Short Form Module Details

Module Title	**Advanced Engineering Mathematics and Modelling**
Level	Second Year Undergraduate
Reference No. *(showing level)*	EEA_5_007
Credit Value	15 CAT points
Student Study Hours	Total learning hours: 150 hours Contact hours up to 50 hours Student managed learning hours: 100 hours or more
Pre-requisite learning	None
Co-requisites	None
Excluded combinations	None
Module co-ordinator	George A Georgiou
Faculty/Department	Engineering, Science and the Built Environment
Short Description	This module covers advanced undergraduate engineering mathematics and modelling.
Aims	This module's aims are as follows: • To develop the student's knowledge and understanding of engineering mathematics, • To provide the student with key skills that are required for the identification, classification and description of the performance of engineering systems through the use of analytical methods.
Learning Outcomes	**Knowledge and Understanding** Upon successful completion of this module, the student should be able to: • Classify differential equations according to their order, linearity and homogeneity, • Understand how differential equations are used for modelling engineering systems, • Know how to apply various numerical methods (for example Newton Raphson and Runge Kutta) to engineering problems. **Intellectual Skills** Upon successful completion of this module, the student should have acquired analytical skills using vector calculus (div, grad and curl), matrix algebra, Laplace Transforms and Fourier Series. **Practical Skills** Upon successful completion of this module, the student should be able to: • solve a variety of different types of differential equations analytically, • use appropriate computer-based mathematical tools such as Matlab or Mathcad in problem solving. **Transferable Skills** Upon successful completion of this module, the student should have acquired the ability to • quantify data, and know about distributions, orders of magnitude, and scaling, • test and verify mathematical models of engineering systems and apply optimisation techniques using mathematical software.
Employability	Mathematical skills are in high demand from employers and are

	required for the professional recognition of all engineers. This is a Core Subject for nearly all BEng(Hons), engineering students, and as such is a necessary module for enhancing the student's opportunity for work experience and eventual employment
Teaching and learning pattern	The course will be composed of lectures and tutorials, which are complemented by a comprehensive set of accompanying notes, worked solutions as well as mathematical aids (e.g. revision cards, video footage of worked examples) to help the student maximise their capacity to learn and do mathematics
Indicative content	**Overview of the Main Content** **Computational Techniques in Engineering** Review the use of a mathematical software package such as Matlab or Mathcad with a view to acquiring skill in basic programming operations to be used in the computational topics listed below. This will be embedded in other topic areas. **Vectors** Vector fields, grad, div, curl, solenoidal and irrotational fields. **Differential equations** Linear ordinary differential equations, complementary functions and particular integrals. Introduction to partial differential equations. **Transforms** • Introduction to Laplace transforms with application to selected control problems. • Fourier transforms and z-transforms. • Fourier series solutions and Signal representation. **Selected Numerical and Computational methods** • Types of error, numerical differentiation and integration, Gaussian elimination, Newton-Raphson method. • Solution of polynomial and transcendental equations by iterative methods. • Functional representation. • Numerical solution of differential equations: Runge-Kutta and predictor corrector methods. • Application of finite difference techniques to partial differential equations. **Matrix computation** • Advanced matrix algebra, Gaussian elimination, Gauss-Seidel method Eigenvalue problems. • Further techniques for solution of linear equations - LU decomposition, orthogonal expansions **Computational Optimisation** • Constrained and unconstrained optimisation. • Lagrange undetermined multipliers. • Introduction to linear programming. • Formulation of problems. • Nonlinear optimisation. • Positive and negative definite forms, Hessian matrices and use in optimisation. **Statistics** Permutations and combinations. Binomial, Poisson and normal distributions

Assessment *Elements & weightings*	This module shall be assessed as follows: o 70% end of year examination. o 30% continual assessment. This could include a phase test, online test and/or assignment
Indicative Sources *(Reading lists)*	**CORE:** 1. Advanced Engineering Mathematics, A.Bajpai, L.Mustoe, D.Walker, J.Wiley 1995, Chichester UK. 2. Advanced Modern Engineering Mathematics, Glyn James, Addison -Wesley 1993. **REFERENCE:** 1. Advanced Engineering Mathematics Kreyszig, Erwin.New York ; Chichester : Wiley, c1993.