Published Preview Edit

Exam1

This is a preview of the draft version of the quiz

This exam is open book, open notes, you may use any online/hardback textbooks you like. You may use calculators and matlab, but may not collaborate with other people. All multiple choice answers should be within 5% of correct value.

Unless stated otherwise in the question, use 3 decimal precision in fill-in-the blank questions, such as "132.312" or "58.023" for example. Do not give numerical fill-in-the-blank answers as fractions such as "4/5," give answer as decimal "0.800" form. Also, canvas might force you to enter a leading "0" for numbers less than one, such as "0.113" and entries such as ".113" might be disallowed.

As always, make sure that you are in a location with good internet connectivity during the exam. It is not a bad idea to practice

Quiz Type	Graded Quiz
Points	150
Assignment Group	Exams
Shuffle Answers	Yes
Time Limit	75 Minutes
Multiple Attempts	No
View Responses	No
One Question at a Time	No
Require Respondus LockDown Browser	No
Required to View Quiz Results	No
Webcam Required	No

Due	For	Available from	Until
Apr 20 at 2:15pm	Everyone else	Apr 20 at 1pm	Apr 20 at 2:15pm
Apr 20 at 3:30pm	1 student	Apr 20 at 1pm	Apr 20 at 3:30pm

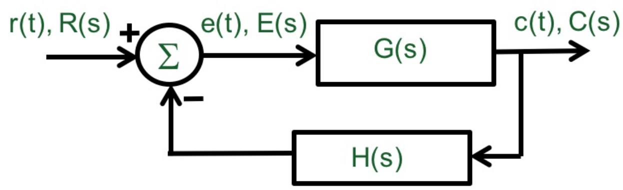
Preview

Correct answers are hidden.

Score for this quiz: **150** out of 150
Submitted Apr 19 at 12:19pm
This attempt took 4 minutes.

Question 1

5 / 5 pts



For the continuous-time system above with H(s)=1/(s+2) and G(s)=5/(s+3), the closed-loop transfer function is $G_{CL}(s)$=C(s)/R(s)=

$$= \frac{G(s)}{1+G(s)H(s)} = \frac{5/(s+3)}{1+5/((s+3)(s+2))}$$

$$= \frac{5(s+2)}{(s+3)(s+2)+5} = \frac{5s+10}{s^2+5s+11}$$

- $\frac{5s+10}{s^2+5s+11}$
- None above
- $\frac{5(s+10)}{s^2+5s+12}$
- $\frac{5s+2}{s^2+6s+11}$
- $\frac{5(s+10)}{(s+5)(s+11)}$

Question 2

5 / 5 pts

If $X(s) = \frac{3}{s(s+4)}$ then, x(t)=

Laplace table

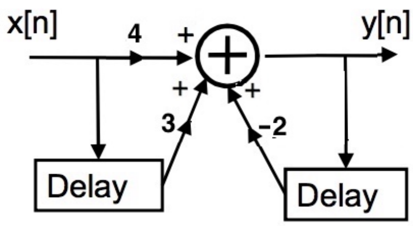
$$\frac{a}{s(s+a)} \Rightarrow (1-e^{-at})u(t)$$

$$\frac{3}{4}\frac{4}{s(s+a)} \Rightarrow \frac{3}{4}(1-e^{-4t})u(t)$$

- 3(1-e^{-4t})u(t)
- (3/4)(1-$e^{-t/4}$) u(t)
- (4/3)(1-e^{-4t})u(t)
- 4 (1-e^{-3t}) u(t)/3
- None above

Question 3

5 / 5 pts



$= -2y[n-1] + 4x[n] + 3x[n-1]$

$Y(z)(1+2z^{-1}) = X(z)(4+3z^{-1})$

For the LTI system above with impulse response h[n], the z-transform of h[n] is H(z)=Y(z)/X(z)=

- (3z+4)/(z-2)
- (4z+3)/(z+2)
- (2z+1)/(3z+4)
- None above
- (2z+1)/(4z-3)

