Subject Description Form

Subject Code	AMA524
Subject Title	Scientific Computing
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	In scientific computing, we solve scientific and engineering problems posed in mathematical form using numerical algorithms/methods which can be implemented on computers. The aim of this subject is to provide students with basic training in computational methods. The subject covers many important and widely used computational techniques and their practical applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the theoretical and practical aspects of the basic algorithm for solving mathematical problems. (b) Design programmes for numerical computation. (c) Choose numerical methods so as to avoid or control error propagation. (d) Apply the standard numerical methods for solving mathematical problems.
Subject Synopsis/ Indicative Syllabus	<u>Computer programming</u> A brief introduction to the language of MATLAB. Students are expected to use MATLAB to explore the vast area of application of numerical methods. <u>Error analysis</u> Absolute error, relative error, round-off error, truncation errors, error propagation and significant digits. <u>Solutions of linear systems</u> Gaussian elimination, LU factorization, Cholesky factorization, the conjugate gradient method, iterative methods, vector norms, matrix norms, convergence of iterative methods. <u>Solutions of nonlinear equations</u> Fixed point method, Newton's method, the secant method, Broyden method, BFGS method. <u>Matrix eigenvalue problems</u>

<table>
<tr><td></td><td>Eigenvalues, eigenvectors, inclusion of eigenvalues, power method, Householder tridiagonalization, the QR-factorization method.

<u>Interpolation polynomials</u>

Polynomial interpolation, the Lagrange and Newton formula, error formula.

<u>Numerical integration</u>

The rectangular rule, the trapezoidal rule, the Simpson rule and Newton-Cotes rules.

<u>Initial value problems for ordinary differential equations</u>

Euler’s method, Runge-Kutta methods.

<u>Finite difference methods for differential equations</u>

Two-point boundary value problems, elliptic equations, parabolic equations, hyperbolic equations</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>The subject will be delivered mainly through lectures and tutorials. The teaching and learning approach is mainly problem-solving oriented. The approach aims at the development of mathematical techniques and how the techniques can be applied to solving problems. Students are encouraged to adopt a deep study approach by employing high level cognitive strategies, such as critical and evaluative thinking, relating, integrating and applying theories to practice.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="4">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Assignments</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Mid-term test</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Examination</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="4"></td></tr>
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Continuous Assessment comprises of assignments and a mid-term test. A written examination is held at the end of the semester.</td></tr>
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Student Study Effort Required	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorial	13 Hrs.
	Other student study effort:	
	▪ Assignment	20 Hrs.
	▪ Case study/Mini-project	38 Hrs.
	▪ Self-study	40 Hrs.
	Total student study effort	137 Hrs.

Reading List and References

Higham, N.J.	Accuracy and Stability of Numerical Algorithms, 2nd Edition	Addison-Wesley, 2002
Sedgewick, R. and Flajolet, P.	An introduction to the Analysis of Algorithms	SIAM, 1996
Schilling, R.J. and Harris, S.L.	Applied Numerical Methods for Engineers using MATLAB and C.	Brooks/Cole, 2000
Van Loan, F.	Introduction to Scientific Computing, 2nd Edition	Prentice Hall, 2000
Kincaid, D. and Cheney, W.	Numerical Analysis, 3rd Edition	Brooks/Cole, 2002
Golub, G.H. and Ortega, J.M.	Scientific Computing and Differential Equations, 2nd Edition	Academic, 1992