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Unit 9 - Week 5: Control of systems with some known parameters, Introduction to 2-degree of freedom control

Week-5 Assessment

The due date for submitting this assignment has passed. **Due on 2018-09-12, 23:59 IST.**
As per our records you have not submitted this assignment.

Week-5 Assessment

1) Consider a plant whose transfer function is given by   *1 point*

$P(s) = \dfrac{5}{(s/10+1)(s/100+1)}$. A unity feedback control system is employed to perfectly track a DC reference and to perfectly reject sinusoidal output disturbance of frequency 1 rad/s. Which of the following controllers C(s) would be appropriate to achieve this desired performance while ensuring a stable closed loop system? (Hint: Use Bode plot to check for stability)

○ $C(s) = \dfrac{(s+1)^2}{s(s^2+1)}$

○ $C(s) = \dfrac{(s+1)}{s(s^2+1)}$

○ $C(s) = \dfrac{(s+1)^2}{s^2(s^2+1)}$

○ $C(s) = \dfrac{(s+1)}{s^2(s^2+1)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$C(s) = \dfrac{(s+1)^2}{s(s^2+1)}$

2) Consider a plant whose transfer function is given below   *2 points*

$$P(s) = \dfrac{10}{(s/10+1)(s/50+1)}$$

Although the nominal gain of the plant is 10, this could change by a factor of 2, i.e., it could drift to any value between 5 and 20. The plant is expected to track a reference r(t)=sin(t) perfectly. A unity feedback control system is employed to achieve the objective. Which of the following controllers C(s) would be appropriate to achieve the desired performance while assuring a stable closed loop operation? (Hint: Use Bode plot to check for stability).

○

$$C(s) = \frac{10}{s^2+1}$$

○

$$C(s) = \frac{(s+2)^2}{s^2+1}$$

○

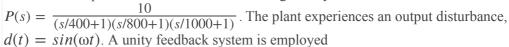$$C(s) = \frac{s^2+2}{s^2+1}$$

○

None of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$C(s) = \frac{(s+2)^2}{s^2+1}$$

3) Consider a plant whose transfer function is given by   **2 points**
$P(s) = \dfrac{10}{(s/400+1)(s/800+1)(s/1000+1)}$. The plant experiences an output disturbance, $d(t) = sin(\omega t)$. A unity feedback system is employed

   (i) To track a DC reference perfectly.
   (ii) To reject the disturbance d(t) by at least 98% for $\omega < 16$ rad/s.
   (iii) To perfectly reject the disturbance d(t) at $\omega = 16$ rad/s.
   (iv) To perfectly track the reference input $r(t) = sin(\omega_1 t)$, where $\omega_1 = 32$ rad/s.

Which of the following controllers C(s) would be appropriate to achieve the desired performance and also ensures the stability of the closed-loop system? (Hint: Use Bode plot to check for stability)

○

$$C(s) = 80/s$$

○

$$C(s) = \frac{80(s/450+1)(s+30)^2}{s(s^2+32^2)}$$

○

$$C(s) = \frac{80(s/450+1)(s+10)^2(s+30)^2}{s(s^2+16^2)(s^2+32^2)}$$

○

$$C(s) = \frac{80(s+10)^2(s+30)^2}{s(s^2+16^2)(s^2+32^2)}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$C(s) = \frac{80(s/450+1)(s+10)^2(s+30)^2}{s(s^2+16^2)(s^2+32^2)}$$

4) A unity feedback control system has a plant transfer function   **1 point**
$P(s) = 1/(s + 5)$. A PI controller $C(s) = K_P + K_I/s$ is employed to ensure the damping factor ζ & the natural frequency ω_n of the closed loop system is 0.3 & 10 rad/s respectively. Determine the value of proportional gain K_P & integral gain K_I of the controller.