Question 4

5 / 5 pts

The z-transform of x[n]=$(3/4)^{n-1}$ u[n-1] is

- 4z/(3z-9/4); |z|>3/4
- None above
- 1/(z-3/4); |z|>3/4
- 0.75z/(z-3/4); |z|>3/4
- 0.75/(z-4/3); |z|>4/3

$\left(\frac{3}{4}\right)^n u[n] \Rightarrow \frac{z}{z-3/4}$

delay prop $\Rightarrow \frac{z^{-1} \cdot z}{z-3/4}$

Question 5

5 / 5 pts

In a 10 sample/s system with $X^*(s) = 1/(5 + e^{s/5})$ the z-transform (ignoring ROC) is X(z) =

$e^{s/10} = z$

- $\frac{1}{z^2+5}$
- none above

$= \frac{1}{5+(e^{s/10})^2} \Rightarrow \frac{1}{5+z^2}$

- $\frac{z^2}{z^2+0.5}$
- $\frac{5z}{z^2+5}$
- $\frac{1}{z^{-2}+5}$

Question 6

5 / 5 pts

In a in a 5 sample/s system with X(s)=4/s^2, the starred transform is X*(s) =

$x(t) = 4t\,u(t)$

$\Rightarrow x[n] = 4nT\,u[n]$

$X(z) = 4T\frac{z}{(z-1)^2}.$

$X^*(s) = 4T\frac{e^{sT}}{(e^{sT}-1)^2} = \frac{4}{5}\frac{e^{s/5}}{(e^{s/5}-1)^2}$

- $\frac{0.2\,e^{s/5}}{(e^{s/5}-4)^2}$
- none above
- $\frac{e^{s/5}}{e^{s/5}-1}$
- $\frac{0.8e^{s/5}}{(e^{s/5}-1)^2}$
- $\frac{0.2\,e^{-4/5}}{(e^{-s/5}-1)^2}$

Question 7

5 / 5 pts

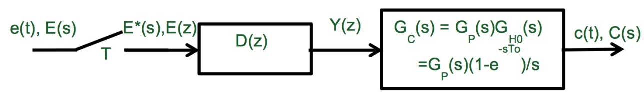
A continuous-time signal x(t) is sampled with period T_0=0.1 s to create discrete-time signal x[n], and the z-transform of x[n] is $X(z) = \frac{2}{3z-1}; \quad |z| > \frac{1}{3}$. Then, the starred transform of x(t) is $X^*(s)$ =

$\left.\frac{2}{3z-1}\right|_{z=e^{sT}} = \frac{2}{3e^{s/10}-1}$

- $\frac{2}{3e^{s/10}-1}$
- $\frac{2e^{s/10}}{3-e^{s/10}}$
- $\frac{2e^{-s/10}}{3e^{-s/10}-e^{-1/10}}$
- None above
- $\frac{2}{3e^{-s/10}-1}$

Question 8

5 / 5 pts



In the system above, let T=0.1 s, D(z)=1-1/z, $G_P(s)=4/(s+4)$, $G_{H0}(s)= (1-e^{-sT})/s$.

For the system above, the pulse transfer function is G(z)=C(z)/E(z)=

$G'(s)$

$$\left(1-1/z\right)\frac{4}{s+4}\,\frac{1-e^{-sT}}{s} = \left(1-\frac{1}{z}\right)\frac{4}{s(s+4)}\cdot 1-e^{-sT}$$

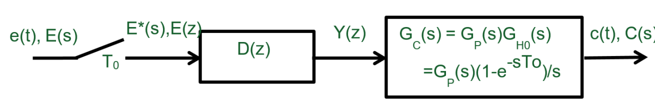
- $(1+1/z)(1+e^{-4/5})/(z-e^{-4/5})$
- $(1-1/z)(1-e^{-2/5})/(z-e^{-2/5})$
- None above
- $(4/10)(1+e^{-2/5})/(z+e^{-2/5})$
- $(2/5)(1-e^{-5/2})/(z-e^{-5/2})$

$$\Rightarrow \left(1-\frac{1}{z}\right)\underbrace{\frac{z(1-e^{-4T})}{(z-1)(z-e^{-4T})}}_{G'(z)}\,\frac{z-1}{z}$$

$$= \left(1-\frac{1}{z}\right)\frac{1-e^{-4/10}}{z-e^{-4/10}}$$

Question 9

5 / 5 pts



For the system above, $D(z) = 1-0.5z^{-1}$, $G_P(s)=3/s$, $G_{H0}(s)=(1+e^{-sT_0})/s$, $T_0=1/10$

