



## NOTIFICATION

On the recommendations of Academic Council made in its 24<sup>th</sup> (1/2025) meeting held on 26.08.2025, the Syndicate in its 72<sup>nd</sup> (4/2025) meeting held on 12.09.2025 has approved the Syllabi of following Short Courses and Certifications.

### Short Courses:

- I. Applied Data Analysis with R and Python (Annex-‘A’)
- II. Machine Learning and Deep Learning with Python (Annex-‘B’)
- III. Mastering Statistical Process Control: A Data Driven Approach for Practitioners (Annex-‘C’)
- IV. Planning, Conducting, and Analyzing Surveys: A Practical Approach (Annex-‘D’)
- V. Designing and Analyzing Experimental Data in Applied Research (Annex-‘E’)

### Certifications:

- I. Data Visualization and Reporting (Annex-‘F’)
- II. Machine Learning Applications in Natural Sciences (Annex-‘G’)
- III. Biostatistics and Data Analytics for Medical Research (Annex-‘H’)
- IV. Modern Statistical Techniques and Data Analytics for Postgraduate Research (Annex-‘I’)
- V. Thematic Analysis for Qualitative Data with Python (Annex-‘J’)
- VI. Six Sigma for Business and Industry (Annex-‘K’)

  
(WAQAR AHMAD)  
Additional Registrar (General)

Dated: 30.10.2025

No. SU/Acad/25/ 1169

### Distribution:

- Chairman, Department of Statistics
- Controller of Examinations
- Director Academics

### C.C:

- Dean, Faculty of Sciences
- Director, QEC
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

**SYLLABI OF  
SHORT COURSES AND CERTIFICATIONS  
IN  
STATISTICS**



**Session: Fall 2025 – Onward**

**DEPARTMENT OF STATISTICS  
UNIVERSITY OF SARGODHA**

## Short Courses

1. Applied Data Analysis with R and Python
2. Machine Learning and Deep Learning with Python
3. Mastering Statistical Process Control: A Data Driven Approach for Practitioners
4. Planning, Conducting, and Analyzing Surveys : A Practical Approach
5. Designing and Analyzing Experimental Data in Applied Research

## Certifications

1. Data Visualization and Reporting
2. Machine Learning Applications in Natural Sciences
3. Biostatistics and Data Analytics for Medical Research
4. Modern Statistical Techniques and Data Analytics for Postgraduate Research
5. Thematic Analysis for Qualitative Data with Python
6. Six Sigma for Business and Industry



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## Short Courses

### 1 Applied Data Analysis with R and Python

**Type:** Short Course    **Duration:** 3 Weeks    **Contact Hours:** 15 Hours  
**Fee:** PKR 15,000

**Target Audience:** MPhil/PhD students and early-career researchers in natural sciences, social sciences, statistics, economics, and health sciences.

**Minimum Qualification:** Intermediate    **Minimum Enrolment:** 10

#### 1.1 Course Objectives

1. Understand the complete data analysis workflow.
2. Gain hands-on experience using R and Python for data analysis.
3. Clean, visualize, and model real-world datasets.
4. Develop reproducible scripts for reporting analytical results.

#### 1.2 Weekly Outline

##### Week 1: Introduction to Data Analysis and Programming Basics

- Overview of data analysis and types of data
- Introduction to RStudio and Jupyter Notebook
- Importing data using `readr` (R) and `pandas` (Python)
- Exploring DataFrames in `dplyr` and `pandas`
- Hands-on: Load and explore a real-world dataset

##### Week 2: Data Cleaning and Exploratory Data Analysis (EDA)

- Handling missing values and outliers
- Data transformation: filtering, grouping, and recoding
- Descriptive statistics and distributions
- Visualization with `ggplot2` (R) and `seaborn` (Python)
- Hands-on: Clean and visualize a research dataset

##### Week 3: Statistical Analysis and Reporting

- Correlation and covariance
- Simple linear regression in R and Python
- T-tests and ANOVA basics
- Exporting tables and charts (Excel, PDF, PNG)
- Final mini-project: End-to-end data analysis

### 1.3 Tools and Packages Used

1. R: tidyverse, ggplot2, readr, dplyr
2. Python: pandas, matplotlib, seaborn, statsmodels, scikit-learn
3. Platforms: RStudio, Jupyter Notebook / Google Colab

### 1.4 Certification

Certificate will be awarded upon attending at least 80% of sessions and successful completion of the final project.

