Subject Description Form

Subject Code	ME46002
Subject Title	Numerical Methods for Engineers
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: AMA2111 Mathematics I
Objectives	To teach students numerical methods of solving typical engineering problems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Formulate simple engineering problems with knowledge in data analysis and engineering mathematics. b. Solve non-linear equations, simultaneous linear algebraic equations, eigenvalue problems, using numerical methods. c. Perform numerical differentiation and integration and analyze the errors. d. Know the contemporary issues, and understand the impact of artificial intelligence in a global and societal context. e. Use MATLAB or other data analysis tools to compute the solutions of engineering problems using the appropriate numerical methods.
Subject Synopsis/ Indicative Syllabus	***Introduction to Mathematical Modelling and Computational Methods –*** Importance of computational modelling in engineering. Data representation and errors. Applications of commercial software packages such as MATLAB. Functions and plotting using MATLAB. ***Computer Solution of Non-linear Equations*** - Bracketing Methods. Bisection Method. Open Methods. Newton-Raphson Method. Secant Method. Convergence of methods. Determination of multiple roots. Engineering applications. ***Simultaneous Linear Equations*** **-** Solving simultaneous linear equations by Matrix Inversion. Cramer's Rule. Gauss Elimination. Gauss-Jordan Elimination. LU decomposition method. Engineering applications and choice of methods. Eigenvalues Problems. ***Optimization*** **-** Unconstrained optimization. Multi-dimensional optimization. Unconstrained optimization. ***Curve Fitting and Data Analysis*** **-** Interpolation using splines. Linear Least-Squares Regression. Nonlinear Regression. Introduction to Machine Learning Algorithms. ***Numerical Differentiation and Integration*** **-** Taylor's series expansion. Finite differences for the first derivative and the second derivative. High-accuracy differentiation formulas. Trapezoidal rule. Simpson's rule. High-order Newton-Cotes formulas. Applications of numerical differentiation and integration in heat transfer, solid mechanics and fluid flow problems.

Teaching/Learning Methodology

Lectures are used to deliver the fundamental knowledge in relation to numerical methods. (Outcomes a - d)

Tutorials will be conducted in small groups to facilitate discussions. (Outcomes a - d)

Computational workshops provide hands-on experience in using software to solve numerical problems. (Outcomes b - e)

Teaching/Learning Methodology	Outcomes				
	a	b	c	d	e
Lecture	√	√	√	√	
Tutorial	√	√	√	√	
Computational workshop		√	√	√	√

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Test	20%	√	√	√	√	
2. Assignment	30%	√	√	√	√	√
3. Examination	50%		√	√		
Total	100%					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

$0.50 \times$ End of Subject Examination + $0.50 \times$ Continuous Assessment

Tests will be conducted to assess students' learning on numerical methods.

Assignments will be used to assess students' learning on using numerical methods in solving engineering problems and using computational software in solving such problems.

Examination will be conducted to assess students' learning on numerical methods.

Student Study Effort Expected

Class contact:	
▪ Lecture	33 Hrs.
▪ Tutorial	4 Hrs.
▪ Computational Workshop	2 Hrs.
Other student study effort:	
▪ Performing assignment	40 Hrs.
▪ Applying computational software	12 Hrs.

	▪ Private study	25 Hrs.
	Total student study effort	116 Hrs.
Reading List and References	1. S.C. Chapra and R.R. Canale, Numerical Methods for Engineers, McGraw-Hill, latest edition. 2. S.S. Rao, Applied Numerical Methods for Engineers and Scientists, Prentice-Hall, latest edition. 3. S.C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill, latest edition. 4. D.M. Etter, Engineering Problem Solving with Matlab, Prentice-Hall, latest edition.	

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