In the open-loop system above, the starred transform of the output is C*(s)=

$G'(s)$

$$\left(1-\frac{1}{2z}\right)\frac{3}{s}\,\frac{1-e^{-st}}{s} = \frac{z-1/2}{z}\,\frac{3}{s^2}\left(1-e^{-sT}\right)$$

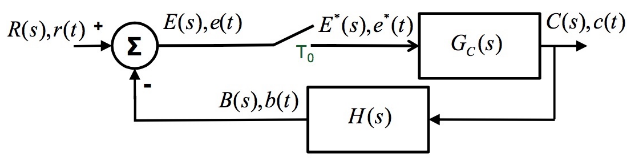
- none of the answers
- $\left(\frac{4}{5}\right)\frac{2e^{s/10}+1}{e^{s/5}\left(e^{s/10}-1\right)}E^*(s)$
- $\left(\frac{3}{20}\right)\frac{2e^{s/10}-1}{e^{s/10}\left(e^{s/10}-1\right)}E^*(s)$
- $\left(\frac{4}{5}\right)\frac{e^{s/10}-2}{e^{s/10}\left(e^{s/5}-1\right)}E^*(s)$

$$\frac{z-1/2}{z}\,\underbrace{3\,\frac{zT}{(z-1)^2}}_{G'(z)}\,\frac{z-1}{z} = \frac{2z-1}{2z}\cdot\frac{3/10}{z-1}$$

$$= \frac{3}{20}\,\frac{2z-1}{z(z-1)}\Bigg|_{z=e^{sT}=e^{s/10}}$$

Question 10

5 / 5 pts



In the system above, let:

$H(s)=1/10$, $G_C(s)=G_P(s)G_{H0}(s)$, $G_P(s)=15$, $G_{H0}(s)=(1-e^{-sT})/s$.

The closed-loop **continuous-time step response** is

- 1.6 u(t)
- 3 u(t)
- 6 u(t)
- None above

$G_c(s) = 15\frac{1-e^{-sT}}{s} = \frac{15}{s}(1-e^{-sT})$

$G_c(z) = 15\frac{z}{z-1}\frac{z-1}{z} = 15$

$\frac{C(z)}{R(z)} = \frac{G_c(z)}{1+G_cH(z)} = \frac{15}{1+15/10} = \frac{150}{25} = 6$

$C(s) = E^*(s)\,G_c(s)$

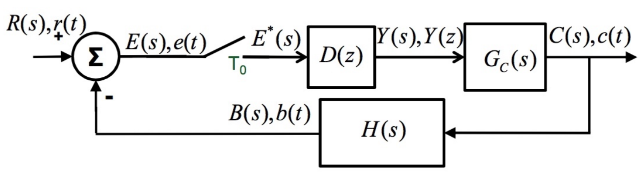
$E^*(s) = R^*(s) - E^*G^*H^* \Rightarrow E^* = \frac{R^*}{1+G^*H^*}$

$C(s) = \frac{R^*G_c(s)}{1+GH^*} = \frac{\frac{z}{z-1}\frac{15}{s}\frac{z-1}{z}}{1+15/10}$

$= \frac{15}{2.5}\frac{1}{s} = 6\cdot\frac{1}{s}$

Question 11

5 / 5 pts



If the characteristic equation for the system above is

$z^2 + z - 5/16=0$,

then the closed-loop pulse transfer function $G_{CL}(z)=C(z)/R(z)$ is stable.

