A–0694

Total Pages : 4 **Roll No. .....**

MAT-610

Mathematics (MSCMAT/MAMT)

(Mathematical Modelling)

Examination, June 2025

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

(Long Answer Type Questions) 2×19=38

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. Explain Population growth models with example.

2. If the contact rate (β) be 0.001 and the number of susceptiles (n) be 2000 initially, determine :

   (i) The number of susceptible left after 3 weeks.

   (ii) The density of susceptible when the rate of appearance of new cases is maximum.

   (iii) The time (in weeks) at which the rate of appearance of new cases is a maximum.

   (iv) The maximum rate of appearance of new cases and.

   (v) The epidemic curve.

3. A soda-can is taken out from the refrigerator, and its Temperature is recorded after 1/2 an hour. After wait of another 1/2 hour, the temperature is recorded again. If the two readings are 45° F and 55°F respectively, what is the temperature inside the refrigerator (assume the room temperature to be70°F) ?

4. Define Prey-Predator Models in your words and explain it clearly ?

5. What are the different types of epidemic models ? Explain it.

Section–B

(Short Answer Type Questions) 4×8=32

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. Using the mathematical modelling find the width of a river or a canal (without crossing it).

2. For the system of equations :

$$\frac{dx}{dt} = x - y + xy$$

$$\frac{dy}{dt} = 3x - 2y - xy$$

Verify that (0, 0) is a critical point. Show that the system is almost linear and discuss the type and stability of the critical point (0, 0).

3. Obtain the difference equation by eliminating the arbitrary constants from $u_n = A2^n + B(-3)^n$.

4. Explain density-dependent model and Richer's model.

5. Explain what is the difference between Arms Race Model and Epidemic Models ?

6. Consider a laterally insulated rod of length 100 cm with diffusivity D of the material of the rod, whose ends are also insulated. The initial temperature is x, when $0 \leq x \leq 40$ and $100 - x$, when $40 \leq x \leq 100$:

   (i) If $u(x, t)$ represents the temperature function at any point x at time t, formulate a mathematical model of the given situation, stating clearly the boundary and initial conditions.

   (ii) Using the method of separation of variables, find the temperature function $u(x, t)$. Obtain the numerical solution of the problem for D = 0.475 and plot the graph.

7. What is the difference between a Delay Differential Equation (DDE) and an Ordinary Differential Equation (ODE) ?

8. Why Mathematical Modelling is needed, define in your words explain the definition of model and process of modelling ?

****