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ESE 2020 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 4

Section A : Control Systems + Microprocessors and Microcontroller

Section B : Network Theory-1

Section C : Digital Circuits-1

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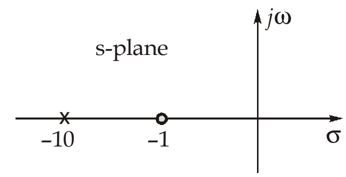
DETAILED EXPLANATIONS
Section A : Control Systems + Microprocessors and Microcontroller

1. (a)

$$C_1 = \frac{10(s+1)}{(s+10)}$$

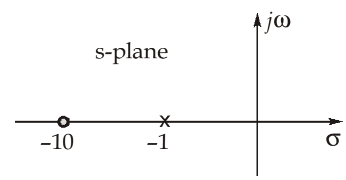
zero at s = –1
pole at s = –10



As zero is closer to origin, zero dominates pole. Hence C_1 is a lead compensator.

$$C_2 = \frac{s+10}{10(s+1)}$$

zero at s = –10
pole at s = –1



As pole is closer to origin, pole dominates zero. Hence C_2 is a lag compensator.

2. (a)

Given, $$G(s) = \frac{16}{s(s+8)}$$

Damped frequency, $$\omega_d = \omega_n\sqrt{1-\xi^2}$$

Characteristic equation, $$s^2 + 8s + 16 = 0$$

$$\therefore \quad \omega_n = 4 \text{ rad/sec}$$

$$\xi = 1$$

$$\therefore \quad \omega_d = 0$$

4. (c)

Given, $$G(s) = \frac{K(s+10)(s+20)}{s^2(s+2)}$$

characteristic equation,

$$s^2(s + 2) + K(s + 10)(s + 20) = 0$$

$$s^3 + 2s^2 + Ks^2 + 200K + 30Ks = 0$$

$$s^3 + (K + 2)s^2 + 30Ks + 200K = 0$$

For closed loop system to be stable,

$$(30K)(K + 2) > 200K$$

$$K + 2 > \frac{20}{3}$$

$$K > \frac{20}{3} - 2$$

$$\therefore \quad K > 4.67$$

6. (d)

$$\therefore \quad \frac{Y(s)}{R(s)} = \frac{\frac{3K}{2s+1}}{1+\frac{3K}{2s+1}} = \frac{3K}{2s+1+3K}$$

$$= \frac{3K}{(1+3K)\left(1+s\frac{2}{1+3K}\right)} = \frac{\frac{3K}{1+3K}}{1+s\frac{2}{1+3K}}$$

By comparing the above transfer function with $\frac{K}{1+s\tau}$ (I^{st} order transfer function), we get,

$$\tau = \frac{2}{1+3K} = 0.2$$

$$1+3K = 10$$

$$K = 3$$

7. (c)

$$t_p = \frac{\pi}{\omega_d}$$

$$5 = \frac{\pi}{\omega_d}$$

$$\therefore \quad \omega_d = \frac{\pi}{5}$$

now, first undershoot occurs at $\frac{2\pi}{\omega_d}$

$$t_{\text{undershoot}} = \frac{2\pi}{\left(\frac{\pi}{5}\right)} = 10 \text{ sec}$$

8. (c)

From the given data,

$$G(s) = \frac{K}{s(s+2)} \text{ for type-1 system}$$

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

$$2\xi\omega_n = 2 \quad \Rightarrow \quad \xi = \frac{1}{\omega_n} = \frac{1}{\sqrt{K}}$$

$$\therefore \quad K = \left(\frac{1}{\xi}\right)^2 = \frac{1}{(0.4)^2} = 6.25$$

Steady state error for $r(t) = 4tu(t)$,

$$e_{ss} = \frac{4}{K_v}$$

where, $$K_v = \lim_{s \to 0} sG(s) = \lim_{s \to 0} s\frac{6.25}{s(s+2)} = \frac{6.25}{2}$$

$\therefore$ $$e_{ss} = \frac{4}{K_v} = \frac{8}{6.25} = 1.28$$

10. (c)