## 2 Machine Learning and Deep Learning with Python

**Type:** Short Course    **Duration:** 4 Weeks    **Contact Hours:** 20 Hours  
**Fee:** PKR 20,000

**Target Audience:** MPhil/PhD students and professionals in computer science, data science, environmental modeling, life sciences, and applied AI fields.

**Minimum Qualification:** BS/MA/MSc    **Minimum Enrolment:** 10

### 2.1 Course Objectives

1. Understand the core concepts of machine learning and deep learning.
2. Implement supervised and unsupervised learning techniques in Python.
3. Develop deep learning models using neural network architectures.
4. Apply ML/DL methods to real-world datasets using best practices.

  
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## 2.2 Weekly Outline

### Week 1: Introduction to Machine Learning Concepts

- Overview of Machine Learning (ML) paradigms
- Data preparation and feature engineering
- Introduction to Python libraries for ML
- Implementing linear regression and logistic regression
- Hands-on: Training basic ML models using `scikit-learn`

### Week 2: Supervised and Unsupervised Learning Techniques

- Decision trees, random forests, K-Nearest Neighbors (KNN)
- Evaluation metrics: accuracy, precision, recall, F1-score
- Clustering: K-Means and Hierarchical methods
- Dimensionality reduction: PCA overview
- Hands-on: Classification and clustering with real datasets

### Week 3: Introduction to Deep Learning

- Neural network basics: perceptron, activation functions
- Introduction to TensorFlow and Keras
- Building and training deep neural networks (DNN)
- Understanding overfitting, dropout, and regularization
- Hands-on: Image or tabular data classification using DNN

### Week 4: Model Optimization and Deployment

- Hyperparameter tuning: grid search and cross-validation
- Model saving, loading, and evaluation on new data
- Introduction to model interpretability (SHAP/feature importance)
- Model deployment basics (web or notebook-based)
- Final mini-project: Complete ML/DL pipeline on a selected dataset

## 2.3 Tools and Packages Used

1. Python Libraries: scikit-learn, pandas, matplotlib, seaborn
2. Deep Learning: TensorFlow, Keras
3. Platforms: Jupyter Notebook, Google Colab

## 2.4 Certification

Certificate will be awarded upon attending at least 80% of sessions and successful completion of the final project.

# 3 Mastering Statistical Process Control: A Data Driven Approach for Practitioners

**Type:** Short Course    **Duration:** 3 Weeks    **Contact Hours:** 15 Hours  
**Fee:** PKR 15,000

**Target Audience:** Operations managers, engineers, quality control managers, business process analysts, faculty, students, and practitioners engaged in manufacturing and service process improvement.

**Target Organizational Departments:** Operations, Quality Control, Production, Process Improvement, Manufacturing Management.

**Target Industries:** Manufacturing, Pharmaceuticals, Food and Beverages, Chemicals, Automotive, Textiles and Garments, Packaging and Printing.

**Minimum Qualification:** Intermediate    **Minimum Enrolment:** 10

## 3.1 Course Objectives

1. Understand and model process variation using statistical techniques.
2. Construct and interpret statistical process control (SPC) charts.
3. Use control charts to detect, correct, and prevent variation.
4. Integrate SPC tools into quality and operations management.
5. Apply SPC in manufacturing and service-based industries.