- True
- False

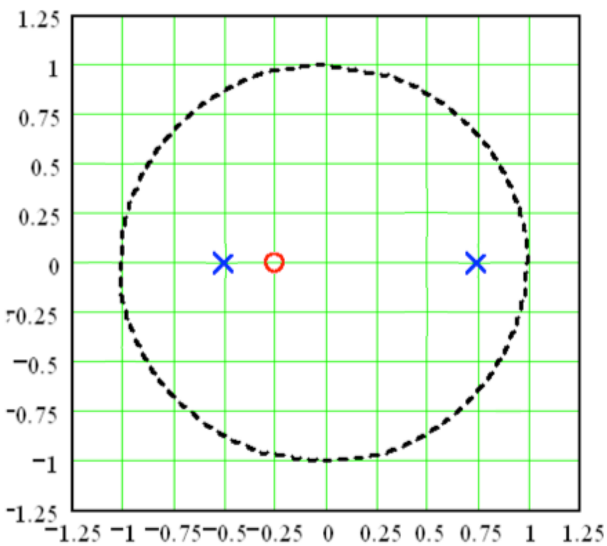
$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$= \frac{-1\pm\sqrt{1+20/16}}{2}$

$= -\frac{1}{2} \pm \frac{\sqrt{36/16}}{2} = -\frac{1}{2} \pm \frac{3}{4}$

Question 12

5 / 5 pts



The causal LTI system with closed-loop pulse transfer function $G_{CL}(z)$ having the pole/zero plot above is BIBO stable.

- True
- False

Question 13

5 / 5 pts

For a system with variable gain K>0, the closed-loop response $G_{CL}(z) = \frac{C(z)}{R(z)} = \frac{\frac{K}{2z+4}}{1-\frac{K}{2z+4}}$ is stable for

$$= \frac{K}{2z+4-K}$$

$$= \frac{K/2}{z+2-K/2}$$

Real Poles @ $z = \frac{K}{2} - 2$

Pole @ 1 for z=6, @ -1 for $z=2$

- 2<K<4
- 2<K<6
- 0<K<2
- none of the answers

Question 14

5 / 5 pts

The w-transform of 1/(3z-4) in a 5 sample/s system is

$$\frac{1}{3\left(\frac{1+wT/2}{1-wT/2}\right)-4} = \frac{1-w/10}{3+\frac{3w}{10}-4+4\frac{w}{10}}$$

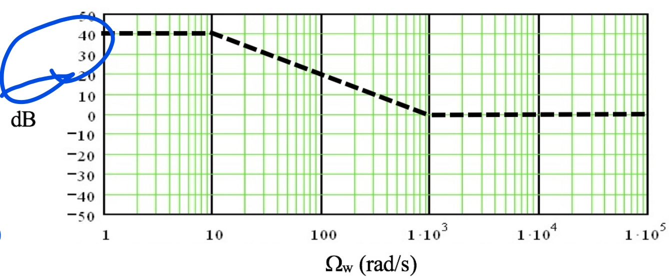
$$= \frac{10-w}{30+3w-40+4w}$$

- none of the answers

- $\frac{4-3w}{21w-4}$
- $\frac{5-2w}{14w-5}$
- $\frac{10-w}{7w-10}$

Question 15

5 / 5 pts



DC → 100

For the w-transform of the digital lag filter with |D(w)| shown above, D(w) =

$100 \frac{1+w/1000}{1+w/10}$

$= 100 \frac{\frac{1}{1000}(w+1000)}{\frac{1}{10}(10+w)}$

- None above
- 0.1(w+10)/(w+1000)
- 0.3(w+1000)/(w+10)
- 100(w+1000)/(w+10)
- (w+1000)/(w+10)

Question 16

5 / 5 pts

For a lag compensator with $D(w) = 4\frac{1+\frac{w}{16}}{1+\frac{w}{2}}$ in a system with sample period T_s=1/4 s, the corresponding discrete-time compensator is D(z) =

$w_0 = 16$ $T = 1/4$

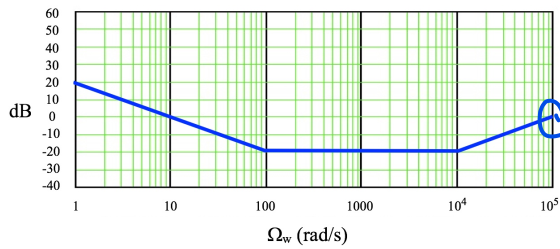
$D(z) = \left(a_0 \frac{w_p}{w_0}\left(\frac{1+w_0T/2}{1-w_pT/2}\right)\right) \frac{z-(1-w_0T/2)/(1+w_0T/2)}{z-(1-w_pT/2)/(1+w_pT/2)}$

$a_0 = 4$ $w_p = 2$

- (10z -2)/(z + 3)
- none of the answers
- (8z + 4)/(6z - 3)
- (6z + 2)/(5z - 3)

Question 17

5 / 5 pts



$K_i/w + K_p + K_D w$

$\approx K_D w$ @ High Freq.