Here,

Number of poles at RHS of s-plane = 1

$$N = P - Z$$

$$N = 1 - Z$$

and $$N = -1$$

$\therefore$ $$-1 = 1 - Z$$

or $$Z = 2$$

11. (a)

$$\frac{C(s)}{R(s)} = T(s) = \frac{G}{1+GH} = \frac{200}{5} = 40$$

$$\frac{\partial G}{G} = 10\% = 0.1$$

$$S_G^T = \frac{\partial T}{T} \times \frac{G}{\partial G} = \frac{1}{1+GH} = \frac{1}{5}$$

$$\frac{\partial T}{T} \times 100 = \frac{1}{5} \times 0.1 \times 100 = 2\%$$

12. (d)

Given, $$G(s) = \frac{5(1+0.25s)}{(1+0.01s)}$$

By comparing with standard equation,

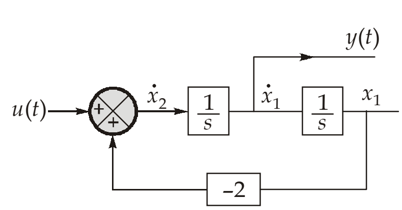
$$G(s) = \frac{\alpha(1+Ts)}{(1+\alpha Ts)}$$

We get, $T = 0.25$ and $\alpha T = 0.01$

Maximum phase compensation occurs at frequency,

$$\omega_m = \sqrt{\frac{1}{\alpha T} \times \frac{1}{T}} = \sqrt{\frac{1}{0.25} \times \frac{1}{0.01}} = \frac{1}{0.5 \times 0.1} = \frac{100}{5} = 20 \text{ rad/sec}$$

13. (c)



$$y = x_2$$
$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = u - 2x_1$$
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$$
$$[y] = \begin{bmatrix}0 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + [0]u$$

$\therefore$ $$A = \begin{bmatrix}0 & 1\\ -2 & 0\end{bmatrix}, B = \begin{bmatrix}0\\ 1\end{bmatrix} \text{ and } C = \begin{bmatrix}0 & 1\end{bmatrix}$$

For controllability, $$Q_C = \begin{bmatrix}B & AB\end{bmatrix}$$
$$Q_C = \begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix} \Rightarrow |Q_C| \neq 0$$

Hence the given system is controllable.

For observability, $$Q_O = \begin{bmatrix}C\\ CA\end{bmatrix}$$
$$Q_O = \begin{bmatrix}0 & 1\\ -2 & 0\end{bmatrix} \Rightarrow |Q_O| \neq 0$$

Hence the given system is observable.

14. (b)

There are "6" poles symmetric about the origin. So, there exists a row of zeros in the RH table which causes an auxiliary equation of order 6. Hence, s^5 row will have all zeros in the RH table.

To have row of zeros in the s^5 row,

s^8	1	–2	–25	α	24
s^7	1	4	–1	–4	0
s^6	–6	–24	$(\alpha + 4)$	24	0
s^5					

$$\frac{\alpha+4}{(-6)} = -1$$
$$\alpha + 4 = 6$$
$$\alpha = 2$$

15. (a)

Given, $$\frac{C(s)}{R(s)} = \frac{Ks+\beta}{s^2+s\alpha+\beta}$$

Open-loop transfer function, $$G(s) = \frac{Ks+\beta}{s^2+s\alpha+\beta-(Ks+\beta)}$$
$$= \frac{Ks+\beta}{s^2+(\alpha-K)s} = \frac{Ks+\beta}{s[s+(\alpha-K)]}$$

The given system is type-1 system. So, e_{ss} due to step input is zero.

16. (d)

$$\frac{C(s)}{R(s)} = \frac{KG}{1+KGH}$$

$$C(s) = \frac{KG}{1+KGH}R(s)$$

$$C(s) = \frac{1}{\left(\frac{1}{KG}+H\right)}R(s)$$

If $KG >> 1$, then
$$C(s) = \frac{R(s)}{H}$$

17. (c)

$$\frac{C(s)}{R(s)} = \frac{25}{s^2+6s+25}$$

$$\omega_n = 5 \text{ rad/sec}$$

$$2\xi\,\omega_n = 6$$

$\therefore$
$$\xi = 0.6$$

$$t_p = \frac{\pi}{\omega_d}$$

$$= \frac{\pi}{\omega_n\sqrt{1-\xi^2}} = \frac{\pi}{5\sqrt{1-(0.6)^2}} = \frac{\pi}{4} = 0.79 \text{ sec}$$

18. (c)

The given system is type 1 and order 3 system having transfer function,

$$G(s) = \frac{K}{s(s+2)(s+3)}$$

$$[G(j\omega)]_{\omega=0} = \infty\angle -90°$$

$$[G(j\omega)]_{\omega=\infty} = 0\angle -270°$$

Thus, option (c) is the correct choice.

