.

Unit 4. Sampling Distribution

Introduction of sampling techniques, sample design and sampling frame, bias, sampling and non-sampling errors. Sampling with and without replacement. Probability sampling and non-probability sampling.

Unit 5. Association, Correlation, Regression and Hypothesis Testing

Introduction of hypothesis testing, Type I & Type II error. Hypothesis testing for population mean, hypothesis testing for difference between two population means. Hypothesis testing for population proportion, hypothesis testing for difference between two population proportion. Chi square test: Basic idea, testing goodness of fit to a ratio, testing association, contingency table. Correlation and regression.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J.L. (2020). *Probability with STEM applications*. (3rd ed.). Wiley.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
4. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson.
5. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
6. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
7. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.
8. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. Pearson.
9. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Statistical Inference

Course Code: STA-109

Credit Hours: 03

Pre-requisite: Nil

Objectives

The aim of the course is that the students should understand the general principles that constitutes the foundation of theory of inferential statistics. The course outlines are designed to familiarize students with basic techniques of sampling and estimation, their properties and application. Furthermore, the students will learn the methods regression and correlation analysis and hypothesis testing for various parameters to draw inferences about them.

Learning Outcomes

- Students will gain understanding of the concepts and application of probability-based statistical inference and perform tests of hypothesis.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Student will gain knowledge about both theoretical and practical framework of sample surveys.

Course Outline

Unit 1. Sampling Distribution

Introduction of sampling techniques, sample design and sampling frame, bias, sampling and non-sampling errors. Sampling with and without replacement. Probability sampling and non-probability sampling.

Unit 2. Estimation and Testing of Hypothesis

Introduction to inferential statistics, point estimation and interval estimation. Interval estimation of mean, proportion, difference of mean of two population, difference of proportion of two population, variance of the population, ratio of variances of two population. Hypothesis testing of mean, proportion, difference of mean, difference of proportion, variance, ratio of variances.

Unit 3. Regression and Correlation Analysis

Linear regression, coefficient of determination, calculation of standard error. Correlation analysis. Hypothesis testing of OLS estimates.

Unit 4. Chi square and Analysis of Variance (ANOVA)

Goodness-of-fit-tests. Test of independents. Contingency table 2x2 and higher orders. One way ANOVA. Two-way ANOVA.

Unit 5. Time Series Analysis

Basic definitions and terms. Moving average. Seasonality. Measure of trend and seasonal variations. Time series analysis in forecasting.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
2. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Pearson, Boston.
3. Levin, R. I., Rubin, D. S., Siddique, M. H., & Rastogi, S. (2017). *Statistics for management*, (8th ed). Pearson.
4. Martian, S. K., & Bowen, E. K (1983). *Statistics for business and economics*. New York: McGraw Hill.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
6. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
7. Walpole, R. E. (2002). *Introduction to Statistics*, (7th ed.). New York: Macmillan.
8. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Business Statistics-I

Course Code: STA-110

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objectives of the course are to enhance student's competency in application of statistics to solve business management problems and to improve their level of quantitative sophistication for further advanced business analysis. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis.

Learning Outcomes

- Students will be able to condense the business-related data and understand the basic concepts of central tendency and index numbers.
- Students will be able to present the data using suitable graph, chart, and diagram.
- Students will be able to calculate and explain the difference between measure of absolute and relative dispersion.
- Students will gain understanding about basic probability concepts and probability distributions as an aid to business decision making.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.

Course Outline

Unit 1. Data Condensation and Presentation

Basic definitions, descriptive statistics and inferential statistics. Statistics applications in business data. The data array and frequency distribution, relative

frequency and cumulative frequency distribution. Graphical representation, Pie chart, Bar chart, Histogram and frequency polygon, Ogive.

Unit 2. Measures of Central Tendency and Dispersion

Means: (Arithmetic, Geometric and Harmonic mean), median and mode for grouped and ungrouped data. Quartiles for grouped and ungrouped data. Range, mean absolute deviation, variance, standard deviation, relative measures of dispersion.

Unit 3. Index Numbers and Sets

Defining an Index number, unweighted and weighted index numbers. Quantity and value indices. Basic sets and subsets, operations on sets. Venn diagram, permutations for all or part of elements of a set, permutation of the objects ranged in circle. Combinations.

Unit 4. Probability

Basic concepts, addition rules of probability. Conditional probabilities. Multiplication rule of probability. Mathematical expectation, expected monetary value. Decision criterion utility and expected utility.

Unit 5. Probability Distribution and Regression Analysis

Types of probability distribution. Random variables. Binomial distribution. Poisson distribution. Normal distribution. Regression and correlation analysis.

