ECE-205

Exam 3

Winter 2010-2011

Calculators and computers are not allowed. You must show your work to receive credit.

Problem 1 _____/30

Problem 2 _____/20

Problem 3 _____/20

Problem 4 _____/15

**Problems 5-9_____/15 (3 points each)**

Total _____

1) (30 points) For the following transfer functions, determine the _unit step response_ of the system. _Do not forget any necessary unit step functions._

a) $H(s) = \dfrac{1}{(s+1)(s+2)}$

b) $H(s) = \dfrac{e^{-3s}}{(s+1)^2}$

c) $H(s) = \dfrac{13}{s^2 + 4s + 13}$

2) (20 points) Consider the following simple feedback control block diagram. The plant, the thing we want to control, has the transfer function $G_p(s) = \dfrac{5}{s+2}$

$$R(s) \longrightarrow \overset{+}{\underset{-}{\sum}} \rightarrow \boxed{G_c(s)} \longrightarrow \boxed{G_p(s)} \longrightarrow Y(s)$$
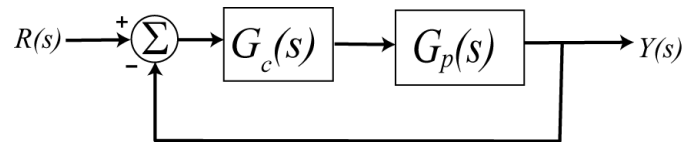
a) Determine the settling time of the plant alone (assuming there is no feedback)

b) For a proportional controller, $G_c(s) = k_p$, determine the closed loop transfer function $G_0(s)$ and then

   i) the settling time, in terms of k_p

   ii) the steady state error for a unit step, in terms of k_p

c) For and integral controller, $G_c(s) = \dfrac{k_i}{s}$, determine the closed loop transfer function $G_0(s)$ and the steady state error for a unit step in terms of k_i

**3) (20 points)** For the following circuit determine the *transfer function* and the corresponding *impulse response.*
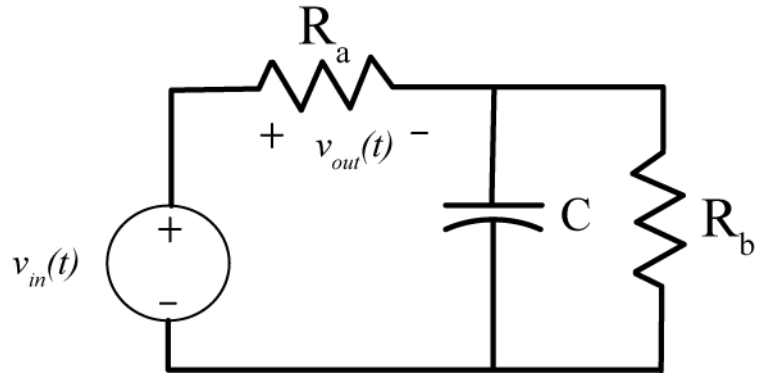
4) (15 points) For the following signal flow diagram

$$G_3 \quad G_2 \quad G_1 \quad 1 \quad X \quad G_4 \quad G_5 \quad G_6 \quad G_7 \quad G_8 \quad G_9 \quad 1 \quad Y$$
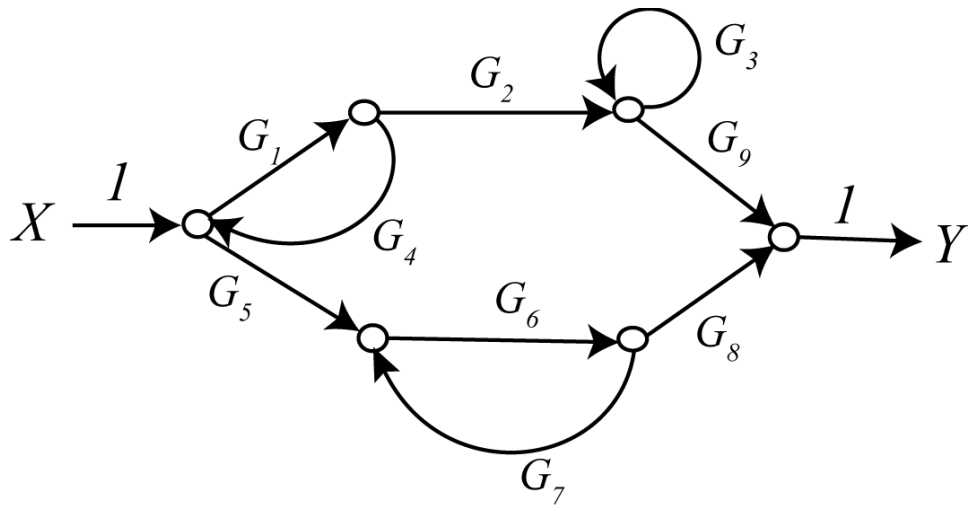
Determine the system transfer function using Mason's gain rule. You must clearly indicate all of the paths, the loops, the determinant and the cofactors, but *you do not need to simplify your final answer* (it can be written in terms of the $P_i, L_i,$ and Δ_i)