19. (b)

When a zero is added to the system in LHS of s-plane,

- Root locus shifts away from $j\omega$-axis.
- Damping improves, hence less oscillatory.
- Relative stability increases.
- Range of K for stable operation increases.

20. (c)

Since, the system is of minimum phase system, it has no poles or zeros in the right hand side of s-plane.

There are four corner frequencies for the transfer function $G(s)$.

(i) Two poles at ω_1 = 5 rad/sec as slope changes by –40 dB/dec.

(ii) Two zeros at ω_2 = 20 rad/sec as slope changes by +40 dB/dec.

(iii) Two poles at ω_3 = 40 rad/sec as slope changes by –40 dB/dec.

(iv) A pole at ω_4 = 100 rad/sec as slope changes here by –20 dB/dec.

Therefore open loop transfer function in time constant form;

$$G(s) = \frac{K\left(1+\frac{s}{20}\right)^2}{\left(1+\frac{s}{5}\right)^2\left(1+\frac{s}{40}\right)^2\left(1+\frac{s}{100}\right)}$$

$\because$ Initial slope = 0 dB

then, $20 \log K = 40$ dB

or $K = 100$

Now open loop transfer function,

$$G(s) = \frac{100\times 25\times 40^2\times 100(s+20)^2}{20^2(s+5)^2(s+40)^2(s+100)} = \frac{10^6(s+20)^2}{(s+5)^2(s+40)^2(s+100)}$$

21. (a)

Using Routh's array, we get,

s^4	1	15	K
s^3	25	20	0
s^2	$\frac{355}{25}$	K	0
s^1	$\frac{284-25K}{355/25}$	0	0
s^0	K	0	0

For the system to be marginally stable

$$\frac{284-25K}{355/25} = 0$$

or, $25K = 284$

or, $K = \frac{284}{25} = 11.36$

22. (b)

Point $s = (-1 + j)$ lie on the root locus, therefore the magnitude condition is

$$\left|\frac{K}{(-1+j)\left((-1+j)^2+7(-1+j)+12\right)}\right| = 1$$

or,
$$\begin{aligned} K &= \left|(-1+j)\left((-1+j)^2-7+7j+12\right)\right| \\ &= \left|(-1+j)[-1-2j+1-7+7j+12]\right| \\ &= \left|(-1+j)(5+5j)\right| = |-5+5j-5j-5| \\ K &= |-10| = 10 \end{aligned}$$

23. (c)

$$M_r = \frac{1}{2\xi\sqrt{1-\xi^2}} = \frac{1}{2\times\frac{1}{\sqrt{2}}\times\sqrt{1-\frac{1}{2}}} = \frac{1}{2\times\frac{1}{\sqrt{2}}\times\frac{1}{\sqrt{2}}} = 1$$

24. (a)

From figure (B), the closed loop transfer function,

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

From figure (A),
$$\frac{C(s)}{R(s)} = \frac{(s+4)}{(s+3)}$$

On equating both, we get,
$$\begin{aligned} \frac{G}{s+3}+1 &= \frac{s+4}{s+3} \\ \frac{G+s+3}{s+3} &= \frac{s+4}{s+3} \\ G+s+3 &= s+4 \\ G &= 1 \end{aligned}$$

26. (d)

Forward paths:
$$P_1 = 2\times 3\times 4 = 24$$
$$P_2 = 8$$

Loops:
$$L_1 = -1,\ L_2 = -1,\ L_3 = -24,\ L_4 = -24,$$

Non touching loops:
$$L_1L_2 = 1 \text{ and } L_1L_3 = 24$$
$$\Delta_1 = 1$$
$$\Delta_2 = 1-(L_1+L_2)+L_1L_2 = 1+2+1 = 4$$

$\therefore$
$$\begin{aligned} \frac{C(s)}{R(s)} &= \frac{P_1\Delta_1+P_2\Delta_2}{1-[L_1+L_2+L_3+L_4]+[L_1L_2+L_1L_3]} \\ &= \frac{24\times1+8\times4}{1+1+1+24+24+1+24} = \frac{24+32}{76} = \frac{56}{76} = \frac{14}{19} \end{aligned}$$

27. (d)

$$\text{Vector location of ISR} = 003CH = (3 \times 16 + 12)_{10} = (60)_{10}$$

$$\frac{60}{8} = 7.5$$

So, the interrupt is RST 7.5.

