UNSW Course Outline

MANF4611 Process Modelling and Simulation - 2024

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General Course Information

Course Code : MANF4611
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Mechanical and Manufacturing Engineering
Delivery Mode : Multimodal
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links
Handbook Class Timetable

Course Details & Outcomes

Course Description

The design of complex systems, including manufacturing systems, factories, supply chains and business processes requires in-depth understanding of the nature of the system itself, the environment and context in which it operates as well as the behaviour, performance and capability of the resources and building blocks of this system and the architecture and layout of its design and implementation. An important task for engineers is to model these systems so as to optimize the design in the first instance and to analyse and improve the ongoing performance of the system. The objective thus is to create, what is called, a "Digital Twin" of the real system or process. This is an invaluable tool for designing, operating and improving real systems and it is increasingly used as a cornerstone in Industry 4.0. Few decisions are made directly without testing, experimenting and optimising strategic as well as design and operational alternatives and options.

Manufacturing engineers routinely solve complex problems involving resource allocation, process and supply chain optimization, work and activity flow and balancing, machine capacity analysis and the planning of capital expenditure. Since simulation (particularly discrete event simulation) is increasingly used in industry, this course will place heavy emphasis on simulation and the statistical analysis of results. Simulation software used is Rockwell Arena ®.

One of the important aims of the course is to develop the ability to analyse real world systems by understanding the nature of the underlying process, the ability to abstract its behaviour, and to select appropriate quantitative techniques for modelling this behaviour with the goal of improving it.

Course Aims

The course aims to develop you into a skilled and all-rounded design engineer and operational analyst, able to carry out and manage the key design, operations and decision-making processes. Operations and design are inherently complex and a systematic, yet a flexible, agile and interdisciplinary approach is required to manage and improve complex systems.

The course teaches this approach, at the system and managerial levels, based on global best-practice methodologies, and incorporates case studies and projects, to apply these methodologies and become proficient at them. Key factors for success in modern engineering systems include efficient and effective allocation of resources, infrastructure, capacity and capital investment. Depending on the characteristics of the system, for example a product and its market, appropriate processes, resources, entity flows, layouts and systems need to be designed. The aim of this course is precisely that: the understanding, analysis, design and, to some extent, the optimisation of resourcing and processes in line with practical requirements and a constantly evolving set of task and operational requirements.

This course focuses on analytical techniques for decision making and solving complex process and resource allocation problems. It includes statistical characterisation and analysis of systems as well as the theory and use of discrete event simulation. It covers the essential mathematical, statistical and computer simulation techniques for modelling and analysing complex systems involving multiple variables, internal, external and disturbances. Depending on the scope of the system to be analysed and the nature of its behaviour, different analytical techniques apply. Specific techniques discussed include statistical and regression analysis and simulation using Rockwell Arena ® software.

The course is focused on analysing, modelling and finally understanding and solving complex systems under multiple constraints. These may be manufacturing systems, but they can also be service systems, transportation systems, in fact any system involving multiple entities, processes, resources and constraints.

Topics include:
• Discrete event simulation and associated analysis techniques, using Rockwell Arena© simulation software
• Design of experiment techniques
• Regression analysis
• Decision analysis

The course will combine lectures with practical case studies that require the theory taught to be applied to actual manufacturing and industrial systems.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.
CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.
CLO3 : Apply design of experiment techniques to solve complex system performance problems.
CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.

Course Learning Outcomes	Assessment Item
CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.	• Flow chart, identification of issues and definition of scope of the problem. • Simulation Model Development, Verification and Validation • Design of Experiment, simulation, statistical analysis, recommendations and documentation. • Final exam
CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.	• Flow chart, identification of issues and definition of scope of the problem. • Simulation Model Development, Verification and Validation • Design of Experiment, simulation, statistical analysis, recommendations and documentation. • Final exam
CLO3 : Apply design of experiment techniques to solve complex system performance problems.	• Design of Experiment, simulation, statistical analysis, recommendations and documentation. • Final exam
CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.	• Flow chart, identification of issues and definition of scope of the problem. • Simulation Model Development, Verification and Validation • Design of Experiment, simulation, statistical analysis, recommendations and documentation. • Final exam

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Additional Course Information

