

## Module 1: Reliability Mathematics

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| Day 1                                                                                                                                                                                                                                                                  | Session 1<br>(9:30 AM - 1:00 PM) | <b>INTRODUCTION TO RELIABILITY</b> <ul style="list-style-type: none"> <li>Reliability, Availability, Maintainability, and Safety Terms and Definitions</li> <li>Times-to-Failure Distribution, Reliability, Conditional Reliability, Failure Rate, Mean Life, MTTF, MTBF, Median Life.</li> <li>Bath-Tub Curve</li> <li>Probability Basics (Sets, Permutation, Combination, Probability, Central Tendency, Variance, Covariance, Random Variables etc.)</li> <li><i>Exercises using Calculator</i></li> </ul> |
|                                                                                                                                                                                                                                                                        | Session 2<br>(2:30 PM - 6:00 PM) | <b>IMPORTANT DISCRETE DISTRIBUTIONS</b> <ul style="list-style-type: none"> <li>Discrete Distributions: Uniform, Binomial, Negative Binomial, Geometric, Poisson etc.</li> <li><i>Exercises</i></li> </ul>                                                                                                                                                                                                                                                                                                     |
| Day 2                                                                                                                                                                                                                                                                  | Session 3<br>(9:30 AM - 1:00 PM) | <b>IMPORTANT CONTINUOUS DISTRIBUTIONS</b> <ul style="list-style-type: none"> <li>Continuous Distributions: Normal, Exponential, Weibull, Lognormal, Gamma etc.</li> <li><i>Exercises</i></li> </ul>                                                                                                                                                                                                                                                                                                           |
|                                                                                                                                                                                                                                                                        | Session 4<br>(2:30 PM - 6:00 PM) | <b>PRACTICE PROBLEMS ON RELIABILITY CALCULATIONS</b> <ul style="list-style-type: none"> <li><i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                                                                                                                                                                                                                                                  |
| <b>PLEASE NOTE:</b> <ol style="list-style-type: none"> <li>Each Session has three hours of interaction divided in multiple lectures.</li> <li>Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Module 2: Reliability Estimation (Non-repairable systems)

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | <b>INTRODUCTION TO ESTIMATION</b> <ul style="list-style-type: none"> <li>• The need and purpose of estimation</li> <li>• Data Types: Complete, Censored</li> <li>• Point and Interval Estimation</li> <li>• Maximum Likelihood Estimation (MLE)</li> <li>• Least Square Error (LSE)</li> <li>• <i>Exercises using Excel/Minitab</i></li> </ul>                                         |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | <b>NON-PARAMETRIC DATA ANALYSIS</b> <ul style="list-style-type: none"> <li>• Evaluation of basic reliability terms: Reliability, Unreliability, Hazard Rate, PDF etc.</li> <li>• <i>Exercises using Excel</i></li> </ul>                                                                                                                                                               |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | <b>PARAMETER ESTIMATION</b> <ul style="list-style-type: none"> <li>• Inferential Statistics: Null &amp; Alternate Hypotheses, Z, t, F, Chi-square etc.</li> <li>• Distribution Fitting and Parameter Estimation</li> <li>• Graphical Approach for Distribution Fitting and Parameter Estimation</li> <li>• Point and Interval Estimation</li> <li>• Exercises using Minitab</li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | <b>PRACTICE PROBLEMS ON ESTIMATION</b> <ul style="list-style-type: none"> <li>• <i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                                                                                                                                       |
| <b>PLEASE NOTE:</b> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                                                                                                        |

### Module 3: System Reliability Modeling

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | <b>RELIABILITY BLOCK DIAGRAM</b> <ul style="list-style-type: none"> <li>• Model Representations: RBD, Network graph etc.</li> <li>• Static Reliability Models (Series, Parallel Systems)</li> <li>• k out of m systems</li> <li>• Concept of Minimal Pathset and Cutset</li> <li>• Reliability with Multiple Failure Modes.</li> <li>• Reliability of Systems with Cyclic Load</li> <li>• <i>Exercises using Calculator</i></li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | <b>MARKOV MODELS</b> <ul style="list-style-type: none"> <li>• Discrete Markov Models</li> <li>• Continuous Markov Models</li> <li>• System Modeling using Markov Models</li> <li>• <i>Exercises using Excel</i></li> </ul>                                                                                                                                                                                                             |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | <b>STRESS-STRENGTH MODELS</b> <ul style="list-style-type: none"> <li>• Stress-strength analysis using various distributions and their combinations.</li> <li>• Normal Distribution Stress–Normal Distribution Strength</li> <li>• Normal Distribution Stress–Weibull Distribution Strength</li> <li>• Weibull Distributed Stress–Weibull Distribution Strength</li> <li>• <i>Exercises using Minitab</i></li> </ul>                    |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | <b>PRACTICE PROBLEMS ON MODELING</b> <ul style="list-style-type: none"> <li>• <i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                                                                                                                                                                                         |
| <b>PLEASE NOTE:</b> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Module 4: Design for Reliability (DfR)