29. (c)

	MVI C, 10H	; (7 T × 1 time)	⇒ 7 T
LOOP:	NOP	; (4 T × 16 times)	⇒ 64 T
	DCR C	; (4 T × 16 times)	⇒ 64 T
	JNZ LOOP	; (10 T × 15 times + 7 T)	⇒ 157 T
	NOP	; (4 T × 1 time)	⇒ 4 T

Total number of T-states required = 7 + 64 + 64 + 157 + 4 = 296

30. (a)

XTHL exchanges the contents of HL pair and stack top two locations.
Number of machine cycles = 5 (F, R, R, W, W)

$$\text{Number of T-states} = 4 + (4 \times 3) = 16$$

$$\text{Execution time} = \frac{16}{f_{\text{clk}}} = \frac{16}{2} = 8\ \mu s$$

31. (a)

PUSH D, POP H require the access of stack memory.
SPHL loads the stack pointer (SP) with the contents of HL pair. SP is a 16-bit register present inside the microprocessor. So, it is not required to access the stack memory (which is external to the microprocessor) to update the contents of SP.

32. (d)

2000H :	MVI B, 4FH	⇒ 2 Bytes (2000H, 2001H)
2002H :	MVI A, 78H	⇒ 2 Bytes (2002H, 2003H)
2004H :	SUB B	⇒ 1 Bytes (2004H)
2005H :	ANI 0FH	⇒ 2 Bytes (2005H, 2006H)
2007H :	STA 2020 H	⇒ 3 Bytes (2007H, 2008H, 2009H)
200AH :	HLT	⇒ 1 Byte (200AH)

34. (a)

A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	Port	
1	0	0	0	1	1	0	0	*A*	8CH
1	0	0	0	1	1	0	1	*B*	8DH
1	0	0	0	1	1	1	0	*C*	8EH
1	0	0	0	1	1	1	1	Control register	8FH

35. (d)

STAX and LDAX must be used with either BC or DE pairs only but not with HL pair.
So, instruction given in option (d) is invalid.

36. (d)

MVI A, 69H	;	A = 69H
ANI F0H	;	A = 60H
RRC	;	
RRC	;	
RRC	;	
RRC	;	A = 06H = 0000 0110
CMA	;	A = 1111 1001 = F9H

37. (b)

MUL AH; (AX) ← (AL) × (AH)

39. (a)

During external memory access,

- Port 0 acts as a multiplexed lower order address/data bus.
- Port 2 acts as a higher order address bus.

40. (c)

There are 4 independent channels in 8237 DMA controller.

41. (d)

Gain margin alone is inadequate to indicate relative stability when system parameters other than the loop gain are subject to variation. Due to variation in some parameters, phase shift of the system can vary which may results instability. Hence, we must also consider the concept of phase margin for determining the relative stability of the system.

42. (c)

The transient response in a closed loop system decays more quickly than in open loop system.

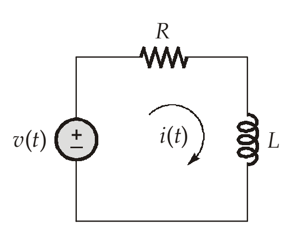
45. (d)

In an 8085 microprocessor, PUSH operation requires more clock cycles than POP operation.

Section B : Network Theory-1

46. (c)