The following assumed knowledge is expected for postgraduate students undertaking this course: MATH2089 or equivalent.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Flow chart, identification of issues and definition of scope of the problem. Assessment Format: Individual	15%	Start Date: Week 1 Due Date: Friday Week 3, 10pm
Simulation Model Development, Verification and Validation Assessment Format: Individual	25%	Start Date: Not Applicable Due Date: Friday, Week 7, 10pm
Design of Experiment, simulation, statistical analysis, recommendations and documentation. Assessment Format: Group	25%	Start Date: Not Applicable Due Date: Friday, Week 10, 10pm
Final exam Assessment Format: Individual	35%	Start Date: Refer to Term 2 Exam Timetable Due Date: Refer to Term 2 Exam Timetable

Assessment Details

Flow chart, identification of issues and definition of scope of the problem.

Assessment Overview

The purpose of the first part of the assignment is to demonstrate an understanding of the process and to formulate issues to be investigated as part of a simulation model. This will be assessed during a VIVA demonstration by all individual members of the team. Each VIVA session will take approximately 45minutes. Feedback will be given immediately during this session.

Submissions will consist of detailed flowchart(s) covering all aspects of the process as well as an Issue Analysis (limited to two (2) typewritten pages) that identifies potential problems and improvements to be modelled at the next stage.

Submissions and marks awarded will be assessed on the following basis:

1. Flowcharts accurately represent the operation and functioning of the process.
2. Flowcharts are annotated in sufficient detail to understand the process.
3. Key issues and possible solutions have been identified.
4. The scope of the simulation model to be designed has been determined and is appropriate.
5. Individual contribution, knowledge and understanding of their part of the process and the overall logic of the flowchart.

Course Learning Outcomes

- CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.
- CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.
- CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.

Assessment Length

two (2) typewritten pages and a VIVA Examination

Submission notes

The deadline for absolute failure for each part of the assignment will be one week after the submission date.

Criteria with marking rubric

Criteria: Flowcharts accurately represent the operation and functioning of the process.

Fail - Fundamental flaws in logic, little detail about how the process works and where problems may occur.

Pass - Overall logic is correct but there are areas where logic or process characteristics are either missing or incorrect. Little work has been done to identify and document problem areas.

Credit - Logic is correct, most critical logic and characteristics are represented. Some work has been done to identify problem areas and develop possible solutions, but this is still lacking in detail and thought.

Distinction - Logic is correct, most critical logic and characteristics are represented, some key problem areas have been identified and solution strategies to be tested have also been identified and these strategies are well documented and appropriate.

High Distinction - Logic is correct, all logic and characteristics are represented, most key problem areas have been identified and solution strategies to be tested have also been identified and these strategies are well documented and appropriate.

Criteria: Flowcharts are annotated in sufficient detail to understand the process.

Fail - Little or no annotation

Pass - Some annotation is present, but it is difficult to understand how the process works and what its issues are by inspecting the flowchart and its commentary. Presentation quality is ordinary.

Credit - A reasonable amount of supporting commentary and annotation that gives a reasonable insight into the behaviour of the process and its key issues. Average quality of presentation.

Distinction - Anyone not familiar with the process can inspect the flowchart(s) and understand the process and its behaviour as well as problem areas and understand the key issues that will be investigated. Presentation good overall, but lacking in some areas, some important information may be missing or not included.

High Distinction - Anyone not familiar with the process can inspect the flowchart(s) and understand the process and its behaviour as well as problem areas and understand the key issues that will be investigated. Neatly annotated and quality formatting, visual representation.

Criteria: Key issues and possible solutions have been identified.

Fail - Few key issues have been identified and little/no thought given to the modelling strategy going forward

Pass - Some key issues and hypotheses have been identified but little thought given to what data is required to prove or disprove these hypotheses and solve these issues.

Credit - Reasonable analysis of key issues, some important issues left out, has thought about some good hypotheses and information/data required but modelling strategy going forward needs further work.

Distinction - Comprehensive analysis of key issues, a good selection of hypotheses, some information/data requirements identified and linked to experiments that will be modelled, modelling strategy going forward (Stage 2) still in development.

High Distinction - Comprehensive analysis of key issues, hypotheses, information/data required, modelling strategy going forward (Stage 2).

Criteria: The scope of the simulation model to be designed has been determined and is appropriate.

