Case Number: 88ABW-2021-0391

STAT 110 Syllabus

Last Updated: 3/11/21

Course Description

This one-day course, designed for any audience, will introduce The Scientific Test and Analysis Techniques (STAT) Process - a powerful methodology for test and evaluation. The course demonstrates how STAT is critical in the planning, design, execution, and analysis of test. The course shows application of the STAT process using real life case studies from the STAT COE. It introduces methods available in the STAT toolbox to evaluate system performance against identified requirements and highlights the uses of sequential testing. Students will leave this class with an understanding of the STAT Process and an arsenal of questions to ask during test planning to ensure your test program is rigorous and defensible. This class is intended for anyone interested in STAT for T&E and is typically delivered virtually in two half-day sessions.

Course Goals/Objectives

A student who successfully completes this course will:

1. Demonstrate proper use of the language of STAT and the STAT process
2. Identify STAT candidates from a list of requirements
3. Compare and describe the methods available in the STAT toolbox for use on the STAT candidates
4. Identify how sequential testing can be used to enhance decision quality information
5. Justify the use of STAT in testing to be a STAT/STAT COE advocate

Course Duration

1 Class Day (total of 6 hours of material for one day) – typically delivered virtually over two days

Course Materials

Electronic copies of slides and course notes will be provided.

Target Audience

In general, we recommend this course for any person interested in STAT for T&E.

Student Standards

All students must be familiar with and adhere to the standards of academic freedom, nonattribution and academic integrity. Below are the definitions for these terms:

Academic Freedom

- You may express your opinions concerning current or proposed policies, regulations and procedures openly, honestly, and professionally
- You may not attack the character, personality or other personal attributes of any individual
- Academic freedom must be tempered by good judgment to refrain from making offensive remarks, unfounded opinions, or irresponsible statements.

Non-Attribution

- What you say in class will not be attributed to you if and when your thoughts or ideas are repeated outside of class
- All guest speakers, students, and permanent-party personnel are prohibited from divulging the identity of any particular speaker, whether a guest speaker, faculty member, or student, for the purpose of attributing to that speaker any specific remarks or statements, including but not limited to offensive remarks and irresponsible statements

STAT 410 Syllabus

Last Updated: 3/17/21

Course Description

This half-day course, designed for executives, will introduce the Scientific Test and Analysis Techniques (STAT) Process - a powerful methodology for test and evaluation. The course provides a high level overview of STAT with a focus on planning and reporting results. The course utilizes STAT COE case studies to demonstrate real-life applications of STAT. Executives will leave this course knowing how to support STAT implementation in their current work by asking insightful questions on STAT rigor.

Course Goals/Objectives

A student who successfully completes this course will:

1. Justify the use of STAT to senior leadership
2. Understand a formal process to implement STAT in a variety of test scenarios
3. Describe the planning process and how to report risk and results to maximize information from a test
4. Recognize the cost, risk, schedule, and information tradeoffs when planning a test
5. Recognize the value of STAT in real-life applications from the STAT COE
6. Formulate relevant questions regarding STAT use in programs

Course Duration

Half-class Day (total of 4 hours of material for one day)

Course Materials

Electronic copies of slides will be provided.

Target Audience

In general, we recommend this course for SES-equivalent or higher.

Student Standards

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DOE 320 Syllabus

Last Updated: 3/9/21

Course Description

This two-day course introduces the basic concepts of Scientific Test and Analysis Techniques (STAT), with a focus on Design on Experiments (DOE) and how it can be applied to test programs. The course emphasizes why DOE is important in DOD testing and how it can be applied for many different systems under test. Students will leave this class with an understanding of the STAT Process and an arsenal of questions to ask during test planning to ensure your test program is rigorous and defensible. Students will also learn test metrics to evaluate the risk that a program incurs by tracing risk through test planning, design, execution, and analysis. This course is intended for practitioners, managers, and stakeholders with a few hands-on activities and software demonstrations.

