MONASH University

Unit Guide

ECE2191
Probability models in engineering

Semester 2, 2017

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Unit handbook information

Synopsis

This unit will introduce fundamental concepts of probability theory applied to engineering problems in a manner that combines intuition and mathematical precision. The treatment of probability includes elementary set operations, sample spaces and probability laws, conditional probability, independence, and notions of combinatorics. A discussion of discrete and continuous random variables, common distributions, functions, and expectations forms an important part of this unit. Transform methods, limit theorems, convergences, and bounding techniques are also covered. Special consideration is given to the law of large numbers and the central limit theorem. Markov chain, transition probabilities and steady state distribution will be discussed.
Application examples from engineering, science, and statistics will be provided: The Gaussian distribution in source and channel coding, the exponential, Chi-square, and Gamma distributions in wireless communications and Bayesian statistics, the Rayleigh distribution in wireless communications, the Cauchy distribution in detection theory, the Poisson and Erlang distributions in traffic engineering, queuing theory and networking, the Gaussian, Laplacian and generalised Gaussian distributions in image processing, the Weibull distribution in high voltage engineering and electrical insulation, Markov chain in queuing theory, and first-order Markov process in predictive speech/image compression.

Mode of delivery

Clayton (Day)
Malaysia (Day)

Workload requirements

3 hours lectures, 3 hours laboratories/tutorials and 6 hours of private study per week.

Unit relationships

Prerequisites

ENG1091 or ENG1005

Prohibitions

ENG2092

Co-requisites

None

Chief Examiner(s)

Professor Manos Varvarigos

Unit Coordinator(s)

Name: Professor Zixiang Xiong
Email: Zixiang.Xiong@monash.edu

Clayton/Malaysia staff contact details

Clayton campus	
Campus Coordinator	Name: Professor Zixiang Xiong Email: Zixiang.Xiong@monash.edu Building: , Room: Consultation hours: Check the ENG2191 website on Moodle
Lecturer(s)	Name: Professor Zixiang Xiong Email: Zixiang.Xiong@monash.edu Building: , Room:

Malaysia campus	
Campus Coordinator	Name: Dr Mohamed Hisham Jaward Email: Mohamed.Hisham@monash.edu Building: 2, Room: 2431 Consultation hours: Would be displayed outside the room
Lecturer(s)	Name: Dr Mohamed Hisham Email: Mohamed.Hisham@monash.edu Building: , Room:

Demonstrator(s)

Larry Arjomandi (larry.m.arjomandi@monash.edu)

Anindya Harchowdhury (anindya.harchowdhury@monash.edu)

Anchal Sareen (anchal.sareen@monash.edu)

Section A: For Clayton students

Academic Overview

Engineers Australia Stage 1 competencies

The Engineers Australia Policy on Accreditation of Professional Engineering Programs requires that all programs ensure that their engineering graduates develop to a substantial degree the stage 1 competencies. Listed below are the activities in this unit that will help you to achieve these competencies.

Note: that not all stage 1 competencies are relevant to each unit.

Element of competency	Indicators of attainment	Learning outcomes
1 Knowledge and skill base		
1.1 Engages with the engineering discipline at a phenomenological level, applying sciences and engineering fundamentals to systematic investigation, interpretation, analysis and innovative solution of complex problems and broader aspects of engineering practice.	**a)** Engages with the engineering discipline at a phenomenological level, applying sciences and engineering fundamentals to systematic investigation, interpretation, analysis and innovative solution of complex problems and broader aspects of engineering practice.	1,2,3,4,5,6,7
2. Engineering application ability		
2.1 Application of established engineering methods to complex engineering problem solving.	**a)** Identifies, discerns and characterises salient issues, determines and analyses causes and effects, justifies and applies appropriate simplifying assumptions, predicts performance and behaviour, synthesises solution strategies and develops substantiated conclusions.	7

Teaching and learning method

Lectures: The lectures will be delivered using a set of lecture notes. Electronic version of these notes will be available on Moodle site of this unit.

Tutorials: In tutorials you will work on problem sets under the guidance of a tutor. Electronic version of the problem set will be available on Moodle.

