Department of Mechanical Engineering
Indian Institute of Technology Madras

ME 5233 Multi-body Dynamics & Applications
Assignment 4

Due on: **November 12, 2023**

- This is a computational assignment. You can use MATLAB/GNU Octave or any other programming language to carry out this assignment.
- Program code need not be submitted.
- You need to include justification for the results in your report

1. For a four-bar mechanism, the lengths of the input (l^2), coupler (l^3) and output (l^4) links are 0.1 m, 0.45 m and 0.35 m respectively. The horizontal distance between the fixed pivots (l^1) is 0.35 m. The mass of the input, coupler and output links are $m^2 = 1$ kg, $m^3 = 4.5$ kg and $m^4 = 3.5$ kg. Assume that the links are uniform bars to calculate the mass moments of inertia and include the effect of gravity in your model.

   The input link is subjected to a dynamic torque $M^2(t) = 10 + 4\sin(4\pi t)$ Nm. The initial orientation of the input link is $\theta_0^2 = 45^\circ$ and assume that $\dot{\theta}_0^2 = 0.1$ rad/s.

   (a) Use the **embedded form** to solve for the accelerations, velocities and displacements of the crank and from this calculate the angular acceleration, velocity and displacement of the output link; *you can assume the independent variable(s) to be the same for all time and need not use Gauss elimination scheme to identify it/them at each time instant.* Use the second-order Heun's method for numerical integration with an appropriate choice for the constant time step used. Integrate from $t = 0$ to $t = 0.5$ seconds.

      i. If I want to extract the reaction forces at the joint between links 3 and 4, how can I do it?

      ii. What about the reaction forces at the other joints?

   (b) Using ADAMS software obtain the acceleration/ velocity/ displacement of the output link as a function of time. Also plot the reaction forces at the joint between links 3 and 4 as a function of time. Compare these results with those obtained from above.