For series RL circuit,



Using KVL, $$v(t) = R\,i(t) + L\frac{di(t)}{dt}$$

$\therefore$ $$6e^{-2t} = L\frac{d}{dt}(6e^{-2t} - 6e^{-3t}) + R(6e^{-2t} - 6e^{-3t})$$

$$6e^{-2t} = -12e^{-2t} + 18e^{-3t} + R(6e^{-2t} - 6e^{-3t})$$

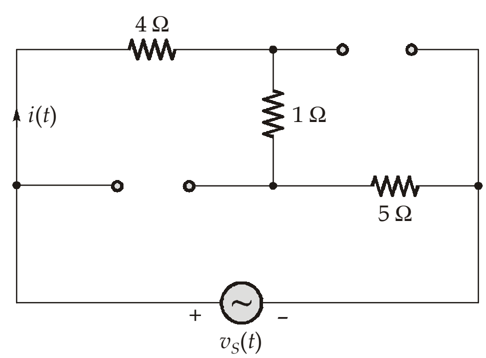
$$(18e^{-2t} - 18e^{-3t}) = R(6e^{-2t} - 6e^{-3t})$$
$$18(e^{-2t} - e^{-3t}) = 6R(e^{-2t} - e^{-3t})$$
or $$R = 3\ \Omega$$

47. (c)

$$\frac{1}{\sqrt{L_1C_1}} = \frac{1}{\sqrt{250\times4\times10^{-9}}} = 1000 \text{ rad/sec}$$
$$\frac{1}{\sqrt{L_2C_2}} = \frac{1}{\sqrt{2\times500\times10^{-9}}} = 1000 \text{ rad/sec}$$

The supply voltage is also oscillating at 1000 rad/sec.

So, both the parallel combinations of L and C act as open circuits, and the steady-state equivalent circuit can be drawn as,



$$i(t) = \frac{v_s(t)}{4\ \Omega+1\ \Omega+5\ \Omega} = \frac{20\cos(1000t)}{10} = 2\cos(1000t)\text{ A}$$

So, the average power absorbed by the 4 Ω resistor will be,

$$P_{4\Omega} = \frac{(2)^2}{2}\times4 = 8\text{ W}$$

48. (b)

For an ideal transformer, $K = 1$

applying KVL in the primary and secondary loops, we get,

$$V_1 = (j\omega L_1)I_1 + j\omega MI_2$$
$$V_2 = (j\omega L_2)I_2 + j\omega MI_1$$

($\because$ I_1 and I_2 both enters through the dots)

$$\frac{V_1}{V_2} = \frac{L_1I_1+MI_2}{L_2I_2+MI_1}$$

$\because$ $$K = 1$$

$\therefore$ $$M = \sqrt{L_1L_2}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{L_1}{L_2}}\left[\frac{\sqrt{L_1}\cdot I_1+\sqrt{L_2}I_2}{\sqrt{L_1}I_1+\sqrt{L_2}I_2}\right] = \sqrt{\frac{L_1}{L_2}}$$

49. (d)

The input impedance of the given circuit is given by,

$$Z_{in} = 3 + \frac{j2 \times 2}{(2 + j2)} = 3 + \frac{j4}{(2 + j2)}$$

$$= 3 + \frac{j4(2 - j2)}{8}$$

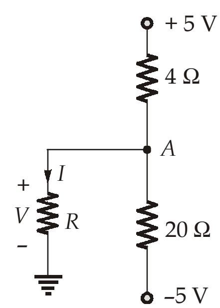
$$= 3 + j + 1 = (4 + j)$$

The input current will be in phase with the supply voltage provided the reactive part of the impedance does not exist. So, for the required series capacitor,

$$\frac{j}{\omega C} = j \Rightarrow \omega C = 1$$

$$C = \frac{1}{2\pi f} = \frac{1}{100\pi} = \frac{10}{\pi}\text{mF} \simeq 3.18\text{ mF}$$

50. (b)



$\because \; I = \frac{1}{4}\text{A} \quad \therefore \; V = I \times R = R/4\text{ V}$

At Node 'A' by using KCL, we get,

$$\frac{5 - V}{4} + \frac{-V - 5}{20} = I$$

$$\Rightarrow \quad \frac{5 - R/4}{4} + \frac{-R/4 - 5}{20} = \frac{1}{4}$$

$$25 - \frac{5R}{4} - \frac{R}{4} - 5 = 5$$

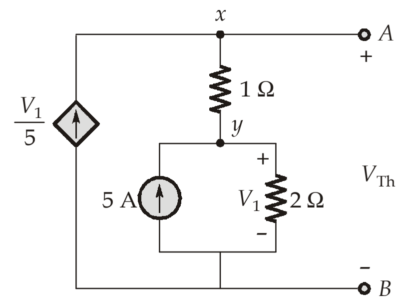
$$20 - \frac{6R}{4} = 5$$

$$\frac{6R}{4} = 15$$

$$R = 10\ \Omega$$

51. (c)

