Approved in 40th BoA Meeting (11-05-2021)

Course Name : Computational Methods for Engineering
Course Number : EP302
Credits : 2-0-2-3
Prerequisites : IC110 Engineering Mathematics
Intended for : UG
Distribution : Core
Semester : Odd/Even

Preamble: Computational Methods are becoming an important tool of industrial design and development and so, it is necessary to train the students in these techniques. Computational Methods have been matured over the years with its own body of knowledge, theory, and research methodology. At the core of the discipline is the realization that every system can be represented by differential equations, the computational methodology can be helpful to analyses physical system in virtual domain. This course objective is to impart computational and numerical solving skills to students for the purpose of design analysis of multi-physics systems. This course focuses on various aspects with particular reference to application and implementation of computational methodology by using computational software package.

Course Modules with Quantitative Lecture Hours:

Module 1: (14 hours)
Numerical Techniques: Linear Equations and Non-linear Equations.
Solving Linear Systems: Gauss Elimination, Gauss-Jordan; LU Decomposition.
Solving Linear System with iterative methods: Jacobi method, Gauss-Seidel Method, Successive Over Relaxation (SOR) method.
Finding roots of polynomial and transcend equations:bisection method, Newton-Raphson method.
Numerical Integration: Trapezoid Rule, Simpson's Rule, Gaussian Quadrature.
Case study from multi-physics systems,Computer implementation.

Module 2: (6 hours)
FEM Concept: Introduction, Engineering applications of finite element method,Weak formulation, Interpolation scheme, FEM formulation for 1D and 2D problems, Computer implementation issues, Convergence and Error analysis.

Module 3: (5 hours)
FEM for Multi-Physics Systems: Case study of thermo-mechanical systems, electro-mechanical systems, thermo-electro-mechanical systems.

Module 4: (3 hours)
Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems.

Laboratory sessions:
Exp. 1 & 2 Use of numerical techniques to solve system of equations using computer programming platform.
Exp. 3&4 Introductions to computational software (FEM based packages).
Exp. 5,6 & 7 Find the simulation response of a physical system under (i) Mechanical load (ii) Thermal load (iii) Electrical load environment.
Exp. 8 & 9 Use of computational (FEM based) package to simulate multi-physics systems case e.g. Electric motor under electro-mechanical and thermal environment.
Exp. 10 & 11 Monte Carlo simulation.

Text books:
Reddy J. N., An introduction to Finite Element Methods, 3rd Ed., Tata McGraw-Hill, 2005
Steven C. Chapra and Raymond P. Canale, Numerical methods for engineers, 4th Edition, McGrawHill. 2015

References:
S D Conte and C de Boor, Elementary numerical analysis: algorithmic approach, 3rd Edition McGraw-Hill International, 1980.
Reuven Y. Rubinstein, Simulation and the Monte Carlo Method, 2ndEdition,,Wiley, 2007.
I. M. Smith, D. V. Griffiths, L. Margetts, Programming the Finite Element Method, 5th Edition, Wiley. 2013.
Anju Khandelwal, Numerical Methods and Computer Programming, 4th Edition, Alpha Science International Ltd. 2015.

Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	ME504	Partially Module 1	10%
2	PH621	Partially Module 1	5 %
3	ME513	Partially Module 2	5 %

Justification for new course proposal if cumulative similarity content is > 30%:
NA