Subject Description Form

Subject Code	ME6602
Subject Title	Computer Simulation Methods in Science and Engineering
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	N.A.
Objectives	1. To provide students with different simulation related methodologies in scientific research from different disciplines; 2. To equip students with numerical method technologies to support computer simulation and its realization; 3. To enable the students to apply computer-oriented simulation techniques and methods to solve modern science and engineering research problems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Use the numerical methods in solving ordinary differential equations and partial differential equations b. Understand the numerical simulation methods and how simulation is used in the modeling of engineering processes c. Select and apply different simulation methods in modelling of scientific problems in different size scales d. Apply simulation methods to solve practical scientific and engineering problems and provide feasible solutions.
Subject Synopsis/ Indicative Syllabus	***Simulation Methods and fundamentals*** – Random numbers. Probability distributions and correlation functions. Stochastic equations. Brownian motions. Random walks. Statistical ensembles. Statistical calculation of physical quantities. Monte Carlo simulation. Lattice Boltzmann simulation, other simulation methods, Case studies and examples. ***Finite element method*** – Finite element formulation for elastic deformation. Finite element for plastic and visco-plastic deformation. Shape function. Element type and isoparametric element, Numerical integration. Selection of mesh and discretization. Case studies and examples. ***Computational Fluid Dynamics (CFD)*** – Classification of partial differential equations, Navier-Stokes Equations, Grid generation, structured grid, unstructured grid. Turbulence and its modeling. ***Finite Difference Method*** – Finite difference formulations; parabolic partial differential equations, explicit method, implicit method, stability analysis; elliptic equations, solution algorithms; hyperbolic equations, explicit method, implicit method, splitting method. ***Applications of Numerical Simulation*** – Product strength design. Manufacturing process simulation and optimization. Product fatigue life design and analysis. Product damage and fracture analysis and prediction

Teaching/Learning Methodology*)*	The subject will be taught via lectures and tutorials.

Lectures are used to deliver the knowledge of computer simulation methods.

Tutorials will be conducted in small groups to facilitate discussions.

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
Lectures	√	√	√	√
Tutorials	√	√	√	√

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
1. Assignment	40%	√	√	√	√
2. Test	10%	√	√	√	√
3. Examination	50%	√	√	√	√
Total	100%				

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

Assignments will be used to assess students' learning on the mathematics used in computer simulation methods, and on the principles and basic techniques of computer simulation methods.

Tests will be conducted to assess students' learning on fundamental knowledge of computer simulation methods.

Examination will be conducted to assess students' learning on the mathematics used in computer simulation methods, and on the principles of computer simulation methods.

Student Study Effort Expected

Class contact:	
▪ Lectures	27 Hrs.
▪ Tutorials	12 Hrs.
Other student study effort:	
▪ Performing assignments	40 Hrs.
▪ Private study	27 Hrs.
Total student study effort	106 Hrs.

Reading List and References	1. M. P. Allen, and D. J. Tildesley, Computer simulation of liquids, Oxford Science Publications, latest edition. 2. A. R. Leach, Molecular modelling: principles and applications, Prentice Hall, latest edition. 3. Harvey Gould, Jan Tobochnik, and Wolfgang Christian**,** An introduction to computer simulation methods: applications to physical systems, Addison-Wesley, latest edition. 4. K.A. Hoffmann and S.T. Chiang, Computational fluid dynamics for engineers, Engineering education system, latest edition. 5. H. K. Versteeg and W Malalasekera, An introduction to Computational Fluid Dynamics, Pearson Prentice Hall, latest edition. 6. MW FU, Design and Development of Metal Forming Processes and Products aided by Finite Element Simulation, Springer International Publishing AG, 2016

Revised August 2020