SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING
THE UNIVERSITY OF NEW SOUTH WALES

MECH9211 - MODELLING AND CONTROL OF MECHATRONIC SYSTEMS

TUTORIAL 2

1. The close loop transfer function of a particular system can be expressed as:

$$\frac{C(s)}{R(s)} = \frac{K}{s^3 + as^2 + bs + c}$$

Choose K to have unity gain all the time.

Shown below are four possible cases of root locations on the s-plane:

Case 1: $s_1, s_2 = -4 \pm j8;\ s_3 = -0.5;$
Case 2: $s_1, s_2 = -4 \pm j8;\ s_3 = -4.0;$
Case 3: $s_1, s_2 = -4 \pm j8;\ s_3 = -12.0;$
Case 4: $s_1 = -10.0;\ s_2 = -1;\ s_3 = -12.0;$

Compare the step responses for the four cases. Give a qualitative explanation to the behaviour of the four systems based on the concepts of dominant poles and pole attenuation.

Then obtain the step response of the system:

$$\frac{C(s)}{R(s)} = \frac{K}{(1+s)}$$

Choose K to have unity gain. Compare the response of this system with the system in case 4 above and comment on the comparison.

2. Plot the root-loci for the systems with the following open loop transfer functions. Discuss what happens to the closed loop system stability when the gain K is increased for each case.

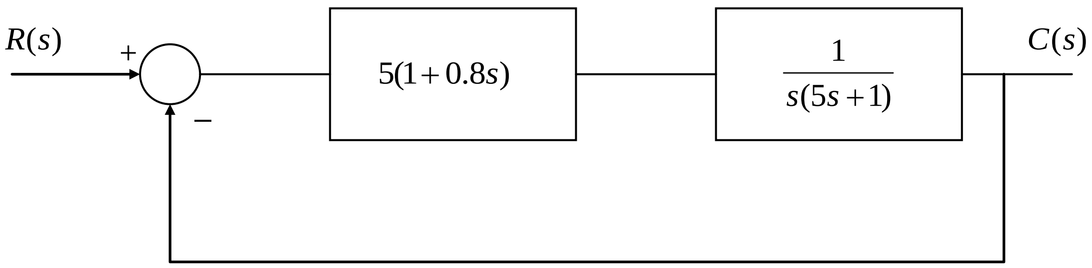
$$\frac{K}{s(s+1)} \qquad \frac{K}{s(s+1)(s+2)}$$

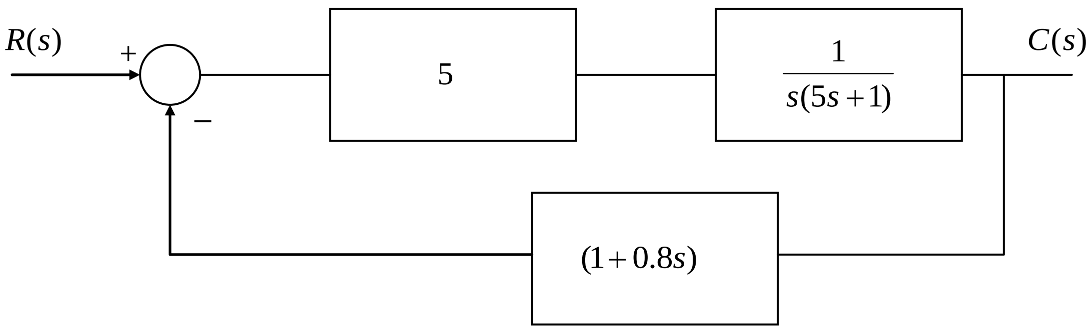
$$\frac{K(s+2)}{(s^2+2s+3)} \qquad \frac{K(s^2+2s+4)}{s(s+4)(s+6)(s^2+1.4s+1)}$$

$$\frac{K(1-2s)}{s(s+1)} \qquad \frac{K(s+2)(s+3)}{s(s+1)}$$

$$\frac{K(s+1)}{s(s-3)} \qquad \frac{K(s+1)}{s(s-1)(s^2+4s+16)}$$

3. Write down the open-loop transfer functions and the characteristic equations of the two systems given below. Obtain the step responses for the two closed loop systems and discuss reasons for any discrepancies found in the response curves.





4. The open loop transfer function of a system has four poles and one zero. The pole locations are as follows.

$$s_1 = 0.0;\ s_2 = -1.0; s_3, s_4 = -2.5 \pm j3.0;$$

Vary the open loop zero location from –1.2 to –2.0 in steps of 0.2 and plot the root-locus each time. Study the effect of a zero location on the root locus.

5. The open loop transfer function of a unity feedback control system is;

$$\frac{K}{s^2(s+1)}$$

Try inserting an open loop zero on the real axis in an attempt to stabilize the close loop system performance.