

## MODULE SPECIFICATION

<b>Module Title</b>	Probability and Statistics for Engineers
<b>Module Code</b>	STAT 465
<b>Credits</b>	4
<b>Pre-requisites</b> ( <i>including Year 1</i> )	Calculus III and Introduction to Probability and Statistics

### Description

<b>Course Overview</b>
<p>This course introduces the fundamental principles of probability and statistics with emphasis on engineering and applied scientific applications. Students develop probabilistic reasoning skills, statistical intuition, and analytical techniques commonly used in engineering, manufacturing, data analysis, quality improvement, and scientific decision-making. The course integrates theoretical foundations with practical problem-solving methods using real-world engineering examples.</p> <p>Topics include probability concepts, discrete and continuous random variables, probability distributions, descriptive statistics, parameter estimation, confidence intervals, hypothesis testing, regression analysis, and statistical inference methods used in engineering practice.</p> <p>By the end of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Apply probability laws to engineering and scientific problems</li> <li>• Analyze discrete and continuous probability distributions</li> <li>• Compute and interpret descriptive statistical measures</li> <li>• Construct confidence intervals and perform parameter estimation</li> <li>• Conduct hypothesis tests using appropriate statistical methods</li> <li>• Develop and interpret simple linear regression models</li> <li>• Apply statistical reasoning to engineering decision-making and data analysis</li> </ul>
<b>Method of Teaching and Learning</b>
<p>This module will be taught using a combination of lectures, tutorials and consultation hours. Learning will also be reinforced by appropriate readings from the course text.</p>
<b>Syllabus</b>
<p>Modules</p> <p><b>Module 1 – Introduction to Statistics and Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Types of data and variables</li> <li>• Engineering applications of statistics</li> <li>• Descriptive and inferential statistics</li> <li>• Data collection methods</li> </ul>

- Graphical and numerical summaries of data
- Measures of central tendency and variability
- Stem-and-leaf plots, histograms, boxplots, and scatterplots

**Module 2 – Fundamentals of Probability**

- Sample spaces and events
- Set operations and Venn diagrams
- Counting methods and combinatorics
- Permutations and combinations
- Probability axioms and rules
- Conditional probability
- Independence of events
- Bayes' theorem

**Module 3 – Discrete Random Variables and Distributions**

- Random variables and probability distributions
- Probability mass functions
- Expected value and variance
- Bernoulli distribution
- Binomial distribution
- Geometric and negative binomial distributions
- Hypergeometric distribution
- Poisson distribution

**Module 4 – Continuous Random Variables and Distributions**

- Continuous probability distributions
- Probability density functions
- Cumulative distribution functions
- Expected value and variance for continuous variables
- Uniform distribution
- Normal distribution
- Standard normal distribution
- Exponential distribution
- Gamma and Weibull distributions

**Module 5 – Joint Probability Distributions**

- Joint probability distributions
- Marginal distributions
- Conditional distributions
- Covariance and correlation
- Independent random variables
- Functions of random variables

**Module 6 – Descriptive Statistics and Exploratory Data Analysis**

- Data visualization techniques
- Measures of location and spread
- Percentiles and quartiles
- Boxplots and comparative graphical analysis
- Correlation analysis

- Exploratory interpretation of engineering data

#### **Module 7 – Sampling Distributions**

- Random sampling
- Sampling distributions of means and proportions
- Central Limit Theorem
- Sampling distribution of variance
- Chi-square, t, and F distributions

#### **Module 8 – Point Estimation**

- Statistical estimation concepts
- Point estimators
- Properties of estimators
- Bias and unbiasedness
- Efficiency and consistency
- Maximum likelihood estimation
- Method of moments estimation

#### **Module 9 – Confidence Intervals**

- Confidence interval fundamentals
- Confidence intervals for a single mean
- Confidence intervals for proportions
- Confidence intervals for variances and standard deviations
- Sample size determination
- Two-sample confidence intervals

#### **Module 10 – Hypothesis Testing I**

- Fundamentals of hypothesis testing
- Null and alternative hypotheses
- Type I and Type II errors
- p-values and significance levels
- One-sample hypothesis tests
- Tests for means and proportions
- Hypothesis testing using normal and t distributions

#### **Module 11 – Hypothesis Testing II**

- Two-sample hypothesis testing
- Paired comparisons
- Tests for variances
- Goodness-of-fit testing
- Chi-square tests
- Analysis of categorical data
- Statistical decision-making in engineering

#### **Module 12 – Simple Linear Regression**

- Introduction to regression analysis
- Least squares estimation
- Regression equations
- Correlation and coefficient of determination
- Residual analysis

- Model assumptions
- Confidence intervals and hypothesis tests for regression parameters
- Engineering applications of regression models

**Module 13 – Regression Applications and Model Diagnostics**

- Multiple regression concepts
- Model building strategies
- Prediction and forecasting
- Residual diagnostics
- Multicollinearity concepts
- Practical engineering case studies

**Supplemental Readings Provided by Instructor**

**Module 14 – Comprehensive Review and Final Examination Preparation**

- Integrated review of probability concepts
- Review of statistical inference procedures
- Regression interpretation and applications
- Practice problem sessions
- Final examination preparation

## Assessment

Assessment Type	% of Final Mark
Midterm 1	25%
Midterm 2	25%
Final Exam	30%
Homework & Quizzes	10%
Course Participation	10%

<i>Range</i>	<i>Letter Grade</i>
90% - 100%	A
80% – 89%	B
70% - 79%	C
60% - 69%	D
< 60%	U

## Textbooks

### *Mandatory Textbooks*

<b>Title</b>	<b>Editor/Author</b>	<b>ISBN/Publisher</b>
<i>Applied Statistics and Probability for Engineers, 7th Edition</i>	Montgomery, D. C., & Runger, G. C.	Wiley

### *Optional Textbooks*

<b>Title</b>	<b>Author</b>	<b>ISBN/Publisher</b>
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### *Reference Textbooks*

<b>Title</b>	<b>Author</b>	<b>ISBN/Publisher</b>
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