Fail - Little or no idea has been given of how the model will be designed and what the deliverables (eg information, data, experiments) of the model are.

Pass - The scope of the model going forward is lacking in detail, especially in terms of what experiments will be undertaken and what information will be gained from these experiments. In terms of what features the model should include, a lot of work still needs to be undertaken.

Credit - Scope of the simulation model to be designed (as part of Stage 2) has been clearly identified and documented. The scope may not include all the key issues and hypotheses identified and this would leave a substantial portion of the model design still to be developed (and put more stress on the activities to be undertaken for Stage 2). Output (data, information) has been identified but some major gaps may be present. Team shows reasonable organisation going forward.

Distinction - Scope of the simulation model to be designed (as part of Stage 2) has been clearly identified and documented. The scope is consistent with the issues identified. Output (data, information) has been well identified but some gaps may be present. Team shows reasonable organisation going forward.

High Distinction - Scope of the simulation model to be designed (as part of Stage 2) has been clearly identified and documented. Team members know what they will be responsible for. The scope is consistent with the issues identified. Output (data, information) has been clearly identified, is comprehensive and aligned with the issues identified.

Criteria: Individual contribution, knowledge and understanding of their part of the process and the overall logic of the flowchart.

Fail - No clearly defined contribution

Pass - Has made a contribution but overall process understanding, key issues and process understanding needs more development

Credit - Clearly defined contribution, good understanding of the process, somewhat lacking in detail in relation to key issues and the scope of the modelling to be undertaken next.

Distinction - Clearly defined contribution, critical to deliverables of the assignment, good understanding of the process

High Distinction - Clearly defined contribution, critical to the deliverables of the assignment, complete understanding of the process and its characteristics, has identified key issues and appropriate approach to modelling the process.

Assignment submission Turnitin type

Not Applicable

Simulation Model Development, Verification and Validation

Assessment Overview

The purpose of the second part of the assignment is to design and develop a simulation model using the Rockwell Arena (c) simulation software platform. This will be assessed during a VIVA demonstration by all individual members of the team. Each VIVA session will take approximately 45minutes. Feedback will be given immediately during this session.

Submissions will consist of a working computer simulation model using Rockwell Arena simulation programming environment as well as the results of running the Base Case, presented in the form of summary statistical tables and associated graphics (such as histograms, box plots etc).

Submissions and marks awarded will be assessed on the following basis:

1. A model that accurately reflects the operation of the base case
2. Appropriate verification and validation of the model
3. Appropriate statistical reporting of key model variables and parameters
4. The quality of model documentation, design and annotation
5. Individual contribution, knowledge and understanding of their part of the simulation model design and statistical analysis.

Course Learning Outcomes

- CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.
- CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.
- CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.

Assessment Length

Approximately 2 typewritten pages of simulation results, a demonstration of the program and a 45minute VIVA examination

Submission notes

The deadline for absolute failure for each part of the assignment will be one week after the submission date.

Criteria with marking rubric

Criteria: A model that accurately reflects the operation of the base case.

Fail - The model exhibits basic logic problems, errors and fundamental inconsistencies and it does not generate results aligned with expected behaviour of the process.

Pass - The model works, it generates results and data even though there are some fundamental errors in logic and omissions. The model generates results that are capable of being used in Stage 3 of the assignment, perhaps with corrections and fixes to the model.

Credit - The model, to a large extent, reflects both the logic, operational specifications, assumptions and characteristics as outlined in the assignment document, perhaps with one or two substantial omissions or errors. The model generates results that are capable of being used in Stage 3 of the assignment, perhaps with some corrections and fixes to the model.

Distinction - The model, to a large extent, reflects both the logic, operational specifications, assumptions and characteristics as outlined in the assignment document, perhaps with a few minor omissions or errors. The model generates results that are in broad agreement with the actual performance of the process.

High Distinction - The model accurately reflects both the logic, operational specifications, assumptions and characteristics as outlined in the assignment document. The model generates results that are in agreement with the actual performance of the process.

Criteria: Appropriate verification and validation of the model.

Fail - No evidence of verification and validation performed by the team.

Pass - Very basic verification in terms of model logic and performance. Little validation in terms of a "back of the envelope" analysis. Little reliance on using the debug facilities in Arena.

