HW #7 No due date. Just study yourself!

<Note>

※Solve the problem 5, 6, 7 after Tuesday lecture class time.

※To reference for midterm exam 2, please study yourself the example 4.1~4.6 in the text book, Control Systems Engineering, Norman S. Nise. If you don't have the text book, copy your friend's book or visit our LAB, 301-219. Then TA will copy a example part that you want.

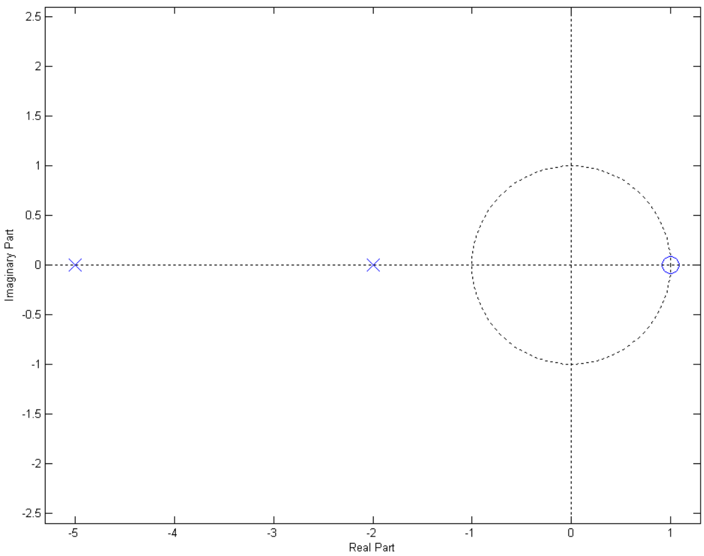
1. Determine the system poles and zeros for each of the systems described by the differential equations that follow. Also write each transfer function in factored form, with its poles, zeros, and gain constant. Make an s-plane plot of the poles and zeros.

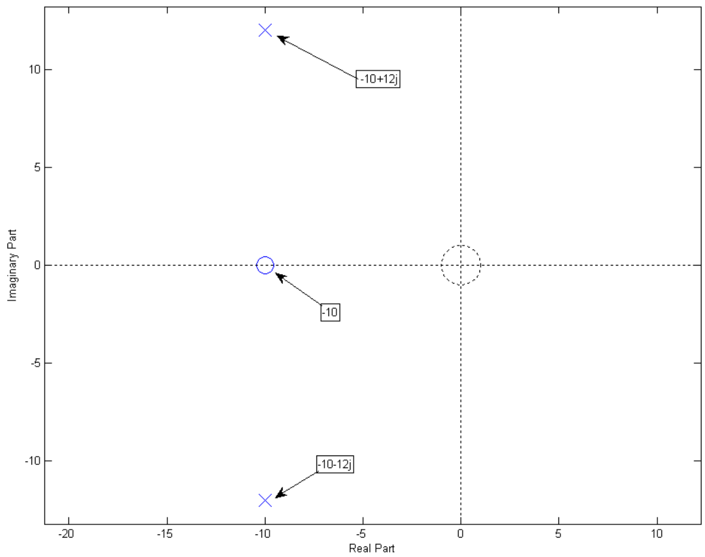
   (a) $\frac{dy}{dt} + 3y = \frac{du}{dt} + 3u$

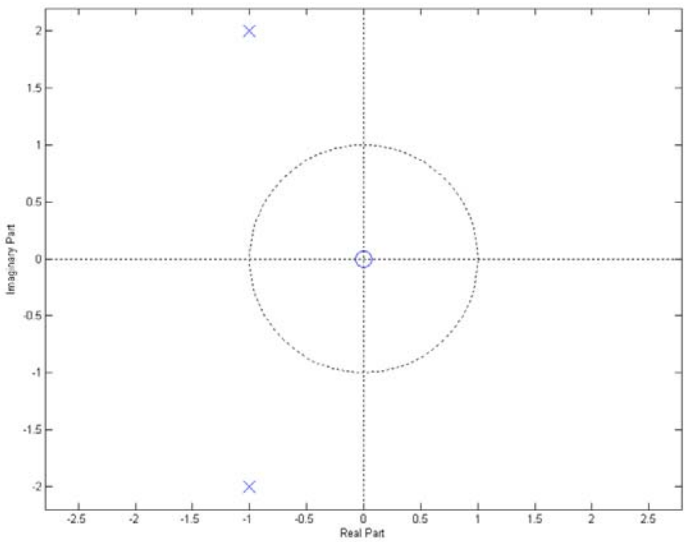
   (b) $\frac{d^2y}{dt^2} + 7\frac{dy}{dt} + 12y = 2\frac{du}{dt} + u$