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | RELIABILITY SPECIFICATIONS AND ALLOCATION <ul style="list-style-type: none"> <li>• Components of Reliability Specifications</li> <li>• Reliability Allocation</li> <li>• <i>Exercises using Excel</i></li> </ul>                                                                                             |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | RELIABILITY PREDICTION <ul style="list-style-type: none"> <li>• RIAC 217 Plus and others</li> <li>• <i>Exercises using Excel</i></li> </ul>                                                                                                                                                                  |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | RELIABILITY DESIGN TECHNIQUES <ul style="list-style-type: none"> <li>• Part and Material Selection</li> <li>• Redundancy Allocation</li> <li>• Derating Analysis</li> <li>• S-N Curve</li> <li>• Degradation Analysis</li> <li>• Life Cycle Cost Modeling</li> <li>• <i>Exercises using Excel</i></li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | PRACTICE PROBLEMS ON DFR <ul style="list-style-type: none"> <li>• <i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                                                                           |
| <p>PLEASE NOTE:</p> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                              |

## Module 5: Repairable System Modeling

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | <b>MAINTAINABILITY AND AVAILABILITY</b> <ul style="list-style-type: none"> <li>• Types of Maintenance</li> <li>• Components of Downtime</li> <li>• Repair Time Distributions</li> <li>• Availability and Maintainability</li> <li>• Reliability under Preventive Maintenance</li> <li>• <i>Exercises using Excel</i></li> </ul>           |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | <b>STOCHASTIC POINT PROCESSES</b> <ul style="list-style-type: none"> <li>• Renewal Process</li> <li>• Minimal Repair Process</li> <li>• Generalized Repair Process</li> <li>• System Repair Time</li> <li>• Repair Time Allocation</li> <li>• <i>Exercises using Excel</i></li> </ul>                                                     |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | <b>DESIGN TRADEOFFS AND SPARE PROVISIONING</b> <ul style="list-style-type: none"> <li>• Effect of Modularization, accessibility, self-diagnosis etc. on maintainability</li> <li>• Spare Provisioning</li> <li>• Repair vs replacement</li> <li>• Queuing Models for Repair Facilities</li> <li>• <i>Exercises using Excel</i></li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | <b>AVAILABILITY EVALUATION</b> <ul style="list-style-type: none"> <li>• Understanding Availability</li> <li>• System Availability Evaluation</li> <li>• <i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                  |
| <b>PLEASE NOTE:</b> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                                                           |

## Module 6: Field Data Analysis

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | INTRODUCTION <ul style="list-style-type: none"> <li>• Data Sources</li> <li>• Warranty Data</li> <li>• Warranty terms and conditions, uses and limitations</li> <li>• Failure Reporting and Corrective Action System (FRACAS)</li> <li>• <i>Exercises using Minitab</i></li> </ul>                 |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | REPAIRABLE SYSTEM DATA ANALYSIS <ul style="list-style-type: none"> <li>• Repairable System Data Analysis Approach</li> <li>• Statistical Test to dependency, trend etc.</li> <li>• Correlation and Regression</li> <li>• Degradation Analysis</li> <li>• <i>Exercises using Minitab</i></li> </ul> |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | FIELD DATA ANALYSIS CASE STUDY <ul style="list-style-type: none"> <li>• Evaluating Maintainability, Availability, Reliability etc.</li> <li>• <i>Exercises using Minitab</i></li> </ul>                                                                                                            |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | PRACTICE PROBLEMS ON FIELD DATA <ul style="list-style-type: none"> <li>• <i>Exercises using Minitab</i></li> </ul>                                                                                                                                                                                 |
| <p>PLEASE NOTE:</p> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                    |

## Module 7: Basic Risk Modeling

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | HAZARD IDENTIFICATION <ul style="list-style-type: none"> <li>• Definitions of Hazard and Risk</li> <li>• Preliminary Hazard Analysis</li> <li>• Risk Matrix</li> <li>• FMECA</li> <li>• <i>Group Activity on Performing PHA/FMECA</i></li> </ul>                 |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | RISK MODELING <ul style="list-style-type: none"> <li>• Fault Tree Analysis</li> <li>• Event Tree Analysis</li> </ul>                                                                                                                                             |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | SENSITIVITY AND UNCERTAINTY ANALYSIS <ul style="list-style-type: none"> <li>• Risk Importance Measures</li> <li>• Uncertainly Analysis (Method of Moments, Monte Carlo Simulation)</li> <li>• Risk Acceptance</li> <li>• <i>Exercises using Excel</i></li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | PRACTICE PROBLEMS ON RISK EVALUATION <ul style="list-style-type: none"> <li>• <i>Exercises using Excel, Minitab</i></li> </ul>                                                                                                                                   |
| <p>PLEASE NOTE:</p> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                  |

