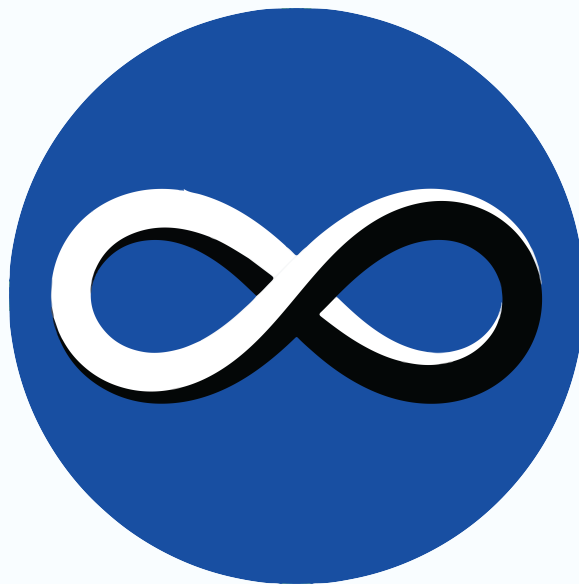


SOLVING THE UNSOLVABLE

2026-27



MATHEMATICS CLUB



CENTRE FOR INNOVATION
IIT MADRAS

Solving The Unsolvable

SATVIK, KARTHIK

Instructions

- You must think independently and refer to credible resources if needed.
- Use of Large Language Models (LLMs) like ChatGPT, Gemini, or Copilot is strictly discouraged. If detected, the submission will be disqualified.
- Submit your answers in a single PDF file. Handwritten work is allowed but must be neatly scanned or photographed and compiled.
- Name your file as:

`YourName_AssignmentTitle.pdf`

- Provide clear explanations. For theoretical questions, justify your answers. For calculations or code, include brief reasoning or method.
- Ensure the work is your own. Discussions are permitted, but plagiarism is not. Any plagiarism will lead to disqualification.
- Submit your assignment by **20 July 2026 11:59pm**. Late submissions will not be accepted without prior approval.
- Submission is through a [Google form](#).
- Feel free to reach out to us for doubts! Contact information of the problem-set creators:

Problem Set Creators

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Question 1

A ground station is aligning a satellite dish. The optimal pointing angle θ satisfies the equation,

$$\theta + \sin \theta = 2$$

Using the Newton–Raphson method with the initial guess $\theta_0 = 1$ rad, determine the pointing angle correct to 5 decimal places.

Question 2

The velocity of a ball is

$$v(t) = 20 + 5t, \quad 0 \leq t \leq 4$$

Estimate the distance travelled during the 4 seconds by the ball using Trapezoidal rule with 4 equal intervals.

Question 3

The battery percentage B of a mobile phone satisfies

$$\frac{dB}{dt} = 18 - 0.25B, \quad B(0) = 20$$

Using Euler's method with a step size of $h = 1$ hour, estimate the battery percentage after 4 hours.

Question 4

The concentration C (in mol/L) of a chemical satisfies

$$\frac{dC}{dt} = -0.3C, \quad C(0) = 10$$

Using the Runge-Kutta fourth order (RK4) method with a step size of $h = 0.5$ min, estimate the concentration after 1 minute.

Question 5

An autonomous drone relies on numerical methods to predict its motion, estimate the energy consumed during flight, and calibrate its onboard sensors. Complete the following tasks:

(a)

The horizontal position x (in m), of the drone is governed by the equation

$$\frac{dx}{dt} = 5 - 0.3x, \quad x(0) = 0$$

Using Euler's method with a step size of $h = 0.5$ min, estimate the position after 1 minute. Repeat the same using RK-2 and RK-4 methods. Tabulate the results and compare with the analytical solution.

(b)

The power consumed by the drone during its flight is given by the equation,

$$P(t) = 120 - 8t + 0.5t^2, \quad 0 \leq t \leq 2$$

Estimate the total energy E consumed during the first 2 minutes by evaluating the integral $E = \int_0^2 P(t)dt$ using the Trapezoidal rule with 4 equal sub-intervals.

(c)

The voltage V across the drone's distance sensor satisfies the equation

$$V^3 + 2V = 4$$

Using the Newton–Raphson method with an initial guess $V_0 = 1$, determine the operating voltage correct to 4 decimal places.

Resources

- You can access the slides here: [Slides](#)
- Desmos Graph on Newton Raphson Method: [Newton_Raphson_graph](#)
- Desmos Graph on Trapezoidal rule: [Trapezoidal_rule_graph](#)
- Desmos Graph on Euler, RK Methods: [ODE_graph](#)
- A Cool Video on Taylor Series: [Video](#)
- Proof for Multivariable Newton–Raphson: [Proof](#)
- Reference book: Numerical Methods for Engineers by Chapra and Canale