Course Code : **ME 753**

Course Title : **Advanced Computational Methods**

Credit Hours : **3**

Course Description

solution of ordinary differential equations (odes) for the initial value problem, Solution of the system of odes, Solution of the system of odes, The stiff odes, The solution of the value boundary problem using the linear shooting, finite difference, and non-linear shooting methods, Applications to mechanical, hydraulic, and thermal system design, The finite difference approximation, Numerical solution of partial differential equation (PDEs) using finite difference method, Application on elliptic, parabolic, and hyperbolic PDEs, Direct and iterative methods of solution, Solution of PDEs using the finite volume method. Solution of PDEs using the finite element method, Applications to problem in fluid mechanics, steady and transient conduction heat transfer, elastic deformation of solid element, and stress analysis, Case study using MATLAB programming and available software and modules.

Course Objectives

Develop ability to use personal computers to solve advanced problems in mechanical engineering.
Write and/or use computer software to numerically solve a variety of problems.

Course Topics

Week no. 1: Error analysis.

Week no. 2: Solution of non-linear algebraic equations.

Week no. 3: Numerical integration.

Week no. 4: Numerical solution of ordinary differential equations (odes) for the initial value problem. Solution of the system of odes.

Week no. 5: Solution of the system of odes.

Week no. 6: The stiff odes.

Week no. 7: The solution of the value boundary problem using the linear shooting, finite difference, and non-linear shooting methods / 7th week evaluation.

Week no. 8: Applications to mechanical, hydraulic, and thermal system design.

Week no. 9: The finite difference approximation.

Week no. 10: Numerical solution of partial differential equation (PDEs) using finite difference method.

Week no. 11: Application on elliptic, parabolic, and hyperbolic PDEs.

Week no. 12: Direct and iterative methods of solution / 12th week evaluation

Week no. 13: Solution of PDEs using the finite volume method. Solution of PDEs using the finite element method.

Week no. 14: Applications to problem in fluid mechanics, steady and transient conduction heat transfer, elastic deformation of solid element, and stress analysis.

Week no. 15: Case study using MATLAB programming and available software and modules.

Week no. 16: Final exam.

References

Smith W. “Numerical Solution of Partial Differential Equations”, Oxford Univ. Press, 1990

Versteeg H. and Malalasekera W. “An Introduction to Computational Fluid Dynamics” The finite volume method, Longman Scientific and Technical, 1995

Anderson J. D. “Computational Fluid Dynamics: The Basics with Applications”, McGraw Hill, 1995

Nakamura S. “Numerical Analysis and Graphic Visualization with MATLAB”, Prentice Hall, 1996

Burden F. “Numerical methods”, PWS Pub. Co., 1997

- Coombes K. R. “Differential Equations with MATLAB”, John Wiley, 2000