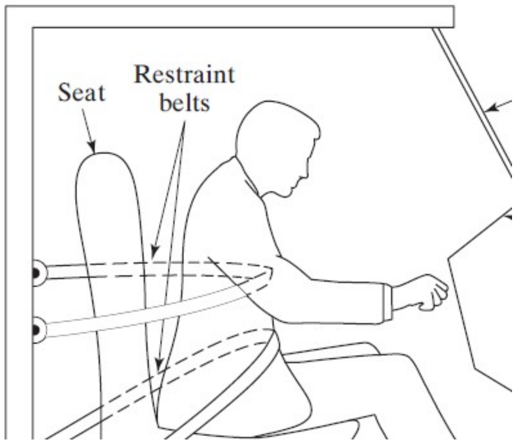
Vibration Mechanics Hw #1

(Fundamental of Vibration)
10 Points /each, total 70 points

Issued: Tue. Feb. 20, 2024 Due: Mon. Mar. 04, 2024(18:00)

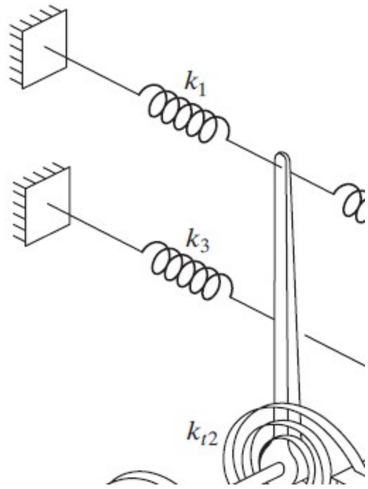
1. Rao. P 1.2 Vibration problems formulation

The following figure shows a human body and a restraint system at the time of an automobile collision. Suggest a simple mathematical model by considering the elasticity, mass, and damping of the seat, human body, and restraints for a vibration analysis of the system. (直接將該圖變成 mass-spring-damper 圖)



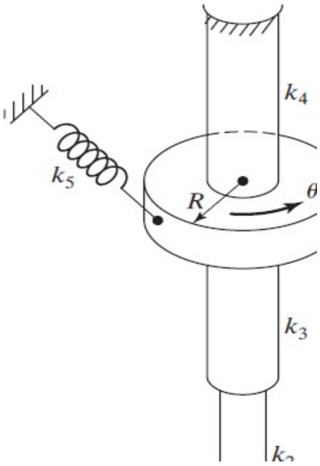
2. Rao. P 1.9 Spring combinations

In Fig. 1.69, find the equivalent spring constant of the system in the direction of θ.



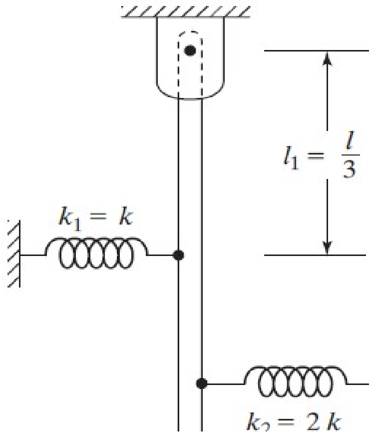
3. Rao. P 1.10 Spring combinations

Find the equivalent torsional spring constant of the system shown in Fig. 1.70. Assume that k_1, k_2, k_3, and k_4 are torsional and k_5 and k_6 are linear spring constants.



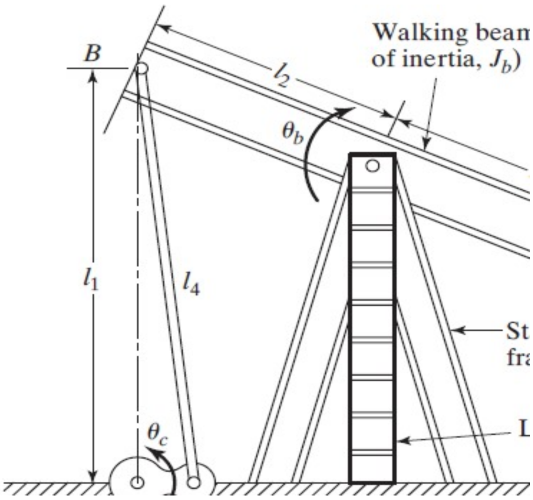
4. Rao. P. 1.31 Equivalent stiffness

Derive the expression for the equivalent spring constant that relates the applied force F to the resulting displacement x of the system shown in Fig. 1.86. Assume the displacement of the link to be small.



5. Rao. P 1.52 Equivalent mass

A simplified model of a petroleum pump is shown in Fig. 1.99, where the rotary motion of the crank is converted to the reciprocating motion of the piston. Find the equivalent mass, m_{eq}, of the system at location A.



6. Rao. P.1.55 Equivalent damping

Find a single equivalent damping constant for the following cases:

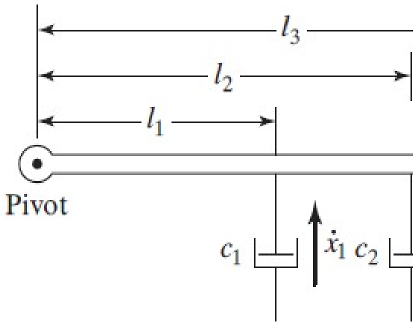
a. When three dampers are parallel.

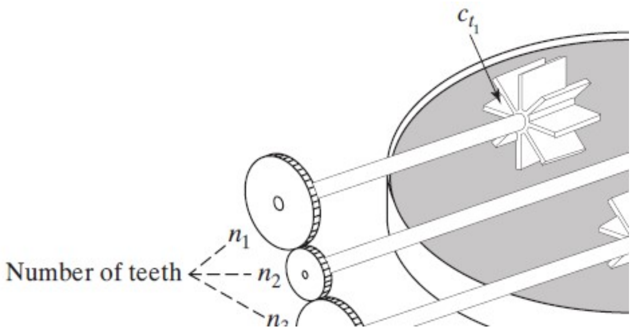
b. When three dampers are in series.

c. When three dampers are connected to a rigid bar (Fig. 1.102) and the equivalent damper is at site c_1.

d. When three torsional dampers are located on geared shafts (Fig. 1.103) and the equivalent damper is at location c_{t1}.

Hint: The energy dissipated by a viscous damper in a cycle during harmonic motion is given by $\pi c \omega X^2$, where c is the damping constant, ω is the frequency, and X is the amplitude of oscillation.





7. Rao. P.1.74 Equivalent damping

Find an expression for the equivalent translational damping constant of the system shown in Fig. 1.110 so that the force F can be expressed as $F=c_{eq}v$, where v is the velocity of the rigid bar A.