Writing in mathematics: In this unit we will pay great attention to how you write mathematics. The degree to which you will have to put an effort into improving your mathematics writing will depend very much on the good or bad habits you developed so far. You will be given opportunities to improve your mathematics writing in lectures and in tutorials.

You can also find information on inclusive teaching practices for students with learning disabilities or mental health conditions at: www.monash.edu.au/lls/inclusivity/

Learning outcomes

On successful completion of this unit, students will be able to:

1. Describe random variables including probability mass functions, cumulative distribution functions and probability density functions including the commonly encountered Gaussian random variables.
2. Characterise the distributions of functions of random variables.
3. Examine the properties of multiple random variables using joint probability mass functions, joint probability density functions, correlation, covariance and the correlation coefficient.
4. Estimate the sample mean, standard deviation, cumulative distribution function of a random variable from a series of independent observations.
5. Describe the law of large numbers and the central limit theorem, and illustrate how these two theorems can be employed to model random phenomena.
6. Calculate confidence intervals and use this statistical tool to interpret engineering data.
7. Apply probability models to current engineering examples in reliability, communication networks, power distribution, traffic and signal processing.

Your feedback to us

One of the formal ways students have to provide feedback on teaching and their learning experience is through the Student Evaluation of Teaching and Units (SETU) survey. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied with and areas for improvement.

Previous student evaluations of this unit

In response to previous SETU results of this unit, the following changes have been made:

N/A

Student feedback has highlighted the following strength(s) in this unit:

N/A

If you wish to view how previous students rated this unit, please go to:
https://unitevaluations.connect.monash.edu.au/unitevaluations/index.jsp

Unit schedule - Clayton campus

Week	Activities	Assessment
0		No formal assessment
1	Introduction & Mathematical Review	No formal assessment
2	Basic Concepts of Probability	No formal assessment
3	Conditional Probability	No formal assessment
4	Equiprobable Outcomes and Combinatorics	Assignment 1
5	Discrete Random Variables	No formal assessment
6	Discrete Expectations	Assignment 2
7	Discrete Random Vectors	No formal assessment
8	Continuous Random Variables	Assignment 3
9	Functions and Derived Distributions	No formal assessment
10	General Expectations and Bounds	Assignment 4
11	Empirical Distributions	No formal assessment
12	Real-World Applications	Assignment 5
SWOT VAC	No formal assessment	SWOT VAC
Examination period	LINK to Assessment Policy: www.policy.monash.edu/policybank/academic/education/assessment/assessment-in-coursework-policy.html	Examination period

Assessment requirements

Assessment summary

Continuous assessment: 40%
Examination (2 hours): 60%
Students are required to achieve at least 45% in the total continuous assessment component (assignments, tests, mid-semester exams, laboratory reports) and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.

Assessment task	Value	Due date
Assignments	8% each	Monday of Week 4, 6, 8, 10, 12
Examination	60%	To be advised

Assessment tasks

Assessment title: Assignments
Mode of delivery: Each assignment will be released and available on Moodle two weeks prior to its due date.
Details of task: Assignments will be released and available on Moodle in Weeks 2, 4, 6, 8, and 10. Students get two weeks to complete their assignments. Submission is online.
Release dates (where applicable): Two weeks prior to due date
Word limit (where applicable): N/A
Due date: Monday of Week 4, 6, 8, 10, 12
Value: 8% each
Presentation requirements: Online submission of written reports. If MATLAB is used for the assignment, the MATLAB codes as well as the generated output must be submitted along.
Hurdle requirements (where applicable): Please refer to section on Hurdle requirements.
Individual assessment in group tasks (where applicable): N/A
Criteria for marking: N/A
Additional remarks: N/A

Exam title: Examination
Weighting: 60%
Length: 2 hours
Type (Open/closed book): Open book
Hurdle requirements (where applicable): Students are required to achieve at least 45% in the total continuous assessment component and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.
Electronic devices allowed: None
Remarks (where applicable): Students are permitted to bring with them one double-sided A4 sheet of their own notes.

