EE 231 **Exam#2** **Nov. 19, 1991**

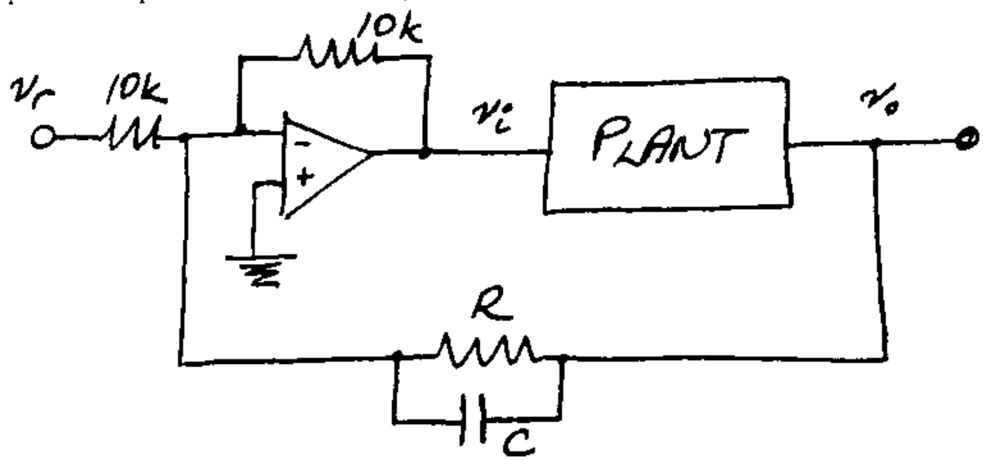
75 minutes

1. A plant with input v_i and output v_o is described by the transfer function,

$$\frac{v_o}{v_i} = \frac{5}{s^2 + 6s + 100}\,.$$

   (a) Determine the maximum percent overshoot and the 2% settling time for a unit-step input. (05pts)

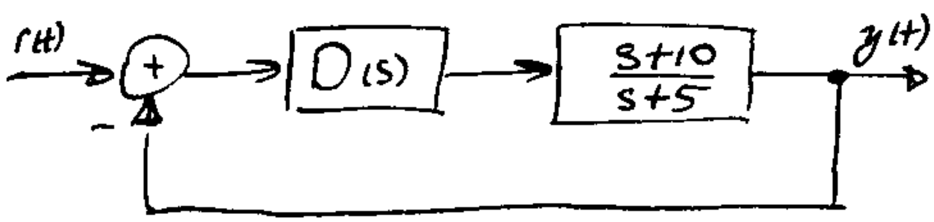
   To improve the performance of the system, a controller is implemented as shown below.



   (b) State the type of the controller by obtaining the expression for v_i in terms of v_r and v_o, and then draw the block diagram showing the variables, v_i, v_r and v_o. (10pts)

   (c) Design the controller, i.e., find R and C, such that the new maximum percent overshoot is 4.6%, and the new 2% settling time is 0.381 sec. (15pts)

2. For the following feedback system,



   (a) Design the simplest controller, such that the steady-state error for a unit-step input is 0.1. (05pts)

   (b) Design the simplest controller, such that the steady-state error for a unit-ramp input is 0.2. (05pts)

   (c) Design the simplest controller, such that the steady-state error for a unit-ramp input is zero. (10pts)

3. The open-loop transfer function of a unity-feedback control system is

$$\frac{Y(s)}{U(s)} = K\frac{2(s+20)(s+100)}{s(s+5)(s+125)}\ .$$

Determine the range of K, such that the closed-loop system has all the real parts of its poles less than -25. (20pts)

4. Consider a unity-feedback control system with the open-loop transfer function

$$G(s) = K\frac{s+1}{s(s^2+30s+200)(s^2+10s+50)}$$

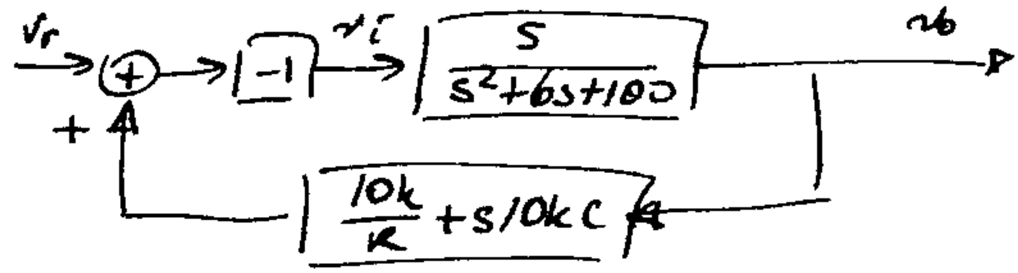
(a) Construct the root-locus diagram. Determine the important features like asymptotes, imaginary-axis crossings, angle of arrivals or departures; however *do not* determine the break-away and/or break-in points explicitly. Obtain only the equation whose solutions would give those points i.e., *do not solve that equation.* (25pts)

(b) Determine all the values of K such that the closed-loop system is stable. (03pts)

(c) Determine all the value(s) of K such that the system has sustained oscillations. (02pts)

#1 a// $M_p = 37.23\%$, 2% $t_s = 1.3333$ sec

b// PD controller , $v_i = -\left[v_r + \left(\frac{10k}{R} + s10kC\right) v_o \right]$



c// $R = 400\Omega$, $C = 300\mu F$

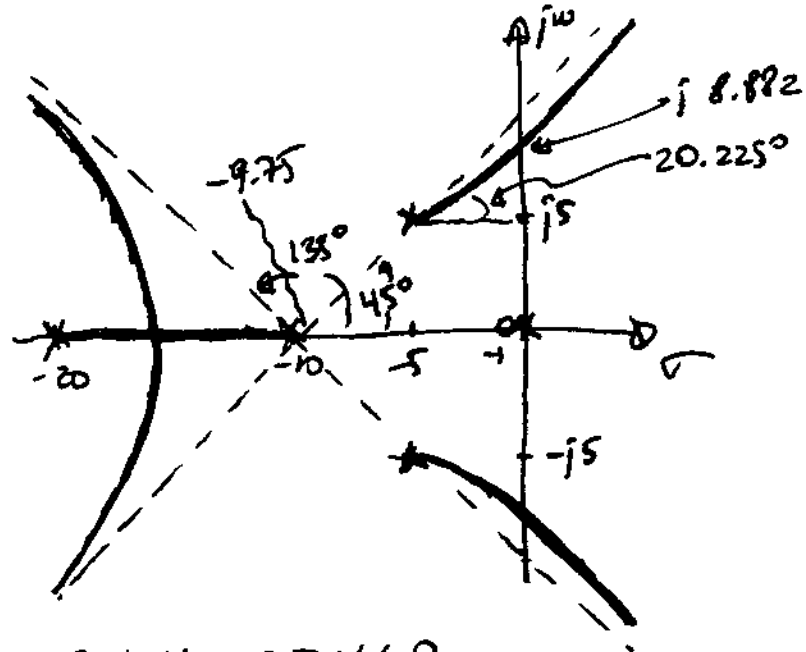
#2 a// $D(s) = 4.5$

b// $D(s) = \frac{2.5}{s}$

c// One choice $D(s) = K\frac{s+5}{s^2}$, $K > 0$

#3 $30.260 < K < 66.667$

#4 a//



b// $0 < K < 27166.3$

c// $K = 27166.3$