SOLUTION

① Qpcode: (23172)

Q1] a) Write minimum five points of difference

b) Draw diagram and explain.

c) $\frac{E_o(s)}{E_i(s)} = \frac{R}{R + sL + 1/sC}$

d) $k_p = \lim_{s \to 0} G(s)H(s)$ $k_p = \infty$

$k_v = \lim_{s \to 0} sG(s)H(s)$ $k_v = \infty$

$k_a = \lim_{s \to 0} s^2 G(s)H(s)$ $k_a = 0.5$

e) Definitions of both systems with explaination.
Examples of both the systems

Q2] a). $\frac{C(s)}{R(s)} = \frac{G_1 G_2 G_3 G_4}{1 + G_3 G_4 H_3 + G_2 G_3 H_2 + G_1 G_2 G_3 G_4 H_1}$

b) $$\frac{C(s)}{R(s)} = \frac{[G_1 G_2 G_3 G_9 (1 + G_5 H_2 + G_8 H_2) + G_1 G_7 G_6 G_9 + G_1 G_7 G_3 G_9 (1 + G_5 H_2) + G_4 G_5 G_6 G_9 (1 + G_2 H_1 + G_7 H_1) + G_4 G_8 G_6 G_9 (1 + G_2 H_1) + G_4 G_8 G_3 G_9]}{[1 + G_2 H_1 + G_5 H_2 + G_7 H_1 + G_8 H_2 + G_2 G_5 H_1 H_2 + G_5 G_7 H_1 H_2 + G_2 G_8 H_1 H_2]}$$

(2)

(Q3) a) Draw block diagram (03)
Explain working (03)
Advantages (01)
Derivation. (03)

b) Draw set up and define (02)
Frequency finding formula & example (04)
Phase finding formula & example (04)

(Q4) a) $K / s(s+4)(s+4)$
Breakaway pt exists between 0 and −2.
$\theta_1 = 60^\circ$, $\theta_2 = 180^\circ$, $\theta_3 = 300^\circ$
centroid $= -2$
Breakaway points $= -0.845, -3.15$
$s = -0.845$ valid breakaway point.
$k_{max} = 48$; $0 < k < 48 \Rightarrow$ absolutely stable
$k_{max} = 48 \rightarrow$ system marginally stable oscillating @ 2.82 rad/sec
$48 < k < \infty$ system unstable.

b). Row of zeroes
$A(s) = 2s^4 + 12s^2 + 16 = 0$
$$\frac{dA}{ds} = 8s^3 + 24s = 0.$$

NO sign change, so system may be stable.
But as there is a row of zero, system will be (i) marginally stable or (ii) unstable.
To examine this solve $A(s) = 0$
$2s^4 + 12s^2 + 16 = 0$
$s^4 + 6s^2 + 8 = 0$
$s = \pm j\sqrt{2}$ and $s = \pm j2$
Non repeated roots on imaginary axis.
Hence system is marginally stable.

c) Draw the diagram
Explain Delay time T_d, Rise time T_r,
Peak time T_p, Peak overshoot M_p and
settling time T_s.

Q5 a) (i) Arrange $G(s)H(s)$ in time constant form
(ii) Factors are
a) $k=4$, b) 2 poles at origin $1/s^2$
c) Simple zero $1+\frac{s}{2}$, $T_1 = 1/2$ $\omega_{c_1} = 1/T_1 = 2$ rad/sec
d) simple pole $\frac{1}{1+s/10}$, $T_2 = \frac{1}{10}$, $\omega_{c_2} = \frac{1}{T_2} = 10$ rad/sec
e) Simple pole $\frac{1}{1+s/40}$, $T_3 = 1/40$, $\omega_{c_3} = \frac{1}{T_3} = 40$ rad/sec

(iii) a) For $k=4$, $20\log k = 20\log 4 = 12$ dB
b) 2 poles at origin $1/s^2$. Straight line of slope −40dB/dec passing throug point $\omega=1$, 0 dB.
Starting slope at −40dB/dec.
c) The resultant of a & b continue till $\omega_{c_1}=2$. At $\omega_{c_1}=2$ simple zero (+20dB/dec)
Resultant $-40+20 = -20$ dB/dec. This is till $\omega_{c_2}=10$.
d) At $\omega_{c_2}=10$, simple pole (−20dB/dec)
$-20-20 = -40$ dB/dec. This is till $\omega_{c_3}=40$
e) At $\omega_{c_3}=40$, simple pole (−20dB/dec)
$-40-20 = -60$ dB/dec. This continues till $\omega \to \infty$.

(4)

Phase Angle

ω	$1/(j\omega)^2$	$+\tan^{-1}\omega/2$	$-\tan^{-1}\omega/10$	$-\tan^{-1}\omega/40$	ϕ_R
0.2	−180°	+5.7°	−1.14°	−0.28°	−175.72°
2	−180°	+45°	−11.3°	−2.86°	−149.16°
10	−180°	+78.6°	−45°	−14.03°	−160.43°
20	−180°	+84.28°	−63.43°	−26.56°	−185.71°
50	−180°	+87.7°	−78.6°	−51.3°	−222°
100	−180°	+88.85°	−84.28°	−68.19°	−243.54°
∞	−180°	+90°	−90°	−90°	−270°

Plot on semilog paper.

$\omega_{gc} = 2.1$ rad/sec

$\omega_{pc} = 6.35$ rad/sec

G.M = +21 dB ; P.M = +38°

System stable.

b) $\frac{16.8 - 5k}{4.2} > 0 \qquad 16.8 - 5k > 0$

$k < 3.36$

Range of k $0 < k < 3.36$.

c) Write 5 factors.

Q6 a) Draw diagram and explain cooking.

b) Draw block diagram and explain with working of flip flops and AND gates.

c) Draw block diagram and explain.

d) zeroes $s = -2$

poles $s = 0$; $s = -1 \pm j1$; $s = -3$; $s = -4$

Plot pole-zero

$s(s^2+2s+2)(s^2+7s+12) = 0$ (solve)