Recommended Books/Reference Material

1. Carlton, M.A., & Devore, J. L. (2020). *Probability with STEM applications*, (3rd ed.). Wiley.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
3. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana
4. Kazmier, L. J. (2009). *Shaum's outline of business statistics*, (4th ed.). New York: McGraw Hill.
5. Levin, R. I., Rubin, D. S., Siddique, M. H., & Rastogi, S. (2017). *Statistics for management*, (8th ed.). Pearson.
6. Martian, S. K., & Bowen, E. K. (1983). *Statistics for business and economics*. New York: McGraw Hill.
7. Michael J. Evans, M. J., & Rosenthal, J.S. (2010). *Probability and statistics*. Macmillan Learning.
8. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
9. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.

Business Statistics-II

Course Code: STA-111

Credit Hours: 03

Pre-requisite: Nil

Objectives

The aim of the course is that the students should understand the general principles that constitutes the foundation of theory of inferential statistics. The course outlines are designed to familiarize students with basic techniques of sampling and estimation, their properties and application. Furthermore, the students will learn the methods regression and correlation analysis and hypothesis testing for various parameters to draw inferences about them.

Learning Outcomes

- Students will gain understanding of the concepts and application of probability-based statistical inference and perform tests of hypothesis.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Student will gain knowledge about both theoretical and practical framework of sample surveys.

Course Outline

Unit 1. Sampling Distribution

Introduction of sampling techniques, sample design and sampling frame, bias, sampling and non-sampling errors. Sampling with and without replacement. Probability sampling and non-probability sampling.

Unit 2. Estimation and Testing of Hypothesis

Introduction to inferential statistics, point estimation and interval estimation. Interval estimation of mean, proportion, difference of mean of two population, difference of proportion of two population, variance of the population, ratio of variances of two population. Hypothesis testing of mean, proportion, difference of mean, difference of proportion, variance, ratio of variances.

Unit 3. Regression and Correlation Analysis

Linear regression, coefficient of determination, calculation of Standard error. Correlation analysis. Hypothesis testing of OLS estimates.

Unit 4. Chi square and Analysis of Variance (ANOVA)

Goodness-of-fit-tests. Test of independents. Contingency table 2x2 and higher orders. One way ANOVA. Two way ANOVA.

Unit 5. Time Series Analysis

Basic definitions and terms. Moving Average. Seasonality. Measure of trend and seasonal variations. Time series analysis in forecasting.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson.
4. Levin, R. I., Rubin, D. S., Siddique, M. H., & Rastogi, S. (2017). *Statistics for Management*, (8th ed). Pearson.
5. Martian, S. K., & Bowen, E. K (1983). *Statistics for business and economics*. New York: McGraw Hill.
6. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
7. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
8. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
9. Wu, C., & Thompson, M.E. (2020). *Sampling theory and practice*. Springer.

Quantitative Reasoning-II

Course Code: STA-112

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis, estimation and testing of hypothesis. It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

Learning Outcomes

- Student will understand the basic statistical concepts and have basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts and equation etc.
- Understand basic quantitative modeling and analyses.
- Ability to critically evaluate quantitative information to make evidence based decision through appropriate statistical tools.

Course Outline

Unit 1. Introduction of Statistic and Data Condensation

Types and sources of data. Measurement scales. Population and sample. Tabular and graphical presentation of data. Quantitative reasoning exercises using fundamental statistical concepts.

Unit 2. Measure of Central Tendency and Dispersion

Measure of central tendency. Measure of dispersion. Data interpretation. Quantitative reasoning exercises using statistical concepts.

Unit 3. Probability and Probability Distributions

Basic probability theory. Rules of counting (multiplicative, permutation, combinations). Introduction to random variables and their probability distributions. Quantitative reasoning exercises using probability theories and distribution concepts.

Unit 4. Regression and Correlation Analysis

Introduction to probabilistic models. Bivariate analysis. Scatter plots. Simple linear regression model. Correlation analysis. Quantitative reasoning exercises using statistical modelling.

Unit 5. Estimation and Testing of Hypothesis

Basics of estimation and confidence interval. Testing of Hypothesis (z-test; t-test). Statistical inference in decision making. Quantitative reasoning exercises using estimation and Statistical inference concepts and techniques.

Recommended Books/Reference Material

1. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson Education.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
6. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
7. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.
8. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientists*, (6th ed.). New York: Prentice Hall.

Statistical Reasoning

Course Code: STA-113

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis, estimation and testing of hypothesis. It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

Learning Outcomes

- Student will understand the basic statistical concepts and have basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts and equation etc.
- Understand basic quantitative modeling and analyses.
- Ability to critically evaluate quantitative information to make evidence based decision through appropriate statistical tools.

Course Outline

Unit 1. Introduction of Statistic and Data Condensation

Types and sources of data. Measurement scales. Population and sample. Tabular and graphical presentation of data. Quantitative reasoning exercises using fundamental statistical concepts.

Unit 2. Measure of Central Tendency and Dispersion

Measure of central tendency. Measure of dispersion. Data interpretation. Quantitative reasoning exercises using statistical concepts.

