M. TECH. –I (CHEMICAL ENGINEERING) (CBCS – 2015 COURSE) : SUMMER - 2018

SUBJECT : APPLIED MATHEMATICS FOR CHEMICAL ENGINEERING

Day : **Monday** | **S-2018-2990** | Time : **11.00 AM TO 02.00 PM**
Date : **28/05/2018** | Max. Marks : 60

N.B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer books.
4) Assume suitable **DATA** if necessary.

SECTION - I

Q.1 **a)** Explain the significance of the analysis of variance. **[05]**

b) State the basic assumption of the analysis of variance. **[05]**

OR

a) Explain the different types of errors and elaborate the necessity of error minimization. **[07]**

b) Explain accuracy and precision. **[03]**

Q.2 Locate the first positive root of $f(x)=\sin x+\cos\left(1+x^2\right)-1$ where x is in radians. Use iterations of the secant method with the initial guesses of $x_{i-1} = 1.0$ and $x_i = 3.0$. **[10]**

OR

The following system of equations is designed to determine concentration (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 **[10]**

$$-17C_1 - 2C_2 - 3C_3 = 500$$
$$-5C_1 + 21C_2 - 2C_3 = 200$$
$$-5C_1 - 5C_2 + 22C_3 = 30$$

Use matrix inversion to determine the concentrations.

Q.3 Experiments were performed to determine the following values of heat capacity C_P at various temperatures T for a gas. **[10]**

T ^{0}C	-40	-20	10	70	100	120
C_P J/kg ^{0}C	1250	1280	1350	1480	1580	1700

Use regression to determine a model to predict C_P as a function of T.

OR

Specific volume of superheated steam is listed in steam table at various temperatures. For eg. at a pressure of 2950 N/m^2 absolute, determine volume at T = 750 ^{0}C. **[10]**

T ^{0}C	700	720	740	760	780
V m^3	0.1058	0.128	0.1462	0.1603	0.1703

P.T.O.

SECTION – II

Q.4 An experiment data is as given below: **[10]**

X_A	0.028	0.07	0.112	0.154	0.196	0.238	0.28
$(-V_A)$	9.02	7.87	6.41	5.42	5.7	8.03	13.2

The reactor performance is given as,

$$\frac{W}{F_A} = \int_{0.028}^{0.28} \frac{dX_A}{(-V_A)} \qquad F_A = 2000 \frac{molA}{hr}$$

Find the weight of catalyst W(kg) to be charged into reactor.

OR

Estimate the integral of $f(x) = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$. **[10]**
Evaluate the integral with the help of multiple application of Simpson's $1/3^{rd}$ rule and estimate the error with number of segments 4; a = 0, b = 0.8.

Q.5 Use the explicit method to solve for the temperature distribution of a long, thin rod with a length of 10cm and the following values: $\lambda = 0.020875$, $\Delta x = 2$ cm and $\Delta t = 0.1$s. At t = 0, the temperature of the rod is zero and the boundary conditions are fixed for all times at $T(0) = 100^0$C and $T(10) = 50\ ^0$C. **[10]**
Note that the rod is aluminum with $C_P = 0.2174$ cal / (g ^{0}C) and $\rho = 2.7$ g/cm^3.
Solve for two iterations.

OR

Use the simple implicit finite difference approximation to solve the above numerical. **[10]**

Q.6 **a)** What is Chi-square test? Explain its significance in statistical analysis. **[05]**

b) How do you define mathematical statement of a problem? What is the necessity of it? **[05]**

OR

a) Write note on design and analysis of experiments. **[05]**

b) Write note on generalization and interpretation of engineering data. **[05]**

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