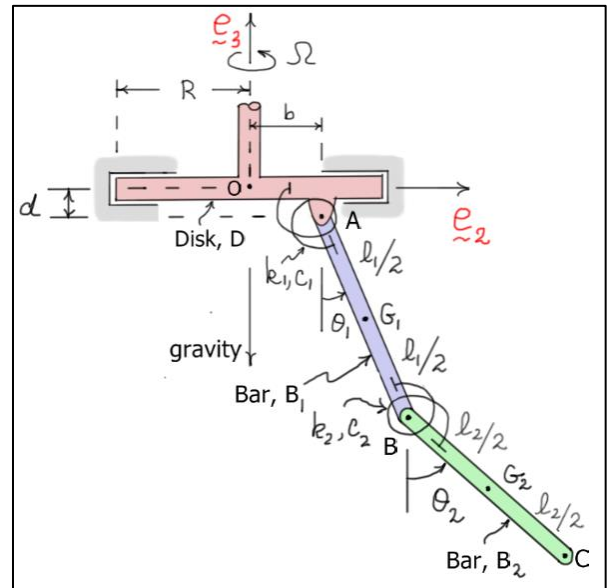


ME 5550 Intermediate Dynamics

Exercises #9 MATLAB/Simulink/SimMechanics Modeling

A three-body mechanical system is shown in the diagram. The disk D is connected to the ground with a revolute joint allowing rotation only in the fixed e_3 direction. Bar B_1 is connected to the disk and bar B_2 is connected to bar B_1 with revolute joints allowing relative rotations only in the rotating e_1 (i.e. $e_2 \times e_3$) direction. The disk rotates at a **constant** rate of $\Omega = 2\pi$ (rad/s), while the motions of the bars are free. The attached **torsional springs** and **dampers** restrain motion of the bars. Develop a dynamic model of the system using the following data and *SimMechanics*. The model should be developed using the physical data provided, and it should produce the required output.



Model Input and Assumptions:

- Disk physical dimensions: $R = 1$ (ft), $b = 0.5$ (ft), $d = 0.2$ (ft)
- Disk mass: $m = 0.2$ (slug)
- Disk inertia: disk is assumed to be a thin circular disk
- Disk angular velocity: $\Omega = 2\pi$ (rad/s) = constant
- Bars' physical dimensions: lengths $\ell = 2$ (ft) and radii $r = 0.1$ (ft)
- Bars' masses: $m = 0.1$ (slug)
- Bars' inertias: bars are assumed to have cylindrical shape with the given length and radius
- Bar B_1 spring and dampers: $k_1 = 50$ (ft-lb/rad) and $c_1 = 4$ (ft-lb-s/rad)
- Bar B_2 spring and dampers: $k_2 = 5$ (ft-lb/rad) and $c_2 = 0.4$ (ft-lb-s/rad)
- Initial conditions for bars: both bars hang vertically downward (i.e. $\theta_1 = \theta_2 = 0$)

Model Output: All output should be plotted over the time interval $0 \leq t \leq 6$ (sec)

- $\theta_1(t)$, $\theta_2(t)$, $\dot{\theta}_1(t)$, $\dot{\theta}_2(t)$ - from these graphs identify the **final values** of the angles θ_1 and θ_2 .
- **Inertial components** of the angular velocities ${}^R\omega_{B_1}$ and ${}^R\omega_{B_2}$ as functions of time. Using these graphs, identify the final angular velocities of the bars.
- **Disk-fixed components** of the **driving** and **reaction torques** acting on the disk as functions of time. Using these graphs, identify the steady-state torque acting on the disk.

Model Validation and Reporting Results

- a) In this case, no hand calculations are available to which comparisons can be made. However, the analyst can still ask whether the results make sense (at least from a qualitative point of view). Analyze the results to see if they seem reasonable.
- b) Execute the model using an M-file and “publish” the results to a PDF file. *All plots* should be *labeled* to indicate which variable is plotted on that graph. Make sure to include the results of your model validation as well.