Unit 3. Probability and Probability Distributions

Basic probability theory. Rules of counting (multiplicative, permutation, combinations). Introduction to random variables and their probability distributions. Quantitative reasoning exercises using probability theories and distribution concepts.

Unit 4. Regression and Correlation Analysis

Introduction to probabilistic models. Bivariate analysis. Scatter plots. Simple linear regression model. Correlation analysis. Quantitative reasoning exercises using statistical modelling.

Unit 5. Estimation and Testing of Hypothesis

Basics of estimation and confidence interval. Testing of Hypothesis (z-test; t-test). Statistical inference in decision making. Quantitative reasoning exercises using estimation and Statistical inference concepts and techniques.

Recommended Books/Reference Material

1. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Hogg, R., Mckean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson Education.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
6. Moore, D. S., McCabe, G.P., & Craig, B. A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
8. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.
9. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientists*, (6th ed.). New York: Prentice Hall.

Introductory Statistics

Course Code: STA-121

Credit Hours: 03

Pre-requisite: Nil

Objectives

To provide students basic understanding of statistical methods and its applications in various fields. This course focuses on descriptive statistics and its applications.

Learning Outcomes

- Student will understand the basic statistical concepts and able to explain measures of central tendency and dispersion.
- Students will be able to present the data using suitable graph, chart, and diagram.
- Students will be able to calculate and explain the difference between measure of absolute and relative dispersion.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.

Course Outline

Unit 1. Introduction to Statistics and Presentation of Data

Basic definitions, characteristics, limitations and uses of statistics. Types of data. Classification and tabulation of data. Frequency distribution. Stem and leaf display. Graphical presentation. Diagrams and graphs.

Unit 2. Measure of Central Tendency

Definitions and types of averages. Criteria of good average. Arithmetic mean and its properties (ungrouped & grouped data). Geometric mean (ungrouped & grouped data). Harmonic mean (ungrouped & grouped data). Mode (ungrouped & grouped data). Median and quantiles (ungrouped & grouped data).

Unit 3. Measures of Dispersion

Range, quartile deviation and their coefficients. Mean deviation and coefficient of mean deviation. Variance and standard deviation. Coefficients of variation. Trimmed and winsorized measures.

Unit 4. Measure of Symmetry and Skewness

Moments about arbitrary value and mean. Concept of symmetry and skewness. Moment ratios. Measures of skewness and kurtosis.

Unit 5. Regression and Correlation Analysis

Regression and its application. Residual plot. Simple Correlation, its application and properties. Rank correlation. Association.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.
5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
6. Moore, D.S., McCabe, G.P., & Craig, B.A. (2021). *Introduction to the practice of statistics*, (10th ed.). New York: WH Freeman.
7. Walpole, R.E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
8. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientists*, (6th ed.). New York: Prentice Hall.

Statistics in Psychology

Course Code: STA-114

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to train the students in theoretical as well as applied statistics with reference to psychology. Statistical analysis is a very essential part of psychological research and students need to have a grasp over the concepts, theoretical rational of use of certain statistical analysis and also to learn to carry out these analyses.

Learning Outcomes

- Students will be able to understand types of statistics and apply appropriate statistics keeping in view the type of data.
- Students will be able to apply statistical techniques for data analysis in accordance with objectives and hypotheses being formulated in research.

Course Outline

Unit 1. Introduction

Defining statistics. Importance of statistics in psychology. Descriptive statistics. Data: Types of data. Frequency distribution: Cumulative frequency distribution. Measures of central tendency: Mean, mode, and median. Measures of dispersion: Range, variance, and standard deviation.

Unit 2. Inferential Statistics

Basic assumptions / rationale and when to use which inferential statistic. Critical region: One tailed & two tailed tests. Type one and type two (i & ii) errors. Level of significance: Concept of alpha and p value.

Unit 3. Parametric Statistics

Rationale and basic considerations/ assumptions. Z-test, t-test analysis: Independent sample, paired sample, one sample. Analysis of variance: One-way ANOVA, two way ANOVA. Correlation: Correlation & causation, Pearson product moment correlation. Regression: Linear regression, multiple regression.

Unit 4. Non-Parametric Statistics

Rationale and basic considerations/ assumptions. Spearman's rank order correlation. Chi square test (contingency table and proportions). Yates correction, Wilcoxon test. Mann Whitney test. Sign test. Kruskal Wallis.

