Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

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A Constituent Institution of Manipal University

V SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKE UP EXAMINATIONS, DECEMBER 2017

SUB: COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING [CHE 3105]

REVISED CREDIT SYSTEM
21/12/2017, 2-5 PM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Discuss the classification of partial differential equations with example 3

1B. The friction factor f depends on the Reynolds number for turbulent flow in a smooth pipe according to the following relationship: 7

$$\frac{1}{\sqrt{f}} = -0.4 + \sqrt{3}\ln(Re\sqrt{f})$$

Find the friction factor for Re = 10^5 by using Secant method. Take $f_{i-1} = 0.005$ and $f_i = 0.01$

2A The rate of an enzymatic reaction is given by the following expression:

$$r = \frac{k*S}{K_m+S}$$

The problem of estimating k and K_m can be converted to linear regression by inverting the above expression and defining: x = 1/[S], y = 1/r. The following data was obtained in the lab: 7

[S]	1.233	0.540	0.442	0.258	0.198	0.162	0.130	0.128
r	5.970	3.319	2.253	2.547	1.493	1.182	1.095	0.869

Obtain $y_o = a_o + a_1 x$ and find the values of k and K_m.

2B What is the importance of the Numerical Methods in Chemical Engineering? 3

3 A rectangular plate 9×12 cm^2 is subjected to steady state two-dimensional heat transfer. Find the temperatures at all interior nodes taking $\Delta x = \Delta y = 3$ cm. The boundary conditions are given by, T(x,0) = 250 K, T(0,y) = 300 K, T(9,y) = 420 K and T(x,12) = 480 K **10**

4. To understand the mechanism of the depolarization process in a fuel cell, an electro-kinetic model for mixed oxygen-methanol current on platinum was developed in the laboratory at FAMU. A very simplified model of the reaction developed suggests a functional relation in an integral form. To find the time required for 50% of the oxygen to be consumed, the time, T(s) is given by **10**

$$T = -\int_{1.22\times10^{-5}}^{0.61\times10^{-5}} \left(\frac{6.73x + 4.3025\times10^{-7}}{2.316\times10^{-11}x} \right) dx$$

Find the time required for 50% of the oxygen to be consumed. Use Romberg Integration

5. The rate of cooling of a body can be expressed as

$$\frac{dT}{dt} = -k(T - T_a)$$

where T=temperature of the body (°C), Ta=temperature of the surrounding medium (°C), and k is the proportionality constant (min^{-1}). Thus, this equation specifies that the rate of cooling is proportional to the difference in temperature between the body and the surrounding medium. If a metal ball heated to 90°C is dropped into water that is held at a constant value of T_a=20°C, use Runge Kutta 4th order method to compute the temperature after 10 minutes if k=0.25 min^{-1}. Use step size of 2 minute **10**