Credit - Rough agreement of model generated data against a very basic "back of the envelope". Demonstration of a simple V&V strategy used by the team. Demonstrated ability to use the run-time debugging functions within Arena in selected areas.

Distinction - Model generated data has been compared against "back of the envelope" analysis and calculations and the results match to a reasonable extent (given some simplifying assumptions). Demonstration of a reasonable V&V strategy used by the team. Demonstrated ability to use the run-time debugging functions within Arena in selected areas.

High Distinction - Model generated data has been compared against "back of the envelope" analysis and calculations and the results match to a reasonable extent (given some simplifying assumptions). Demonstrated ability to use the run-time debugging functions within Arena to good effect. Demonstration of a V&V strategy/process used by the team. Demonstration how each team member contributed to the V&V process.

Criteria: Appropriate statistical reporting of key model variables and parameters.

Fail - Informal statistical reporting, little attention to data types, sampling information, absence of appropriate data visualisation.

Pass - Statistical reporting is informal, with some key omissions and/or a lack of description related to data types, sampling information, data visualisation.

Credit - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, appropriate inferential statistics, confidence intervals, data visualisation, with a few errors or omissions in terms of important information, description and statistics, including formatting.

Distinction - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, appropriate inferential statistics, confidence intervals, data visualisation, with minor errors or omissions in terms of important information, description and statistics.

High Distinction - Comprehensive statistical reporting follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, appropriate inferential statistics, confidence intervals, data visualisation. Correct formatting.

Criteria: The quality of model documentation, design and annotation.

Fail - Little or no documentation or annotation. Difficult to understand if the model logic is correct, difficult to align model with the process itself.

Pass - Reasonable documentation and graphics, but it is difficult to understand how the process/model works and important pieces of information not revealed, documented or annotated. Presentation quality is ordinary.

Credit - A neat and well laid-out model design with a reasonable amount of supporting commentary and annotation that gives a reasonable insight into the behaviour of the process/model and purpose. Average quality of presentation.

Distinction - Anyone not familiar with the process can inspect the model and understand the process (model), its behaviour as well as the data that the model generates. Documentation and model annotation good overall, but lacking in some areas, some important information may be missing or not included.

High Distinction - Anyone not familiar with the process can understand the model, its behaviour as well as the data that the model generates. Neatly annotated and quality formatting, visual representation.

Criteria: Individual contribution, knowledge and understanding of their part of the simulation model design and statistical analysis.

Fail - No clearly defined contribution, little understanding of the model and its behaviour.

Pass - Has made a contribution but overall process understanding of the model, its design and performance needs more development.

Credit - Clearly defined contribution, reasonable understanding of the model, limited involvement in modelling key aspects of the process.

Distinction - Clearly defined contribution, critical to deliverables of the model, good understanding of the model, its behaviour and limitations.

High Distinction - Clearly defined contribution, critical to the deliverables of the assignment, complete understanding of the model and its characteristics, has delivered key modelling support.

Design of Experiment, simulation, statistical analysis, recommendations and documentation.

<u>Assessment Overview</u>

The third and last part of the assignment involves using the model designed in part 2 to simulate different scenarios for the purpose of improving the behaviour and performance of the process. This will be assessed on the basis of submission of a group report. Feedback will be given upon release of final results.

Submissions will consist of group report that summarises the current behaviour of the process or system (the Base Case) as well as the improved behaviour of the process after key recommendations by the group have been implemented and, of course, simulated using the model they designed in part 2 of the assignment. The report will be comprehensive but at the same time concise. The report will contain an Executive Summary, a description of the Base Case and its summary statistics, an outline of the improvements identified by the team and associated summary statistics for each improvement and finally an overall ANOVA analysis of the combined effect of the recommendations. A typical report including tables and graphics will consist of 10-12 pages of A4 size.

Submissions and marks awarded will be assessed on the following basis:

1. Relevance and appropriateness of improvements identified to the base case.
2. Accuracy and correctness of calculations and results.
3. Appropriate statistical reporting for summary statistics for key model variables and parameters for each improvement in the form of tables and graphics allowing accurate interpretation and comparison.
4. Appropriate statistical reporting of inferential statistical analysis including hypothesis testing and ANOVA analysis where appropriate.
5. The quality of documentation, grammar and style

Course Learning Outcomes

- CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.
- CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.
- CLO3 : Apply design of experiment techniques to solve complex system performance problems.
- CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.