In order to obtain Thevenin's voltage let us redraw the circuit with nodes x and y.



at node 'x' $\quad \dfrac{V_1}{5} = \dfrac{V_{Th} - V_1}{1}$

or $\quad V_1 = 5\,V_{Th} - 5\,V_1$

or $\quad V_{Th} = \dfrac{6}{5}V_1$ ...(i)

at node 'y' $\quad 5 = \dfrac{V_1 - V_{Th}}{1} + \dfrac{V_1}{2}$

$$10 = 2V_1 - 2V_{Th} + V_1$$

$$10 = 3V_1 - 2V_{Th}$$

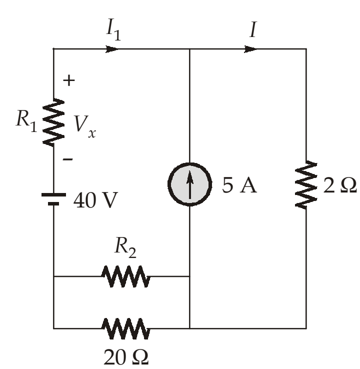
$$10 = 3\times\frac{5}{6}V_{Th} - 2V_{Th}$$

$$20 = (5 - 4)V_{Th}$$

or $\quad V_{Th} = 20\text{ V}$

53. (a)

The circuit can be redrawn as



$\because \quad V_x = -5\text{ V}$

$\therefore \quad I_1 = \dfrac{-V_x}{R_1} = \dfrac{5}{R_1}\text{A}$

also $\quad I_1 + 5 = I = 10\text{ A}$

or $\quad I_1 = -5 + 10 = 5\text{ A}$ ...(i)

$$\Rightarrow \qquad R_1 = \frac{5}{5} = 1\,\Omega$$

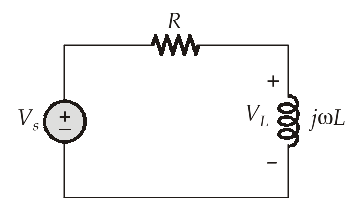
By applying KVL, we get,

$$40 = -V_x + 2(I_1 + 5) + (20 \,||\, R_2)I_1$$
$$40 = 5 + 2(10) + (20 \,||\, R_2)I_1$$
$$40 - 25 = \frac{20 \times R_2}{20 + R_2} \times I_1$$
$$15 = \frac{20 \times R_2}{20 + R_2} \times I_1$$

From equation (i), by using the value of I_1, we get,

$$R_2 = \frac{20 \times 3}{17} = \frac{60}{17} \simeq 3.53\,\Omega$$

54. (a)



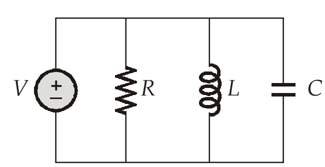
Here,
$$V_L = \left(\frac{j\omega L}{R + j\omega L}\right)V_s$$
$$= \frac{V_s \omega L \angle 90°}{\sqrt{R^2 + \omega^2 L^2} \angle \tan^{-1}\dfrac{\omega L}{R}}$$

$$\therefore \qquad \phi = 90° - \tan^{-1}\frac{\omega L}{R}$$

Thus, when R increases, $\tan^{-1}\left(\dfrac{\omega L}{R}\right)$ decreases and hence ϕ increases.

55. (d)

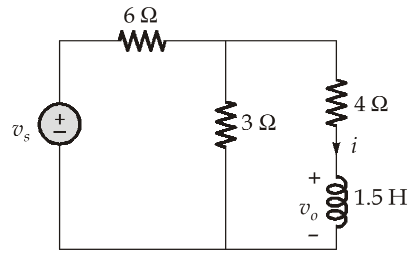
As per the question,



$$Q = R\sqrt{\frac{C}{L}} = \frac{1}{2\xi}$$
$$\xi = \frac{1}{2R}\sqrt{\frac{L}{C}} = \frac{1}{2 \times 100}\sqrt{\frac{0.8}{20 \times 10^{-6}}}$$
$$= \frac{1}{200}\sqrt{\frac{8}{2 \times 10^{-4}}} = \frac{1}{2}\sqrt{\frac{8}{2}} = 1$$

$\therefore$ Critically damped response.