Calculators NOT permitted
No electronic (e.g., calculators or handheld) devices are permitted.

Examination material or equipment

Students are permitted to bring with them one double-sided A4 sheet of their own notes.

Section B: For Malaysia students

Academic Overview

Program Education Objectives
The Electrical and Computer Systems engineering discipline expects to produce graduates, who are:
1. competent in Electrical and Computer Systems engineering
2. responsible and effective global citizens
3. leaders in their chosen profession or society at large.

Program Outcomes
The Electrical and Computer Systems engineering discipline has developed a set of Program Outcomes (POs) for all of its graduates based on the competencies required by the Malaysian Engineering Accreditation Council.

Program Outcomes (POs)	Activities used in this unit to develop POs, achievement of Bloom's domains and complex problem solving
PO1 **Electrical and Computer Systems Engineering Knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and specialisation in Electrical and Computer Systems engineering to the solution of complex engineering problems	Cognitive: Apply knowledge of probably models to engineering problems
PO2 **Problem Analysis:** Identify, formulate, survey research literature and analyse complex Electrical and Computer Systems engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences	Cognitive: Analyse random processes using probability concepts
PO3 **Design/Development of Solutions:** Design solutions for complex Electrical and Computer Systems engineering problems and design systems, components or processes that meet specified needs.	Cognitive: Psychomotor:
PO4 **Research-based Investigation:** Conduct investigations of complex Electrical and Computer Systems engineering problems using research-based knowledge and research methods including design of experiments, (analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Cognitive:
PO5 **Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex Electrical and Computer Systems engineering problems, with an understanding of the limitations	Cognitive: Psychomotor:
PO6 **Engineer and Society:** Apply reasoning informed by contextual knowledge to assess	Affective:

Program Outcomes (POs)	Activities used in this unit to develop POs, achievement of Bloom's domains and complex problem solving
societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex Electrical and Computer Systems engineering problems	
PO7 **Environment and Sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex Electrical and Computer Systems engineering problems in environmental contexts.	Cognitive: Affective:
PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Affective:
PO9 **Communication:** Communicate effectively on complex Electrical and Computer Systems engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	Affective:
PO10 **Individual and Team work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings	Affective:
PO11 **Lifelong Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Affective:
PO12 **Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to manage projects	Cognitive: Affective:

Teaching and learning method

Teaching and learning method

The unit consists of lectures and tutorial classes. Learning in the unit is mainly through lectures and working on the tutorial problem sets and assignments, which consist of a wide range of problems. By working on different types of problems, students will develop a deeper understanding to the subject materials.

Tutorial allocation

There are 2-hours of practice classes scheduled each week, commencing in week 1. Students must enroll in the practice class using Allocate Plus.

Communication, participation and feedback

Monash aims to provide a learning environment in which students receive a range of ongoing feedback throughout their studies. In this unit it will take the form of group feedback via practice classes, individual feedback, peer feedback, self-comparison, verbal and written feedback, discussions in class, as well as more formal feedback related to assignment marks and grades. Students are encouraged to draw on a variety of feedback to enhance their learning.

Teaching Approach

Lectures: The lectures will be delivered using a set of lecture notes. Electronic version of these notes will be available on Moodle site of this unit.

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Learning outcomes

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4. Estimate the sample mean, standard deviation, cumulative distribution function of a random variable from a series of independent observations.
5. Describe the law of large numbers and the central limit theorem, and illustrate how these two theorems can be employed to model random phenomena.
6. Calculate confidence intervals and use this statistical tool to interpret engineering data.

7. Apply probability models to current engineering examples in reliability, communication networks, power distribution, traffic and signal processing.

