Class Test No. 19 & 20   Thursday 07th Nov 2019   Duration: 15 Minutes   Closed Notes

Name: ________________________   Roll No. ________________

Choose only one option which is the most appropriate for questions 1 - 5.

1. Primary specification for the design of a PD control is

(a) gain margin
(b) ramp error constant
(c) phase margin
(d) bandwidth

2. The reason for calculating angle deficiency and gain at desired closed loop pole while designing PD control is to ensure that

(a) pole is on the original root locus
(b) controller zero is on the modified root locus
(c) controller DC gain is unity
(d) pole is on the modified root locus

3. For a 3rd order all pole stable plant, best closed loop transient performance is possible if the controller zero is

(a) to the left of all plant poles
(b) to the right of all plant poles
(c) to the left of dominant plant pole
(d) to the right of the most non-dominant plant pole

4. In the design of PD control in frequency domain, we generally need to iterate because

(a) frequency domain is an approximation
(b) GM specification needs multiple trials
(c) GCO increases
(d) PCO decreases

5. In the presence of a PD control, all transient response parameters improve over their uncompensated values, under the condition that

(a) controller corner frequency is zero
(b) controller DC gain is unity
(c) controller corner frequency is infinite
(d) controller magnitude at dominant pole is unity

6. PID controllers are preferred options in general case because these

(a) provide the best closed loop performance
(b) are efficient
(c) are implemented in time domain
(d) do not need iteration

..... 2 (PTO)

7. In the design of PID using PI and PD based methods, we can design for transient response first if

(a) the plant is type '0'
(b) the plant is of the order '3' or higher
<u>(c) there is no value specified for ramp error constant</u>
(d) the plant is stable

8. In general, acceptable PID action can be created by putting independently designed PI and PD in cascade with each other because

(a) all the three actions are included
(b) PI & PD design processes use different specifications
(c) the design is only for dominant closed loop behaviour
<u>(d) PI and PD broadly have different domains of action</u>

9. In the first method of Zeigler-Nichols for PID design, the controller zeros are located at

(a) -1/L
(b) -T/L
(c) -1/T
(d) -0.6T/L

10. In the first method of Zeigler-Nichols for PID design, the controller gain is

(a) 1.2L
<u>(b) 0.6T</u>
(c) 1.2T
(d) 0.6L

Give short (1 - 2 lines) answer to the questions 11-20

11. While designing PD control with root locus, can we aleays achieve the desired tracking performance? Support your answer with reason.

No. Tracking performance may not be compatible with controller DC gain.

12. Give reason for employing a phase margin buffer, while designing PD control in frequency domain.

Addition of PD control reduces the PM by pushing the GCO to a higher value.

13. Determine angle deficiency at -2+j√3, of the following plant.

$$G(s) = \frac{1}{(s+1)^3}$$

Angle Deficiency $\phi = -180^o + 3\times\tan^{-1}\frac{\sqrt{3}}{1} = 0$

..... 3 (PTO)

14. What is the impact of satisfying the tracking requirement, before fixing the controller corner frequency, while designing PD with Bode plots?

We can achieve both tracking and transient response requirements at the same time, using the PD controller.

15. Give the controller corner frequency of a PD controller which will ensure a phase margin of 45^o at the GCO, for the plant given alongside. (Hint: Do not use any buffer).

$$G(s) = \frac{2}{s^2}$$

$$\frac{2}{\omega_{GCO}^2} = 1 \rightarrow \omega_{GCO} = \sqrt{2}; \quad PM = 0^o; \quad \angle\left(1 + T_d\sqrt{2}\right) = 45^o \rightarrow \omega_c = \frac{1}{T_d} = \sqrt{2}$$

16. Why is the plant step response used for configuring the PID control?

Plant step response exhibits features that indicate the nature and extent of deficiency, which is helpful in designing a generic PID controller.

17. Give the equivalent transfer function employed for the first method of Zeigler-Nichols.

$$G(s) = \frac{Ke^{-Ls}}{Ts+1}$$

18. Determine the non-zero location of the double zero of the PID controller with unity gain for the following plant, if $\zeta = \omega_n$ for the closed loop dominant poles.

$$G(s) = \frac{1}{s}$$

$$D(s) = s^2 + zs + {z^2}/{2} = s^2 + 2\zeta^2 s + \zeta^2 \rightarrow z = z^2 = 2\zeta^2 \rightarrow z = 1$$

19. Define the parameters, K & L contained in the equivalent transfer function, as per the first method.

K $\rightarrow$ Plant DC gain; L $\rightarrow$ Slope line intersection point with 't' axis

20. Derive the expression for proportional gain of the resultant controller when (K_P + $K_D s$) is put in cascade with 'K_I/s'. Also, what would be the nature of resulting controller?

$$G_c(s) = \left(K_P + K_D s\right)\frac{K_I}{s} = K_I K_D + \frac{K_P K_I}{s}; \quad \text{P-gain} = K_I K_D$$