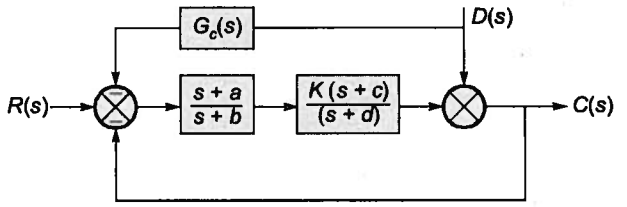
6 Controllers and Compensators

Multiple Choice Questions

Q.1 To eliminate the effect of Noise $D(s)$ the condition of feed forward controller $G_c(s)$ should be



(a) $\frac{K(s+a)(s+b)}{(s+d)(s+c)}$ (b) $\frac{(s+b)(s+d)}{K(s+a)(s+c)}$

(c) $\frac{K(s+b)(s+d)}{(s+a)(s+c)}$ (d) $\frac{(s+a)(s+c)}{K(s+b)(s+d)}$

Q.2 How does cascading an integral controller in the forward path of a control system affect the relative stability (*RS*) and the steady-state error (*SSE*) of that system?

(a) Both are increased
(b) RS is reduced but SSE is increased
(c) RS is increased but SSE is reduced
(d) Both are reduced

[ESE-2004]

Q.3 Which one of the following is an advantage of a *PD* controller in terms of damping (δ) and natural frequency (ω_n)?

(a) δ remains fixed but ω_n increases
(b) δ remains fixed but ω_n decreases
(c) ω_n remains fixed but δ increases
(d) ω_n remains fixed but δ decreases

[ESE-2005]

Q.4 A PD controller is used to compensate a system. Compared to the uncompensated system, the compensated system has

(a) a higher type number
(b) reduced damping
(c) higher noise amplification
(d) larger transient overshoot

[GATE-2003]

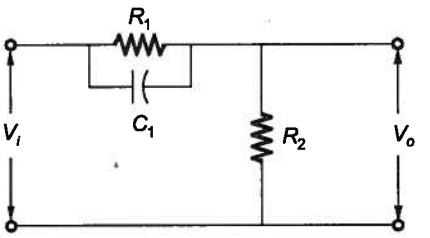
Q.5 A system is said to posses a derivative output compensation when the generation of its output depends on

(a) rate of change of input
(b) rate of change of actuating/error signal
(c) rate of change of output
(d) none of the above

Q.6 The maximum value of controller output is 100 V and is obtained when the input error is 1 V. If the controller is working at 20% proportional band the error and output will be

(a) 0.2 V and 100 V (b) 1 V and 20 V
(c) 1 V and 120 V (d) 0.2 V and 120 V

Q.7 For the given network, the maximum phase lead ϕ_m of V_0 with respect to V_i is



(a) $\sin^{-1}\left(\frac{R_1}{2R_2}\right)$ (b) $\sin^{-1}\left(\frac{R_1}{R_1+2R_2}\right)$

(c) $\sin^{-1}\left(\frac{R_1}{R_1+3R_2}\right)$ (d) $\sin^{-1}\left(\frac{R_1}{2R_1C_1}\right)$

[ESE-2000]

Q.8 The transfer function of phase-lead compensator is given by $G(s)=\frac{1+aTs}{1+Ts}$, where $T>0$, $a>1$.

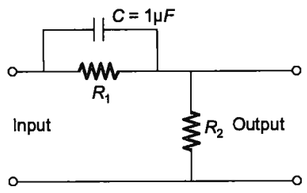
What is the maximum phase shift provided by this compensator?

(a) $\tan^{-1}\left(\frac{a+1}{a-1}\right)$ (b) $\tan^{-1}\left(\frac{a-1}{a+1}\right)$

(c) $\cos^{-1}\left(\frac{a-1}{a+1}\right)$ (d) $\sin^{-1}\left(\frac{a-1}{a+1}\right)$

[ESE-2001]

Q.9 The transfer function of a phase lead network, as shown in the figure below is



$\frac{K(1+0.3s)}{(1+0.17s)}$

The values of R_1 and R_2 are respectively

(a) 300 kΩ and 300 kΩ

(b) 300 kΩ and 400 kΩ

(c) 400 kΩ and 300 kΩ

(d) 400 kΩ and 400 kΩ

[ESE-2003]

Q.10 Consider the following statements for phase-lead compensation:

1. Phase-lead compensation shifts the gain cross-over frequency to the right.
2. The maximum phase-lead angle occurs at the arithmetic mean of the corner frequencies of the phase lead network.
3. Phase-lead compensation is effective when the slope of the uncompensated system near the gain cross-over is low.

Which of the statements given above are correct?

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

[ESE-2004]

Q.11 With regard to the filtering property, the lead compensator and the lag compensator are, respectively:

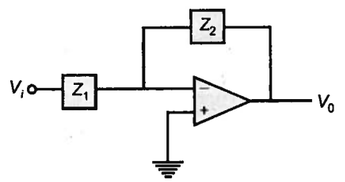
(a) low pass and high pass filters

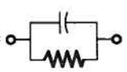
(b) high pass and low pass filters

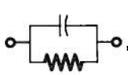
(c) both high pass filters

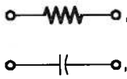
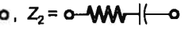
(d) both low pass filters **[ESE-2005]**

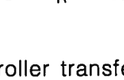
Q.12 For which one of the following, given physical realization corresponds to *PD* controller?