Assessment Length

A typical report including tables and graphics will consist of 10-12 pages of A4 size.

Submission notes

The deadline for absolute failure for each part of the assignment will be one week after the submission date.

Criteria with marking rubric

Criteria: Relevance and appropriateness of improvements identified to the base case.

Fail - Either very few experiments or experiments that are in essence of little effect or moment in terms of improving the base case.

Pass - Very basic selection of experiments broadly aligned with hypotheses identified in Stages 1 and 2 of the assignment. Information generated is aligned with the proof of the hypotheses. A lot of key experiments have not been considered.

Credit - Limited selection of experiments aligned with hypotheses identified in Stages 1 and 2 of the assignment. Information generated is aligned with the proof of the hypotheses. A number of key opportunities have not been modelled.

Distinction - Appropriate selection of experiments aligned with hypotheses identified in Stages 1 and 2 of the assignment. Information generated is aligned with the proof of the hypotheses. One or two key opportunities may be left off the table.

High Distinction - Appropriate and comprehensive (prioritised) selection of experiments aligned with hypotheses identified in Stages 1 and 2 of the assignment. Information generated is aligned with the proof of the hypotheses.

Criteria: Accuracy and correctness of calculations and results.

Fail - The model does not generate results aligned with expected behaviour of the process and a further hypothesis test on the results would yield limited results or insight.

Pass - The results are capable of being used in the hypothesis testing stage of the assignment, even though there are substantial inconsistencies between the results and expected behaviour of the process.

Credit - The results, to a large extent, reflects the experiments (hypotheses), perhaps with one or two substantial omissions or errors. The model generates results that are capable of being tested in the hypothesis testing stage of this submission.

Distinction - The results, to a large extent, reflect the experiments (hypotheses) and assumptions made, perhaps with a few minor inconsistencies. The model generates results that are in broad agreement with the expected performance of the process.

High Distinction - The results accurately reflect the experiments (hypotheses) and assumptions made. The model generates results that are in agreement with the expected performance of the process.

Criteria: Appropriate statistical reporting for summary statistics for key model variables and parameters for each improvement in the form of tables and graphics allowing accurate interpretation and comparison.

Fail - Informal statistical reporting, little attention to data types, sampling information, absence of appropriate data visualisation.

Pass - Statistical reporting is informal, with some key omissions and/or a lack of description related to data types, sampling information, data visualisation.

Credit - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, confidence intervals, data visualisation, with a few errors or omissions in terms of important information, description and statistics, including formatting.

Distinction - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, confidence intervals, data visualisation, with minor errors or omissions in terms of important information, description and statistics.

High Distinction - Comprehensive statistical reporting follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of summary statistics, description of variables, confidence intervals, data visualisation. Correct formatting.

Criteria: Appropriate statistical reporting of inferential statistical analysis including hypothesis testing and ANOVA analysis where appropriate.

Fail - Informal statistical reporting, little attention to data types, sampling information, absence of appropriate data visualisation.

Pass - Statistical reporting is informal, with some key omissions and/or a lack of description related to data types, sampling information, data visualisation.

Credit - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of inferential statistics, confidence intervals, data visualisation, with a few errors or omissions in terms of important information, description and statistics, including formatting.

Distinction - Statistical reporting mostly follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of inferential statistics, confidence intervals, data visualisation, with minor errors or omissions in terms of important information, description and statistics.

High Distinction - Comprehensive statistical reporting follows the reporting style as outlined in the lectures for MANF4611, appropriate reporting of inferential statistics, confidence intervals, data visualisation. Correct formatting.

Criteria: The quality of documentation, grammar and style.

Fail - A poor report in most aspects.

Pass - Ordinary report with format problems, grammatical errors, redundant information, unclear descriptions and discussion.

Credit - Good quality report lacking in more than one aspect (above list).

Distinction - Mostly professional but perhaps lacking in one aspect.

High Distinction - A professional quality report, good formatting, reporting and grammar. Something one can put in front of a client. Discussion is efficient and to the point and supported by information, data and visuals.

Final exam

Assessment Overview

Assessment length: 2 hours

Final Examination to cover all material taught in the course.

