Subject Description Form

Subject Code	**BSE3302**
Subject Title	**Computer Methods in Building Services Engineering**
Credit Value	3
Level	3
Pre-requisite Co-requisite Exclusion	Nil Nil Nil
Objectives	(1) Introduce students to the common mathematical idealisations used in building services engineering, usually in the form of linear and non-linear ODEs, PDEs, Integral and Integro-differential equations; (2) Introduction to numerical solution methods based on discretisation ofcontinua using finite difference and finite element methods (FDM/FEM); (3) Introduction to the solution of homogenous and non-homogenous linear systems arising from FDM/FEM discretisations. (4) Introduction to MATLAB for solving problems in building services engineering using native MATLAB capabilities and by programming user functions and algorithms. This will provide students with the requisite computing knowledge to support their study in later stage, e.g., project work and elective subjects in the final year.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) apply mathematical reasoning to analyze essential features of different problems in building services engineering; b) extend their knowledge of mathematical and numerical techniques and adapt known solutions to different situations in building services engineering; c) analyze and model application problems using computational methods and fundamental knowledge in building services engineering; d) write computational code using Matlab for solving problems in application and explain the computation results based on fundamental knowledge in building services engineering.
Subject Synopsis/ Indicative Syllabus	The syllabus will be organised in four sections of equal weighting as follows: *Taxonomy of mathematical models in Building Services Engineeering* Introduction to the idea of mathematical and computational modelling based on governing equations (ODEs/PDEs etc.); sub-models such as constitutive equations; and finally assumptions and constraints, such as initial and boundary conditions. Introduction to methods of solution including analytical methods and their limitations and how they can be overcome by numerical and computational approaches such the finite difference method and the finite element method. *Mathematical Equations of Building Services Engineering* This subject introduces students to the fundamental theory of computational approaches used to as a general tool for numerically solving elliptic, parabolic and hyperbolic differential equations for a wide range of building services engineering problems. Field problems described by the Laplace, Poisson equations are presented first and including analytical and computational approaches to solve them in the context of heat and mass transfer problems. Time dependent problems and time integraton schemes are presented in the context of transient heat transfer and solution of Fourier Equations. Wave equation is then introduced in the context of acoustics and electromagnetism. Incompressible flow problems are introduced through Euler and Navier-Stokes equations. BSE applications will include: acoustics and vibration; HVACR; indoor environment quality modelling and simulation including propagation of pollutants and pathogens; lighting and electrical services; and fire services.

	Finite Difference Method (FDM) and the Finite Element Method (FEM) Theory and application of FDM and FEM based discretisation to selected mathematical representations of Building Services Engineering problems introduced in the second section. Introduction to Strong and weak formulations of a problem and discretisation using FDM and variational and weighted residual approaches used in FEM. Methods for solving discretised linear systems; Solutions of non-linear equations; Newton-Raphson methods; *Matlab programming* Introduction to Matlab; Realization of computational methods introduced using Matlab; Visualization of computation results in Matlab; Computational code creation using Matlab; Applications.
Teaching/Learning Methodology	Lectures –13sessions of 2-hour lecture are provided. Lectures are to introduce the basic concepts and associated theories. Tutorials – 13 sessions of 1-hour tutorial help students solve difficult exercises in which the students cannot solve by themselves. Students are encouraged to prepare and complete the tutorial exercises at home. It helps enhance their learning outcomes. Assignment – Provide opportunities to test students' understanding (formative & judgmental).
Assessment Methods in Alignment with Intended Learning Outcomes	(see table below)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	
1. Class quizzes/tests	20%	✓	✓	✓	✓	
2. MATLAB Projects	30%	✓	✓	✓	✓	
3. Examination	50%	✓	✓	✓	✓	
Total	100 %					

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

Quizzes and tests (week 4 to 7) – Facilitator can have a better understanding of individual student / students' weaknesses or strength so that remedial actions can be taken timely.
MATLAB Projects (week 8 to 12) – Introductory and advanced programming projects with increasing level of difficulty based on taught and computing tutorial classes will be set to ensure students develop sufficient confidence in using MATLAB for computational work.
Examination – Held at the end of the unit with questions aligned with the intended subject learning outcomes.

Student Study Effort Expected	Class contact:	
	▪ Lectures	26 Hrs.
	▪ Tutorials and Computing Lab	13 Hrs.
	Other student study effort:	
	▪ Tutorial exercises and MATLAB Projects	28 Hrs.
	▪ Self-study and revision	50 Hrs.
	Total student study effort	117 Hrs.

Reading List and References	References:		
	Kreyszig, E.	Advanced Engineering Mathematics	John Wiley 2011
	Germund Dahlquist and Åke Björk	Numerical Methods in Scientific Computing, Volumes I and II	SIAM 2007
	E. G. Thompson.	Introduction to the Finite Element Method - Theory, Programming and Applications	John Wiley and Sons, 2004

	Palm, W.J.	Introduction to MATLAB for engineers, 3rd edition	McGraw Hill, 2011