Course Goals/Objectives

A student who successfully completes this course will:

1. Understand concepts, principles, and tools of the Scientific Test and Analysis Techniques (STAT) Process
2. Explain the planning elements of a comprehensive test design
3. Understand the basic concepts of design and analysis of experiments including factorial and optimal designs
4. Identify assumptions and principles of test execution
5. Interpret results of a designed experiment using linear regression

Course Duration & Schedule

2 Class Days, 0800-1630, including a one-hour lunch break (on your own)

Day	Lesson Description
Day 1	1 Introduction and overview 2 Stats Foundation 3 Planning
Day 2	4 2k Designs 5 Execution 6 Analysis 7 Constraints and Limitations

Course Materials

Course notes (print and electronic copies) will be provided along with data files used in demonstrations. Laptops are not required for this course, but you're welcome to follow along with us. We will demonstrate a few techniques for you using the statistical software package JMP.

Target Audience

GS-11 and above, O-2 and above, or equivalent
In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: program manager, T&E lead, chief developmental tester, test engineer, test manager, test scientist, range/lab personnel.

Continuous Learning Points (CLPs)

In order for students to receive 16 continuous learning points for this course, we expect students to be present and participating throughout the course. Students gone for longer than a total of 2 hours of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

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Lesson Outline and Objectives

Lesson 1 – Introduction and Overview

Lesson Objectives: The objectives of this lesson are for each student to:

- Summarize the STAT Process
- Recognize policy and guidance for implementing STAT in DOD test and evaluation
- Understand the difference between assigning causation and correlation in test results
- Define what DOE is and is not
- Differentiate a designed experiment from other approaches

Lesson 2 – Statistics Foundations

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain the difference between a population and a sample
- Discuss the best methods (graphically and numerically) to describe a dataset
- Recognize the importance of the Central Limit Theorem
- Identify the differences among confidence intervals, prediction intervals, and tolerance intervals
- Interpret the results of a confidence interval and hypothesis test

Lesson 3 – Planning

Lesson Objectives: The objectives of this lesson are for each student to:

- Recognize the importance of system decomposition and the mapping to the requirements
- Understand why defining a test objective is important to test planning
- Understand methods to generate and evaluate responses and factors
- Describe the difference between continuous and categorical responses and factors
- Identify the importance of the design metrics and the impacts to the design size

Lesson 4 – 2^k Designs

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand the basics of Full Factorial and Fractional Factorial Designs
- Discuss how to evaluate a test design through power analysis and evaluating color maps of correlation
- Understand and use randomization, blocking, and replication in test designs
- Apply design and test execution methods to a sample problem

Lesson 5 – Execution

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain how data collection limitations can impact test planning

- Understand consequences to analysis when test execution deviates
- Justify why the test team needs to understand the fundamentals of DOE

Lesson 6 – Analysis

Lesson Objectives: The objectives of this lesson are for each student to:

- Interpret results of ANOVA in context of the problem statement
- Recognize when regression analysis can be used to study relationships between variables
- Describe methods and implications of model fit

Lesson 7 – Constraints and Limitations

Lesson Objectives: The objectives of this lesson are for each student to:

- Describe methods to design a test with resource limitations
- Identify hard to change factors and how to implement in a design
- Recognize how disallowed combinations impact designs
- Describe when to use a sequential approach to testing

DOE 251 Syllabus

Last Updated: 3/2/21

Course Description

This five-day course in design of experiments (DOE) teaches students basic techniques and processes needed to create a statistically rigorous and defensible test for complex systems. A well-designed test can lead to reduced development lead time with fewer test runs required, provide greater insight into system performance, and ultimately lead to fielding better systems. Using examples from military test and evaluation (T&E) and the students' own test experiences, the course has a strong applied flavor. Students will learn how to plan, design, and analyze tests efficiently and effectively. Students will learn a disciplined approach via the STAT Process to clearly define the test objectives, responses, input factors that impact the responses, and the recommended settings for these factors to effectively span the test space. Students will design effective tests and understand tradeoffs in risk versus test size through appropriate sample size computations. Students will construct efficient test run matrices, develop statistical models, test models for assumptions, and quantify the uncertainty of test results. Factorial, fractional factorial, and custom designs are the methods used throughout this course. Hands-on class projects and exercises will reinforce learning objectives.

