Mock Exam

Please refer to the "Exam" document on Nestor for more information on how the final exam will be conducted and graded. You will have one hour to do an exercise similar to the one below, individually.

Three particles are constrained to move on a unit circle without colliding. Each has mass M_i, is driven by torque T_i, and experiences a viscous damping force that opposes its motion and scales with a damping coefficient D_i. Each pair of particles is interconnected with a spring of stiffness k_{ij}.

a) Draw the free-body diagram of the system defined above and include all necessary information. Describe quantitatively what you expect will be the behavior of the system as a function of the magnitude of the masses, the damping coefficients and spring stiffness values. What do you expect will be this behavior if the natural frequencies of the system are numerically close to each other versus when they are strongly dissimilar? Use plots of the kinematics and dynamics as necessary to support your arguments.

b) Derive the equation of motion of each particle and present the equation describing the system using indicial notation (i.e. using M_i, D_i, T_i, etc.). List all relevant assumptions used in your model. Subsequently, simplify the equation of motion assuming uniformly high viscous damping $D = D_i$ and small masses, and express the equation in terms of the particles' natural frequency ω_i instead of their applied torque T_i.

c) Write pseudo-code to describe how your model can be solved numerically and briefly discuss expected numerical issues (type of solver, convergence issues, etc.).