Subject Description Form

Subject Code	ME6603
Subject Title	Advanced Mathematics of Physics and Modern Engineering
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Prerequisite: Fundamental knowledge on single-variable and multi-variable calculus.
Objectives	The subject aims at: 1. To equip students with advanced concepts, definitions and theories of linear algebra and matrices, complex analysis and transformations, ODEs and PDEs. 2. To introduce students with advanced knowledge of engineering mathematics to various classical problems in mechanical engineering.
Intended Learning Outcomes	Upon satisfactory completion of the subject, students are expected to achieve the following outcomes: a. Understand and relating concepts of linear algebra and matrices, and be able to illustrate them using examples in their research area. b. Use the taught theories/methods to solve ODEs and PDEs from mathematical physics. c. Describe the main properties of the analytic functions and transformation methods and understand their potential applications. d. Relate the knowledge of advanced engineering mathematics to their research topics.
Subject Synopsis/ Indicative Syllabus	1. **Linear algebra and matrices:** (a) Finite dimensional transformation and matrix representations: rank, null space, inner products, adjoints, determinants, Ax=b. (b) Eigen-problems Av=λv: similarity transforamtions, diagonalization and Jordan forms. (c) Symmetric, Hermitian, orthogonal and unitary matrices; spectral decomposition. (d) Schur's therom, Gershgorin's theorem, singular value and L-U decomposition. 2. **ODEs:** (a) ODE theory: existence, uniqueness, dependence on initial data. (b) Initial value problems for linear ODEs, fundamental solution matrices and matrix exponentials; non-linear ODEs and linearization. (c) Bounary value problems, Green's functions for ODEs. (d) Green's functions for PDE boundary value problems, Posson's equation. 3. **Complex variables:** (a) Elementary functions, analytic functions, linear integrals and Cauchy's integral formula, Taylor and Laurent series, singularities and residues, Cauchy's residue theorem and contour ingerations. (b) Conformal mapping. 4. **Transform Methods:** (a) Fourier transforms, (b) Laplace transforms.

	5. **PDEs:** (a) Linear, quasilinear and nonlinear PDE; classifications of 2nd order linear PDE: hyperbolic, parabolic and elliptic equations. (b) Methods of solutions: separation of variables, Fourier and Laplace transform methods, travelling waves.
Teaching/Learning Methodology	This subject will be taught via lectures, tutorials, mini-projects and case studies. Tutorials, mini-projects and case studies will be conducted in small groups to facilitate discussions.
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. Continuous Assessment	60%	√	√	√	√
2. Examination	40%	√	√	√	
Total	100%				

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

Overall Assessment:
0.40 × End of Subject Examination + 0.60 × Continuous Assessment

Examination is adopted to assess students on the overall understanding and the ability of applying the concepts. It is supplemented by continuous assessment including assignments, closed-book tests and projects. The continuous assessment is aimed at enhancing the students' comprehension and assimilation of various topics of the syllabus. Continuous assessment will also be used to assess the students' capacities of self-learning and problem-solving and effective communication skill in English so as to fulfill the requirements of being a qualified PhD student.

Student Study Effort Expected		
	Class contact:	
	• Lecture	39 Hrs.
	Other student study effort:	
	▪ Precepts or Tutorials	32 Hrs.
	▪ After-class reading	34 Hrs.
	Total student study effort	105 Hrs.

Reading List and References	1. D. A. McQuarrie, Mathematics Methods for Scientists and Engineers, University Science Books, latest edition. 2. M. Greenberg, Foundations of Applied Mathematics, Pretice Hall, latest edition. 3. R. A. Horn and C. R. Johnson, Matrix Analysis, Cambridge University Press, latest edition. 4. F. B. Hildebrand, Advanced Calculus for Applications, Prentice Hall, latest edition. 5. I. S. Sokolnikoff and R. M. Redheffer, Mathematics of Physics and Modern Engineering, McGraw Hill, latest edition.

(Implemented from 2019/20 academic year.)

March 2019