Course Goals/Objectives

A student who successfully completes this course will:

1. Understand concepts, principles, and tools of the Scientific Test and Analysis Techniques (STAT) Process
2. Recognize when and how to use tools for each phase of the STAT Process: Plan, Design, Execute, and Analyze
3. Understand the basic concepts of design and analysis of experiments including factorial and optimal designs
4. Identify assumptions and principles of test execution
5. Interpret results of a designed experiment
6. Apply knowledge and tools to execute the STAT process on a class project

Course Duration & Schedule

4.5 Class Days (flexibly scheduled based on class and classroom conditions), 0800-1630 Monday through Thursday and 0800-1230 Friday.

Day	Lesson Description
Day 1	1 Introduction and overview 2 Stats Foundation
Day 2	3 Planning
Day 3	4 Design 5 2k Designs 6 Execution
Day 4	7 Analysis Catapult Experiment
Day 5	Catapult Analysis 8 Constraints and Limitations

Course Materials

Students will need to bring a laptop with the JMP trial version installed. Course notes (print and electronic copies) will be provided along with JMP files.

Target Audience

GS-11 and above, O-2 and above, or equivalent
In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: test engineer, test manager, and test scientist.

Continuous Learning Points (CLPs)

In order for students to receive 36 continuous learning points for this course, we expect students to be present and participating throughout the course. Students gone for longer than a total of 3 hours of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

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Lesson Outline and Objectives

Lesson 1 – Introduction and Overview

Lesson Objectives: The objectives of this lesson are for each student to:

- Summarize the STAT Process
- Recognize policy and guidance for implementing STAT in DOD test and evaluation
- Understand the difference between assigning causation and correlation in test results
- Define what DOE is and is not
- Differentiate a designed experiment from other approaches

Lesson 2 – Statistics Foundations

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain the difference between a population and a sample
- Discuss the best methods (graphically and numerically) to describe a dataset
- Recognize the importance of the Central Limit Theorem
- Identify the differences among confidence intervals, prediction intervals, and tolerance intervals
- Interpret the results of a confidence interval and hypothesis test

Lesson 3 – Planning

Lesson Objectives: The objectives of this lesson are for each student to:

- Recognize the importance of system decomposition and the mapping to the requirements
- Understand why defining a test objective is important to test planning
- Understand methods to generate and evaluate responses and factors
- Describe the difference between continuous and categorical responses and factors
- Explain the importance of the design metrics and the impacts to the design size

Lesson 4- Design

Lesson Objectives: The objectives of this lesson are for each student to:

- Outline the basics of a designed experiment
- Understand the characteristics of a factorial design
- Interpret basic results from a factorial design

Lesson 5 – 2^k Factorial Designs

Lesson Objectives: The objectives of this lesson are for each student to:

- Distinguish the properties of Full Factorial and Fractional Factorial Designs
- Evaluate a test design through power analysis and color maps of correlation
- Understand and use randomization, blocking, and replication in test designs

Lesson 6- Execution

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain how data collection limitations can impact test planning
- Understand consequences to analysis when test execution deviates
- Justify why the test team needs to understand the fundamentals of DOE

Lesson 7- Analysis

Lesson Objectives: The objectives of this lesson are for each student to:

- Interpret results of ANOVA in context of the problem statement
- Recognize when regression analysis can be used to study relationships between variables
- Evaluate regression models to ensure assumptions are met
- Differentiate between the different analysis techniques that can be used on designs

Lesson 8 – Constraints and Limitations

Lesson Objectives: The objectives of this lesson are for each student to:

- Describe methods to design a test with resource limitations
- Understand benefits & limitations of computer-generated custom designs
- Identify hard to change factors and how to implement in a design
- Recognize how disallowed combinations impact designs
- Describe when and how to use a sequential approach to testing

DOE 252 Syllabus

Last Updated: 3/4/21

Pre-requisite: DOE 251

Course Description

This course reinforces the fundamentals from DOE 251, examines (more closely) what a good design entails across a variety of metrics, introduces new classes of designs, and provides advanced modeling and analysis methods. Design evaluation topics include power, sample size, optimality, and aliasing criteria. Students will learn additional design approaches for realistic test issues such as constrained test regions, multiple factor levels, categorical factors, nuisance factors, and hard-to-change factors. Sequential design is highlighted with augmentation methods. The course begins by reinforcing and building upon student knowledge (from DOE 251) on factorials, power, fractional factorials, and optimal designs. Advanced material on definitive screening designs are addressed with additional focus on response surface methods to model nonlinear behavior particularly when the test objective is to optimize performance; several variations of response surface designs are presented. The course includes advanced DOE topics and elective lessons that can be tailored to the organization's requirements including multiple response optimization, design optimality (with an introduction to robust screening and alias optimal designs), split-plot designs for hard-to-change factors, designs for software testing and others.