Recommended Books/Reference Material

1. Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

2. Gravetter, F. J., & Forzano, L. A. B. (2003). *Research methods for the behavioral sciences*. Wadsworth Publishing Company.
3. Heiman, G. (2013). *Basic statistics for the behavioral sciences*. Cengage Learning.
4. Jaccard, J., & Becker, M. A. (2021). *Statistics for the behavioral sciences*. Cengage Learning.
5. King, B. M., & Minium, E. W. (2003). *Statistical reasoning in psychology and education*. New York: Wiley.
6. Knapp, H. (2013). *Introductory statistics using SPSS*. Sage Publications.
7. Neave, H. (2013). *Statistics tables: for mathematicians, engineers, economists and the behavioural and management sciences*. Routledge.
8. Perezgonzalez, J. D. (2017). *Statistical sensitiveness for the behavioral sciences*.
9. Schweigert, W. A. (2021). *Research methods in psychology: A handbook*. Waveland Press.
10. Watt, R., Collins, E. (2019). *Statistics for Psychology: A Guide for Beginners*. Sage Publications.
11. Whitley Jr, B. E., & Kite, M. E. (2012). *Principles of research in behavioral science*. Routledge.

Statistics for Chemists

Course Code: STA-115

Credit Hours: 03

Pre-requisite: Nil

Objectives

The purpose of this study is conduct a literature survey and identify research problems.

Learning Outcomes

Students should be able to understand:

- Conduct a literature survey and identify research problems.
- Handle data and calculate various statistical parameters which may make the data meaningful.
- Comprehend error, its types and distribution.

Course Outline

Unit 1. Introduction to Research Methodology

Concept of Research: Definition and scope of research, use of digital resources for literature survey, designing research problems and objectives, Research Ethics: Importance of ethics in research, ethical considerations in data collection, analysis, and reporting.

Unit 2. Errors in Research

Concept of Error: Definition and types of errors in research, sources and implications of errors in data, Distribution and Propagation of Error: Theory behind error distribution, methods to quantify and propagate errors in experimental data.

Unit 3. Statistical Methods in Research

Introduction to Statistical Methods: Role of statistics in research, basic concepts such as population, sample, and variability, Application of Statistical Methods: Use of statistical methods for data analysis and interpretation, techniques for determining and eliminating errors in data.

Unit 4. Spreadsheets for Statistical Analysis

Introduction to Spreadsheets: Overview of spreadsheet software (e.g., Excel), benefits of using spreadsheets for statistical analysis, Statistical Analysis Techniques: Handling outliers in data, concepts and applications of regression analysis, calculating correlation coefficients.

Unit 5. Advanced Topics in Research Methodology

Modern Tools for Research: Advanced digital resources for literature survey, techniques for efficient data collection and management, Emerging Issues in Research Ethics: Current trends and challenges in research ethics, ethical considerations in digital research and big data analytics.

Recommended Books/Reference Material

1. Agresti, A., & Finlay, B. (2009). *Statistical methods for the social sciences* (4th ed.). Pearson Education.
2. Babbie, E. R. (2016). *The practice of social research* (14th ed.). Cengage Learning.
3. Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4thed.). Sage Publications Ltd.
4. Montgomery, D. C., Runger, G. C., & Hubele, N. F. (2015). *Engineering statistics* (5th ed.). Wiley.
5. Peck, R., Olsen, C., & Devore, J. L. (2015). *Introduction to statistics and data analysis* (5th ed.). Cengage Learning.

Scientific Inquiry and Research Methods

Course Code: STA-116

Credit Hours: 2

Pre-requisite: Nil

Objectives

To introduce the students to the principles of scientific thinking, inquiry-based learning, and systematic research methods. To develop critical skills in formulating research questions, designing studies, analyzing data, and report findings ethically and effectively.

Learning Outcomes

By the end of this course

- Students will be able to understand the principles of scientific research.
- Students will learn how to use research techniques to conduct botanical experiments.
- Students will get awareness on ethical considerations for research scientific writing.

Course Outline

Unit 1. Introduction to Scientific Inquiry

Science: Nature and scope. Scientific thinking. The Scientific Method: Types of Scientific Research: Basic research, applied research, exploratory research, descriptive research.

Unit 2. Research: Problem, Design and Data Collection

Identifying and Defining Research Problems. Reviewing the Literature. Formulating Hypotheses and Research Questions. Experimental Design. Principles and types of designs. Experimental vs. Non-experimental Research. Sampling Methods: Probability and Non-Probability Sampling. Validity and Reliability in Research. Qualitative/Quantitative Data.

Unit 3. Communicating Research

Structuring a research report or Thesis. Writing an Abstract, Introduction, Methods Results Discussion and Conclusions. Referencing and Citation Styles (APA). Presenting Research: Posters, Oral Presentations and Conferences.

Unit 4. Ethical Challenges and Considerations

Ethical issues in data collection (Informed Consent, Anonymity, Confidentiality). Research misconduct. Data fabrication. Plagiarism and Academic Integrity.

