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Roll No. 59

EIGHTH SEMESTER

B.Tech.

END SEMESTER EXAMINATION

May/June-2017

MC-411 MATHEMATICAL MODELING AND SIMULATIONS

Time: 3:00 Hours

Max. Marks : 70

Note : Answer any five question.  
All questions carry equal marks.  
Assume suitable missing data, if any.

Q.1[a] Find all the critical points of the non linear system and determine the type and stability of each critical point

$$x' = x^2y + 3xy - 10y$$

$$y' = xy - 4x$$

[b] A battle is modeled by

$$x' = -4y, x(0) = 150$$

$$y' = -x, y(0) = 90$$

i. Write the solution in parametric form?

ii. Who wins and when? State the losses at each side.

Q. 2[a] Obtain the cubic spline fit for the data

x	0	1	2	3
f(x)	1	4	10	8

under the end conditions  $f''(0) = 0 = f''(3)$  and valid in the interval  $[1,2]$ . Hence obtain the estimate of  $f(1.5)$ .

[b] The table shows the yield (in mg) of a chemical reaction in the first 6 minutes

Time (minutes)	1	2	3	4	5	6
Yield(mg)	1.2	6.9	9.3	12.7	14.1	15.7

- i. Find the best model to fit the data
- ii. Using that model determine in how many minutes will the yield be 20 mg.

Q. 3[a] The relation between the radius and the volume of a sphere is measured to be as table given below

Radius r	1	2	3	4	5
Volume V	4.19	33.51	113.10	268.08	523.60

Use regression to find the formula for the volume as a function of the radius.

[b] Explain and solve the Susceptible-infected-Susceptible (SIS) and susceptible-infected-recovered (SIR) model for an epidemic

Q.4[a] Write down the common characteristics of Conceptual model and physical model.

[b] The breeding of rabbits started with one pair of rabbits. Every month, each pair of rabbits produces one pair of offspring. After one month, the offspring is adult and will start reproduction. Describe the long term behavior of the rabbit population by assuming that no rabbit ever dies.

Q. 5[a] Discuss the linear and non-linear population growth and decay model for bacteria population

[b] Use Euler method to solve numerically the initial value problem

$$u' = -2tu^2, \quad u(0) = 1$$

With  $h=0.2, 0.1$  and  $0.05$  on the interval  $[0,1]$ . Neglecting the round off errors, determine the bound for the error.

Q.6[a] Discuss the non-linear prey predator model and also stability.

[b] Develop a technique for simulating a random variable having density function

$$f(x) = \begin{cases} e^{2x}, & -\infty < x < 0 \\ e^{-2x}, & 0 < x < \infty \end{cases}$$

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