



Australian Government

Department of Education, Employment and Workplace Relations

ICTTEN8197A Produce engineering solutions using numerical computations and simulation

Release: 1

ICTTEN8197A Produce engineering solutions using numerical computations and simulation

Modification History

Not Applicable

Unit Descriptor

Unit descriptor	This unit describes the performance outcomes, skills and knowledge required to analyse, calculate and solve complex mathematical engineering problems that provide underpinning knowledge and skills for advanced telecommunication mathematical systems requiring numerical simulation No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.
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Application of the Unit

Application of the unit	Telecommunication network engineers apply the skills and knowledge in this unit. It involves the application of complex mathematical analysis to technical problems. It involves the design and evaluation of systems and networks, system enhancement, and interaction with design engineering sections from manufacturers to resolve telecommunications network problems that are not common. Relevant job roles may include: • digital signal processing • antenna performance and propagation evaluation • queuing systems • forecasting • data analysis • capacity predictions • traffic engineering • radio networks.
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Licensing/Regulatory Information

Refer to Unit Descriptor

Pre-Requisites

Prerequisite units		

Employability Skills Information

Employability skills	This unit contains employability skills.
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Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.
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Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1. Use advanced engineering mathematics for a range of complex engineering solutions	1.1. Solve mathematical functions using complex trigonometric ratios 1.2. Solve mathematical functions using manipulation of matrices and determinants to perform standard calculations 1.3. Solve trigonometric functions using operations on complex numbers 1.4. Solve complex functions using integral and differential calculus 1.5. Solve mathematical functions using ordinary differential equations (ODE) 1.6. Solve mathematical equations using Laplace transforms 1.7. Solve mathematical problems using algorithmic control structures 1.8. Use software simulations where possible to produce simulated calculations for a range of engineering solutions 1.9. Analyse the results from the simulated solution and compare to the derived solutions to adjust any variables in the calculation process
2. Design a simulation control system with queues	2.1. Design a simple control system using simulation software 2.2. Design a queuing system using simulation software 2.3. Design a stochastic system using simulation software 2.4. Document and present all numerical software simulations for the engineering problems

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit.

Required skills

- advanced mathematical skills to perform a range of complex engineering solutions
- communication skills to work effectively within group
- information technology skills for word processing and desktop research
- literacy skills to read and interpret technical documentation

REQUIRED SKILLS AND KNOWLEDGE
• numeracy skills to gather and record data from measurements • research skills to gather data and information • technical skills to operate test equipment
Required knowledge
• integration and differentiation processes • mathematical simulations • mathematical theories • numerical analysis of signals • queuing theories • software programming and debugging • software simulation

Evidence Guide

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

Overview of assessment

Critical aspects for assessment and evidence required to demonstrate competency in this unit

Evidence of the ability to:

- analyse and manipulate functions using symbolic and numerical software, including the operations of entering and manipulating polynomials in suitable software and then substitution of values and graphing
- analyse and manipulate matrices and determinants, numerically with and without symbolic and numerical software
- design and debug programs using algorithmic control structures and output the results to the screen, a graph and a file
- analyse and manipulate complex numbers numerically and with symbolic software
- determine and manipulate equations using the advanced calculus operations of differentiation and integration numerically and with symbolic software
- determine and manipulate equations of the type called ODE met in telecommunications engineering applications numerically and with symbolic software
- determine and manipulate Laplace transforms met in telecommunications engineering applications numerically and with symbolic software
- design a simulation control system and simulate queues using software.

Context of and specific resources for assessment

Assessment must ensure:

- networked computers
- simulation software
- relevant documentation.

Method of assessment

A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:

- oral questioning or written questioning to assess required knowledge
- direct observation of the candidate carrying out

EVIDENCE GUIDE	
	- mathematical simulations • review of simulation control system prepared by the candidate.

EVIDENCE GUIDE**Guidance information for assessment**

Holistic assessment with other units relevant to the industry sector, workplaces and job role is recommended, for example:

- ICTRFN8180A Analyse a mobile network system
- ICTRFN8181A Analyse a satellite communications system
- ICTTEN8194A Analyse a telecommunications switching network
- ICTTEN8195A Evaluate and apply network security
- ICTTEN8196A Evaluate and apply digital signal processing to communications system.

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

Where applicable, physical resources should include equipment modified for people with special needs.