Course Learning Outcomes

- CLO1 : Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimising it.
- CLO2 : Characterise the behaviour of a system in terms of the nature of its variables and interactions using statistical methods.
- CLO3 : Apply design of experiment techniques to solve complex system performance problems.
- CLO4 : Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.

Assessment Length

2 hours

Submission notes

Invigilated exam

Assignment submission Turnitin type

This is not a Turnitin assignment

General Assessment Information

The assignment is to be undertaken in a Team of 3-5 members, and consists of 3 stages. Stages 1 and 2 involve a VIVA assessment, where individual marks will be given to each team member. Stage 3 is a group report submission.

Assignments Each part of the Assignment (3 parts) will involve a written submission. Details will be posted on Moodle. The final part of the assignment requires a write-up and this is due at the end of Week 10. You need to ensure that you use both an appropriate writing style as well as professional formatting and editing of style and content in your report. The assignments will be posted on Moodle and discussed in class (as shown in the teaching schedule) and the due dates shown are firm. The final report will be submitted electronically on Moodle by the end of week 10. The assignments support the learning outcomes by incorporating an appropriate mix of analytical techniques, enabling software, and data analysis that supports achievement of appropriate solutions.

Presentation All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided. The following criteria will be used to grade Viva examinations (Detailed instructions will be posted on Moodle):

- The level of progress achieved by the team at Stages 1 and 2 of the assignment. Stage 1 focuses on understanding the process flow and logic (flow charts and documentation) as well as identifying the issues, aims and scope of the model. Stage 2 needs to deliver a model,

coded in Arena, appropriately verified, validated and documented that will be the engine for generating data from appropriate scenarios that the team will test and analyse (and ultimately submit as Part 3 of the assignment).
- The quality of work produced by the team at each of these stages. This includes the correctness of the work produced, an appropriate level of detail and documentation.
- The contribution of each team member to the efforts of the team. Each team member will be expected to present their part of the work and answer questions by the examiner(s).
- The following criteria will be used to grade written assignments:
- Analysis and evaluation of requirements by integrating knowledge and methods learned in lectures and demonstrations
- Sentences in clear and plain EnglishÑthis includes correct grammar, spelling and punctuation
- Correct referencing in accordance with the prescribed citation and style guide
- Appropriateness of engineering techniques and methodologies used
- Accuracy of numerical answers and comprehensiveness of methods and techniques employed
- Evidence of quality data and analysis-based decision making
- All working shown
- Use of diagrams, where appropriate, to support or illustrate the calculations
- Use of graphs, where appropriate, to support or illustrate the calculations
- Use of tables, where appropriate, to support or shorten the calculations
- Neatness

Examinations The end-of-session exam will cover all material including the simulation part of the course. It will specifically examine statistical analysis, simulation theory and design of experiment (DOE).