Course Goals/Objectives

A student who successfully completes this course will:

1. Apply concepts, principles, and tools of the Scientific Test and Analysis Techniques (STAT) Process
2. Understand how to evaluate commonly used test designs
3. Distinguish when and how to use blocked designs vs split plot designs
4. Select the appropriate analysis method for different response types
5. Understand how to use metrics to evaluate a design
6. Use JMP to perform common statistical tasks including exploratory data analysis, design of experiments, and analysis
7. Recommend the use of a particular type of design or test method suitable to the system under test

Course Duration

4.5 Class Days (flexibly scheduled based on class and classroom conditions), 0800-1630 Monday through Thursday and 0800-1230 Friday.

Day	Lesson Description
Day 1	1 Overview 2 Screening Designs 3 Analysis Review
Day 2	4 Response Surface Designs 5 Optimal Designs 6 Split Plot Designs
Day 3	7 Analysis of Binary Responses 8 Design for Simulation 9 Sequential Test and Evaluation
Day 4	NERF Gun Experiment NERF Gun Analysis Elective Modules
Day 5	Elective Modules

Course Materials

Students will need to bring a laptop with the JMP trial version installed. Course notes (print and electronic copies) will be provided along with JMP files

Target Audience

GS-11 and above, O-2 and above, or equivalent
In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: test engineer, test manager, and test scientist.

Continuous Learning Points (CLPs)

In order for students to receive 36 continuous learning points for this course, we expect students to be present and participating throughout the course. Students gone for longer than a total of 3 hours of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

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Lesson Outline and Objectives

Lesson 1 – Overview

This lesson discusses the:

- The course curriculum
- Learning expectations for students
- Choices of elective lessons

Lesson 2 – Screening Designs

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand the relevance of 2^k factorial designs for testing
- Explain the reasons why center points should be added to a design
- Understand the difference between a factorial and fractional factorial design
- Recognize some uses for definitive screening designs

Lesson 3 – Analysis Review

Lesson Objectives: The objectives of this lesson are for each student to:

- Interpret results of ANOVA in context of the problem statement
- Recognize when regression analysis can be used to study relationships between variables
- Evaluate regression models to ensure assumptions are met
- Understand how categorical factors are handled in regression
- Implement remedial measures when model assumptions fail
- Interpret results of a regression model in the context of the problem

Lesson 4 – Response Surface Designs

Lesson Objectives: The objectives of this lesson are for each student to:

- List the desirable properties of an RS design
- Define various types of surfaces
- Describe the basics of sequential testing
- Compare relevant design metrics
- Describe the different choices for central composite designs (CCD)

Lesson 5 – Optimal Designs

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand when to use an optimal design
- Explain the required inputs to create an optimal design
- Understand benefits and limitations of optimal designs
- Explain the difference between D- and I-optimal designs
- Create an optimal design suitable to the system under test

Lesson 6 – Split-Plots

Lesson Objectives: The objectives of this lesson are for each student to:

- Determine what differentiates split-plot designs from completely randomized designs and blocked designs
- Identify the two different error terms in models and their tradeoffs for split-plot designs
- Describe how to analyze a replicated and unreplicated split-plot design
- Create a split plot design suitable to the system under test

Lesson 7 – Analysis of Binary Responses

Lesson Objectives: The objectives of this lesson are for each student to:

- Evaluate a single proportion using point estimates, confidence intervals, and hypothesis tests
- Compare two independent proportions using confidence intervals, hypothesis tests, relative risk, and odds ratios
- Fit a predictive model for binary responses using logistic regression
- Interpret the output of a logistic regression model
- Assess the fit of a logistic regression model
- Understand potential pitfalls when fitting a logistic regression model
- Explain how to size a test for binary responses

Lesson 8 – Design for Simulation

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain the difference between deterministic and stochastic models
- Create space filling designs including sphere-packing, Latin hypercube, uniform, and fast flexible designs
- Understand the properties of space filling designs
- Compare space filling designs using common evaluation metrics and design geometry
- Analyze and interpret the results of space filling designs using Gaussian process modeling