  
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## 3.2 Weekly Outline

### Week 1: Foundations of SPC and Quality Improvement

- Introduction to SPC and its benefits across industries
- Understanding variation and its impact on process control
- Overview of control charts and process capability
- Introduction to software-based SPC tools
- Reflection & discussion on value of SPC in organizational settings

### Week 2: Control Charts for Variables and Attributes

- Control charts for variables ( $\bar{X}$ ,  $R$ , and  $S$  charts)
- Control charts for attributes ( $p$ ,  $np$ ,  $c$ ,  $u$  charts)
- Detecting special and common cause variations
- Group work: Reading and interpreting control charts
- Reflection & review of case examples

### Week 3: Process Capability and Implementation Strategies

- Process capability indices ( $C_p$ ,  $C_{pk}$ ) and interpretation
- SPC applications in manufacturing and service sectors
- Statistical concepts feeding into SPC (mean, SD, distributions)
- Real-world case study discussion and integration exercise
- Final project briefing and course wrap-up

## 3.3 Methodology

- Case studies from real industry examples
- Hands-on chart analysis using software tools
- Group discussions and team-based problem-solving
- Instructor feedback and reflective learning activities



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### 3.4 Course Toolbox

- Printable course workbook
- Control chart templates
- Digital resource: *Understanding Statistical Process Control*
- Access to SPC software (trial or open source)

### 3.5 Certification

Certificate will be awarded upon attending at least 80% of sessions and successful completion of a mini-project.

## 4 Planning, Conducting, and Analyzing Survey Data: A Practical Approach

**Type:** Short Course    **Duration:** 3 Weeks    **Contact Hours:** 15 Hours  
**Fee:** PKR 15,000

**Target Audience:** Postgraduate students, researchers, statisticians, and M&E professionals working in education, public health, development, or market research.

**Target Organizational Departments:** Social Sciences, Public Health, Education, Monitoring and Evaluation.

**Target Industries:** Government, NGOs, Health Systems, Development Projects, Market Research Agencies.

**Minimum Qualification:** Intermediate    **Minimum Enrolment:** 10

### 4.1 Course Objectives

1. Understand the foundations of survey methodology.
2. Design valid and reliable questionnaires.
3. Apply appropriate probability-based sampling methods.
4. Perform descriptive and inferential analysis of survey data.
5. Report and interpret findings for data-driven decision-making.



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## 4.2 Weekly Outline

### Week 1: Survey Design Foundations

- Types of surveys: cross-sectional, longitudinal, mixed-mode
- Measurement scales and question types
- Questionnaire design and validation
- Ethical considerations and consent

### Week 2: Sampling and Data Collection

- Sampling techniques: SRS, stratified, cluster, multistage
- Calculating sample size and dealing with non-response
- Enumerator training, field management, and quality control
- Data entry and cleaning in Excel/SPSS

### Week 3: Data Analysis and Reporting

- Descriptive statistics and visualization
- Chi-square, t-test, and basic regression for survey analysis
- Weighting and design effects (intro only)
- Final mini-project and report writing

## 4.3 Certification

1. Certificate will be awarded upon attending 80% of sessions and completing a mini survey project report.

# 5 Designing and Analyzing Experimental Data in Applied Research

**Type:** Short Course    **Duration:** 3 Weeks    **Contact Hours:** 15 Hours  
**Fee:** PKR 15,000

**Target Audience:** Graduate students, agricultural scientists, biologists, engineers, and applied researchers in natural sciences.

**Minimum Qualification:** BS/MA/MSc    **Minimum Enrolment:** 10

  
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## 5.1 Course Objectives

1. Understand experimental design principles including replication, randomization, and blocking.
2. Plan controlled experiments in real-world applied contexts.
3. Use ANOVA and other methods to analyze experimental data.
4. Interpret interaction effects and model assumptions.
5. Report findings using graphs, tables, and interpretation frameworks.