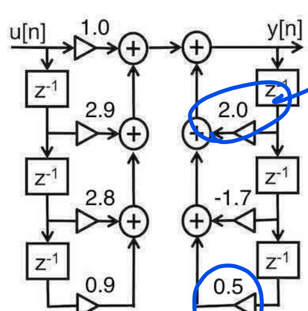
For the w-transform of the PID controller with |D(w)| shown above, to within +/- 20% the differentiator coefficient is K_D=

$|K_D w| = |K_D \cdot 10^5| = 1$

- None above
- 0.1
- 10
- 10^{-5}
- 1,000

Question 18

5 / 5 pts



$-a_1$

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_3 & -a_2 & -a_1 \end{bmatrix}$$

$-a_3$ 0.5 -1.7 2

For the digital system above with sample period To=0.001 s, controllable form state-variable matrix A=

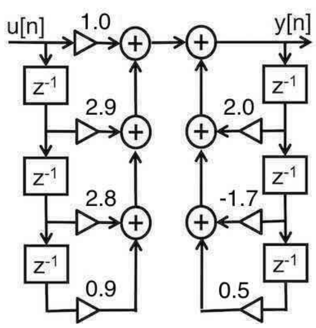
- $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 2 & -1.7 & 0.5 \end{bmatrix}$
- none of the answers
- $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.9 & 2.8 & 2.8 \end{bmatrix}$

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.5 & 1.7 & -2 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.5 & -1.7 & 2 \end{bmatrix}$$

Question 19

5 / 5 pts



$$\begin{bmatrix} B & AB & A^2B \end{bmatrix}$$

For the digital system above with sample period To=0.001 s, the controllability matrix is

$$= \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 2 \\ 1 & 2 & 2.3 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0.5 \\ 0 & 1 & 1 \\ 1 & 0.9 & 1.9 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 2 \\ 1 & 2 & 2.3 \end{bmatrix}$$

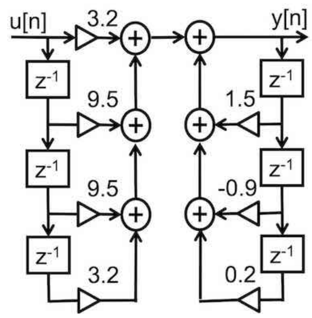
$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 2 \\ 1 & 1.7 & -1.1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 1 \\ -2.9 & -2.8 & -0.9 \end{bmatrix}$$

none of the answers

Question 20

5 / 5 pts



Control. Matrix HAS INVERSE

For the digital system above with sample period To=0.001 s, the system is controllable.

- True
- False

Question 21

5 / 5 pts

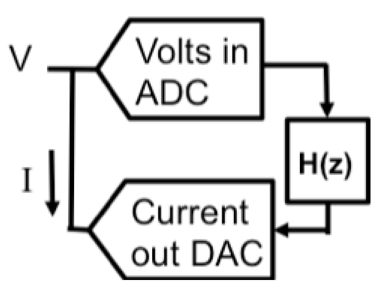
A state-variable system with observability matrix $\begin{bmatrix} -1 & 1 \\ 2 & -2 \end{bmatrix}$ is observable.

