HW4_6533Sp2015 physicsMechanicsControl 1 Due: Feb 25

1 The term robotics is attributed to
Isaac Asimov _____ Bill Nix _____ Andre Carot ____ Karel Capek___

2. What is the purpose of Idler gears?

3.You have a box of 8-tooth gears and a box of 16-tooth gears.

a. What combination of these gears on motor and wheel will make the fastest moving robot on a flat surface with nothing being pushed?

b. What combination of gears will make the robot that is best able to push a heavy load from one area to another?

4. Convert 7.0 oz-in of torque to kg-m units of torque.

5. A motor accelerates a load to ω = 150 radians/second in 0.5 seconds.

a. What is the maximum acceleration?

b. What torque of the motor is needed (oz-in) if the inertias are as follows:
Jmotor = 0.004 oz-in-s^2
Jload = 0.003 oz-in-s^2

(10 points each)

6. Make a brief table comparing Proportional, Integral, and Derivative control. In what circumstances is one method better than the others? Consider effects on rise time, overshoot, errors and settling time. (**20 Points**)

   Be sure to read Section 1.3 of the Robot Control paper on the WEB site.

7. Consider the Feedback loop shown in Figure 1.7 of the Robot Control paper on the WEB site:

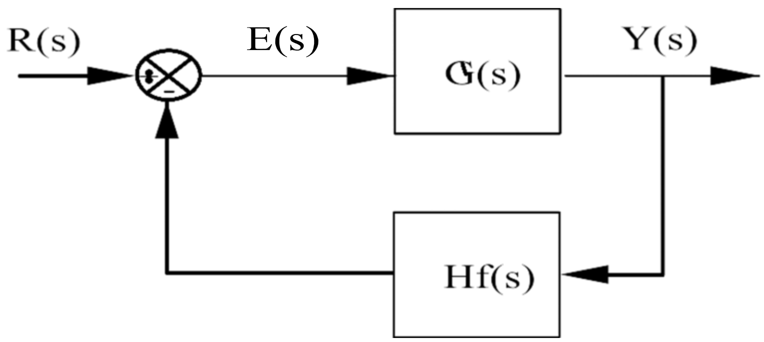

FIGURE 1.7 Feedback control model

Let Hf(s)= 0.09 and G(s)= 500 initially for the robot joint. Suppose after wear the value of G(s)= G_1(s) = 450.

a. Calculate the closed-loop transfer function value for the loop with G(s) = 500. See Equation 1.16 on the WEB.

b. Calculate the closed-loop transfer function value for the loop with G_1(s) = 450.

c. Calculate the change in the closed-loop transfer function with the new value G_1(s) = 450 again with respect to the original value of the transfer function.

d. Calculate the percentage change in G(s) to G_1(s) for the joint. This is with respect to the original gain.

(20 Points)

8. Consider Klafter figure 3.2.6. Compute the torque to balance a 5-lb load mounted on the end of the bar. How does the torque change with the length of the bar L and the angle theta with respect to the horizontal :
[a] If the bar itself is weightless?
[b] If the slender bar has mass M?
(10 Points)

$J\ddot{\theta}(t) + B\dot{\theta}(t) + K\theta(t) = T(t)$ TORQUE

$T = \vec{r} \times \vec{F}$

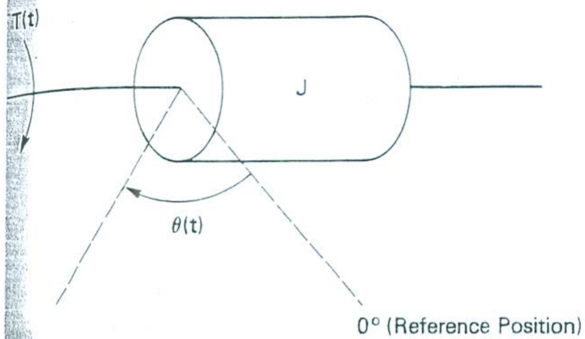

Figure 3.2.5 Torque-inertia system.

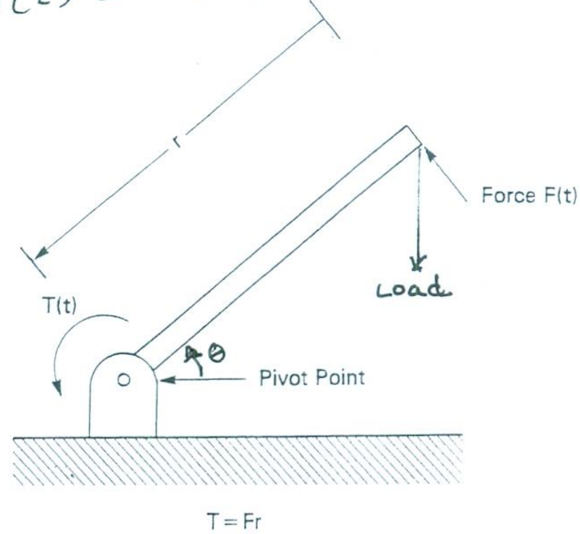

Figure 3.2.6 Torque generated by a force acting at a distance.

that if we apply a torque of magnitude T to a body having a moment of inertia, J, the body will experience an angular acceleration of $\ddot{\theta}$. Compare Eqs. (3.2.1) and (3.2.8).

Figure 3.2.6 illustrates another way of defining torque—as the product of force and the perpendicular distance from the pivot to the force vector. The applied force $F(t)$ can cause the arm to rotate in either a clockwise or a counterclockwise direction. Consider, for example, the case of a robotic manipulator carrying a load against the force of gravity. Figure 3.2.6 is an ideal model for calculating the torque which must be produced by a rotary joint to hold the object at rest. In the situation where multiple forces are applied to a lever each at a known distance from the pivot point, a resultant torque may be calculated by summing all the torques with the appropriate signs.