## 5.2 Weekly Outline

### Week 1: Principles of Experimental Design

- Randomization, replication, and blocking
- CRD, RCBD, and Latin square designs
- Experimental units and error control
- Field layout planning and documentation

### Week 2: Data Collection and Analysis Techniques

- Data recording protocols and spreadsheet design
- One-way and two-way ANOVA
- Multiple comparisons and contrasts
- Checking assumptions (normality, homogeneity)

### Week 3: Interpretation, Visualization, and Reporting

- Post-hoc tests and model diagnostics
- Creating publication-quality tables and plots
- Writing results for research reports and journals
- Final mini-project: design and analysis of a simulated experiment

## 5.3 Certification

Certificate will be awarded upon attending 80% of sessions and submitting a completed experimental design analysis project.

  
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# Certifications

## 6 Data Visualization and Reporting

**Type:** Certification    **Duration:** 2 Weeks    **Contact Hours:** 16 Hours  
**Fee:** PKR 16,000

**Target Audience:** Postgraduate students, researchers, data analysts, business intelligence professionals, monitoring and evaluation specialists, journalists, and corporate reporting teams.

**Minimum Qualification:** Intermediate    **Minimum Enrolment:** 10

### 6.1 Course Objectives

1. Master the fundamentals and best practices of data visualization.
2. Design static and dynamic charts for academic, policy, and business purposes.
3. Build interactive dashboards for data-driven decision making.
4. Develop storytelling approaches to deliver compelling narratives from data.
5. Enhance data visualization skills using industry-standard tools.

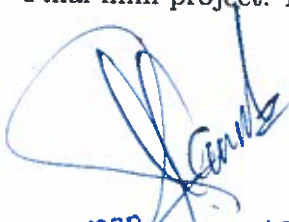
### 6.2 Weekly Outline

#### Week 1: Advanced Data Visualization Principles and Techniques

- Principles of effective data visualization and data-ink ratio
- Advanced chart types: heatmaps, treemaps, bubble charts, violin plots
- Visual perception and cognitive biases in interpreting charts
- Hands-on chart development with R (ggplot2) and Python (seaborn, plotly)

#### Week 2: Storytelling, Dashboards, and Reporting Best Practices

- Crafting a data-driven narrative: Story arcs, hooks, and key messages
- Building dynamic dashboards: Introduction to Google Data Studio or Power BI
- Reporting for impact: Executive summaries, data briefs, and policy memos
- Final mini-project: Develop a report integrating visualizations and storytelling



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### 6.3 Certification

Certificate will be awarded upon attending at least 80% of sessions and submitting a complete data visualization and reporting project.

## 7 Machine Learning Applications in Natural Sciences

**Type:** Certification    **Duration:** 2 Weeks    **Contact Hours:** 16 Hours  
**Fee:** PKR 16,000

**Target Audience:** Postgraduate students, researchers, environmental scientists, biological scientists, agricultural researchers, health science professionals, and data science enthusiasts.

**Minimum Qualification:** BS/MA/MSc    **Minimum Enrolment:** 10

### 7.1 Course Objectives

1. Understand key machine learning concepts applicable to natural sciences.
2. Apply supervised and unsupervised learning methods to scientific datasets.
3. Develop models for classification, regression, and clustering in biological and environmental contexts.
4. Perform feature engineering and model evaluation tailored for scientific research.
5. Gain practical skills in Python-based machine learning frameworks.

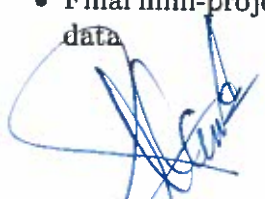
### 7.2 Weekly Outline

#### Week 1: Fundamentals of Machine Learning in Scientific Applications

- Introduction to machine learning: Key terms and types
- Supervised vs unsupervised learning in natural sciences
- Data preparation: Handling missing values, scaling, and encoding
- Practical session: Implementing simple ML models using scikit-learn

#### Week 2: Applied Modeling and Case Studies in Natural Sciences

- Regression and classification problems in biological and environmental research
- Clustering applications for ecological and agricultural data
- Model evaluation metrics: Accuracy, RMSE, confusion matrix, ROC curve
- Final mini-project: Develop and present a simple ML solution using real-world scientific data

  
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### 7.3 Certification

1. Certificate will be awarded upon attending at least 80% of sessions and successfully completing the assigned machine learning project.