Lesson 9 – Sequential Test and Evaluation

Lesson Objectives: The objectives of this lesson are for each student to:

- Justify the use of sequential testing
- Understand how to augment test designs to leverage existing data
- Identify test strategies to address resource cuts or schedule changes during testing
- Perform test design augmentation

Elective Modules (Class will choose)

Module A- Decision Trees (0.5 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Describe an appropriate use of a decision tree for analysis
- Interpret the results from a decision tree
- Evaluate the effectiveness of a decision tree
- Determine the appropriate size of a decision tree using validation data

Module B- Design Comparison (0.5 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Interpret methods to convey design choices
- Understand the rationale for comparing various design metrics
- Explain how to differentiate “best” design from “best value”

Module C- Designs for Software Testing (1 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand the scope, challenges, and common characteristics of software testing
- Understand which DOE techniques and principles apply to software testing
- Explain how covering arrays can be used to efficiently test software
- Interpret common design evaluation metrics for software tests

Module D- Equivalence Testing (0.5 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Differentiate between traditional hypothesis testing and equivalence testing
- Apply an equivalence test to sample problems
- Interpret the results of an equivalence test

Module E- Modeling and Simulation Test and Evaluation (1.5 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Recognize when to use modeling and simulation in the T&E spectrum
- Identify the different steps involved in M&S and the VV&A process
- Integrate M&S into the STAT process
- Discover statistical methods used for validation of M&S

Module F- Multiple Response Optimization (1 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Apply graphical and analytical methods to find settings of factors that optimize multiple responses simultaneously

Module G- Survey and Questionnaire design (1 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Identify the pros and cons of using a survey
- Describe the importance of a research question
- Recognize the STAT Process can be applied to survey design
- Contrast the differences between the different types of survey questions
- Recognize several analysis methods and their importance when designing a survey

Module H- Lessons Learned from Incompletely Randomized Design (0.5 hrs)

This lesson provides a case study of test executed differently than planned. Key concepts discussed in the case study include:

- Evaluate an original test design and provide recommendations for improvement
- Analyze data from the test that was actually executed
- Understand the limitations in conclusions drawn from the executed test
- Develop recommendations for future testing to resolve ambiguities of test results

Module I- Handling Missing and Messy Data (2.5 hrs)

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain when a covariate might be appropriate
- Name the different types of missing data
- Describe how missing data might change the outcome of an experiment
- Manipulate messy data into a more useable format using JMP

REL 220 Syllabus

Last Updated: 3/24/21

Course Description

This two-day course provides an overview of methods and concepts in reliability. The course emphasizes planning and analysis techniques for DoD reliability testing, both at the sub-system and system level. Students will learn how to apply the STAT process for reliability testing by assessing requirements, decomposing the system, creating a test design, and analyzing the results. Additional special topics include reliability growth methods, Bayesian reliability, and reliability software testing. This course is intended for practitioners, managers, and stakeholders with a few hands-on activities and software demonstrations.

Course Goals/Objectives

A student who successfully completes this course will:

1. Understand the nature of reliability and the purpose of testing for it
2. Understand requirements, system decomposition, and the tools at your disposal to form a strong plan to test for reliability
3. Design and execute effective, cost-efficient reliability tests
4. Analyze the results of a reliability test to draw meaningful and accurate conclusions
5. Recognize techniques to estimate reliability of complex systems (e.g., software systems)
6. Outline methods and tools for Reliability Growth Planning, Tracking, and Projection

Course Duration & Schedule

2 Class Days, 0800-1630, including a one-hour lunch break (on your own)

Day	Lesson Description
Day 1	1 Introduction to Reliability 2 Requirements for RAM 3 Assessing Reliability 4 System Reliability
Day 2	5 Test Planning and Assessing Risk 6 Reliability Growth, Tracking, and Projection 7 Bayesian Reliability Analysis 8 Software Reliability 9 Course Summary

Course Materials

Course notes (print and electronic copies) will be provided along with data files used in demonstrations. Laptops are not required for this course, but you're welcome to follow along with us. We will demonstrate a few techniques for you using the statistical software package JMP and Excel.

