University of Moratuwa, Faculty of Engineering, Department of Mathematics-20160914
BSc Engineering Honors Degree
Batch 15-Semester 2-2016/09/12: 2016/12/23-14 weeks
Reading Week-2016/10/28: 2016/11/07
CS(**128**)-Wed-0815:1015-AUD1

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Module Code	**MA 1032**	**Module Title**	**Numerical Methods for Computer Science**			
Credits	**03**	**Hours/Week**	**Lectures**	**3**	**Pre – requisites**	**MA 1013**
			Lab/Assignments	**0**		

Learning Outcomes

After completing this module, the students should be able to

- understand the basic concepts of numerical methods including error analysis , methods for solving non – linear equations, methods for solving liner systems, approximations of functions, derivatives and integrals
- practically apply these methods in engineering problems

Outline Syllabus

Modeling, Computers, and Error Analysis

- Mathematical Modeling and Engineering Problem Solving
- Programming and Software
- Approximations and Round-Off Errors
- Truncation Errors and the Taylor Series

Roots of Equations

- Bracketing Methods (bisection, false-position, incremental searches etc.)
- Open Methods (fixed- point iteration, Newton-Raphson, Secant method, etc.)
- Roots of Polynomials
- Case Studies: Roots of Equations

Liner Algebraic Equations

- Gauss Elimination
- LU Decomposition and Matrix Invention
- Special Matrices and Gauss-Seidel
- Case Studies: Liner Algebraic Equations

Optimization

- One-Dimensional Unconstrained Optimization (golden-section search, quadratic interpolation, Newton's method etc.
- Multidimensional Unconstrained Optimization (direct and gradient methods, etc.)
- Constrained Optimization (liner programming, non-linear constrained optimization etc.)
- Case Studies: Optimization

Curve Fitting

- Least- Squares Regression (linear, non-linear, polynomial, multiple-linear regression etc.)
- Interpolation (Newton's divided difference, Lagrange polynomials, inverse interpolation etc.)
- Fourier Approximation
- Case Studies : Curve Fitting

Numerical Differentiation & Integration

- Newton – Cotes Integration Formulas (trapezoidal rule, Simpson's rule, unequal segment etc.)
- Integration of Equations
- Numerical Differentiation
- Case Studies: Numerical Differentiation & Integration

The above content is an emphasis on the Numerical Methods section of MA1023 which is given below. It is impossible to do it and all your future math courses without a proper knowledge of the content of MA1023 especially without multivariate calculus. So we will also cover the Integration and Multivariate Calculus sections of MA1023 and study them with Numerical Methods. We will use *MATHEMATICA, MATLAB and PYTHON* as teaching tools and programming languages.

<table>
<tr><th>Module Code</th><th>MA1023</th><th>Title</th><th colspan="4">Methods of Mathematics</th></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">03</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>03</td><td rowspan="2">Prerequisites</td><td rowspan="2">MA1013</td></tr>
<tr><td>Lab/Tutorial</td><td>01</td></tr>
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Learning Outcomes

At the end of this module the student should be able to

- Solve a non-linear equation in a single variable, to a desired accuracy.
- Integrate a function of a single variable numerically, to a desired accuracy.
- Solve first order non-linear ordinary differential equations.
- Solve initial value problems involving second order linear ordinary differential equations.
- Application of multivariate calculus to solve simple engineering problems.
- Apply statistical skills in engineering problems.
- Use probability distributions for decision making in engineering.

Outline Syllabus

Numerical Methods

- Algorithms and errors;
- Numerical solution of non-linear equations. Bisection and false position methods, simple iterations. Newton-Raphson method;
- Estimation of errors and acceleration of convergence. Approximations of functions.
- Numerical integration; Trapezoidal rule, Simpson's rule.

Ordinary Differential Equations & Multivariate Calculus

- Reimann integration;
- First order ordinary differential equations: Variable separable, homogeneous and exact eqations.
- Second order differential equations: Reducible forms.
- Functions of several variables: partial differentiation, chain rule, directional derivatives.
- Maxima and minima, Lagrange multipliers;
- Taylor series expansion of multivariate functions.

Basic Probability and Statistics

- Conditional probability, Bayes' theorem.
- Discrete and continuous random variables. Probability and cumulative distribution functions, joint distribution functions.
- Uniform, Binomial, Poisson and Normal distributions and their applications.
- Basic statistical indicators in data analysis, correlation coefficients;
- Introduction of Minitab - statistical software.

Method of Assessment

- End of semester examination: 3 hour closed book paper: 70%
- Mid semester examination: 1 hour open book paper: 10%(on 2016/11/07 from 5.30-6.30pm)
- In class tests: 12% (there will 14 of them, one on each class, 12 counted)
- Take home assignments and Lab classes: 8%

References

- *Mathematical Analysis,* Tom M. Apostol
- *Calculus*-Volume1 and 2, Tom M. Apostol
- *Advanced Calculus,* David V. Widder
- *Numerical Methods for Scientific and Engineering Computation,* M.K. Kain, S.R.K. Iyenger, R.K. Jain
- *Classical and Modern Numerical Analysis, A.S. Ackleh, E.J. Allen, R.B. Hearfott, P. Seshaiyer.*
- *Numerical Analysis*, F. Scheid.
- *Numerical Analysis*: Mathematics of Scientific Computing, D. Kincaid, W. Cheney.
- *Numerical Recipes in C++, W.H. Press, S.A. Teukosky, W.T. Vetterling, B.P. Flannery.*