○

$$K_P = 1, \ K_I = 10$$

○

$$K_P = 10, \ K_I = 10$$

○

$$K_P = 100, \ K_I = 10$$

$K_P = 1, \ K_I = 100$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$K_P = 1, \ K_I = 100$

5) Identify the correct statement regarding the limitation of one degree of freedom   *1 point*
control.
    (i) Large variation in plant parameters results in significant change in transient
response.
    (ii) Sensitivity function 'S' and transmission function 'T' can't be independently
controlled.
    (iii) Sensitive to measurement noise
    (iv) Sensitive to disturbances

  ○ i,ii,iv
  ○ ii,iii,iv
  ○ i,ii,iii
  ○ i,iii,iv

No, the answer is incorrect.
Score: 0

Accepted Answers:
i,ii,iii

6) Under a situation where there is significant variation in a minimum phase plant's *1 point*
parameter, a closed-loop control system is applied in order to achieve a specified closed-
loop dynamics even in the face of this variation. Which of the following control strategies
should be employed to achieve insensitivity to plant's parameter variation while attaining
the desired closed-loop performance.

  ○ Employ 2 DOF control such that the controller transfer function possess zero near
the desired closed-loop pole position and the pre-filter transfer function possess pole
exactly at the added zero.
  ○ Employ 2 DOF control such that the controller transfer function possess pole near
the desired closed-loop pole position and the pre-filter transfer function possess zero
exactly at the added pole.
  ○ Employ 1 DOF and make sure that the magnitude of the open loop transfer
function is as high as possible at the desired closed-loop pole.
  ○ Both option a and c

No, the answer is incorrect.
Score: 0

Accepted Answers:
*Employ 2 DOF control such that the controller transfer function possess zero near the
desired closed-loop pole position and the pre-filter transfer function possess pole exactly at
the added zero.*

7) What should be the structure of the pre-filter transfer function F(s) for the given *1 point*
2 DOF control system so as to reject a white noise while simultaneously achieve tracking
of faster reference signals?

  ○
$F(s) = (s/K_0 K_i + 1)/(s/K_2 + 1); \ K_2 \gg K_0 K_i$
  ○
$F(s) = (s/K_i + 1)/(s/K_2 + 1); \ K_2 \gg K_i$
  ○
$F(s) = (s/K_2 + 1)/(s/K_0 K_i + 1); \ K_2 \gg K_0 K_i$
  ○
$F(s) = (s/K_0 K_i + 1)/(s/K_2 + 1); \ K_2 \ll K_0 K_i$
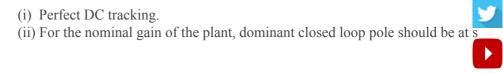
No, the answer is incorrect.
Score: 0

Accepted Answers:
$F(s) = (s/K_0 K_i + 1)/(s/K_2 + 1); K_2 >> K_0 K_i$

8) Consider a plant whose transfer function is given by $P(s) = \dfrac{20}{(s+20)}$. The **1 point**

gain of the plant varies from 4 to 100 while the nominal value of the gain is 20. A unity feedback control system with a controller C(s) along with a pre-filter F(s) is designed to achieve the following specifications:

(i) Perfect DC tracking.
(ii) For the nominal gain of the plant, dominant closed loop pole should be at s = -30.

The transfer function of the designed controller is $C(s) = \dfrac{200(s+20)(s+z)}{s(s+130)}$. Identify

the value of z among the following:

- ○ 30.75
- ○ 33
- ○ 31.5
- ○ 32.6

No, the answer is incorrect.
Score: 0

Accepted Answers:
30.75

9) Find out the location of the dominant closed loop pole for the control system **1 point**
designed in Question number 8 when the plant gain is 100.

- ○ s = -30.598
- ○ s = -30.669
- ○ s = -30.225
- ○ s = -30.426

No, the answer is incorrect.
Score: 0

Accepted Answers:
s = -30.598

10)Identify the appropriate transfer function for the pre-filter F(s) designed in **1 point**
Question number 8 which ensures that the dominant closed loop pole does not get
cancelled due to the open loop zero (z) of the CP(s).

- ○
  $F(s) = \dfrac{30.75}{s+30.75}$
- ○
  $F(s) = \dfrac{33}{s+33}$
- ○
  $F(s) = \dfrac{31.5}{s+31.5}$
- ○
  $F(s) = \dfrac{36}{s+36}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$F(s) = \dfrac{30.75}{s+30.75}$

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