RANK = 1

- True
- False

Question 22

5 / 5 pts



$\frac{C}{T} = -20$

$C = -\frac{20}{1000}$

If H(z)= -20(1 - z^{-1}) and $T_0=10^{-3}$ s for the system above, and for the direction of DAC current as shown, the input capacitance in seen at the point V is

- none of the answers
- 0.02 F

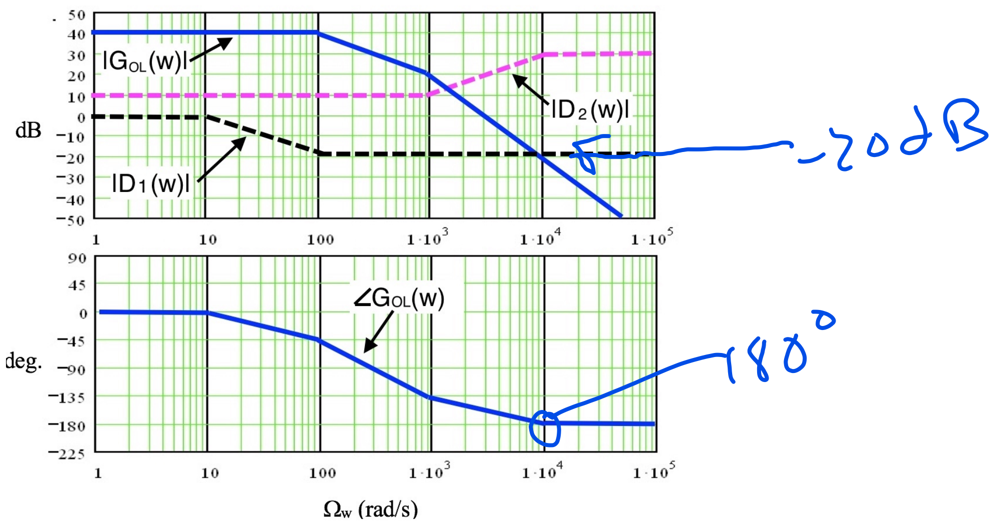
0.005

-0.02 F

-0.005 F

Question 23

5 / 5 pts



For the w-transforms shown above, the Bode plots for phase of the two compensators are not shown (you may assume the phases are the correct Bode plot phases for lag, lag-lead, PID, or lag compensators). For **uncompensated** open-loop gain $G_{OL}(w)$ shown above, using Bode plot analysis the gain margin to within +/-3 dB is