Problems 5 and 6 refer to the **unit step response** of a system, shown below
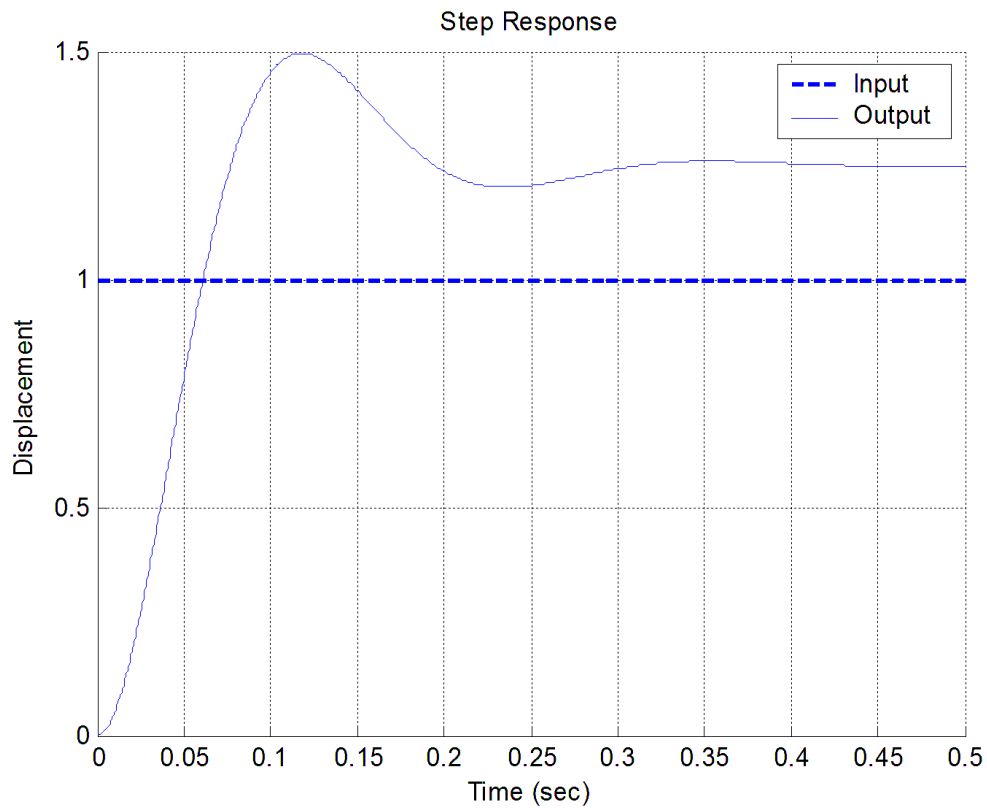
5) The best estimate of the **steady state error** for a **unit step input** is

a) 0.50   b) 0.25   c) -0.25   d) 0.0   e) impossible to determine

6) The best estimate of the **percent overshoot** is   a) 20%   b) 50%   c) 25% d) 150%

7) How many of the following transfer functions represents (asymptotically) **stable** systems?
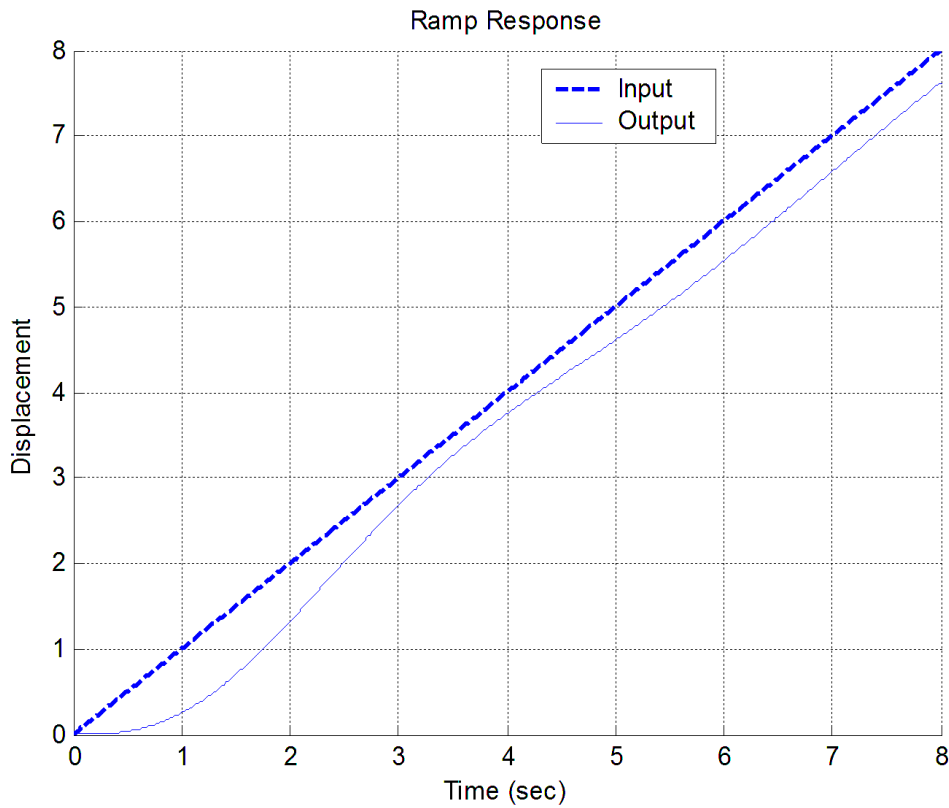
$$G_a(s) = \frac{s+1}{s-1} \qquad\qquad G_b(s) = \frac{1}{s(s+1)} \qquad\qquad G_c(s) = \frac{s}{s^2-1}$$

$$G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \qquad G_e(s) = \frac{(s-1-j)(s-1+j)}{s} \qquad G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)}$$

a) 0 b) 1 c) 2 d) 3 e) 4 f) 5 g) 6

8) For the **unit ramp response** of a system shown below, the best estimate of the **steady state error** is

a) 0.8   b) -0.8   c) 0.5   d) -0.5

9) For a plant with transfer function $G_p(s) = \dfrac{5}{(s+4)(s+2)}$ The (2%) settling time for this plant is

a) 1 seconds   b) 2 seconds   c) 3 seconds   d) 4 seconds   e) none of these