## 8 Biostatistics and Data Analytics for Medical Research

**Type:** Certification    **Duration:** 2 Weeks    **Contact Hours:** 16 Hours  
**Fee:** PKR 16,000

**Target Audience:** Medical researchers, clinical scientists, postgraduate and doctoral students in medical, pharmaceutical, and life sciences, epidemiologists, biostatisticians, and public health analysts.

**Minimum Qualification:** BS/MA/MSc    **Minimum Enrolment:** 10

### 8.1 Course Objectives

1. Build a strong theoretical and applied foundation in biostatistical methods for medical and clinical research.
2. Analyze and model complex biomedical data using appropriate statistical techniques.
3. Perform inferential statistics including advanced hypothesis testing, regression modeling, and survival analysis.
4. Develop competency in handling real-world challenges like missing data, confounding, and effect modification.
5. Gain hands-on proficiency in statistical software (R/SPSS) for data management, analysis, and scientific reporting.

### 8.2 Weekly Outline

#### Week 1: Advanced Foundations in Biostatistics and Exploratory Data Analysis

- Data structures in medical research: longitudinal, clustered, and time-to-event data
- Exploratory data analysis (EDA) techniques: robust summaries, transformations, and visualization strategies
- Probability theory and important distributions for medical applications (Normal, Poisson, Negative Binomial, Gamma)
- Practical session: Data exploration and visualization using R/SPSS

  
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## Week 2: Statistical Inference, Modeling, and Survival Analysis in Healthcare Research

- Hypothesis testing: parametric vs nonparametric methods, multiple comparisons
- Generalized linear models (GLM) for binary and count data: logistic and Poisson regression
- Survival analysis: Kaplan-Meier estimation, Cox proportional hazards modeling
- Addressing confounding and interaction in medical studies
- Final mini-project: Analyze and report findings from a real clinical trial dataset

### 8.3 Certification

Certificate will be awarded upon attending at least 80% of sessions and submitting a complete applied biostatistics project involving real medical research data.

## 9 Modern Statistical Techniques and Data Analytics for Postgraduate Research

**Type:** Certification    **Duration:** 2 Weeks    **Contact Hours:** 16 Hours  
**Fee:** PKR 16,000

**Target Audience:** Postgraduate students (M.Phil., Ph.D.), early-career researchers across natural sciences, social sciences, engineering, and management fields, data analysts, and academic professionals involved in data-driven research.

**Minimum Qualification:** MPhil/PhD    **Minimum Enrolment:** 10

### 9.1 Course Objectives

1. Equip researchers with modern statistical and analytical tools required for high-quality postgraduate research.
2. Introduce advanced modeling techniques including multivariate analysis, regression analysis, and dimension reduction methods.
3. Enhance ability to handle real-world research data involving multicollinearity, heteroscedasticity, and missing values.
4. Apply machine learning techniques for exploratory and predictive research analysis.
5. Build strong hands-on skills using R and Python for research-grade data analysis and reporting.

## 9.2 Weekly Outline

### Week 1: Advanced Statistical Methods for Research Data

- Regression analysis: Linear, multiple, and generalized regression models
- Multivariate techniques: Principal Component Analysis (PCA), Factor Analysis
- K-Nearest Neighbors (KNN) and Decision Trees
- Support Vector Machines (SVM): concept and basic kernel trick

### Week 2: Data Analytics, Predictive Modeling, and Research Applications

- Machine learning for classification and prediction: Supervised and unsupervised methods
- Clustering Techniques: K-Means, Hierarchical Clustering (Agglomerative/Divisive)
- Final mini-project: Apply supervised and unsupervised methods to a research problem

## 9.3 Certification

Certificate will be awarded upon attending at least 80% of sessions and successfully submitting a complete research analytics project.