Recommended Books/Reference Material

1. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Los Angeles, CA: SAGE Publications. ISBN: 978-1506386706.
2. Patten,, M. L., & Newhart, M. (2017). *Understanding research methods: An overview of the essentials* (10th ed.). New York, NY: Routledge. ISBN: 978-0415790529.
3. Crang, R., Lyons-Sobaski, S., & Wise, R. (2018). *Plant Anatomy: A concept-based approach* (2nd ed.). Cham, Switzerland: Springer International Publishing. ISBN: 978-3319773155.
4. Neuman, W. L. (2017). *Understanding research* (2nd ed.). Boston, MA: Pearson Education. ISBN: 978-0134041032.
5. Field, A. (2017). *Discovering statistics using IBM SPSS statistics* (5th ed.). London: Sage Publications. ISBN: 978-1526419529

Scientific Inquiry and Research Methods (Lab)

Course Code: STA-116L

Credit Hours: 1

Pre-requisite: Nil

Lab outline

Practical exercises on observation on a simple phenomenon and apply the scientific method to identify problem, propose hypotheses and design an experiment. Literature survey on assigned topic. Collecting and analyzing data, presenting results and writing a report. Submission of lab report

Scientific Writing and Research Methods

Course Code: STA-117

Credit Hours: 03

Pre-requisite: Nil

Objectives

The present course is designed to learn basic research techniques, guidance and research writing techniques. The specific objectives are:

- To learn basic about research and its background, need and planning.
- To acquire the advanced knowledge about identification of research problems, development of hypothesis and Research synopsis.
- To learn the basic tools, techniques and approaches in reviewing the research literature and its writing report.
- To learn advanced techniques about Research publication steps, process and its components.
- To get practical knowledge about components of thesis, report writing and Research Papers techniques and practices.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the key principles of scientific writing, including structure, clarity, and coherence.
- Apply research methodologies to design, conduct, and analyze scientific studies.
- Present research findings effectively through structured reports, presentations, and publications.

Course Outline

Unit 1. Introduction to research

Introduction to research and educational research (definitions, characteristics). Steps to conduct the research (research process). Purpose of research: Basic research, applied research, and action research. Methods of research: Qualitative and quantitative research.

Unit 2. Introduction to action research

Definitions and characteristics of action research. Origin of action research. History of action research in the educational context. Purpose of conducting action research. Importance and limitations of action research. Differences between other research and action research (with respect to purposes and methods).

Unit 3. Approaches and models of action research

Approaches to action research. First-person research (individual action research). Second-person research (collaborative action research). Third-person research (school-wide action research).

Unit 4. Literature review, ethics, and methodology

Investigating action research problems. Developing research questions. Literature review. Ethical issues in action research. Data collection tools. Procedure of tool development. The validity and reliability of action research tools.

Unit 5. Writing action research proposals, reports, and data analysis techniques

Parts of a research proposal and research report. Components of synopsis, report writing, thesis and research publication. Research publication process. Research journals. Literature review databases. Reference writing: for books, journals, anonymous, internet etc. Format of a research proposal and research report. Referencing (APA styles). How to avoid plagiarism. Review and conclusion.

Recommended Books/Reference Material

1. Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners*. Sage Publications Limited.
2. Humphries, B. (2017). *Re-thinking social research: anti-discriminatory approaches in research methodology*. Taylor & Francis.
3. Perna, L. W. (2020). *Higher Education: Handbook of Theory and Research*. Volume 35. Springer. 233 Spring Street, New York, NY 10013.
4. Glasman-Deal, H. 2009. *Science Research Writing for Non-Native Speakers of English*. Imperial College Press. London.<https://doi.org/10.1142/p605>
5. Blum, D., M. Knudson & R. Marantz Henig. 2006. *A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers*. Oxford University Press, 321 pages.
6. Hayden, T. & M. Nijhuis (eds). 2013. *The Science Writers' Handbook: Everything You Need to Know to Pitch, Publish, and Prosper in the Digital Age*. DaCapo Press, 308 pages.

7. McMillan, Victoria E. (2012). *Writing Papers in the Biological Sciences*, (5th ed.).

Statistics-I

Course Code: STA-118

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to equip students with foundational statistical concepts, including data collection, presentation, and analysis. It emphasizes descriptive statistics, probability and introductory distributions with an applied focus on decision-making.

Learning Outcomes

- Students will be able to collect, organize, and present data using standard statistical methods.
- Students will be able to compute and interpret measures of central tendency, dispersion and correlation.
- Students will be able to analyze simple data sets using software such as MS Excel or SPSS.
- Students will be able to interpret and communicate statistical results effectively.

Course Outline

Unit 1. Introduction to Statistics and Statistical Thinking

The science of statistics and its importance. Fundamental elements of statistics. Role of statistics in critical thinking and ethical decision-making.

Unit 2. Organizing Data

Types of variables and measurement scales (nominal, ordinal, interval, ratio). Methods of data collection. Classification and tabulation. Data presentation through diagrams and graphs.

Unit 3. Descriptive Measures

Measures of central tendency: mean, median, mode, geometric mean, quartiles, deciles, and percentiles. Measures of dispersion: range, mean absolute deviation, standard deviation, coefficient of variation. Boxplots.