OBE requirements to learning outcomes (LOs)

Learning Outcomes (LOs) for Outcome Based Education (OBE) requirements	Handbook Learning Outcomes (LOs)
LO1 – Analyse random processes using probability concepts such probability mass functions, cumulative distribution functions and probability density functions	1. Describe random variables including probability mass functions, cumulative distribution functions and probability density functions including the commonly encountered Gaussian random variables. 2. Characterise the distributions of functions of random variables. 3. Examine the properties of multiple random variables using joint probability mass functions, joint probability density functions, correlation, covariance and the correlation coefficient. 4. Estimate the sample mean, standard deviation, cumulative distribution function of a random variable from a series of independent observations.
LO2- Use statistical tools such confidence intervals, law of large numbers and centra limit theorem to interpret engineering data	1. Describe the law of large numbers and the central limit theorem, and illustrate how these two theorems can be employed to model random phenomena. 2. Calculate confidence intervals and use this statistical tool to interpret engineering data.
LO3 – Apply knowledge of probably models to engineering problems.	1. Apply probability models to current engineering examples in reliability, communication networks, power distribution, traffic and signal processing.

Relationship between unit learning outcomes and program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO1		x										
LO2	x											
LO3	x											

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Examination	60%	To be advised

Bloom's Taxonomy:
Three domains of educational activities have been identified under the general taxonomy known as Bloom's.

- **Cognitive**: mental skills (*Head*)
- **Affective**: growth in feelings or emotional areas (*Heart*)
- **Psychomotor**: manual or physical skills (*Hand*)

The *cognitive* domain involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills.

The *affective* domain includes the attitudes with which someone deals with things emotionally, such as feelings, values, appreciation, enthusiasms and motivations.

The *psychomotor* domain includes physical movement, coordination, and use of the motor-skill areas. Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures, or techniques in execution.

Key for the LO-assessment relationship table above:

Cognitive

C1	C2	C3	C4	C5	C6
Knowledge: Remembers previously learned material	**Comprehension:** Grasps the meaning of material (lowest level of understanding)	**Application:** Uses learning in new and concrete situations (higher level of understanding)	**Analysis:** Understands both the content and structure of material	**Synthesis:** Formulates new structures from existing knowledge and skills	**Evaluation:** Judges the value of material for a given purpose

Psychomotor

P1	P2	P3	P4	P5	P6	P7
Perception: Senses cues that guide motor activity	**Set:** Is mentally, emotionally and physically ready to act	**Guided Response:** Imitates and practices skills, often in	**Mechanism:** Performs acts with increasing efficiency,	**Complete Overt Response:** Performs automatically	**Adaption:** Adapts skill sets to meet a problem situation	**Organisation:** Creates new patterns for specific situations

		discrete steps	confidence and proficiency			

Affective

A1	A2	A3	A4	A5
Receiving: Selectively attends to stimuli	**Responding:** Responds to stimuli	**Valuing:** Attaches value or worth to something	**Organisation:** Conceptualises the value and resolves conflict between it and other values	**Internalising:** Integrates the value into a value system that controls behaviour

Relationship between Assessments and OBE Learning Outcomes (LOs)

No.	Learning Outcomes	Assignments	Final Exam
1	Analyse random processes using probability concepts such probability mass functions, cumulative distribution functions and probability density functions	C4	C4
2	Use statistical tools such confidence intervals, law of large numbers and centra limit theorem to interpret engineering data	C3	C3
3	Apply knowledge of probably models to engineering problems.	C3	C3

Relationship between Assessments and Complex Problems /Activities

Assessment		Complex Problems (CP)						
		WP1	WP2	WP3	WP4	WP5	WP6	WP7
1	Assignments	x	x	x				

2	Final Exam	x	x					

Assessment requirements

Assessment tasks

Assessment title: Assignments
Mode of delivery: Each assignment will be released and available on Moodle two weeks prior to its due date
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Release dates (where applicable): Two weeks prior to due date
Word limit (where applicable): N/A
Due date: Monday of Week 4, 6, 8, 10, 12
Value: 8% each
Presentation requirements: Online submission of written reports. If MATLAB is used for the assignment, the MATLAB codes as well as the generated output must be submitted together
Hurdle requirements (where applicable): Please refer to section on Hurdle requirements
Individual assessment in group tasks (where applicable): N/A
Criteria for marking: Critical analysis of the problem will be awarded bonus marks
Additional remarks: N/A

Exam title: Examination
Weighting: 60%
Length: 2 hours
Type (Open/closed book): Open book
Hurdle requirements (where applicable): Students are required to achieve at least 45% in the total continuous assessment component and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.
Electronic devices allowed: None
Remarks (where applicable): Students are permitted to bring with them one double-sided A4 sheet of their own notes.