56. (c)



For $t < 0$, $V_s = 0,\ i(0) = 0$

For $t > 0$ $R_{eq} = (6 \,||\, 3) + 4 = 2 + 4 = 6\ \Omega$

$$L_{eq} = 1.5\text{ H}$$

$$\tau = \frac{L_{eq}}{R_{eq}} = 0.25\text{ sec} \Rightarrow \frac{1}{\tau} = 4\text{ sec}^{-1}$$

$$v_o(t) = v_o(0^+)e^{-t/\tau}u(t)$$

$v_o(0^+)$ = voltage across inductor at $t = 0^+$ (when inductor is open circuited)

$$v_o(0^+) = \frac{3\ \Omega}{3\ \Omega + 6\ \Omega} \times 1\text{ V} = \frac{1}{3}\text{ V}$$

So, $v_o(t) = \frac{1}{3}e^{-4t}u(t)$ V

57. (b)

Here, $T = 2$ and $v(t) = \begin{cases} 4; & 0 < t < 1 \\ 8; & 1 < t < 2 \end{cases}$

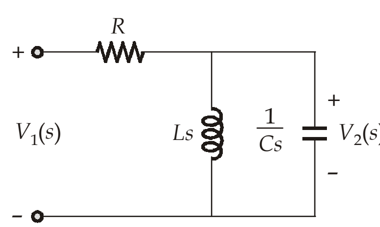
$$V_{\text{rms}}^2 = \frac{1}{2}\left[\int_0^1 4^2\,dt + \int_1^2 8^2\,dt\right]$$

$$= \frac{1}{2}[16 + 64] = \frac{80}{2} = 40$$

$$V_{\text{rms}} = \sqrt{40} = 2\sqrt{10}\text{ V} = 2 \times 3.162 = 6.325\text{ V}$$

58. (b)

From the given circuit,



$$sL \,||\, \frac{1}{sC} = \frac{sL}{1 + s^2LC}$$

$$\frac{V_2(s)}{V_1(s)} = \frac{\dfrac{sL}{1+s^2LC}}{R+\dfrac{sL}{1+s^2LC}} = \frac{sL}{s^2RLC+sL+R}$$

$$= \frac{s\cdot\dfrac{1}{RC}}{s^2+s\cdot\dfrac{1}{RC}+\dfrac{1}{LC}}$$

Comparing this with the given transfer function,

$$\frac{1}{RC} = 4$$

$$\frac{1}{LC} = 8$$

For $R = 1\ \text{k}\Omega$

$$C = \frac{1}{4}\text{mF} = 0.25\ \text{mF} = 250\ \mu\text{F}$$

and $LC = \dfrac{1}{8}$

$$L = \frac{1}{8\times 250\times 10^{-6}} = 500\ \text{H}$$

60. (d)

A capacitor has one pole at $s = 0$ and driving point impedance is $Z(s) = \dfrac{1}{sC}$

Section C : Digital Circuits-1

61. (b)

$$\overline{f(A,B,C)} = \bar{A}\bar{B}C+\bar{A}BC+A\bar{B}\bar{C}+AB\bar{C}$$

$$= \bar{A}C(\bar{B}+B)+A\bar{C}(\bar{B}+B)$$

$$= \bar{A}C+A\bar{C} = A\oplus C$$

$$f(A,B,C) = \overline{A\oplus C} = A\odot C$$

62. (b)

$$Z = x\oplus[y\oplus xy] = x\oplus\left[y\overline{xy}+\bar{y}xy\right]$$

$$= x\oplus\left[y(\bar{x}+\bar{y})+0\right] = x\oplus\left[y\bar{x}+0\right]$$

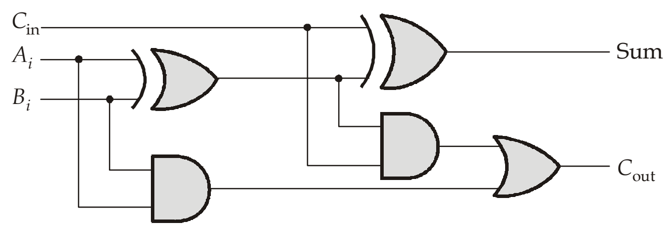
$$= x(\bar{y}+x)+\bar{x}y\bar{x} = x+\bar{x}y = x+y$$

63. (c)

Required number of 2 to 4 decoders $= \left[\dfrac{256}{4}\right]+\left[\dfrac{64}{4}\right]+\left[\dfrac{16}{4}\right]+\left[\dfrac{4}{4}\right] = 64 + 16 + 4 + 1 = 85$

64. (b)

In a full adder circuit, as shown in the following figure, the input carry has to propogate through 2 gates to produce output carry.



