Mahindra University Hyderabad

École Centrale School of Engineering

Minor-I Exam

Program: B. Tech./ Pre PhD **Branch: CM, ME, ECM, SLS** **Year: III** **Semester: II**

Subject: Mathematical modeling (MA3231/MA6012)

Date: 06/03/2025 **Start Time: 10:35 AM**

Time Duration: 1.5 Hours **Max. Marks: 30**

Instructions:

1) Answer all the questions.

2) All questions are self-explanatory; no clarification will be provided during the exam.

3) Use of non-programmable scientific calculator is allowed. However, sharing calculators during exams is strictly prohibited.

Course outcomes (COs)

CO 1: Discrete mathematical models and their analysis

CO 2: Modeling using ordinary and partial differential equations

CO 3: Probabilistic modeling

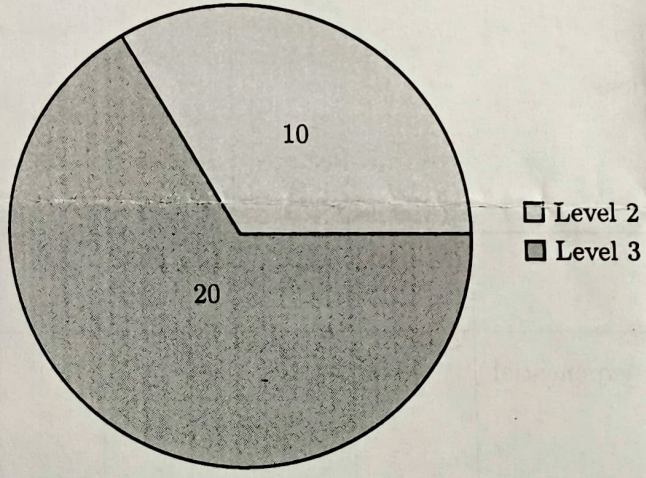
CO 4: Data driven modeling

Q.No.	Questions	Marks	CO	BL	PO	PI Code
1	a) Consider the linear difference equation for exponential growth: $$x_{n+1} = ax_n$$ where a is a constant. Check the stability of this system. b) Extend the exponential growth model to discrete logistic model (discuss in detail).	5+5	CO1	L3	PO3	3.2.2
2	Two competing species follow the discrete nonlinear model: $$x_{n+1} = x_n(1 + r_1 - ax_n - by_n),$$ $$y_{n+1} = y_n(1 + r_2 - cx_n - dy_n),$$ where r_1, r_2 are intrinsic growth rates, and a, b, c, d are interaction coefficients. • (a) Find the equilibrium points. • (b) Analyze their stability of equilibrium points using linear stability analysis for different values of a, b, c, d.	10	CO1	L2	PO3	3.2.2

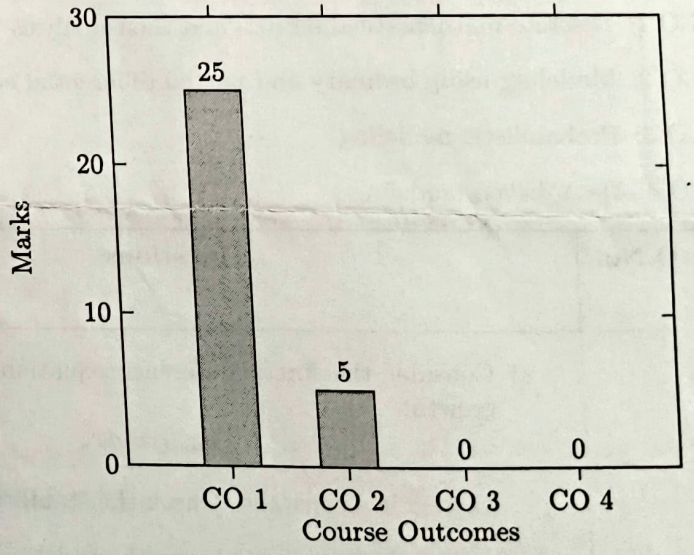
P.T.O.

Q.No.	Questions	Marks	CO	BL	PO	PI Code
3	a) Consider two species, x_n and y_n, with the following linear discrete model: $x_{n+1} = 3x_n + y_n,$ $y_{n+1} = x_n + 2y_n,$ • (a) Find the equilibrium points. • (b) Determine the stability of the equilibrium points. b) Derive an SIR model in continuous modeling approach (ordinary differential equations) such that disease is spread with simple assumptions such as total population is constant, recovered individuals cannot get infected again, susceptibles can be infected only once. Discuss in details.	5+5	CO1+CO2	L3	PO3	3.2.2

Bloom's Level wise Marks Distribution



Course Outcome wise Marks Distribution



BL – Bloom's Taxonomy Levels:
1 – Remembering, 2 – Understanding, 3 – Applying, 4 – Analysing, 5 – Evaluating, 6 – Creating
CO – Course Outcomes
PO – Program Outcomes
PI Code – Performance Indicator Code