Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2014

Subject code: 2713007 **Date: 06-01-2015**

Subject Name: Numerical Methods and Statistical Analysis for Chemical Engineering

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms: **08**

i) Error propagation
ii) Precision
iii) Standard Deviation
iv) Variance

(b) Discuss stability of Ordinary Differential Equations-Initial Value Problem algorithms. **06**

Q.2 **(a)** Discuss stiffness of ODEs. List out methods used for stiff and non-stiff ODE-IVPs. **07**

(b) Obtain the multiple roots of $f(x) = \ln(x^2 + 1) - e^{0.4x}\cos(\pi x) = 0$ **07**

using the Newton-Raphson technique with incremental search.

OR

(b) Compare Bisection method, Method of False Position and Regula Falsi methods. **07**

Q.3 **(a)** Solve the following by Gauss-Jordon elimination method **07**

$$\begin{bmatrix} 1 & -1 & 2 \\ 1 & 1 & 1 \\ 2 & -2 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -8 \\ -2 \\ -20 \end{bmatrix}$$

(b) Develop linear regression expressions for obtaining the constants using three parameter Antoine equation for vapor pressure of any component. **07**

OR

Q.3 **(a)** Solve the following by Gauss-Seidel method **07**

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix}$$

(b) Fit set of cubic splines for four data points (-2.5, 0) (0 1.67) (2.5, 0) and (5, 1.67) **07**

Q.4 **(a)** Show that the Lagrangian interpolation formula for 2nd degree applied to equi-spaced data points gives the same result as Newtonôs forward difference formulae. **07**

(b) The dimension less temperature of a fluid under steady, fully developed laminar flow in a cylindrical pipe, with wall heated electrically, is given by **07**

$$\theta = -4Z - r^2 + \frac{r^4}{4} + \frac{7}{24}$$

Where r is the dimensionless radius. The cup-mixing (bulk) dimensionless temperature is given by

$$\theta_b = 4\int_{r=0}^{1} \theta(1-r^2)rdr$$

Generate values of θ at Z = 0.5 and r = 0, 0.25, 0.5, 0.75 and 1.0 and use composite Simpsons rule to estimate θ_b numerically.

OR

Q.4 **(a)** Solve the following example using shooting method **07**

$$\frac{1}{Pe}\frac{d^2y}{dx^2} - \frac{dy}{dx} - Day^2 = 0, \quad 0 \le x \le 1$$

With boundary conditions

$$\frac{dy}{dx} = Pe(y-1) \quad \text{at } x = 0$$

$$\frac{dy}{dx} = 0 \quad \text{at } x = 1$$

(b) For cubic spline approximation explain free boundaries and clamped boundary conditions with application example. **07**

Q.5 **(a)** Solve the following ODE-IVP **07**

$$\begin{bmatrix} y_1' \\ y_2' \end{bmatrix} = \begin{bmatrix} -100 & 0 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} -100y_1 \\ 2y_1 - y_2 \end{bmatrix} = \begin{bmatrix} f_1(y) \\ f_2(y) \end{bmatrix}$$

With $y_0 = [2 \quad 1]^T$

(b) Discuss probability density functions **07**

OR

Q.5 **(a)** Explain the finite difference method for Partial Differential Equations (PDEs) **07**

(b) Explain the probability distributions for random variable **07**

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