0 dB

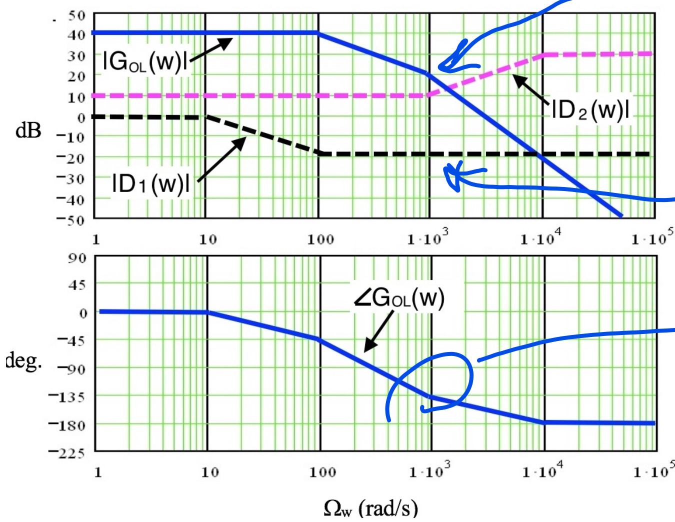
10 dB

none of the answers

20 dB

Question 24

5 / 5 pts



+20dB

-20dB

TOTAl = 0dB

phase = -135

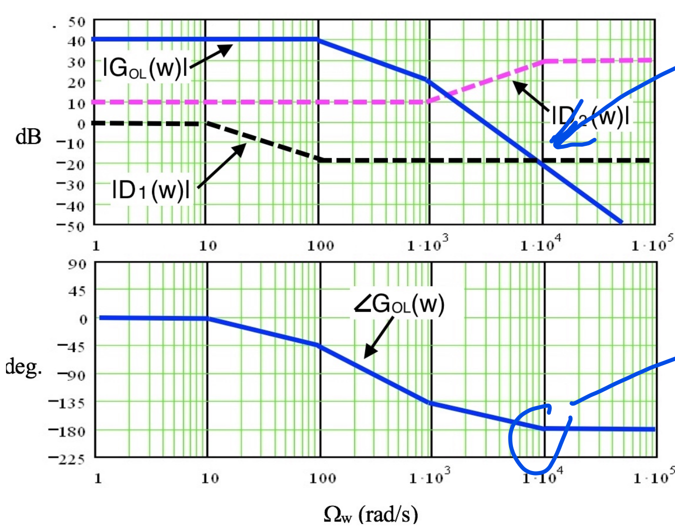
Margin = 45

For the w-transforms shown above, the Bode plots for phase of the two compensators are not shown (you may assume the phases are the correct Bode plot phases for lag, lag-lead, PID, or lag compensators). For open-loop gain $G_{OL}(w)$ combined with compensator $D_1(w)$ shown above, the phase margin of $G_{OL}(w)D_1(w)$ to within +/-10 degrees is

- 135 degrees
- 45 degrees
- none above
- 90 degrees

Question 25

5 / 5 pts



here Compensator = -20dB

GOL = -20dB

-40dB Total

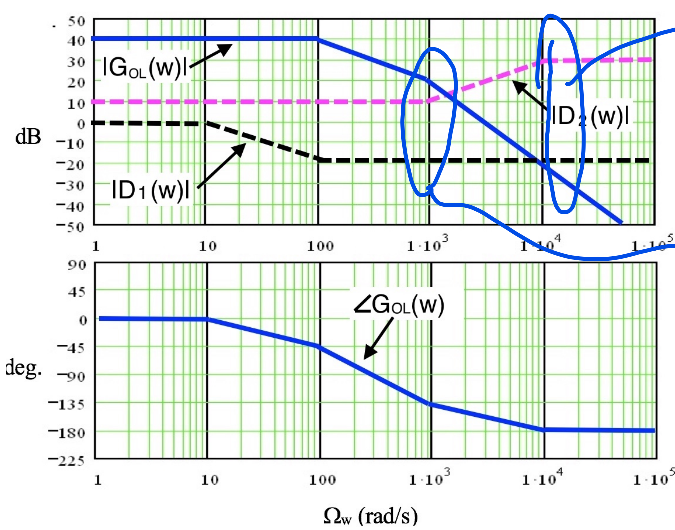
180°

For the w-transforms shown above, the Bode plots for phase of the two compensators are not shown (you may assume the phases are the correct Bode plot phases for lag, lag-lead, PID, or lag compensators). For open-loop gain $G_{OL}(w)$ combined with compensator $D_1(w)$ shown above, the gain margin of $G_{OL}(w)D_1(w)$ to within +/-4 dB is

- 20 dB
- 60 dB
- 40 dB
- None above

Question 26

5 / 5 pts



D2 unity gain

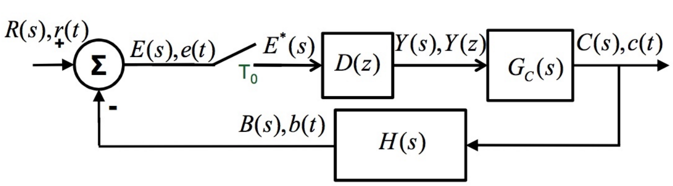
D1 unity @ 1000

For the w-transforms shown above, the Bode plots for phase of the two compensators are not shown (you may assume the phases are the correct Bode plot phases for lag, lag-lead, PID, or lag compensators). For open-loop gain $G_{OL}(w)$, comparing the bandwidth using the two compensators, the unity-gain bandwidth of $G_{OL}(w)D_1(w)$ is larger than $G_{OL}(w)D_2(w)$.

- True
- False

Question 27

5 / 5 pts



In the system above, let

D(z)=2-1/z, H(s)=1/5, $G_C(s)=G_P(s)G_{H0}(s)$, $G_P(s)=20$, $G_{H0}(s)=(1-e^{-sT})/s$.