Unit 4. Index Numbers

Definition and construction of index numbers. Unweighted and weighted aggregate indices. Average of relative methods. Quantity and value indices.

Unit 5. Time Series Analysis

Introduction to time series and its importance. Components of time series. Deseasonalization of data.

Unit 6. Probability

Basic probability concepts. Rules of probability. Conditional probability and Bayes' Theorem.

Unit 7. Random Variables and Discrete Distributions

Discrete random variables. Mean and standard deviation of a discrete random variable. Common distributions: Binomial, Poisson, and others.

Unit 8. The Normal Distribution

Central Limit Theorem. Introduction to normally distributed variables. Areas under the standard normal curve. Working with normally distributed variables. Assessing normality using normal probability plots.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*,(Part II). Pakistan: Ilmi Kitab Khana.
3. Doane, D. P., & Seward, L. E. (2021). *Applied statistics in business and economics* (7th ed.). McGraw-Hill Education.
4. Lind, D. A., Marchal, W. G., & Mason, R. D. (2002). *Statistical techniques in business & economics* (13th ed.). McGraw-Hill.
5. McClave, J. T., Benson, P. G., & Sincich, T. (2021). *Statistics for business and economics* (14th ed.). Pearson
6. Sweeney, D. J., Williams, T. A., & Anderson, D. R. (2020). *Statistics for business and economics* (13th ed.). Cengage Learning.
7. Weiss, N. A., & Weiss, C. A. (2015). *Elementary statistics* (9th ed.). Pearson.

Statistics-II

Course Code: STA-119

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main objective of this course is to equip students with essential inferential statistical tools. The course focuses on making decisions about populations using sample data. It covers estimation,

hypothesis testing, comparison of populations, goodness of fit tests, analysis of variance and nonparametric techniques

Learning Outcomes

- Students will be able understand and apply sampling and estimation techniques to real data.
- Students will be able to formulate and test hypotheses using appropriate statistical methods.
- Students will be able to compare populations using relevant inferential tools.
- Students will be able to apply analysis of variance and nonparametric methods in practical situations.
- Students will be able to interpret and communicate statistical findings effectively.

Course Outline

Unit 1. Sampling and Sampling Distributions

Sampling techniques: random, cluster, systematic, convenience, judgment, stratified. Simple random sampling. Point estimation. Sampling distributions and properties of estimators.

Unit 2. Interval Estimation

Confidence interval for population means. Confidence interval for population proportion. Sample size determination.

Unit 3. Hypothesis Testing

Formulating null and alternative hypotheses. Type I and Type II errors. Tests for population mean. Tests for population proportion. Calculating power and Type II error. Sample size determination for hypothesis testing. Inference for difference between two means. Inference for two population proportions.

Unit 4. Inference for Population Variances

Inference about a single population variance. Inference about the ratio of two population variances.

Unit 5. Goodness of Fit and Independence Tests

Chi-square goodness of fit tests. Test for independence in contingency tables. Applications with categorical data.

Unit 6. Analysis of Variance and Experimental Design

One-way ANOVA. Multiple comparison procedures. Introduction to experimental design, Randomized block design and factorial experiments.

Unit 7. Nonparametric Methods

Sign test and Wilcoxon signed-rank test, Mann-Whitney U test, Kruskal-Wallis test. Rank correlation.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Doane, D. P., & Seward, L. E. (2021). *Applied statistics in business and economics* (7th ed.). McGraw-Hill Education.
4. Lind, D. A., Marchal, W. G., & Mason, R. D. (2002). *Statistical techniques in business & economics* (13th ed.). McGraw-Hill.
5. McClave, J. T., Benson, P. G., & Sincich, T. (2021). *Statistics for business and economics* (14th ed.). Pearson.
6. Rajaretnam, T. (2015). *Statistics for social sciences*. Sage Publications.
7. Sweeney, D. J., Williams, T. A., & Anderson, D. R. (2020). *Statistics for business and economics* (13th ed.). Cengage Learning.
8. Weiss, N. A., & Weiss, C. A. (2015). *Elementary statistics* (9th ed.). Pearson.

Biostatistics

Course Code: STA-120

Credit Hours: 02

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of biological sciences. It familiarizes students with biological data and how to handle with it. Furthermore, this course aims in analyzing and interpreting the results obtained from the data from various health and biological fields.

Learning Outcomes

- Students will be able to understand the biological concepts and categorical variables.
- Students will be able to apply statistical tools in any biological situation.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Students should be able to design and analyze an experiment for a real-life problem.

Course Outline

Unit 1. Introduction and basic Concepts

Definition of biostatistics, types of variables. Observations in biological, health and medical sciences. Uniqueness in terms of behavior of variables their domain and units. Categorical data. Populations, target populations and sample population. Role of sampling in biostatistics.

Unit 2. Introduction to Probability Distributions

Distributional behavior of biological variables. Application of binomial and Poisson distributions in biostatistics. Application of normal distribution in biostatistics.