(a) $Z_1=$  , $Z_2=$

(b) $Z_1=$  , $Z_2=$

(c) $Z_1=$  , $Z_2=$ 

(d) $Z_1=$  , $Z_2=$ 

[ESE-2005]

Q.13 A controller transfer function is given by $C(s) = (2s + 1)/(0.2s + 1)$. What is its nature and parameter?

(a) Lag controller, $\alpha = 10$

(b) Lag controller, $\alpha = 2$

(c) Lead controller, $\beta = 0.1$

(d) Lead controller, $\beta = 0.2$ **[ESE-2007]**

Q.14 A double integrator plant, $G(s)=\frac{K}{s^2}, H(s)=1$ is to be compensated to achieve the damping ratio $\xi = 0.5$, and an undamped natural frequency, $\omega_n = 5$ rad/s. Which one of the following compensator $G_c(s)$ will be suitable?

(a) $\frac{s+3}{s+9.9}$ (b) $\frac{s+9.9}{s+3}$

(c) $\frac{s-6}{s+8.33}$ (d) $\frac{s+6}{s}$

[GATE-2005]

Q.15 What is the effect of phase lead compensator on gain cross-over frequency (ω_{gc}) and on the bandwidth (ω_b)?

(a) Both are increased

(b) ω_{gc} is increased but ω_b is decreased

(c) ω_{gc} is decreased but ω_b is increased

(d) Both are decreased

[ESE-2006]

Q.16 The controller *T.F.* is $\frac{20s^2+21s+1}{10s^2+11s+1}$.

It represents

(a) Lag compensator

(b) Lag - lead compensator

(c) Lead compensator

(d) PID controller.

Q.17 A unity feed back system has plant transfer function $G(s)=\frac{1}{s^2+2s+2}$

Which of the following compensators will give minium steady state error for step input

(a) $\frac{s+1}{s+2}$ (b) $\frac{s+2}{s+1}$

(c) $\frac{(s+1)(s+2)}{(s+3)(s+4)}$ (d) $1+\frac{2}{s}+3s$

Q.18 Consider the following statements for PI controller for a control system?

1. It is equivalent to add a zero at origin
2. It reduces overshoot
3. It improves order of the system by one
4. It reduces steady state error of the system

Which of the statements are correct

(a) 1, 2, 3 and 4 (b) 1, 2 and 3

(c) 2, 3 and 4 (d) 1 and 4 only

Q.19 In control system, excessive bandwidth is not employed because

(a) noise is proportional to bandwidth

(b) it leads to low relative stability

(c) it leads to slower time response

(d) noise is proportional to the square of the bandwidth

Q.20 A plant is controlled by a proportional controller. If a time delay element is introduced in the loop, its

(a) Phase margin remains the same

(b) Phase margin increases

(c) Phase margin decreases

(d) Gain margin increases

Q.21 A proportional plus derivative controller

1. has high sensitivity
2. increases the stability of the system
3. improves the steady-state accuracy

Which of the above statements are correct?

(a) 1, 2 and 3 only (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

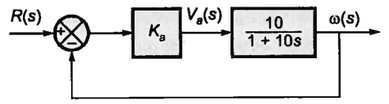
[ESE-2014]

Numerical Data Type Questions

Q.23 The compensator $G_C(s)=\frac{5(1+0.3s)}{1+0.1s}$ would provide a maximum phase shift of____°.

[ESE-1999]

Q.24 The open-loop transfer function of a dc motor is given as $\frac{\omega(s)}{V_a(s)}=\frac{10}{1+10s}$. When connected in feedback as shown below, the approximate value of K_a that will reduce the time constant of the closed loop system by one hundred times as compared to that of the open-loop system is _____.



[GATE-2013]

Q.25 A phase lead compensating network has its transfer function $G_c(s)=\frac{10(1+0.04s)}{(1+0.01s)}$. The maximum phase lead occurs at a frequency of ____ Hz.

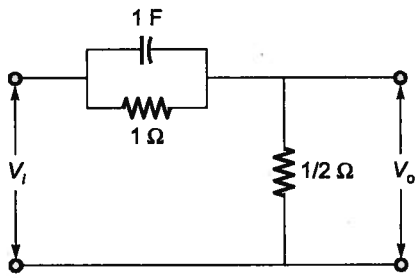
[ESE-2012]

Q.26 A lead compensator network includes a parallel combination of R and C in the forward path. If the transfer function of the compensator is $G_c(s)=\frac{s+2}{s+4}$, the value of RC is_____.

[GATE-2015]

Try Yourself

T1. The maximum possible phase provided by the given network is _____ degree.



[Ans: 30°]

T2. By adding zero to the system transfer function the improvement to transient response is called as

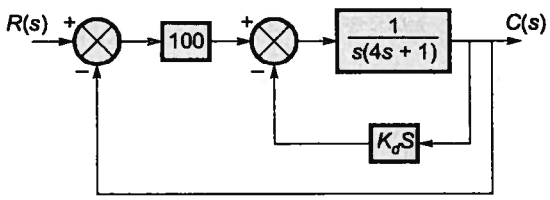
(a) phase lead compensation
(b) phase lag compensation
(c) phase lag and phase lead compensation
(d) phase lead and phase lag compensation

[Ans: (a)]

T3. The network having transfer function, $G(s)=\dfrac{1+\frac{s}{4}}{1+\frac{s}{25}}$ will provide maximum phase lead at a frequency of _____ rad/sec

[Ans: 10 rad/sec]

T4. Derivative feedback is employed in the control system shown in the figure, to improve its damping. If the required damping factor of the system is 0.5, then the value of K_d must be adjusted to _____.



[Ans: 19]

T5. Compare derivative controller and integral controller interms of

(*i*) sensitivity
(*ii*) stability
(*iii*) steady state accuracy