University of Pune

T.E. (Mechanical) - 2012 Course
Numerical Methods and Optimization [302047]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
302047	Numerical Methods and Optimization	4	--	2	30 **(1 hr)**	70 **(2 hrs 30 min)**	--	50	--	**150**

COURSE OBJECTIVES

1 Recognize the difference between analytical and Numerical Methods.
2 Effectively use Numerical Techniques for solving complex Mechanical engineering Problems.
3 Prepare base for understanding engineering analysis software.
4 Develop logical sequencing for solution procedure and skills in soft computing.
5 Optimize the solution for different real life problems with available constraints.
6 Build the foundation for engineering research.

COURSE OUTCOMES

1. Use appropriate Numerical Methods to solve complex mechanical engineering problems.
2. Formulate algorithms and programming.
3. Use Mathematical Solver.
4. Generate Solutions for real life problem using optimization techniques.
5. Analyze the research problem

Unit – I Errors and Approximations (08 hrs)

Types of Errors: Absolute, Relative, Algorithmic, Truncation, Round off Error, Error Propagation, Concept of convergence-relevance to numerical methods.

Roots of Equation

Bisection Method, False position Method, Newton Raphson method and Successive approximation method.

Unit – II Simultaneous Equations (08 hrs)

Gauss Elimination Method, Partial pivoting, Gauss-Seidal method and Thomas algorithm for Tridiagonal Matrix

Unit – III Optimization (10 hrs)

Introduction to optimization, Classification, Constrained optimization: Graphical and Simplex method. One Dimensional unconstrained optimization: Newton's Method. Modern Optimization Techniques: Genetic Algorithm (GA), Simulated Annealing (SA).

Unit –IV Curve Fitting & Interpolation (06 hrs)

Curve Fitting

Least square technique- Straight line, Power equation, Exponential equation and Quadratic equation.

Interpolation

Lagrange's Interpolation, Newton's Forward interpolation, Hermit Interpolation, inverse interpolation.

Unit – V Numerical Integration (06 hrs)

Trapezoidal rule, Simpson's Rule ($1/3^{rd}$ and $3/8^{th}$), Gauss Quadrature 2 point and 3 point method. Double Integration: Trapezoidal rule, Simpson's $1/3^{rd}$Rule.

Unit –VI Numerical Solutions of Differential Equations (10 hrs)

Ordinary Differential Equations [ODE]

Taylor series method, Euler Method, Modified Euler Method(Iterative), RungeKuttafourth order Method, Simultaneous equations using RungeKutta2nd order method.

Partial Differential Equations [PDE]: Finite Difference methods

Introduction to finite difference method, PDEs- Parabolic explicit solution, Ellipticexplicit solution.

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Term-Work

1. Program on Roots of Equation (Validation by suitable solver, all four compulsory)
   a). Bisection Method, b. False position Method,
   c). Newton Raphson method d. Successive approximation method

2. Program on Simultaneous Equations (Validation by suitable solver, all three compulsory)
   a) Gauss Elimination Method,
   b) Thomas algorithm for tridiagonal matrix,
   c) Gauss-Seidal method.

3. Program on Numerical Integration(Validation by suitable solver, all four compulsory)
   a) Trapezoidal rule,
   b) Simpson's Rules ($1/3^{rd}$, $3/8^{th}$) [In one program only]
   c) Gauss Quadrature Method- 2 point, 3 point. [In one program only]
   d) Double integration: Trapezoidal rule, Simpson's $1/3^{rd}$Rule.

4. Program on Curve Fitting using Least square technique (Validation by suitable solver, all four compulsory)
   a) Straight line,
   b) Power equation
   c) Exponential equation
   d) Quadratic equation

5. Program on Interpolation(Validation by suitable solver, all three compulsory)
   a) Lagrange's Interpolation,
   b) Newton's Forward interpolation,
   c) Inverse interpolation

6. Program on ODE(Validation by suitable solver, all three compulsory)
   a) Euler Method(Iterative),
   b) Runge-Kutta Methods- fourth order,
   c) Simultaneous equations.(Runge-Kutta 2nd order: *One step only*).

7. Program on PDE(Validation by suitable solver)

8. Theory assignment on Modern Optimization techniques.

GUIDELINES TO CONDUCT PRACTICAL EXAMINATION

Any one program from each set A & B with flowchart and solver: **Duration: 2 hrs.**

Set A: (Weightage – 60 %)

a). Simultaneous Equation. b). Partial Differential Equation c). Interpolation.

Set B: (Weightage – 40 %)

a). Roots of Equations. b). Curve Fitting. c). Ordinary Differential Equations. d). Integration

Text Books

1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4/e, Tata McGraw Hill Editions
2. Dr. B. S. Garewal, Numerical Methods in Engineering and Science, Khanna Publishers,.
3. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, Tata Mc-GrawHill Publishing Co-Ltd
4. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers

Reference Books

1. Gerald and Wheatley, Applied Numerical Analysis, Pearson Education Asia
2. E. Balagurusamy, Numerical Methods, Tata McGraw Hill
3. P. Thangaraj, Computer Oriented Numerical Methods, PHI
4. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.