Range Statement**RANGE STATEMENT**

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

RANGE STATEMENT

Functions may include:	• $\cos(x)$ • $\text{exponential}(x)$ • $\ln(1+x)$ • $\sin(x)$.
Complex trigonometric ratios refer to:	• analysing the elements of a vector 'term by term' with the operations of division, multiplication and exponentiation • analysing the series expansion of functions commonly used in telecommunications engineering problems • applying series expansion using Taylor and Maclaurins forms to simple formulae: • polynomials • exponentials • logarithmic functions • trigonometric functions • calculating a best fit polynomial of up to degree five for a set of at least ten data points using a least square method in software • calculating a line of best fit and plot the result given a set of at least ten data points using a least square method in software • complex trigonometric ratios: • cosh functions • sinh functions • tanh functions • interpolating data for a curve of best fit • performing calculations with a simulation package.
Matrices and determinants refer to:	• analysing row and column vectors as a special case of a general matrix • applying symbolic software to perform standard calculations on a matrix • calculating the co-factor of a determinant given the desired row and column • calculating the eigen values and eigen vectors of a square matrix of three dimensions • calculating the numerical and symbolic addition and/or subtraction of commensurable matrices • calculating the numerical and symbolic inner product of commensurable row and column vectors • calculating the numerical and symbolic product of a matrix by a scalar • calculating the numerical product of a pair of commensurable matrices • calculating the numerical value for the inverse of a square matrix

RANGE STATEMENT	
	• converting a set of linear equations to Matrix form.

RANGE STATEMENT

Standard calculations may include:	- determinant of a square matrix with up to 4x4 dimension - eigen values and eigen vectors of a square matrix with up to 4x4 dimension - solution of up to four simultaneous equations - symbolic product of a pair of commensurable matrices with outer dimensions not exceeding four.
Trigonometric functions include:	- cos - cosh - sin - sinh - tan - tanh.
Operations on complex numbers refer to:	- analysing the polar and rectangular forms of complex numbers - calculating complex variables with basic arithmetic operations - calculating the complex roots of polynomials with real coefficients up to third order - calculating the results of operations on complex numbers using complex forms of trigonometric functions - deriving the results for the complex operations of square root and multiple roots for up to sixth order - operations on complex numbers: - multiple roots - powers - square roots - solving an engineering problem using euler equation.
Integral and differential calculus refer to:	- calculating derivatives and integrals of a single variable using standard forms and with symbolic software - calculating maximum and minimum values of a differential function - calculating partial derivatives using standard forms of differentiation - calculating the numerical differential of an equation from the sample interval - calculating the numerical integration of an equation given the sample interval - differentiating implicitly defined functions by applying the chain rule and software solution - integrating and evaluating double integrals that use standard forms and substitution methods - integrating equations by applying integration methods.
Ordinary differential	solving first order ODE using standard methods

RANGE STATEMENT	
<i>equations (ODE)</i> refer to:	• solving first and second order ODE equations using various ODE solutions methods: • applying software • numerical plot with constant coefficients • numerical solutions • trial exponential solutions determining the unknown constants.

RANGE STATEMENT

<i>Laplace transforms</i> refer to:	- calculating Laplace transforms of relevant equations using standard forms: - exponential equations - telecommunications related equations with polynomials up to degree two - trigonometric equations - calculating partial fraction expansion of linear equations of one variable with constant coefficients of second order degree or less - calculating the inverse Laplace transform by arrangement, into standard forms - solving a telecommunications related first order ODE using Laplace transforms numerically and with symbolic software.
<i>Algorithmic control structures</i> may include:	- multi-way selection (switch) - post-test repetition (repeat until) - pre-test repetition (Do While) - program fragments that use algorithmic control structures - program to output calculated results - program to request data by command line prompting - sequence - solution expressed in an acceptable algorithmic form - two-way selection (IF then Else) - well structured program to obtain the solution to a given engineering problem.
<i>Simulated calculations</i> may include:	- manipulation of diary files - plotting the results of calculations with equations: - exponential - logarithmic - trigonometric functions - script to repeat previous calculations - simplification and expansion of symbolic equations and arithmetical expressions - symbolic variables, constants and equations - variable browsers window and command history screen - variables to store appropriate data for problem solving.
<i>Engineering solutions</i> may include:	- antenna performance and propagation evaluation - capacity predictions - data analysis - digital signal processing - forecasting - queuing systems

RANGE STATEMENT	
	• radio networks • traffic engineering.
<i>Simple control system</i> is based on:	• delay elements • feedback loop.
<i>Queuing system</i> includes:	• fixed arrival times • fixed processing delay • single queue • single server.
<i>Stochastic system</i> includes:	• random arrival times • random processing delay • single queue • single server.

Unit Sector(s)

Unit sector	Telecommunications
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Co-requisite units

Co-requisite units		

Competency field

Competency field	Telecommunications networks engineering
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