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 20 May - 26 May	Other	No activities in Week 0
Week 1 : 27 May - 2 June	Lecture	Introduction to Process and Operations Modeling • Characteristics of Processes and Operations • Flow Systems, Manufacturing Systems, Business Systems, Engineering Systems • What are Models and why build them o Stochastic Processes o Dynamic Models o Continuous – Discrete Time Models o Input, Output and Disturbance Variables • The Process of Modeling – start with a flowchart • Model Characteristics, scope and detail • Introduction to Operations Research • Introduction to Simulation and Rockwell Arena – a step through model • The Arena environment • Basic Arena constructs: Entity, Process, Resource, Queue
	Laboratory	Tutorial: Live demonstration of model building • Discussion of the major Assignment • Homework: Start working on Tutorial Set 1
Week 2 : 3 June - 9 June	Lecture	Random Variables and Probability Distributions • Observing, Measuring and Analysing Random Behaviour • Binomial, Poisson, Geometric, Exponential, Normal Distribution • Fitting a Distribution and Goodness of Fit • Random Number Generators • Generating Random Observations • Stationary – non-Stationary Processes • Introduction to Analysing Input Data
	Laboratory	Tutorial: Introduction to Analysing Input • Introduction to Minitab • On-going Arena support for Assignments • Homework: Start working on Tutorial Set 2
Week 3 : 10 June - 16 June	Lecture	Model Design • Modeling Operations and Processes in Arena • Essential modules, elements and blocks • Flow Control in Arena: Decisions, Queues, Hold, Signal • Arena variables, logic control and expressions: Variables (TNOW, MREP, NREP), Attributes, Record, Assign, Expressions • Data collection inside Arena
	Laboratory	Tutorial: On-going Arena support for Assignments • Homework: Start working on Tutorial Set 3
Week 4 : 17 June - 23 June	Lecture	Data Manipulation in Arena • Reading and Writing Data between Arena and the outside world • Interfacing to Excel, ASCII files • Data manipulation • Verification and Validation
	Laboratory	Tutorial: On-going Arena support for Assignments • Homework: Start working on Tutorial Set 4
Week 5 : 24 June - 30 June	Lecture	Creating Simulation Scenarios, Generating Data and Analysis of Output • The Arena debugging environment • Finite – Infinite Horizon Simulations • Effect of Initial Conditions, Warming-up Period • Comparison of Different System Configurations and Designs • Types of Statistical Variables • Within – Across Replication Statistics • Reducing variance
	Laboratory	Tutorial: On-going Arena support for Assignments
Week 6 : 1 July - 7 July	Other	Flexibility Week: Assignment Support in Class/Laboratory
Week 7 : 8 July - 14 July	Lecture	Reporting and Documentation • Reporting Statistics • Model layout and presentation • Model Documentation
	Laboratory	Tutorial: On-going Arena support for Assignments
Week 8 : 15 July - 21 July	Lecture	Design of Experiment Theory (DOE) Part I • Single factor experiments • Introduction to factorial designs • Introduction to DOE in Minitab
	Laboratory	Tutorial: On-going Arena support for Assignments
Week 9 : 22 July - 28 July	Lecture	Design of Experiment Theory (DOE) Part II • Blockings in factorial design • Screening and characterization of models • Best practice in DOE
	Laboratory	Tutorial: Minitab Tutorial on DOE Set 1 • On-going Arena support for Assignments
Week 10 : 29 July - 4 August	Lecture	Decision Analysis • Overcoming risk and uncertainty • Decision Trees • Decision tables • Decision methods: Maximax, Maximin, Equally Likely • Expected monetary value • Value of information
	Laboratory	Tutorial: Minitab Tutorial on DOE Set 2 • On-going Arena support for Assignments

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Resources

Prescribed Resources

The student version of Arena may be downloaded from: https://www.arenasimulation.com/academic/students

Recommended Resources

References

1. Simulation modeling and analysis with Arena, Tayfur. Altiok Benjamin Melamed, Warren, N.J. : Cyber Research and Enterprise Technology Solutions, 2001. UNSW Library – High Use Collection.
2. Design and Analysis of Experiments, Douglas C. Montgomery, Wiley, 8th Edition, ©2013
3. Introduction to Linear Regression Analysis, Douglas C. Montgomery, Wiley, 5th Edition, ©2013
4. Simulation with Arena, W.D. Kelton, R.P. Sadowski and N.P. Zupick, 6th edition, McGraw Hill.
5. Simulation Modeling and Arena, M.D. Rossetti, John Wiley & Sons, 2009.
6. UNSW Library website: https://www.library.unsw.edu.au/
7. Moodle: https://moodle.telt.unsw.edu.au/login/index.php

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback. In this course, recent improvements resulting from student feedback include improved tutorial and example models that align better with the requirements of the assignment. This will allow for faster and more efficient model development for all teams.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Erik van Voorthuysen		ME507	9385 4147	Immediately after lectures	No	Yes
Lecturer	Ron Chan		ME507	9385 1535	Immediately after lectures	No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

Short Extensions

Short extensions are not currently applicable to Mechanical and Manufacturing Engineering Courses.

Review of Results

The purpose of a review of results is if there was a marking error. Review of results is for when you have cause to believe that there is a marking error. Review of Results cannot be used to get feedback. If you would like feedback for assessments prior to the final exam, you are welcome to contact the course convenor directly. No feedback will be provided on final exams.

Use of AI

The use of AI is prohibited unless explicitly permitted by the course convenor. Please respect this and be aware that penalties will apply when unauthorised use is detected, such as through Turnitin. If the use of generative AI, such as ChatGPT, is allowed in a specific assessment, they must be properly credited, and your submissions must be substantially your own work.

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook