BRAINWARE UNIVERSITY

Term End Examination 2023
Programme – M.Sc.(MATH)-2021
Course Name – Mathematical Modelling
Course Code - MSCME402
(Semester IV)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Let x(t) be the population size at time t. If the birth rate is equal to the death rate, then write the population size

a) grows exponentially b) decays exponentially
c) remains constant d) None of these

(ii) Select the correct option. The model in which every set of variable states is uniquely determined by parameters in the model and by sets of previous states of these variables is termed as

a) Deterministic model b) Probabilistic model
c) Statistic model d) Stochastic model

(iii) Choose the correct option: Consider a transportation problem with 3 supply points and 4 demand points. The number of constraints in the formulation is

a) <p style="text-align: left;">3 b) <p style="text-align: left;">7
c) <p style="text-align: left;">6 d) <p style="text-align: left;">10

(iv) Select the correct option. Model rests on neither theory nor observation, but is merely the invocation of expected structure is

a) Deductive model b) Inductive model
c) Floating model d) Constant model

(v) Solve the problem. A body in air at 25°C cools from 100°C to 75°C in 1 minute. What is the temperature of the body at the end of 3 minutes? (Take log(1.5)=0.4)

a) 40°C b) 47.5°C
c) 42.5°C d) 50°C

(vi) Select the correct option. Which model follows the changes over time that results from the system activities?

a) Dynamic model b) Static model
c) Analytical model d) Numerical model

(vii) Solve the problem. A bottle of mineral water at a room temperature of 72°F is kept in a refrigerator where the temperature is 44°F. After half an hour water cooled to 61°F. What is the temperature of the body in another half an hour? (Take $\log_{\frac{28}{17}} = 0.498, e^{-0.99} = 0.37$)

a) 18°C
b) 9.4°C
c) 54.4°C
d) 36.4°C

(viii) Choose the correct option: Consider a transportation problem with 3 supply points and 4 demand points. The number of variables in the formulation is

a) <p style="text-align: left;">12
b) <p style="text-align: left;">3
c) <p style="text-align: left;">4
d) <p style="text-align: left;">7

(ix) Select the correct answer. A colony of fruit flies is growing exponentially at a rate of 2% per day. If the initial size of the colony is 100 fruit flies, then find that after t days the size of the colony will be

a) $y(t)=10e^{0.2}$
b) $y(t)=100e^{0.02}$
c) $y(t)=100e^{0.2}$
d) None of these

(x) In the population growth model, if a>0 (i.e., birth rate –death rate>0), then write the population which will become double its present size at time

a) $\frac{1}{a}log\frac{1}{2}$
b) $\frac{1}{a}log2$
c) $\frac{1}{2}log\frac{1}{a}$
d) $\frac{1}{2}loga$

(xi) Solve the problem. According to Newton's law of cooling "The change of temperature of a body is proportional to the difference between the temperature of a body and that of the surrounding medium". If T_1°C is the initial temperature of the body and T_2°C is the constant temperature of the medium, T°C be the temperature of the body at any time t then find the expression for T°C as a function of T_1°C, T_2°C and time t.

a) $T=T_1+(T_2)\exp(-kt)$
b) $T=T_2+(T_1-T_2)\exp(-kt)$
c) $T=T_2+(T_1-T_2)\exp(kt)$
d) $T=T_2+(T_1)\exp(-kt)$

(xii) A particle starts with a velocity 20ft per sec and travels 300ft in 30 sec along a straight line.

Analyse the movement of particle

a) Moving forward
b) Velocity is increasing in the forward direction
c) After going with a retardation, it comes to rest and returns back
d) None of these

(xiii) In the population growth model, if a<0 (i.e., birth rate –death rate<0), then write the population which will become half its present size at time

a) $\frac{1}{a}log\frac{1}{2}$
b) $\frac{1}{a}log2$
c) $\frac{1}{2}log\frac{1}{a}$
d) $\frac{1}{2}loga$

(xiv) Select the correct option: A graph is a tree if and only if it

a) is completely connected
b) is planar
c) contains a act
d) is minimally connected

(xv) Select the correct option: Tree

a) Is a connected graph
b) With n nodes contains n-1 edges
c) Is a bipartite graph
d) All of these

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Deduce the double period and half-life of the linear population growth model. (3)

3. Establish that the orthogonal trajectories of a family of straight line passing through the origin is a family of circle centred at origin. (3)

4. Explain the motion under gravity in a resisting medium. (3)

5. Let $p(t)$ be the price of a commodity at time t, then its rate of change is proportional to the difference between the demand $d(t)$ and the supply $s(t)$ of the commodity in the market. Write the mathematical model for changing or price of a commodity. (3)

6. Conclude about the equation of Continuity in Fluid Dynamics. (3)

OR

Conclude about the equation of Continuity for Heat Flow. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Show that in the motion of the planets the square of the periodic times are proportional to the cube of the radii of the orbit. (5)

8. (5)

	D_1	D_2	D_3	D_4	a_i
O_1	5	3	6	2	19
O_2	4	7	9	1	37
O_3	3	4	7	5	34
b_j	16	18	31	25	90

Determine an initial B.F.S to the T.P using matrix minima method, where o_j and d_j denote the i-th origin and j-th destination.

9. Deduce the components of velocity and acceleration vectors along radial and transverse directions. (5)

10. Analyse the compartment model through the system of ODE. (5)

11. Criticize the mathematical modelling of the motion of a single-stage rocket. (5)

12. Conclude about the balance of signed graph. (5)

OR

Conclude about the four conditions of structure theorem. (5)

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