## 10 Thematic Analysis for Qualitative Data with Python

**Type:** Certification    **Duration:** 2 Weeks    **Contact Hours:** 16 Hours  
**Fee:** PKR 12,000

**Target Audience:** Postgraduate students, qualitative researchers, educationists, psychologists, social scientists, health researchers, and monitoring and evaluation professionals.

**Minimum Qualification:** BS/MA/MSc    **Minimum Enrolment:** 10

### 10.1 Course Objectives

1. Understand the principles, processes, and frameworks of thematic analysis.
2. Develop hands-on skills in coding qualitative data manually and using Python libraries.
3. Identify, construct, review, and refine themes in textual data.
4. Conduct visualization and simple text analytics to support qualitative interpretation.
5. Report thematic findings according to academic and applied standards.

## 10.2 Weekly Outline

### Week 1: Foundations and Initial Coding

- Introduction to qualitative research and thematic analysis
- Braun and Clarke's six-phase approach:
  - Familiarization with data
  - Generating initial codes
- Manual coding practice on interview transcripts
- Introduction to Python for qualitative analysis:
  - nltk for tokenization, stopword removal
  - spacy for advanced text processing
- Hands-on: Cleaning, preparing qualitative data in Python

### Week 2: Theme Development, Visualization, and Reporting

- Searching for, reviewing, and defining themes
- Visualization of text patterns:
  - Word frequency analysis
  - Word clouds using wordcloud package
  - Basic co-occurrence networks
- Producing thematic maps and narrative frameworks
- Reporting results: Writing thematic analysis for academic papers and reports
- Final Mini-Project: Conduct full thematic analysis on a provided dataset using Python

## 10.3 Certification

Certificate will be awarded upon attending at least 80% of sessions and submitting a thematic analysis report based on Python-coded project work.

## 11 Six Sigma for Business and Industry

**Type:** Certification    **Duration:** 4 Weeks    **Contact Hours:** 20 Hours  
**Fee:** PKR 20,000

**Target Audience:** Business professionals, engineers, quality control managers, healthcare administrators, service sector managers, postgraduate students, and early-career professionals interested in quality improvement.

**Minimum Qualification:** Intermediate    **Minimum Enrolment:** 10

## 11.1 Course Objectives

1. Understand the core concepts, tools, and benefits of Six Sigma.
2. Apply the DMAIC (Define, Measure, Analyze, Improve, Control) methodology to practical problems.
3. Use statistical and quality improvement tools like process maps, Pareto charts, control charts, and root cause analysis.
4. Lead basic Six Sigma projects and contribute to continuous improvement initiatives.

## 11.2 Weekly Outline

### Week 1: Introduction to Six Sigma and Define Phase

- Overview of Six Sigma: History, principles, DMAIC framework
- Six Sigma roles (Green Belt, Black Belt)
- Define phase tools: Project charters, SIPOC diagrams, stakeholder analysis
- Assignment: Create a project charter and SIPOC diagram for a sample project

### Week 2: Measure Phase and Basic Statistical Tools

- Data collection methods and key process metrics
- Measuring process capability and calculating sigma levels
- Introduction to basic descriptive statistics and variability concepts
- Assignment: Collect and summarize data for a selected process

### Week 3: Analyze and Improve Phases

- Root cause analysis: Fishbone diagrams, Pareto analysis
- Basics of hypothesis testing and identifying improvement opportunities
- Solution generation and pilot testing strategies
- Assignment: Identify root causes and suggest improvement ideas

### Week 4: Control Phase and Final Project

- Introduction to Statistical Process Control (SPC) and control charts
- Designing a control plan to sustain improvements
- Overview of software tools (Excel, Minitab basics)
- Final Assignment: Complete and present a mini Six Sigma project applying the DMAIC cycle

### 11.3 Certification

Certificate will be awarded upon attending at least 80% of sessions, completing weekly assignments, and submitting a final mini-project demonstrating the application of Six Sigma principles.



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