Unit 3. Inferential Statistics

Z-test, T-Test, F-Test. Basic idea, Confidence limits of means, significant difference of means, Chi square test, Basic idea, testing goodness of fit to a ratio, testing association (Contingency table).

Unit 4. Regression

Introduction to Correlation and Regression. Testing of hypothesis and confidence interval for the coefficients of regression. Regression for categorical response variables.

Unit 5. Basic Experimental Design

Basic concept and principles of experiments. Observational studies, planning of experiments, replication and randomization. Basic One-way ANOVA: types of sum of squares, how ANOVA works, ANOVA table. Two-way ANOVA. Field plot technique, layout and analysis of completely randomized design, randomized completely block design, Latin square, multiple treatment comparison.

Recommended Books/Reference Material

1. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part I). Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S.M., & Kamal. S. (2018). *Introduction to statistical theory*, (Part II). Pakistan: Ilmi Kitab Khana.
3. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of design and analysis of experiments*. CRC Press.
4. Glover, T., & Mitchell, K. (2015). *An introduction to biostatistics*, (3rd ed.). Waveland Press.
5. Gurumani, N. (2021). *An introduction to biostatistics*. India: MJP Publishers.
6. Kuzma, J. W., & Bohnenblust, S. E. (2004). *Basis statistics for the health sciences* (5th ed.). USA: McGraw Hill.
7. Merrill, R.M. (2021). *Principles and applications of biostatistics*. Jones & Bartlett Learning.
8. Rosner, B. (2010). *Fundamentals of biostatistics*, (7th ed.). John Wiley & Sons.
9. Triola, M. M., Triola, M. F., & Roy, J. (2017). *Biostatistics for biological and health sciences*, (2nd ed.). Pearson.
10. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan.
11. Weiss, N. A., & Weiss, C.A. (2017). *Introductory statistics*. Pearson.
12. Zar, J. H. (2009). *Biostatistical analysis*, (5th ed.). Pearson.

Biostatistics (Lab)

Course Code: STA-120L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of biological sciences. Students will use statistical software such as **R** and **SPSS** to apply theoretical concepts to real biological datasets. This hands-on experience will help them in analyzing, interpreting, and drawing meaningful conclusions from data collected in various biological, medical, and health-related studies.

Learning Outcomes

- Students will understand biological concepts, categorize variables, and apply statistical tools using R/SPSS.
- Students will be capable to apply regression, correlation, and experimental design to solve biological problems using R/ SPSS.

Course Outline

7. Introduction to biostatistics and types of variables using R/SPSS, including data entry and variable classification. Explore categorical data, population concepts, and perform basic sampling techniques within R/SPSS.
8. Explore the distributional behavior of biological variables and apply binomial, Poisson, and normal distributions using R/SPSS for real-life biological data modeling. Use built-in functions in R or SPSS procedures to simulate, visualize, and interpret probability distributions in biological contexts.
9. Perform Z-test, T-test, and F-test in R/SPSS to compare means and evaluate confidence limits and significance in biological data. Use Chi-square tests to assess goodness of fit and test associations using contingency tables for categorical biological variables.
10. In R/SPSS, explore correlation and regression analysis to assess relationships between biological variables. Conduct hypothesis testing and compute confidence intervals for regression coefficients, including regression models for categorical response variables.
11. In R/SPSS, learn the basic concepts and principles of experimental design, including observational studies, replication, and randomization. Conduct One-way and Two-way ANOVA, analyze sum of squares, interpret ANOVA tables, and apply experimental designs like completely randomized designs, randomized block designs, and Latin squares for multiple treatment comparisons.

Recommended Books/Reference Material

1. Amork, N.M. (2013). *IBM SPSS statistics 24 core system user's guide*. International Business Machine Corporation.

2. George, D., & Mallery, P. (2020). *IBM SPSS Statistics 23 Step by Step: A simple guide and reference*, (14th ed.). Routledge.
3. Gray, C.D., & Kinnear, P.R. (2012). *IBM SPSS statistics 19 made simple*. Psychology Press.
4. Denis, D.J. (2020). *Univariate, bivariate, and multivariate statistics using R: Quantitative tools for data analysis and data science*. John Wiley & Sons.
5. Xanthidis, D., Manolas, C., Xanthidou, O.K., & Wang, H.I. *Handbook of computer programming with Python*. (2022). CRC Press.
6. McNulty, K. (2021). *Handbook of regression modeling in people analytics: With examples in R and Python*. CRC Press.
7. Thulin, M. (2021). *Modern statistics with R: From wrangling and exploring data to inference and predictive modelling*. BoD-Books on Demand.

