Class Test No. 17 & 18 Monday 04st Nov 2019 Duration: 10 Minutes

Name: ________________________ Roll No. ________________

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

1. In design of P-control with bode plot, the controller gain is amount of additional gain at

(a) new phase crossover frequency
(b) existing gain crossover frequency
<u>(c) new gain crossover frequency</u>
(d) existing phase crossover frequency

2. In the context of Bode diagrams, the design of P-control is primarily driven by

<u>(a) phase margin</u>
(b) bandwidth
(c) gain margin
(d) resonant peak

3. Primary specification for the design of a PI control is

(a) gain margin
<u>(b) ramp error constant</u>
(c) phase margin
(d) bandwidth

4. PI control

<u>(a) adds a pole at origin and zero to the left of it</u>
(b) adds a pole at origin and zero to the right of it
(c) adds a zero at origin and pole to the left of it
(d) adds a zero at origin and pole to the right of it

5. Frequency domain design (using bode plot) of PI control primarily makes use of the requirements related to

(a) gain and phase margins
(b) gain margin and ramp error constant
<u>(c) phase margin and ramp error constant</u>
(d) phase margin and bandwidth

6. PI control design strategy, in frequency domain, generally results in nearly same

<u>(a) GCO & PM</u>
(b) PCO & GM
(c) GM & GCO
(d) PM & PCO

..... 2 (PTO)

7. In the presence of a PI control, the slope of high frequency asymptote is

(a) -20 dB/decade
(b) +20 dB/decade
(c) not possible to determine, as we need number of poles & zeros
<u>(d) same as that obtained in the absence of PI control</u>

8. In lag compensator design, location of pole-zero combination is decided by compensator

(a) gain, K_C
(b) parameter, β
<u>(c) time constant, T</u>
(d) DC gain

9. Very large increase in settling time due to lag compensation is generally because of

(a) large value of parameter β
(b) large gap between compensator pole & zero
<u>(c) large value of time constant, T</u>
(d) large value of gain, K_c

10. In comparison to PI controller, lag compensator avoids changing for compensated plant

<u>(a) system type</u>
(b) total gain
(c) total phase
(d) dominant pole location

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

11. How is the proportional gain obtained when Nyquist plot is used for design based on closed loop resonant peak specification?

The gain can be obtained through an iterative procedure in which a large number of Nyquist plots for different gain are created and one tangent to M-circle is found.

12. Why is caution advised for employing a PI control in case of type '1' plants?

This makes system type '2', resulting in transient response related issues.

13. What is the main impact of keeping phase contribution of PI control, at desired dominant poles, in the range -3^o to -5^o?

The modified root locus is in the vicinity of the original root locus.

..... 3 (PTO)

14. Determine the impact of the PI controller having unity DC gain and unity corner frequency, on the phase margin of the following plant.

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

$$\omega_{GCO} = \sqrt{3}; \quad PM = 180^o - \tan^{-1}\sqrt{3} = 120^o; \quad G_{PI}(s)G(s) = \frac{2}{s} \rightarrow PM = 90^o, \text{ a reduction of } 30^o$$

15. Determine the frequency in terms of the integrator time constant, Ti at which the PI control adds -3º phase.

$$\angle G_{PI}(s) = \tan^{-1}\left(T_i\omega\right) - 90 = -3 \rightarrow T_i\omega = 19.08 \rightarrow \omega = \frac{19.08}{T_i}$$

16. Give the controller corner frequency and T_i of a PI controller for the following plant.

$$G(s) = \frac{2}{(s-1)}$$

$$\omega_{GCO}^2 + 1 = 4 \rightarrow \omega_{GCO} = \sqrt{3}; \quad \frac{1}{T_i} = 0.173; \quad T_i = 5.78s$$

17. What are the values of K_c, T and β in the following lag compensator?

$$G_{Lag}(s) = \frac{2(s+1)}{(s+0.2)} \qquad K_c = 2; \quad T = 1; \quad \beta = 5$$

18. What is the main objective of the lag compensator?

The main objective is to increase the value of applicable error constant without changing system type.

19. What is the possible reason for a large ω_d in root locus based PI design?

Root locus based design, while keeping the lag ~3º, results in large proportional gain, which increases ω_n and hence ω_d.

20. In design of PI control, how do we decide the location of the corner frequency for zero?

Controller zero corner frequency is decided as 1-decade lower than the desired new GCO.