Target Audience

GS-11 and above, O-2 and above, or equivalent
In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: program manager, T&E lead, chief developmental tester, test engineer, test manager, test scientist, range/lab personnel, reliability engineer, reliability/RAM manager.

Continuous Learning Points (CLPs)

In order for students to receive 16 continuous learning points for this course, we expect students to be present and participating throughout the course. Students gone for longer than a total of 2 hours of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

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Lesson Outline and Objectives

Lesson 1 – Introduction to Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Summarize the STAT Process
- Understand the definitions of failures, reliability, availability, and maintainability
- Describe the difference between operational and materiel availability
- Explain how reliability is a key component to availability

Lesson 2 – Requirements for RAM

Lesson Objectives: The objectives of this lesson are for each student to:

- Recognize the genesis of a requirement
- Identify the purpose of requirements
- Assess the quality of requirements
- Define common reliability metrics

Lesson 3 – Assessing Reliability for Non-repairable Systems

Lesson Objectives: The objectives of this lesson are for each student to:

- State the importance of accounting for censoring in reliability data
- Identify the differences between the survival function, failure function, quantile function, and probability density function
- Choose an appropriate distribution to apply for reliability data analysis in particular contexts
- Compare statistical methods as a means of reliability analysis

Lesson 4 – System Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand how to decompose a system into subsystems and components
- Apply a reliability block diagram to a realistic scenario
- Use a fault tree to estimate system reliability in terms of failures
- Describe the tradeoffs in reliability between parallel and series systems

Lesson 5 – Test Planning

Lesson Objectives: The objectives of this lesson are for each student to:

- Describe how risk is impacted by choice of hypothesis test, test time, and sample size
- Explain an operating characteristic curve in context of reliability test planning
- Interpret output from reliability planning tools and the associated risks with the solutions
- Recognize test considerations for commercial off the shelf (COTS) items
- Identify resources to improve level of STAT in defense contracts
- Apply techniques to qualitatively assess reliability at the program level

Lesson 6 – Reliability Growth, Tracking, Projection

Lesson Objectives: The objectives of this lesson are for each student to:

- Identify how reliability growth is limited by initial conditions
- Distinguish differences between reliability growth planning, tracking, and projection
- Describe the impact of management strategies, fixed effectiveness factors, and growth rates on the reliability growth models
- Recognize the uses and restrictions of proposed reliability growth, planning, and projection models

Lesson 7 – Bayesian Reliability Analysis

Lesson Objectives: The objectives of this lesson are for each student to:

- Contrast the difference between frequentist and Bayesian analysis approaches
- Recognize Bayes' Rule and how it is used
- Understand the steps required to implement Bayesian methods for a single component
- Identify scenarios where it is appropriate to use Bayesian analysis methods

Lesson 8 – Software Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain the T&E challenges unique to software
- Recall key software testing definitions
- Examine the difference between software quality and reliability
- Explain why an operational profile is necessary to link quality and reliability
- Describe when a covering array might be appropriate to use during software reliability testing
- Identify metrics that can be useful to track software reliability

REL 250 Syllabus

Last Updated: 3/24/21

Course Description

This five-day course is designed to teach students basic techniques and processes needed to create rigorous reliability tests, assess reliability metrics, analyze reliability data, and explain reliability growth. The course emphasizes planning and analysis techniques for DoD reliability testing, both at the sub-system and system level. Students are introduced to tools and techniques for system decomposition, risk tracking, reliability test designs, and analysis in order apply it their own testing efforts. The course includes advanced reliability topics and elective lessons that can be tailored to the organization's requirements including reliability growth planning, tracking, and projection, Bayesian reliability, reliability software testing, assessing availability, and accelerated life testing. This course is intended for practitioners and reliability engineers with hands-on class projects and exercises to reinforce learning objectives.

Course Goals/Objectives

A student who successfully completes this course will:

1. Understand the nature of reliability and the purpose of testing for it
2. Formulate and evaluate measurable requirements for reliability
3. Perform system decomposition using the tools at your disposal to form a strong plan to test for reliability
4. Design and execute effective, cost-efficient reliability tests
5. Analyze the results of a reliability test to draw meaningful and accurate conclusions
6. Utilize techniques to estimate reliability, availability, and maintainability of complex systems (e.g., software systems)
7. Implement methods and tools for Reliability Growth Planning, Tracking, and Projection
8. Apply knowledge and tools to execute the STAT Process as applied to reliability on a class project

Course Duration & Schedule

4.5 Class Days (flexibly scheduled based on class and classroom conditions), 0800-1630 Monday through Thursday and 0800-1230 Friday.