Data Analysis

Course Code: STA-316

Credit Hours: 02

Pre-requisite: Nil

Objectives

The statistical analysis is an essential part of social research and students need to have a grasp over the concepts, theoretical rational to use certain statistical analysis and also to learn the procedure to carry out these analyses. This course is designed to enhance their competence in using SPSS for data processing, entry, analysis and interpretation of output files and also to select and report analysis in form of table and be able to interpret the findings. Process research data, prepare variable view file, enter data, and select appropriate analysis as per type of data and hypotheses been formulated. Interpret analysis output file, report results in form of tables and graphic form and interpret results in qualitative form in their research report, thesis and research article.

Learning Outcomes

- Students will be able to define basic definitions and concepts of statistical methods, to understand the graphical descriptions of data.
- Students will be capable to apply various method for descriptive & inferential analysis of data using SPSS.
- Students will be able to understand the SPSS output and to explain it. Draw conclusions from statistical analysis.

Course Outline

Unit 1. Introduction to Statistical Package for Social Sciences (SPSS)

Data entry and cleaning. Computation and descriptive statistics.

Unit 2. Parametric Tests

Correlation. T-test & ANOVA. Regression.

Unit 3. Non-parametric Tests

Spearman's Rank Order Correlation. Chi Square Test (Contingency Table and Proportions). Yates Correction. Wilcoxon test. Mann Whitney -U test. Sign Rank test. Krushkal Wallis.

Unit 4. Advanced Analyses

Mediation and moderation through Macro Hayes.

Unit 5. Interpretation

The process and interpretation of SPSS output in form of table and graphical form per APA format.

Recommended Books/Reference Material

1. Bryman, A. (2011). *Quantitative data analysis with IBM SPSS 17, 18 and 19*. Routledge.
2. Camic, P. M. (2021). *Qualitative research in psychology: Expanding perspectives in methodology and design* (pp. xiii-323). American Psychological Association.
3. Coakes, S. J. (2010). *SPSS version 17.0 for windows*. John Wiley & Sons.
4. Dancey, C. P., & Reidy, J. (2017). *Statistics without maths for psychology*: Pearson London.
5. Elliott, A. C., & Woodward, W. A. (2007). *Statistical analysis quick reference guidebook: With SPSS examples*. Sage.
6. Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.
7. George, D., & Mallery, P. (2019). *IBM SPSS statistics 26 step by step: A simple guide and reference*. Routledge.
8. Gray, C. D., & Kinnear, P. R. (2012). *IBM SPSS statistics 19 made simple*. Psychology Press.
9. Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. McGraw-hill education (UK).
10. Pituch, K. A., & Stevens, J. P. (2015). *Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS*. Routledge.
11. Yockey, R. D. (2016). *SPSS demystified: a simple guide and reference*. Routledge

Data Analysis (Lab)

Course Code: STA-316L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The statistical analysis is an essential part of social research and students need to have a grasp over the concepts, theoretical rational to use certain statistical analysis and also to learn the procedure to carry out these analyses. This course is designed to enhance their competence in

using SPSS for data processing, entry, analysis and interpretation of output files and also to select and report analysis in form of table and be able to interpret the findings. Process research data, prepare variable view file, enter data, and select appropriate analysis as per type of data and hypotheses been formulated. Interpret analysis output file, report results in form of tables and graphic form and interpret results in qualitative form in their research report, thesis and research article.

Learning Outcomes

- Students will be capable to apply various method for descriptive & inferential analysis of data using SPSS.
- Students will be able to understand the SPSS output and to explain it. Draw conclusions from statistical analysis.

Course Outline

1. Hands on practice of Software's
2. Introduction of software's to do statistical analysis for Social Sciences
3. Introduction of SPSS,
4. Installation and requirements
5. Data Entry
6. Understanding of Windows
7. Data Entry / Data Cleaning / Computation
8. Analysis (parametric and non-parametric tests)
9. Reliability / Correlation / Regression
10. Interpretation and Reporting of Results.

Recommended Books/Reference Material

1. Bryman, A. (2011). *Quantitative data analysis with IBM SPSS 17, 18 and 19*. Routledge.
2. Camic, P. M. (2021). *Qualitative research in psychology: Expanding perspectives in methodology and design* (pp. xiii-323). American Psychological Association.
3. Coakes, S. J. (2010). *SPSS version 17.0 for windows*. John Wiley & Sons.
4. Dancey, C. P., & Reidy, J. (2017). *Statistics without maths for psychology*: Pearson London.
5. Elliott, A. C., & Woodward, W. A. (2007). *Statistical analysis quick reference guidebook: With SPSS examples*. Sage.
6. Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.
7. George, D., & Mallery, P. (2019). *IBM SPSS statistics 26 step by step: A simple guide and reference*. Routledge.
8. Gray, C. D., & Kinnear, P. R. (2012). *IBM SPSS statistics 19 made simple*. Psychology Press.
9. Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. McGraw-hill education (UK).

10. Pituch, K. A., & Stevens, J. P. (2015). *Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS*. Routledge.
11. Yockey, R. D. (2016). *SPSS demystified: a simple guide and reference*. Routledge.