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|  | **National Institute of Technology Meghalaya**An Institute of National Importance | **CURRICULUM** |
| Programme | **Master of Technology (Structural Engineering)** | Year of Regulation | **2018** |
| Department | **Civil Engineering** | Semester | **I** |
| Course Code | Course Name | Pre-requisite | Credit Structure | Marks Distribution |
| L | T | P | C | INT | MID | END | Total |
| **CE 561** | **NUMERICAL ANALYSIS** | **NIL** | **3** | **0** | **0** | **3** | **50** | **50** | **100** | **200** |
| Course Objectives | To introduce the fundamental concepts relevant to basics of mathematical solution to algebraic equations.  | Course Outcomes | CO1 | Able to understand basic solution to series of linear equations. |
| CO2 | Student will be able to gain knowledge on various approximation solution and interpolations. |
| To impart knowledge about computational techniques of interest with emphasis on the techniques and to equip the students with capabilities to model and solve problems related to engineering and applied science. |
| CO3 | Students will be able to identify different methods of numerical solutions.  |
| SYLLABUS |
| No. | Content | Hours | COs |
| I | **Errors and Accuracy:** Approximate numbers and significant figures, absolute error, relative error and percentage error, error in determinants, accuracy and precision | 3 | CO1 |
| II | **Systems of Linear Algebraic Equations:** Direct elimination method, LU factorization, tridiagonal systems of equations, pitfalls of elimination method, Jacobi iteration, Gauss-Seidel iteration, successive-over-relaxation method, conjugate gradient method, characteristics of Eigen problem, power method, direct method, Eigenvectors | 3 | CO1, CO2 |
| III | **Polynomial Approximation and Interpolation:** Weier strass approximation theorem, Chebyshev's polynomials, Newton’s forward and backward interpolation, divided difference, Newton’s general interpolation formula, Lagrange’s interpolation formula, accuracy of Newton’s and Lagrange’s interpolation, multivariate approximation, least squares approximation | 5 | CO2 |
| IV | **Numerical Solution of Transcendental Equation:** Approximate value of the root, regular falsi method, Newton-Raphson method, error and geometric significant of Newton-Raphson method, method of iteration, convergence of Newton-Raphson and iteration methods, NewtonRaphson method for simultaneous equations | 5 | CO2, CO3 |
| V | **Numerical Differentiation and Difference Formulas:** Taylor series approach, difference formulas, general quadrature formula, Simpson’s rule, trapezoidal rule, Gauss’s quadrature formula, Euler’s quadrature | 5 | CO2, CO3 |
| VI | **Numerical Solution to Ordinary Differential Equation:** Euler’s method, stability analysis of Euler’s method, Picard’s method of successive approximation, Runge-Kutta method | 5 | CO2, CO3 |
| VII | **Finite Difference Method:** Introduction to finite difference, difference equation, initial and boundary conditions, forward difference, backward difference, central difference, explicit and implicit approach, no uniform grids, errors and stability analysis, Courant number, Lax equivalence theorem, coordinate transformation of governing equations | 5 | CO2, CO3 |
| VIII | **Introduction to Finite Element Method:** Introduction to variational approach, Euler–Lagrange equation, Rayleigh-Ritz method, Weighted Residual Method, Galerkin methods, finite element formulation for boundary value problems | 5 | CO2, CO3 |
| **Total Hours** | **36** |  |
| **Essential Readings** |
| 1. Scarborough, J. B., “Numerical Mathematical Analysis”, Oxford & IBH Publishing Co Pvt., 6th edition 2015. |
| 2. Hoffmanm, J. D., Frankel,S., “Numerical Methods for Engineers and Scientists, Second Edition”, CRC Press, 2001. |
| 3. Anderson Jr, J. D., “Computational Fluid Dynamics”, McGraw-Hill Higher Education, 1st edition 1995. |
| **Supplementary Readings** |
| 1. Zienkiewicz, O. C., Taylor, R. L., Zhu, J. Z., “The Finite Element Method: Its Basis and Fundamentals”, Elsevier India Pvt. Ltd, 6 th edition 2005. |
| 2. Huebner, K. H., Dewhirst,D. L., Smith, D. E., Byrom, T. G.,“The Finite Element Method for Engineers”, John Wiley & Sons, 1982. |
| 3. Kincaid, D., Cheney, W., “Numerical Analysis: Mathematics of Scientific Computing”, American Mathematical Society, 2nd edition 2002. |