INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

Department of Mathematics and Statistics

MA621L — Mathematical Modelling

Project-1 **Deadline: September 30, 2026** **Max. Marks: 3**

Instructions: Your report must state the assumptions as A1–A10, each written so that it can be lifted independently, and must identify the triple (S, Q, M) for your model. Marks are awarded for formulation, not for computation. You can use AI tools, but they mostly won't help you for precise answers. Also, the report must be submitted in handwritten format, including figures if drawn any.

Cooling of a cup of tea

A hot tea is prepared without milk first. A cup of hot tea is to be drunk ten minutes from now, and milk is to be added at some point before then. Develop a model to determine *when* the milk should be added so that the tea is at its highest possible temperature at the moment of drinking. Collect your own temperature–time data to estimate the cooling constant, and validate your prediction experimentally. State clearly what your model assumes about the uniformity of temperature within the cup, the constancy of the room temperature, and the heat capacity of the cup itself, and report how your answer changes when each of these is relaxed.

Spread of a forwarded message

A message is forwarded through a hostel cohort, each recipient forwarding it at most once. Develop a compartmental model, in the manner of the SIR model, for the number of students who have seen the message at time t, and use it to predict the final fraction reached and the time to peak forwarding activity. Compare your prediction against timestamp data from an actual forward. Your report must address the homogeneous-mixing assumption explicitly: state why it fails for a real friendship network, and describe how the model would be modified to account for clustering.

Flight of a badminton shuttlecock

A shuttlecock decelerates far more sharply in flight than a ball of comparable mass. Develop a model of the shuttlecock's trajectory that accounts for this, and use it to predict the landing point of a smash struck at a given speed and angle. Determine the drag parameter from a terminal-velocity measurement of your own. Use dimensional analysis to identify the dimensionless group that governs the trajectory, and comment on the range of that group over which your model may be trusted.