ECE-320, Practice Quiz #1

Problems 1 and 2 refer to the following transfer function

\[ H(s) = \frac{2s + 1}{(s + 1)^2 + 4} \]

1) For this transfer function, the corresponding impulse response \( h(t) \) is composed of which terms?

a) \( e^{-t} \cos(2t), e^{-t} \sin(2t) \)  
   b) \( e^{-2t} \cos(t), e^{-2t} \sin(t) \)

   c) \( e^{-t} \cos(4t), e^{-t} \sin(4t) \)  
   d) \( e^{-4t} \cos(t), e^{-4t} \sin(t) \)

2) The poles of the transfer function are

a) \( 2 \pm j \)  
   b) \(-2 \pm j \)

   c) \(-1 \pm 2j \)  
   d) \(-1 \pm 4j \)

Problems 3 and 4 refer to the impulse responses of six different systems given below:

\[
\begin{align*}
    h_1(t) &= [1 + e^{-t}]u(t) \\
    h_2(t) &= e^{-2t}u(t) \\
    h_3(t) &= [2 + \sin(t)]u(t) \\
    h_4(t) &= [1 - t^3 e^{-0.1t}]u(t) \\
    h_5(t) &= [1 + t + e^{-t}]u(t) \\
    h_6(t) &= [te^{-t} \cos(5t) + e^{-2t} \sin(3t)]u(t)
\end{align*}
\]

3) The number of (asymptotically) marginally stable systems is

a) 0  
   b) 1  
   c) 2  
   d) 3

4) The number of (asymptotically) unstable systems is

a) 0  
   b) 1  
   c) 2  
   d) 3
5) Which of the following transfer functions represents a (asymptotically) **stable** system?

\[ G_a(s) = \frac{s-1}{s+1} \quad G_b(s) = \frac{1}{s(s+1)} \quad G_c(s) = \frac{s}{s^2 - 1} \]
\[ G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \quad G_e(s) = \frac{(s-1-j)(s-1+j)}{s} \quad G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)} \]

a) all but \( G_c \) b) only \( G_a, G_b, \) and \( G_d \) c) only \( G_a, G_d, \) and \( G_f \)

b) only \( G_a, G_b, \) and \( G_d \)

d) only \( G_d \) and \( G_f \) e) only \( G_a \) and \( G_d \)

Problems 6 and 7 refer to the following impulse responses of six different systems

\[ h_1(t) = [te^{-t}]u(t) \]
\[ h_2(t) = e^{-2t}u(t) \]
\[ h_3(t) = [2e^{-2t} + t^2 \sin(t)]u(t) \]
\[ h_4(t) = [1 - t^3 e^{-0.1t}]u(t) \]
\[ h_5(t) = [1 + t + e^{-t}]u(t) \]
\[ h_6(t) = [te^{-t} \cos(5t) + e^{-2t} \sin(3t)]u(t) \]

6) The number of (asymptotically) **unstable** systems is \( a) \ 1 \quad b) \ 2 \quad c) \ 3 \quad d) \ 4 \)

7) The number of (asymptotically) **marginally stable** systems is \( a) \ 1 \quad b) \ 2 \quad c) \ 3 \quad d) \ 4 \)

Problems 8 and 9 refer to a system with poles at \(-2+5j, -2-5j, -10+j, -10-j, \) and \(-20\)

8) The best estimate of the **settling time** for this system is

a) 2 seconds b) 0.4 seconds c) 4/5 seconds d) 0.2 seconds
9) The **dominant pole(s)** of this system are  
   a) -2+5j and -2-5j  
   b) -10+j and -10-j  
   c) -20

10) Which of the following transfer functions represents a (asymptotically) **stable** system?

   \[ G_a(s) = \frac{s-1}{s+1} \]
   \[ G_b(s) = \frac{s}{(s+1)} \]
   \[ G_c(s) = \frac{s}{s^2-1} \]
   \[ G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \]
   \[ G_e(s) = \frac{(s-1-j)(s-1+j)}{(s+2)^2} \]
   \[ G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)} \]

   a) all but \( G_c \)  
   b) only \( G_a \), \( G_b \), and \( G_d \)  
   c) only \( G_a \), \( G_d \), and \( G_f \)  
   d) only \( G_d \) and \( G_f \)  
   e) only \( G_a \) and \( G_d \)

Problems 11-13 refer to the figure below, which shows the unit step response of a real 2nd order system and the unit step response of a second order model we are trying to match to the real system.

11) In order to make the model better match the real system, the **damping ratio** of the model should be  
   a) increased  
   b) decreased  
   c) left alone  
   d) impossible to determine

12) In order to make the model better match the real system, the **natural frequency** of the model should be  
   a) increased  
   b) decreased  
   c) left alone  
   d) impossible to determine

13) In order to make the model better match the real system, the **static gain** of the model should be  
   a) increased  
   b) decreased  
   c) left alone  
   d) impossible to determine
For problems 14-18, consider the signal flow graph representation of the following block diagram.

14) The **path** is  a) 1  b) $G$  c) $H$  d) $GH$  e) none of these

15) The **loop** is  a) 1  b) $G$  c) $H$  d) $GH$  e) none of these

16) The **determinant** $(\Delta)$ is  a) 1  b) $1-GH$  c) $1+GH$  d) none of these

17) The **cofactor** is  a) 1  b) $G$  c) $H$  d) $GH$  e) none of these

18) The **transfer function** is  a) 1  b) $G$  c) $GH$  d) $\frac{G}{1-GH}$  e) $\frac{G}{1+GH}$

For problems 19-21, consider the signal flow graph representation of the following block diagram.

19) How many **paths** are there?  a) 0  b) 1  c) 2  d) 3  e) 4

20) How many **loops** are there?  a) 0  b) 1  c) 2  d) 3  e) 4

21) The **determinant** $(\Delta)$ is  a) 1  b) $1-H_2H_3H_4$  c) $1+H_2H_3H_4$  d) none of these

22) The **transfer function** is a) 1  b) $\frac{H_3H_5 + H_1H_2H_3}{1+H_2H_3H_4}$  c) $\frac{H_3H_5 + H_1H_2H_3}{1-H_2H_3H_4}$
For problems 23 – 26 consider the signal flow graph representation of the following block diagram.

23) How many paths are there?  
   a) 0  b) 1  c) 2  d) 3  e) 4

24) How many loops are there?  
   a) 0  b) 1  c) 2  d) 3  e) 4

25) The determinant ($\Delta$) is  
   a) 1  b) $1 - H_2 H_3 - H_3 H_4$  
   c) $1 + H_2 H_3 + H_3 H_4$  d) none of these

26) The transfer function is  
   a) 1  b) $\frac{H_1 H_2 H_3}{1 - H_2 H_3 - H_3 H_4}$  
   c) $\frac{H_1 H_2 H_3}{1 + H_2 H_3 + H_3 H_4}$

For problems 27-29 consider the following signal flow graph

27) How many paths are there?  
   a) 1  b) 2  c) 3  d) 4

28) How many loops are there?  
   a) 2  b) 3  c) 4  d) 5  e) 6  f) 7

29) Are any of the cofactors equal to 1?  
   a) yes  b) no

Answers: 1-a, 2-c, 3-d, 4-b, 5-c, 6-b, 7-a, 8-a, 9-a, 10-a, 11-b, 12-b, 13-b, 14-b, 15-e, 16-c, 17-a, 18-e, 19-c, 20-b, 21-c, 22-b, 23-b, 24-c, 25-c, 26-c, 27-b, 28-d, 29-b