BMAT206L	Numerical Analysis	L	T	P	C
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Pre-requisite	BMAT101L, BMAT102L, BMAT102P	Syllabus version			
		1.0			

Course Objectives

1. To familiarize theory and application of numerical methods for most common mathematical problems.
2. Clearly bring out role of approximation theory in the process of developing a numerical method for solving an engineering problem.
3. To provide the approximation techniques work with emphasis on accuracy and efficiency of the developed methods.

Course Outcome

At the end of the course, the student will be able to

1. Examine errors in numerical procedures and assess the accuracy of the calculated results.
2. Solve system of nonlinear equations numerically using direct and iterative methods.
3. Compute approximations of functions and data using elementary functions.
4. Apply iterative techniques to solve linear systems and Eigenvalue problems.
5. Use numerical techniques to estimate derivatives and integrals of functions.
6. Apply numerical methods to solve initial value problems and boundary value problems.

Module:1	Preliminaries on computing	6 hours

Basic concepts: Numerical algorithms and errors, round-off errors, floating point arithmetic, rounding, error analysis, conditioning, measuring efficiency of numerical procedures - consistency, stability and convergence analysis;

Module:2	Numerical solution of nonlinear equations	6 hours

Solutions of equations in one variable – Bisection method, Secant method, Fixed-point iteration, Newton's method and its variations for simple and multiple roots; Polynomial roots; System of nonlinear equations – Fixed-Point iteration, Newton's method and its variations for system; Steepest Descent method, Convergence analysis and order of convergence;

Module:3	Interpolation and Approximation	6 hours

Interpolating polynomials; Finite differences, Newton's forward and Backward interpolation, Divided differences – Lagrange and Newton's divided difference interpolations and error analysis; Interpolation by Spline functions; Orthogonal polynomials and Least squares approximation, Chebyshev polynomials; Rational function approximation; Trigonometric polynomial approximation, Fourier series;

Module:4	Numerical solutions of linear system of equations	6 hours

Linear systems of equations, Solution by direct methods – Gauss elimination, Gauss-Jordan method and pivoting strategies, Matrix decompositions – LU and Cholesky factorizations; Matrix conditioning - Ill and well-conditioned systems, Condition numbers and norms; Norms of vectors and Matrices, Solution by Iterative methods – Jacobi, Gauss-Siedel, SOR methods; Error bounds and iterative refinement;

Module:5	Eigenvalues and Eigenvectors	6 hours

The Matrix Eigenvalue Problem, Characteristic polynomial, Gerschgorin's theorems, Reduction of matrices to simpler form - Diagonalization; Tridiagonalization and QR-Factorization, Methods for determination of Eigenvalues and Eigen vectors – Power method, Householder's method, QR method; Singular value decomposition; Applications of Eigenvalue Problems;

Module:6	Numerical differentiation and Integration	6 hours

Approximating derivatives by difference equations, error and instability; Richardson extrapolation; Derivatives of unequally spaced data; Partial derivatives; Elements of numerical integration, Newton-Cotes quadrature formulae; Romberg integration, Adaptive

integration, Gaussian quadrature, Error estimation, Multiple integrals;		
Module:7	**Numerical methods for differential equations**	**7 hours**
Existence of solutions for ordinary differential equations, uniqueness; Solving IVPs by Taylor-Series method, Euler's method and its modifications, Runga-Kutta methods, Multistep Methods; Higher-order equations and systems; Stability; Solving BVPs by Shooting methods, Difference methods, Variational methods; Introduction to numerical solutions for partial differential equations;		
Module: 8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	Gerald C.F, Wheatley P.O, Applied Numerical Analysis, 2004, 7th Edition, Pearson Education.
2.	Burden R.L, Faires J.D, Numerical Analysis, 2011, 9th Edition, Cengage Learning.
3.	Chapra S.C, Canale R.P, Numerical methods for Engineers, 2010, 6th Edition, McGraw-Hill Education.
4.	Stoer J, Bulirsch R, Introduction to Numerical Analysis, 2009, Springer (India).
Reference Books	
1.	Hildebrand F.B, Introduction to Numerical Analysis, 2003, 2nd Edition, Dover Publications.
2.	Endre Suli, Mayers D.F, An Introduction to Numerical Analysis, 2003, Cambridge University Press.
3.	Atkinson K.E, Han W, Elementary Numerical Analysis, 2006, 3rd Edition, Wiley International.
4.	Conte S.D, De Boor C, Elementary Numerical Analysis, 2010, TATA McGraw-Hill.

Mode of Evaluation: CAT, Written assignment, Quiz, FAT.			
Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022