

The FE reference book and 1 formula sheet may be used during this exam.

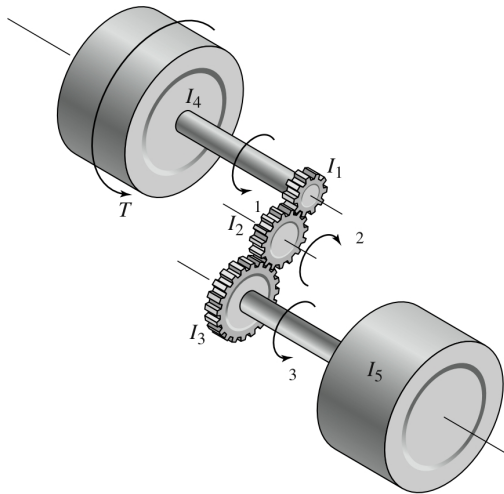
1. Use the least squares method to fit the linear function $y = mx + b$ to the data given in the following table. Evaluate the quality of the fit by computing J , S , and r^2 .

x	0	1	2	3	4
y	1	8	50	178	490

2. For the geared system shown below, assume that the shaft inertias and gear inertias, I_1 , I_2 , and I_3 are negligible. The motor and load inertias are $I_4 = 0.02$ and $I_5 = 0.1$. The speed ratios are

$$\frac{\omega_1}{\omega_2} = \frac{\omega_2}{\omega_3} = 1.4$$

Derive the system model in terms of the speed ω_3 , with the applied torque T as the input.



3. Determine whether the following models are stable, unstable, or neutrally stable:

- (a) $3\dot{x} - 5x = 12$
- (b) $\ddot{x} - 3\dot{x} - 10x = 50$
- (c) $\ddot{x} - 6\dot{x} + 34x = 68$
- (d) $\dot{x} = 3$
- (e) $\ddot{x} + 4x = 5$
- (f) $\ddot{x} + 5\dot{x} = 7$

4. The mass m is attached to a rigid lever having negligible mass and negligible friction in the pivot. The input is the displacement x . When x and θ are 0, the springs are at their free length. Assuming that θ is small, derive the equation of motion for θ with x as the input.