## Module 8: Reliability Testing

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | <b>RELIABILITY ESTIMATION (ACCELERATED LIFE TEST)</b> <ul style="list-style-type: none"> <li>• Types of life tests</li> <li>• </li> <li>• Understanding Use Profile</li> <li>• Understanding Applicability of Stresses</li> <li>• Life Stress Models</li> <li>• <i>Exercises using Minitab</i></li> </ul> |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | <b>RELIABILITY DEMONSTRATION</b> <ul style="list-style-type: none"> <li>• Acceptance Test Plan (Producer Risk, Customer Risk etc.)</li> <li>• Success Run Theorem</li> <li>• Sampling Plans</li> <li>• Sequential Test Plan</li> <li>• <i>Exercises using Excel/Minitab</i></li> </ul>                    |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | <b>HALT/HAST</b> <ul style="list-style-type: none"> <li>• HALT Philosophy and Procedure</li> <li>• HAST Philosophy</li> </ul>                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | <b>BURN-IN/ESS/HASS</b> <ul style="list-style-type: none"> <li>• Burn In</li> <li>• ESS</li> <li>• HASS</li> </ul>                                                                                                                                                                                        |
| <b>PLEASE NOTE:</b> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                                                                                                                                           |



## Module 9: Quality Control

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| Day 1                                                                                                                                                                                                                                                                        | Session 1<br>(9:30 AM - 1:00 PM) | INTRODUCTION TO QUALITY <ul style="list-style-type: none"> <li>• On-line Quality Methods</li> <li>• Control Charts for Variables</li> <li>• <i>Exercises using Minitab</i></li> </ul>        |
|                                                                                                                                                                                                                                                                              | Session 2<br>(2:30 PM - 6:00 PM) | CONTROL CHARTS FOR ATTRIBUTES <ul style="list-style-type: none"> <li>• Process Capability Analysis</li> <li>• Acceptance Sampling Plans</li> <li>• <i>Exercises using Minitab</i></li> </ul> |
| Day 2                                                                                                                                                                                                                                                                        | Session 3<br>(9:30 AM - 1:00 PM) | DESIGN OF EXPERIMENT AND ROBUST DESIGN <ul style="list-style-type: none"> <li>• ANOVA</li> <li>• Taguchi Concepts</li> <li>• <i>Exercises using Minitab</i></li> </ul>                       |
|                                                                                                                                                                                                                                                                              | Session 4<br>(2:30 PM - 6:00 PM) | PRACTICE PROBLEMS <ul style="list-style-type: none"> <li>• <i>Exercises using Minitab</i></li> </ul>                                                                                         |
| <p>PLEASE NOTE:</p> <ol style="list-style-type: none"> <li>1. Each Session has three hours of interaction divided in multiple lectures.</li> <li>2. Assignments shall be given at the end of each module. These assignments are to be submitted in one week time.</li> </ol> |                                  |                                                                                                                                                                                              |

## Module 10: Introduction to Software Reliability

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| Day 1                                                                                                                                                                                                                                                                 | Session 1<br>(9:30 AM - 1:00 PM) | SOFTWARE FAULT TOLERANCE <ul style="list-style-type: none"> <li>• Approaches to Software Fault Tolerance</li> <li>• Recovery Block</li> <li>• N-Version Programming</li> <li>• Retry Block</li> <li>• N-Copy Programming etc.</li> <li>• <i>Discussion</i></li> </ul>                        |
|                                                                                                                                                                                                                                                                       | Session 2<br>(2:30 PM - 6:00 PM) | SOFTWARE RELIABILITY MODELS <ul style="list-style-type: none"> <li>• Software Reliability Modeling Approaches: Estimation, Prediction</li> <li>• Model Classification</li> <li>• Popular Software Reliability Growth Models: GO, SW, Musa, Yamada etc.</li> <li>• <i>Examples</i></li> </ul> |
| Day 2                                                                                                                                                                                                                                                                 | Session 3<br>(9:30 AM - 1:00 PM) | SOFTWARE RELIABILITY PREDICTION: ARTIFICIAL NEURAL NETWORK APPROACH <ul style="list-style-type: none"> <li>• ANN Models for Defect Prediction</li> <li>• ANN Model for Classification of Fault Prone Modules</li> <li>• <i>Examples</i></li> </ul>                                           |
|                                                                                                                                                                                                                                                                       | Session 4<br>(2:30 PM - 6:00 PM) | SOFTWARE RELIABILITY PREDICTION: FUZZY LOGIC APPROACH <ul style="list-style-type: none"> <li>• Fuzzy Approach to Early Software Reliability Prediction</li> <li>• Defect Prediction</li> <li>• Classification of Fault Prone Modules</li> <li>• <i>Examples</i></li> </ul>                   |
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