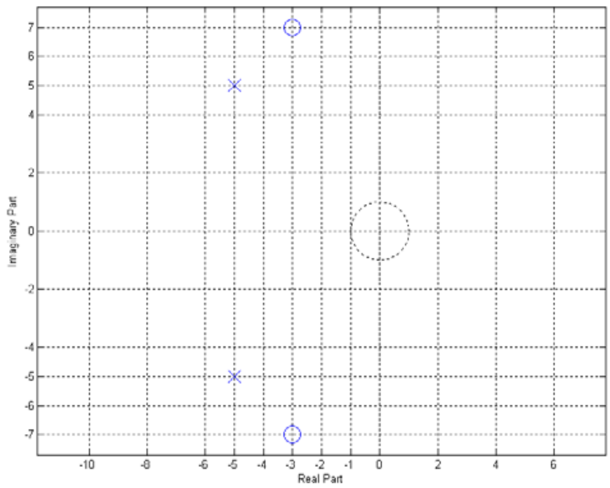
   (c) $\frac{d^3y}{dt^3} + 5\frac{d^2y}{dt^2} + 7\frac{dy}{dt} = \frac{du}{dt}$

2. For systems represented by each of the below four pole-zero plots




-10+12j
-10
-10-12j
Imaginary Part
Real Part


Imaginary Part
Real Part



(a) Determine which ones could gave a steady-state step response $y_{ss}=2$.

(b) Determine the transfer function of the system found in (a). (as far as is possible)

3. A certain rotational system has the equation of motion

$$100\frac{d\omega}{dt} + 5\omega = T(t)$$

where T(t) is the torque applied by an electric motor. The model of the motor's field current i_f in amperes is

$$0.002\frac{di_f}{dt} + 4i_f = v(t)$$

where v(t) is the voltage applied to the motor. The motor torque constant is K_T=15N·m/A. Suppose the applied voltage is $12u_s(t)$ V. Determine the steady-state speed of the inertia and estimate the time required to reach that speed.

4. If applicable, compute ζ, τ, ω_n, and ω_d for the following roots, and find the corresponding characteristic polynomial.

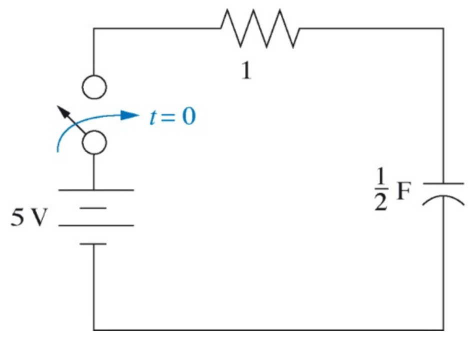
(a) $s = -2 \pm 6j$

(b) $s = 1 \pm 5j$

(c) $s = -10, -10$

(d) $s = -10$

5. Find the capacitor voltage in the network shown in figure 5 if the switch closes at t=0. Assume zero initial conditions. Also find the time constant, rise time, and settling time for the capacitor voltage.



6. A system has a damping ratio of 0.5, a natural frequency of 100 rad/s, and a dc gain of 1. Find the response of the system to a unit step input.

7. For each of the second-order systems that follow, find ζ, ω_n, T_s, T_p, T_r, and %OS.

   (a) $T(s) = \frac{16}{s^2+3s+16}$

   (b) $T(s) = \frac{0.04}{s^2+0.02s+0.04}$

   (c) $T(s) = \frac{1.05\times10^7}{s^2+1.6\times10^3 s+1.05\times10^7}$