RET 7105 Statistics and Research Methods

Course Description:

This course presents the fundamentals, concepts and methods used in the analysis of data. It covers definitions, methods of computation of the various measures of data summarization. It also introduces stochastic analysis of events and the test used to assess whether a given set of data fits into some general pattern. The course will also cover advanced engineering research skills, focusing on research design, design of data collection instruments, implementation of data collection plans, and principles of research report writing and dissemination.

AIM:

The aims of this course are to:

- Provide students with a strong knowledge base for mathematical analysis.
- Equip students with background and fundamental knowledge behind the techniques for analyzing a vast amount of data for different scenarios with ease
- Equip students with the skills to use the tools for handling large amounts of data
- Explain to students the role of research in knowledge creation
- Instruct students on how research is conducted practically and in academic circles

Detailed Course Content:

1. Research Methods (25 Hours)

Introduction: Definition of Research, Role of Research in the Engineering Profession, Types of Research (Basic Vs Applied; Primary Vs Secondary; Exploratory Vs Constructive Vs Empirical), Research Processes (The Scientific Vs Historical Research Process), Information Literacy Strategies, Research Fundin, Research and Publishing

1.2 Elements of General Academic Writing: The Writing Process (Invention, Composition and Revision), Research Concept Note (Synopsis), Proposal, Thesis Report, Papers, Abstracts, Formatting Style (MLA Vs APA)

1.3 Identifying and Formulating a Research Problem: Definition of Research Problem, Identify a Research Problem (Sources of Research Problems), Testing the Feasibility of the Research Problem, Formulating a Research Problem, Statement of the Problem, Components of a Problem Statement

1.4 Developing Other Proposal Components: Formulating a Research Title, Formulating and Stating the Research Objectives, Stating the Research Justification, Literature Review, The Research

Methodology, The Research Resources Plan (Work plan, and Budget), References and Bibliography, Appendices, Pagination of Research Proposal

1.5 Research Ethics: Intellectual Property Rights (Makerere IPM Policy and other International IPM Policies), Research Ownership and Mandate of Researcher, Research and Citations (Notation and Standards), Plagiarism (Definition, manifestation, and consequences), Authenticity of Facts and Opinions (Proper Research Language and avoiding weasel word and fallacies), Rights of Human and Animal Survey Respondents

1.6 Data Collections and Analysis : Designing and Executing a Survey, Sources of Data, Sample and Populations, Sampling Methods, Quantitative and Qualitative Approaches, Data Collections Instruments and Methods, their Context and Limitations (Questionnaires Vs Interview Vs Check Lists), Questionnaire Design: Types of Questions, Response Rate and Sample Size, Coding Data: Missing Values, Open Ended Questions

1.7 Research Designing: Choosing an Operational Definition, Experimental and Non-Experimental Designs, Internal and External Validity and Associated Threats, Groups Vs Repeated Measure Design

1.8 Presentation of Research: Oral Presentation (Proposal and Viva Voce), Use of Presentation Aides, Use of Graphics and Animations in Presenting Research, Presentation Language

2. Statistics and Data Analysis (20 Hours)

2.1 Introduction: Definition of Statistics, Role of Statistics in Engineering Research, Misuse and Abuse of Statistics, Data Measurement

2.2 Descriptive Statistics : Introduction , Frequency Distributions: Histograms and bar charts, The shape of a distribution, Determining if skewness and kurtosis are significantly non-normal, Central Tendency: Measures of central tendency, Choosing a measure of central tendency, Variability: Sums of squares, Variance, Standard deviation, The Normal Distribution, Transformations: Dichotomisation, Z-scores, The standard normal distribution, Normalising, Correlation and Regression, Descriptive Statistics Using Data Analysis Software

2.3 Inferential Statistics: Introduction, Null and alternative hypotheses, Hypothesis testing, Type I and Type II Errors, Analysis of Variance (ANOVA), Inferential Statistics using Data Analysis Software

2.4 **Probability**: probability basics, probability distributions and expectations (2 hrs). Cases of probability distribution curves: poisson and binomial distributions, normal (Gaussian), exponential, gamma, beta and other distributions

Learning Outcomes

At the end of this course, a student should be able to:

- Explain the mathematical concepts of data occurrence and analysis
- Apply the different methods of displaying and reporting data
- Compute the various quantities used to summarize data
- Distinguish among the different scenarios of occurrence of events
- To test different data sets to find which models best describe them
- Explain the various terminology used in research methods
- Describe the various research designs applied in research
- Develop a research proposal including identification of a research problem, formulation of research objectives, description of the methodology and the data analysis techniques
- Identify shortcoming in research proposals, designs and reports

Teaching and Learning Pattern

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

References:

1. **Jay L. Devore**, *"Probability and Statistics for Engineering and the Sciences"*, Cole Publishing Company, Latest edition
2. **Patrick Neil & Steve Chapman,** *"Research Methods", 3rd Edition*, Poutledge Taylor & Francis Group, 1985
3. **Brenda Laurel (ed.)**, *"Design Research; Methods and Perspecitves"*, MIT Press, 2004
4. Handbook of Mathematics for Engineers and Scientists ***Andrei Polyanin, Alexander Manzhirov***