$= \frac{2z-1}{z}$

For the system above, the closed-loop pulse transfer function is $G_{CL}(z)=C(z)/R(z)=$

$G'(s)$

$G_c(s) = 20\frac{(1-e^{-sT})}{s} = \frac{20}{s}(1-e^{-sT})$

$G_c(z) = \underbrace{20\frac{z}{z-1}}_{G'(z)}\frac{z-1}{z} = 20$

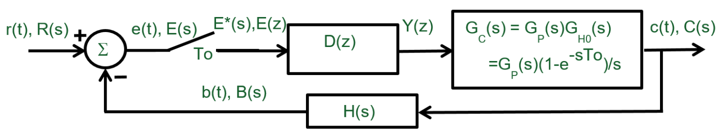
$G_{CL}(z) = \frac{D(z)G_c(z)}{1+D(z)G_cH(z)} = \frac{\frac{2z-1}{z}\cdot 20}{1+\frac{2z-1}{z}\cdot 20\cdot\frac{1}{5}}$

$= \frac{20(2z-1)}{z+(2z-1)4} = \frac{20(2z-1)}{9z-4}$

- $10(2+1/z)(1+e^{-To})/(4z-9)$
- $20(2-e^{-5To})/(z-e^{-5To})$
- None above
- $2(z+20)/(z+8/9)$
- $20(2z-1)/(9z-4)$
- $(20z+1)/(z^2+z+1/4)$

Question 28

5 / 5 pts



For the system above:

In the system above, let

D(z)=2-1/z, H(s)=1/5, $G_C(s)=G_P(s)G_{H0}(s)$, $G_P(s)=20$, $G_{H0}(s)=(1-e^{-sT})/s$.

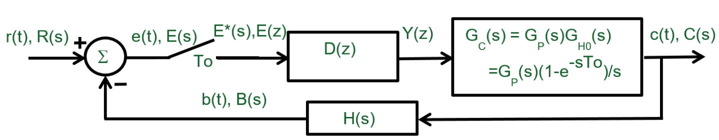
For the system above, the pole of the closed-loop pulse transfer function $G_{CL}(z)$ is at

$z = \frac{4}{9} \simeq .44$

- -0.25
- 0.63
- none of the answers
- 0.44

Question 29

5 / 5 pts



For the system above: $D(z) = 1\text{-}0.5z^{-1}$, $G_P(s)$=8/s, $G_{H0}(s)=(1+e^{-sT_0})/s$, H(s)=1/2, T_0=1/5

$= \frac{z-1/2}{z}$

For the system above, the closed loop pulse transfer function is $G_{CL}(z)$= C(z)/R(z) = $G'(s)$

$G_c(s) = \frac{8}{s}\frac{1-e^{-sT}}{s} \Rightarrow \frac{8}{s^2}(1-e^{-sT})$

$G(z) = \frac{8Tz}{(z-1)^2}\frac{z-1}{z} = \frac{8/5}{z-1}$

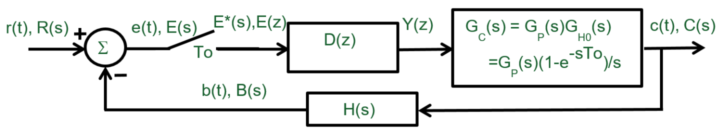
$G_{CL}(z) = \frac{D(z)G_c(z)}{1+D(z)G_cH(z)} = \frac{\frac{z-1/2}{z}\cdot\frac{8/5}{z-1}}{1+\frac{z-1/2}{z}\frac{8/5}{z-1}\frac{1}{2}}$

$= \frac{8z-4}{5z^2-5z+4z-2} = \frac{8z-4}{5z^2-z-2}$

- ◉ $\frac{8z-4}{5z^2-z-2}$
- ○ $\frac{8z-2}{7z^2+2z-6}$
- ○ none of the answers
- ○ $\frac{z-4}{8z^2-4z-2}$

Question 30

5 / 5 pts



$\frac{+1 \pm \sqrt{1^2+40}}{10}$

For the system above: $D(z) = 1\text{-}0.5z^{-1}$, $G_P(s)$=8/s, $G_{H0}(s)=(1+e^{-sT_0})/s$, H(s)=1/2, T_0=1/5

For the system above, the poles of the closed-loop pulse transfer function $G_{CL}(z)$ are at

- ○ 0.32 and 0.65
- ○ -0.53and 0.21
- ○ none of the answers
- ◉ 0.74 and -0.54

Quiz Score: **150** out of 150