Calculators NOT permitted

Calculators are not allowed.

Examination material or equipment

Students are permitted to bring with them one double-sided A4 sheet of their own notes.

Section C: All students

Extensions and penalties

No late homework submission will be accepted.

Resubmission of assignments

Not allowed.

Plagiarism and collusion

Intentional plagiarism or collusion amounts to cheating under Part 7 of the Monash University (Council) Regulations.

Plagiarism: Plagiarism means taking and using another person's ideas or manner of expressing them and passing them off as one's own. For example, by failing to give appropriate acknowledgement. The material used can be from any source (staff, students or the internet, published and unpublished works).

Collusion: Collusion means unauthorised collaboration with another person on assessable written, oral or practical work and includes paying another person to complete all or part of the work. Where there are reasonable grounds for believing that intentional plagiarism or collusion has occurred, this will be reported to the Associate Dean (Education) or delegate,

Referencing requirements

N/A

To build your skills in citing and referencing, and using different referencing styles, see the online tutorial Academic Integrity: Demystifying Citing and Referencing at http://www.lib.monash.edu.au/tutorials/citing/

Assignment submission

Hard Copy Submission:

No need.

Online Submission: If Electronic Submission has been approved for your unit, please submit your work via the Moodle site or other; as directed by your demonstator for this unit.
Please keep a copy of tasks completed for your records.

Feedback to you

Feedback will be given to students via graded assignments (with written comments) and verbal comments to individual students or to the whole class.

Learning resources

Monash Library Unit Reading List (if applicable to the unit):
http://readinglists.lib.monash.edu/index.html

Required resources

Students generally must be able to complete the requirements of their course without the imposition of fees that are additional to the student contribution amount or tuition fees. However, students may be charged certain incidental fees or be expected to make certain purchases to support their study. For more information about this, go to Administrative Information for Higher Education Providers: Student Support, Chapter 21, Incidental Fees at: http://www.innovation.gov.au/HigherEducation/TertiaryEducation/ResourcesAndPublications/Pages/default.aspx

Other information

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University's academic standards, and to provide advice on how they might uphold them. You can find Monash's Education Policies at:
http://www.policy.monash.edu/policy-bank/academic/education/index.html

Graduate Attributes Policy

http://www.monash.edu/policy-bank/academic/education/course-governance-and-design/course-design-policy

Student Charter

http://www.monash.edu/students/policies/student-charter.html

Student Services

The University provides many different kinds of services to help you gain the most from your studies. Contact your tutor if you need advice and see the range of services available at http://www.monash.edu/students.

Malaysia students go to: http://www.monash.edu.my/Student-services/.

Monash University Library

The Monash University Library provides a range of services, resources and programs that enable you to save time and be more effective in your learning and research.
Go to http://www.monash.edu/library or the library tab in http://my.monash.edu.au portal for more information.

For Malaysia students the Library and Learning Commons, Monash University Malaysia Campus, provides a range of services and resources that enable you to save time and be more effective in your learning and research.
Go to http://www.lib.monash.edu.my or the library tab in my.monash portal for more information.

Disability Support Services

Students who have a disability, ongoing medical or mental health condition are welcome to contact Disability Support Services.

Disability Support Services also support students who are carers of a person who is aged and frail or has a disability, medical condition or mental health condition.

Disability Advisers visit all Victorian campuses on a regular basis.

- Website: monash.edu/disability
- Telephone: 03 9905 5704 to book an appointment with an Adviser;
- Email: disabilitysupportservices@monash.edu
- Drop In: Level 1, Western Annexe, 21 Chancellors Walk (Campus Centre) Clayton Campus

At Malaysia campus, for information and referral, telephone: Student Adviser, Student Community Services at 03 55146018 or, drop in at Student Community Services Department, Level 2 Building 2, Monash University Malaysia Campus.