MA6001E ADVANCED ENGINEERING MATHEMATICS

Prerequisite: NIL

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3	1	0	8	4

Total Sessions: 52 Course

Outcomes:

CO1: Apply the concepts of matrix theory and vector calculus.
CO2: Develop the analytic approach for solving differential equations.
CO3: Apply the finite difference and finite volume methods for differential equations.
CO4: Implement the analytical and computational techniques in engineering problems.

Mathematical operations with matrices system of linear equations, consistency – vector spaces, linear dependence and independence, basis and dimension – linear transformation – projections – orthogonal matrices, positive definite matrices, eigenvalues and eigenvectors, similarity of matrices, diagonalisation, singular value decomposition.

Vector fields, line integrals, surface integrals – change of variables, green's theorem, stokes theorem, and divergence theorem.

The ordinary differential equation (ODE), Initial value problems and their solution techniques, general solutions of second-order ordinary differential equations, homogeneous and non-homogenous cases, boundary value problem, Sturm-Liouville problem, and system of ODEs – Partial differential equations (PDEs), Cauchy problem, method of characteristics, second-order PDE and classifications, type of boundary conditions, formulation and solution of the heat, wave, and Laplace equations.

Numerical implementation of ODE and PDE with MATLAB/python – ODE: initial value problem: first order and higher order methods, boundary value problem, shooting method, data-fitting, least-squares – first and higher order numerical methods for scalar transport equation, finite difference methods for heat, wave, and Laplace equations.

Case studies relevant to the program: The acoustic model for seismic waves, diffusion in heterogeneous media, development of flow between two flat plates, welding problem, heat conduction in a solid material, phase field solution to diffusion (Allen Cahn 1D solution), solution to the interaction of two or more molecules with Lennard-Jones Potentials, etc.

References:

[1] Lay, D., C., Lay, S., R., and McDonald, J., J., 2016, *Linear Algebra and its Applications*, Pearson, USA.
[2] Kreyszig, E., 2011, *Advanced Engineering Mathematics*, Wiley, India.
[3] Simmons, G., F., 2011, *Differential Equations with Applications and Historical Notes*, McGraw Hill, USA.
[4] Sneddon, I., N., 2006, *Elements of Partial Differential Equations*, Dover, Inda.
[5] Rao, K., S., 2010, *Introduction to Partial Differential Equations*, Prentice-Hall, India.
[6] Butcher, J., C., 2003, *Numerical methods for Ordinary Differential Equations*, Wiley, USA.
[7] Thomas, J., W.,2013, *Numerical Partial Differential Equations: Finite Difference Methods*, Springer, Switzerland.
[8] Versteeg, H., K., and Malalasekera, W., 2007, *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, Pearson, USA.