

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
Department of Mathematics and Statistics

MA621L — Mathematical Modelling

Project-3

Deadline: November 14, 2026

Max. Marks: 12

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, as each problem has an experiment and data collection. Also, submit the report in handwritten format, including any figures you draw. Each problem takes 3 marks. Each problem includes an experiment and/or data collection, so you must conduct it and develop the model.

Emptying the common room

When a hostel common room or TV room empties, people leave through one door. Develop a cellular automaton for this. Each cell is either empty, furniture, wall, or holds one person, and each person moves towards the door according to local rules. Use it to predict the time taken to empty the room and how that time depends on the door width and on where the furniture is placed. Draw the room to scale, then time several real exits with a fixed number of volunteers: walking normally, and walking briskly (no pushing). Compare the measured times with your predictions. State what physical length one cell represents and why, and whether cells are updated synchronously or one at a time. Explain how you resolve two people choosing the same cell in the same step, and comment on whether your rules can make a brisker crowd leave more slowly.

Equipment: a measuring tape, a stopwatch app, and graph paper.

How long will the phone battery last?

Record the battery percentage of your phone every ten minutes from full charge under three fixed conditions: screen off, a video playing, and a video call. Treat the phone as a black box with the usage as input and the battery level as output, and develop a model that predicts the time to reach 15% for a mixed day of use that you specify in advance. Compare a phenomenological fit with a simple mechanistic model of a battery feeding a constant load. Then check your prediction against one real day. Discuss why the reported percentage is itself the output of a model inside the phone, and what this means for any parameter you identify from it.

Equipment: your own phone.

Drying a wet towel

A towel is washed, wrung by hand, and hung on a line. Develop a model for the mass of water left in the towel at time t , and use it to predict how long the towel takes to become dry enough to use. Weigh the towel before washing and then at regular intervals while it dries, and note the conditions: indoors under a fan, outdoors in the shade, and outdoors in the sun. Decide from your data whether the drying rate stays constant or falls as the towel dries, and identify the parameters for each condition. Explain why the drying towel is an open system, list the inputs from its surroundings, and state which of them you have frozen into constant parameters. Use dimensional reasoning to predict how the drying time changes when the towel is hung folded in half, and test the prediction.

Equipment: a towel, a clothesline, and a hanging luggage scale (about Rs 150).

Will the lake dry up?

After the monsoon, the level of the campus lake falls week by week. Develop a mass-balance model for the volume of water in the lake. Include inflow from rain, loss by evaporation from the surface, and loss by seepage through the bed. Use it to predict the level at the end of the dry season. Fix a graduated stake or a painted mark at the edge and read the level every day at the same time. Next to it, keep a bucket of water in the open and measure its fall each day as a record of evaporation, topping it up after rain. Estimate the surface area of the lake from a satellite map, and take the rainfall from IMD records or your own rain gauge made from a bottle and funnel. Seepage cannot be measured directly, so estimate it from your data as an inverse problem, and report how its value depends on the errors in the other terms. Explain how a lake whose surface area shrinks as it empties changes the form of your equation. State clearly what you assume about the shape of the lake bed, the bucket as a stand-in for the lake surface, and any water drawn from the lake for use on campus.

Equipment: a stake or paint, a ruler, a bucket, a bottle and funnel, and a phone. Take all readings from the bank; do not enter the water.
