ADVANCED ENGINEERING MATHEMATICS

PROF. HARI SHANKAR MAHATO
Department of Mathematics
IIT Kharagpur

PRE-REQUISITES : Differential calculus of one variables, Integral calculus

INTENDED AUDIENCE : BTech. 1st year of all branches, BSc. 1st year students in Mathematics

COURSE OUTLINE :

This course will provide an essential introduction to Engineering mathematics which is required for all UG (BTech and BSc) level courses. I will try to keep the course self-explanatory by providing examples and explain the theories as well wherever necessary. I believe on NPTEL this course hasn't been offered specially for engineering students yet and, for the students looking to attend online courses on engineering mathematics this course will give them a nice opportunity to do so.

ABOUT INSTRUCTOR :

Prof. Hari Shankar Mahato is currently working as an Assistant Professor in the Department of Mathematics at the Indian Institute of Technology Kharagpur. Before joining here, he worked as a postdoc at the University of Georgia, USA. He did his PhD from the University of Bremen, Germany and then he worked as a Postdoc at the University of Erlangen-Nuremberg and afterwards at the Technical University of Dortmund, both located in Germany. His research expertise are Partial Differential Equations, Applied Analysis, Variational Methods, Homogenization Theory and very recently he has started working on Mathematical Biology. He can be able to teach (both online and offline) any undergraduate courses from pre to advanced calculus, mechanics, ordinary differential equations, up to advanced graduate courses like linear and nonlinear PDEs, functional analysis, topology, mathematical modeling, fluid mechanics and homogenization theory

COURSE PLAN :

Week 1: Differentiability, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorem. Functions of several variables: Limit, continuity, partial derivatives and their geometrical interpretation, total differential and differentiability, Derivatives of composite and implicit functions, implicit function theorem, derivatives of higher order and their commutativity, Euler's theorem on homogeneous functions, Taylor's expansion of functions, maxima and minima, constrained maxima/minima problems using Lagrange's method of multipliers

Week 2: Convergence of improper integral, test of convergence, Gamma and Beta functions, their properties, differentiation under the integral sign, Leibnitz rule of differentiation Double and triple integral, change of order of integration, change of variables, Jacobian transformation, Fubini theorem, surface, area and volume integrals, integral dependent on parameters applications, Surface and Volume of revolution. Calculation of center of gravity and center of mass.

Week 3: Differential Equations – first order, solution of first order ODEs, Integrating factor, exact forms, second order ODEs, auxiliary solutions

Week 4: Numerical analysis: Iterative method for solution of system of linear equations, Jacobi and Gauss-Seidal method, solution of transcendental equations: Bisection, Fixed point iteration, Newton-Raphson method.

Week 5: Finite differences, interpolation, error in interpolation polynomials, Newton's forward and backward interpolation formulae, Lagrange's interpolation, Numerical integration: Trapezoidal and Simpson's 1/3rd and 3/8th rule.

Week 6: Vector spaces, basis and dimension, Linear transformation, linear dependence and independence of vectors, Gauss elimination method for system of linear equations for homogeneous and nonhomogeneous equations

Week 7: Rank of a matrix, its properties, solution of system of equations using rank concepts, Row and Column reduced matrices, Echelon Matrix, properties,

Week 8: Hermitian, Skew Hermitian and Unitary matrices, eigenvalues, eigenvectors, its properties, Similarity of matrices, Diagonalization of matrices,

Week 9: Scalar and vector fields, level surface, limit, continuity and differentiability of vector functions, Curve and arc length, unit vectors, directional derivatives,

Week 10: Divergence, Gradient and Curl, Some application to Mechanics, tangent, normal, binormal, Serret-Frenet Formulae, Application to mechanics

Week 11: Line integral, parametric representations, surface integral, volume integral, Gauss divergence theorem, Stokes theorem, Green's theorem.

Week 12: Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane Cauchy's integral formula, derivatives of analytic functions, Cauchy's integral theorem, Taylor's series, Laurent series, zeros and singularities, residue theorem, evaluation of real integrals