Day	Lesson Description
Day 1	1 Introduction to Reliability 2 Requirements for RAM 3 Assessing Reliability – Nonrepairable Systems
Day 2	4 System Reliability 5 Test Planning
Day 3	6 Reliability Growth, Tracking, and Projection 7 Bayesian Reliability Analysis 8 Software Reliability
Day 4	Project Special Topic Modules
Day 5	Special Topic Modules

Course Materials

Students will need to bring a laptop with the JMP trial version installed. Course notes (print and electronic copies) will be provided along with JMP files.

Target Audience

GS-11 and above, O-2 and above, or equivalent

In general, we recommend this course for any reliability T&E practitioner. Common job titles of those that have taken the course in the past include: test engineer, test manager, test scientist, range/lab personnel, reliability engineer, reliability/RAM manager.

Continuous Learning Points (CLPs)

In order for students to receive 36 continuous learning points for this course, we expect students to be present and participating throughout the course. Students gone for longer than a total of 3 hours of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

All students must be familiar with and adhere to the standards of academic freedom, nonattribution and academic integrity. Below are the definitions for these terms:

Academic Freedom

- You may express your opinions concerning current or proposed policies, regulations and procedures openly, honestly, and professionally
- You may not attack the character, personality or other personal attributes of any individual
- Academic freedom must be tempered by good judgment to refrain from making offensive remarks, unfounded opinions, or irresponsible statements.

Non-Attribution

- What you say in class will not be attributed to you if and when your thoughts or ideas are repeated outside of class
- All guest speakers, students, and permanent-party personnel are prohibited from divulging the identity of any particular speaker, whether a guest speaker, faculty member, or student, for the purpose of attributing to that speaker any specific remarks or statements, including but not limited to offensive remarks and irresponsible statements

Lesson Outline and Objectives

Lesson 1 – Introduction to Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Summarize the STAT Process
- Understand the definitions of failures, reliability, availability, and maintainability
- Describe the difference between operational and materiel availability
- Explain how reliability is a key component to availability

Lesson 2 – Requirements for RAM

Lesson Objectives: The objectives of this lesson are for each student to:

- Recognize the genesis of a requirement
- Identify the purpose of requirements
- Develop measurable reliability requirements
- Assess the quality of requirements
- Define common reliability metrics

Lesson 3 – Assessing Reliability for Non-repairable Systems

Lesson Objectives: The objectives of this lesson are for each student to:

- State the importance of accounting for censoring in reliability data
- Explain the differences between the survival function, failure function, quantile function, and probability density function
- Choose an appropriate distribution to apply for continuous and binary reliability data
- Compare statistical methods as a means of analysis

Lesson 4 – System Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain how to decompose a system into subsystems and components
- Apply a reliability block diagram to a realistic scenario
- Use a fault tree to estimate system reliability in terms of failures
- Describe the tradeoffs in reliability between different system structures (e.g., parallel, series, standby)

Lesson 5 – Test Planning

Lesson Objectives: The objectives of this lesson are for each student to:

- Justify the choice of hypothesis test, test time, and sample size based on acceptable risk to the program
- Interpret output from reliability planning tools and the associated risks with the solutions
- Recognize test considerations for COTS items
- Identify resources to improve level of STAT in defense contracts
- Apply techniques to qualitatively assess reliability at the program level
- Design a test using an operating characteristic curve

Lesson 6 – Reliability Growth, Tracking, Projection

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain how reliability growth is limited by initial conditions
- Recommend applications for reliability growth planning, tracking, and projection
- Describe the impact of planning factors on reliability growth models
- Apply reliability growth, planning, and projection models based on their appropriate uses and limitations

Lesson 7 – Bayesian Reliability Analysis

Lesson Objectives: The objectives of this lesson are for each student to:

