No. of Printed Pages : 6 **BTPS–030**

INTEGRATED TEACHER EDUCATION PROGRAMME (ITEP) (BSCBED)

Term-End Examination

June, 2026

BTPS-030 : MATHEMATICS MODELLING

Time : 3 Hours *Maximum Marks : 100*

Note : *(i) Question No. 1 is compulsory.*

*(ii) Attempt any **four** questions from Q. No. 2 to Q. No. 7.*

(iii) Use of calculator is not allowed.

(iv) Symbols have their usual meanings.

1. Which of the following statements are true or false ? Give a short proof or a counter-example as justification. 10×2=20

   (i) A good mathematical model should balance simplicity and accuracy.

(ii) A negative value of k in an exponential model represents decay.

(iii) A discrete model changes continuously with time.

(iv) A model can be mathematically correct but still fail to represent reality due to incorrect assumptions.

(v) The period of a simple pendulum depends on the mass of the bob.

(vi) The maximum range of a projectile on level ground occurs when the angle of projection is 90°.

(vii) The exponential growth model assumes unlimited resources for population growth.

(viii) Coexistence of two completing species is always impossible.

(ix) Compound interest models assume that interest is added to the principal amount over time.

(x) Markov models assume that future states depend only on the present state.

2. (a) A population grows at a rate proportional to its size. Formulate and solve the mathematical model : 10

$$\frac{dP}{dt} = kP$$

Given $P(0) = P_0$, obtain the population at time t and discuss the limitations of this model.

(b) Explain the formulation, solution, and interpretation stages of mathematical modelling. Why is interpretation considered an essential final step of modelling ? 5

(c) A bank account grows continuously at a rate proportional to the amount present. Formulate a mathematical model and find the amount after time t. 5

3. (a) Explain the importance of initial conditions and boundary conditions in mathematical modelling with examples. 4

(b) Explain the concept of equilibrium solution in a mathematical model. Find equilibrium points for : 5

$$\frac{dx}{dt} = x(5 - x)$$

(c) A population of fish in a lake increases at a rate proportional to its population but decreases due to harvesting at a constant rate. Formulate a mathematical model and discuss the possible outcomes. 7

(d) Explain the difference between static models and dynamic models. Give suitable examples. 4

4. (a) Develop a mathematical model for the temperature change of a body placed in an environment whose temperature changes with time. State the assumptions clearly. 6

(b) The motion of a pendulum is given by :

$$\frac{d^2\theta}{dt^2} + \frac{g}{l}\sin\theta = 0$$

Explain why this model is non-linear. Obtain the linear approximation for small oscillations. 4

(c) State Newton's law of gravitation. Use it to formulate a mathematical model for planetary motion. 5

(d) Construct a mathematical model for radioactive decay and explain the concept of half-life. 5

5. (a) Explain how differential equations are used to model oxygen transport in the human body. 5

(b) A population decreases due to environmental factors. Construct an appropriate mathematical model and discuss its behaviour. 5

(c) Derive the Lotka-Volterra predator-prey model and explain each term. 10

6. (a) Explain the assumptions and limitations of simple epidemic models. 6

   (b) Explain the concept of equilibrium in economics using a mathematical model. Discuss stable and unstable equilibrium. 6

   (c) Two companies compete for market share. Develop a mathematical model and analyse possible outcomes. 8

7. (a) Explain the limitations of game theoretic models in real life conflict situations. 7

   (b) Develop a model for loan replacement and explain the effect of interest rate and time period. 7

   (c) Explain the concept of probabilistic modelling. Discuss the importance of randomness in real-life systems. 6

× × × × ×