QP Code: RJ23MTECH003 | Reg. No | | | | | | | | | | | AY 23

GIET UNIVERSITY, GUNUPUR – 765022

M. Tech (First Semester) Examinations, January– 2024

MPCCH1040 - Mathematical and Statistical Methods in Chemical Engineering

(Chemical Engineering)

Time: 3Hrs | Maximum: 70 Marks

(The figures in the right hand margin indicate marks.)

PART – A **(2 x 10 = 20 Marks)**

Q.1. Answer all questions — CO# — Blooms Level

a. Explain about classification of 2nd order P.D.E — CO2 — K2

b. Define Rayleigh Quotient. — CO1 — K1

c. Check the nature of the equation $2U_{xx}+5U_{xy}-3U_{yy}+4U_x+5=0$ — CO3 — K1

d. What is bender-Schmidt explicit formula — CO2 — K2

e. Give any two examples of elliptic equation. — CO3 — K2

f. Find f (2.5) from the data using piecewise linear interpolation. — CO2 — K1

X:	1	2	3
F(x)	0	1	8

g. If $Y(X_{i-1})=Y_{i-1}$ and $Y(X_i)=Y_i$.Write down the piecewise cubic spline interpolation formula for Y(X) Valid in $X_{i-1}\leq X\leq X_i$. — CO4 — K1

h. What are hermites's interpolating conditions? — CO3 — K2

i. What is piecewise interpolation and what is the advantages of it ? — CO2 — K2

j. What is interpolation? What is the difference between interpolation and extrapolation? — CO2 — K1

PART – B **(10 x 5 = 50 Marks)**

Answer ***ANY FIVE*** questions — Marks — CO# — Blooms Level

2. Analyze the following set of three linear algebraic equations in three variables using the Gauss–Seidel method: — 10 — CO1 — K1

$$10X_1 + X_2 + 2X_3 = 44$$
$$2X_1 + 10X_2 + X_3 = 51$$
$$X_1 + 2X_2 + 10X_3 = 61$$

3. Analyze the following set of three linear algebraic equations in three variables using the Gauss Elimination method: — 10 — CO2 — K2

$$3X_1 + X_2 - 2X_3 = 9$$
$$-X_1 + 4X_2 - 3X_3 = -8$$

$$X_1 - X_2 + 4X_3 = 1$$

4. Evaluate the values of x and y that satisfy the following two nonlinear algebraic equations: 10 CO4 K1

$$f(x, y) = e^x + xy - 1 = 0$$
$$g(x, y) = \sin xy + x + y - 1 = 0$$

10 CO4 K2

5. Consider stirred vessels which initially contain 760 kg of solvent at 25°C.12 kg/min of solvent flows into the stirred vessels at 25°C and exits out also at the same rate. At t = 0 the flow of steam is started in a coil in the stirred vessels. The heat supplied by steam to the solvent is given by Q = UA (T_S – T), where UA is the overall heat transfers coefficient multiplied by coil area through which heat exchange takes place and T_S is the temperature of steam and is 150°C. UA = 11.5 kJ/Min-K. The Specific heat of the solvent is Cp = 2.3 kJ/kg- K.

Show that $\frac{dT}{dt}(\circ C/s) = 0.023 - 0.000373T$

Determine the solvent temperature after 50 min. Also determine the maximum temperature that can be reached in the tank. The Specific heat of the solvent is Cp = 2.3 kJ/kg- K

6. Solve the following ordinary differential equations: 10 CO4 K2

$$\frac{dy}{dx} = z, \quad \frac{dz}{dx} = -y$$

With the initial condition y (0) = 2, z (0) = 1. Determine the value of y and z at x =3. Compare the numerical solution with the analytical solution. The analytical solution of the given differential equations is y = Asin(x +α) and z = Acos(x +α).

7. Consider 1-dimensional steady state conduction without heat generation taking place in a rectangular slab. The temperature of the left side of the slab is 100°C and of the right side is 200°G. The length of the slab is 10 cm and the thermal conductivity of the slab is 120 W/Cm-K. Make nine uniform divisions. 10 CO4 K2

The governing equation is $k\frac{d^2T}{dx^2} = 0$

8. Using the Runge–Kutta fourth order method ,Integrate the ordinary equation 10 CO2 K2

$$\frac{dx}{dy} = x + y$$

The initial condition is: at x = 0, y = 0. Determine the value of y at x = 0.2. The analytical solution is given by $y = e^x - x - 1$.

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