- Contrast the difference between frequentist and Bayesian analysis approaches
- Recognize Bayes' Rule and how it is used
- Implement the steps required to apply Bayesian methods for a single component
- Identify scenarios where it is appropriate to use Bayesian analysis methods

Lesson 8 – Software Reliability

Lesson Objectives: The objectives of this lesson are for each student to:

- Explain the T&E challenges unique to software
- Recall key software testing definitions
- Examine the difference between software quality and reliability
- Explain why an operational profile is necessary to link quality and reliability
- Assess when a covering array might be appropriate to use during software reliability testing
- Identify metrics that can be useful to track software reliability

Elective Modules (Class will choose)

Module A- Assessing Reliability – Repairable Systems

Lesson Objectives: The objectives of this lesson are for each student to:

- Differentiate between availability metrics
- Recognize the uses of different availability models
- Identify assumptions of different availability models
- Interpret availability curves and model outputs
- Utilize simulation to assess availability of a repairable system

Module B- Accelerated Life Testing

Lesson Objectives: The objectives of this lesson are for each student to:

- Understand the goal of Accelerated Life Testing
- Plan an accelerated life test
- Discuss the strategy for analyzing accelerated life test data
- Recognize various life-stress models

STAT 201: Survey Syllabus

Last Updated: 3/30/21

Course Description

This 5-hour survey module will walk students through the life cycle of a survey from initial creation to interpretation of end results. The module begins with a discussion on how to decide if a survey is needed and how surveys are developed using the Scientific Test and Analysis Techniques (STAT) process. Students will learn different sampling methods, pros and cons of types of survey questions, survey development, assessment of survey validity and reliability, traditional statistical analysis methods, and analysis of free response. Examples include the System Usability Survey, sample surveys, and an assortment of JMP demos.

Course Goals/Objectives

A student who successfully completes this course will:

1. Identify the pros and cons of using a survey
2. Recognize how the research question fits in with the STAT Process
3. Compare the different sampling methods
4. Contrast the differences between the different types of survey questions
5. Differentiate between the validity and reliability of a survey
6. Explain the importance of analysis when designing a survey and when each method is appropriate

Course Duration

5-hour class – typically delivered virtually

Course Materials

Course notes (electronic copies) will be provided along with data files used in demonstrations. Laptops are not required for this course, but you're welcome to follow along with us. We will demonstrate a few techniques for you using the statistical software package JMP.

Target Audience

GS-11 and above, O-2 and above, or equivalent

In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: test engineer, test manager, and test scientist.

Continuous Learning Points (CLPs)

In order for students to receive 5 continuous learning points for this course, we expect students to be present and participating throughout the course. Students who miss any part of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

Student Standards

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STAT 201: Machine Learning Syllabus

Last Updated: 3/30/21

Course Description

This 5-hour module will introduce fundamental concepts in supervised and unsupervised machine learning algorithms. The course begins with a discussion on the definition of machine learning and types of problems common in machine learning applications including: classification, numeric prediction, and clustering. The course will present examples and demonstrations of several machine learning algorithms to accomplish these tasks, comparing and contrasting competing algorithms. Students will learn best practices for implementing these algorithms to avoid model overfitting and methods for model comparison in order to select the most appropriate model for a given dataset. Demos and exercises with real-life examples will be presented in JMP (with accompanying R code supplied to students as an alternative).

Course Goals/Objectives

A student who successfully completes this course will:

1. Understand the fundamental concepts of machine learning including modeling data with ML algorithms
2. Identify when to use one algorithm over another for a given problem
3. Summarize the pros and cons of common machine learning algorithms
4. Apply machine learning algorithms to real-world datasets and interpret results
5. Understand how to evaluate and compare model performance for a given dataset

Course Duration

5-hour class – typically delivered virtually

Course Materials

Students will need to bring a laptop with the JMP trial version installed. Course notes (electronic copies) will be provided along with JMP files.

Target Audience

GS-11 and above, O-2 and above, or equivalent

In general, we recommend this course for any T&E practitioner. Common job titles of those that have taken the course in the past include: test engineer, test manager, and test scientist.

Continuous Learning Points (CLPs)

In order for students to receive 5 continuous learning points for this course, we expect students to be present and participating throughout the course. Students who miss any part of the course will not receive CLPs. Course certificates will be electronically mailed after the course.

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