Code No: 5115D

R13

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech I Semester Examinations, February - 2017
COMPUTATIONAL METHODS IN ENGINEERING
(Machine Design)

Time: 3hrs **Max. Marks: 60**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 20 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 8 marks and may have a, b, c as sub questions.

PART - A

5 × 4 Marks = 20

1.a) What is the drawback of the Simpson's rules, and how is it overcome in the Adaptive Quadrature methods? [4]

b) Give at least ten common examples of optimization problems in engineering. [4]

c) What are Derivative boundary conditions, and how are they used? [4]

d) Discuss the Explicit Solution of One – Dimensional Heat – Conduction Equation. [4]

e) Explain the approximation fitting of non-linear curves by least squares method, with a suitable example. [4]

PART - B

5 × 8 Marks = 40

2. The following system of equations is designed to determine concentrations (the c's in g/m^3) in a series of coupled reactors as a function of the amount of mass input to each reactor (the right – handsides in g/day):

$$15c_1 - 3c_2 - c_3 = 3300$$
$$-3c_1 + 18c_2 - 6c_3 = 1200$$
$$-4c_1 - c_2 + 12c_3 = 2400$$

a) Determine the matrix inverse.
b) Use the inverse to determine the solution. [4+4]

OR

3. Evaluate the integral of the following tabular data with Simpson's rules:

x	−2	0	2	4	6	8	10
$f(x)$	35	5	−10	2	5	3	20

[8]

4. Solve for the value of x that maximizes $f(x) = -1.5x^6 - 2x^4 + 12x$, using the golden – section search. Employ initial guesses of $x_l = 0$ and $x_u = 2$ and perform three iterations. [8]

OR

5. Perform one iteration of the optimal gradient steepest descent method to locate the minimum of $f(x, y) = -8x + x^2 + 12y + 4y^2 - 2xy$ using initial guesses $x = 0$ and $y = 0$. [8]

6. The Poisson equation can be written in three dimensions as: $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} = f(x, y, z)$. Solve for the distribution of temperature within a unit (1×1) cube with zero boundary conditions and $f = -10$. Employ $\Delta x = \Delta y = \Delta z = \frac{1}{6}$. [8]

OR

7. Solve the Poisson problem:

$$\Delta u = 1, \quad 0 < x < \pi, \quad 0 < y < \pi$$

$$u(x, 0) = u(\pi, y) = u(x, \pi) = u(0, y) = 0.$$

This problem represents the vertical displacement of a membrane due to a uniform downward force, such as gravity. [8]

8. Solve the following Partial Differential Equation:

$$\frac{\partial^2 u}{\partial x^2} + b\frac{\partial u}{\partial x} = \frac{\partial u}{\partial t}$$

Boundary conditions	$u(0, t)$	$u(1, t)$
Initial conditions	$u(x, 0)$	$0 \le x \le 1$

Use second – order accurate finite – difference analogues for the derivatives with a Crank – Nicolson formulation to integrate in time. [8]

OR

9. Solve the system:

$$u_t + \frac{1}{3}(t-2)u_x + \frac{2}{3}(t+1)w_x + \frac{1}{3}u = 0,$$

$$w_t + \frac{1}{3}(t+1)u_x + \frac{1}{3}(2t-1)w_x - \frac{1}{3}w = 0$$

by the Lax–Friedrichs scheme: i.e., each time derivative is approximated as it is for the scalar equation and the spatial derivatives are approximated by central differences. The initial values are:

$$u(0, x) = \max(0, 1 - |x|),$$

$$u(0, x) = \max(0, 1 - 2|x|).$$

Consider values of x in $[-3, 3]$ and t in $[0, 2]$. Take h equal to 1/20 and λ equal to 1/2. At each boundary set $u = 0$, and set w equal to the newly computed value one grid point is from the boundary. Describe the solution behavior for t in the range $[1.5, 2]$. Solve the system in the form given; do not attempt to diagonalize it. [8]

10. Use multiple linear regression to fit the following data:

X_1	0	1	1	2	2	3	3	4	4
X_2	0	1	2	1	2	1	2	1	2
Y	15.1	17.9	12.7	25.6	20.5	35.1	29.7	45.4	40.2

Compute the coefficients, the standard error of the estimate, and the correlation coefficient. [8]

OR

11. The data below represents the bacterial growth in a liquid culture over a number of days.

Day	0	4	8	12	16	20
Amount **x 10^6**	67	84	98	125	149	185

Find a best – fit equation to the data trend. Try several possibilities— linear, parabolic, and exponential. [8]

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