An n-bit ripple carry adder consists n-full adders. So, the carry has to propagate through $2n$ gates. In the given question, for a 6-bit binary ripple carry adder, input carry has to propagate through 12 gates.

65. (b)

$$Y = \bar{C}(A\bar{C} + BC) + C(B\bar{C} + AC)$$
$$= A\bar{C} + AC = A$$

66. (d)

$$(199)_{12} = 12^2 + 9 \times 12 + 9 = (261)_{10}$$
$$(199)_{11} = 11^2 + 9 \times 11 + 9 = (229)_{10}$$
$$(199)_{12} + (199)_{11} = (490)_{10}$$

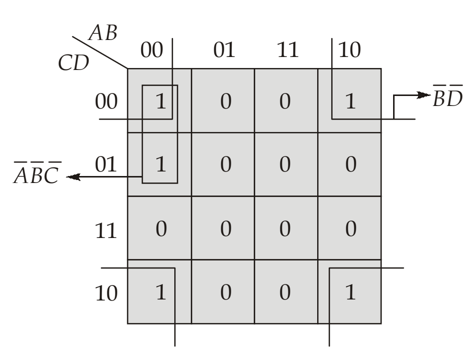
$$\begin{array}{r|l}
5 & 490 \\ \hline
5 & 98 - 0 \\ \hline
5 & 19 - 3 \\ \hline
 & 3 - 4
\end{array}
\quad
\begin{array}{c}
0 \\ 3 \\ 4 \\ 3
\end{array}
\quad
\begin{array}{l}
\text{(LSB)} \\ \\ \\ \text{(MSB)}
\end{array}$$

$\therefore$ $(490)_{10} = (3430)_5$

67. (c)

$$f = A\left\{B + C\left(\overline{AB + AC}\right)\right\} = AB + AC(\overline{AB} \cdot \overline{AC}) = AB$$

68. (c)



$$f = \bar{A}\bar{B}\bar{C} + \bar{B}\bar{D} = \bar{B}(\bar{A}\bar{C} + \bar{D})$$

70. (c)

$$\bar{f} = \overline{(AB + \bar{B}C + AC)A}$$

$$= \overline{(AB + \bar{B}C + AC)} + \bar{A}$$

$$= (\overline{AB})(\overline{\bar{B}C})(\overline{AC}) + \bar{A}$$

$$= (\bar{A} + \bar{B})(B + \bar{C})(\bar{A} + \bar{C}) + \bar{A}$$

$$= (\bar{A}B + \bar{A}\bar{C} + \bar{B}\bar{C})(\bar{A} + \bar{C}) + \bar{A}$$

$$= \bar{A}B + \bar{A}B\bar{C} + \bar{A}\bar{C} + \bar{A}\bar{B}\bar{C} + \bar{B}\bar{C} + \bar{A}$$

$$= \bar{A}(B + B\bar{C} + \bar{C} + \bar{B}\bar{C} + 1) + \bar{B}\bar{C} = \bar{A} + \bar{B}\bar{C}$$

72. (a)

$$f = \overline{AB} + \bar{A}\bar{C}\bar{D} + \bar{A}\bar{B}D + \overline{AB}C\bar{D}$$

$$= \bar{A} + \bar{B} + \bar{A}\bar{C}\bar{D} + \bar{A}\bar{B}D + (\bar{A} + \bar{B})C\bar{D}$$

$$= \bar{A} + \bar{B} + \bar{A}\bar{C}\bar{D} + \bar{A}\bar{B}D + \bar{A}C\bar{D} + \bar{B}C\bar{D}$$

$$= \bar{A}(1 + \bar{C}\bar{D} + \bar{B}D + C\bar{D}) + \bar{B}(1 + C\bar{D})$$

$$= \bar{A} + \bar{B} \quad \Rightarrow \quad \text{Two literals}$$

73. (c)

The expression can be written as

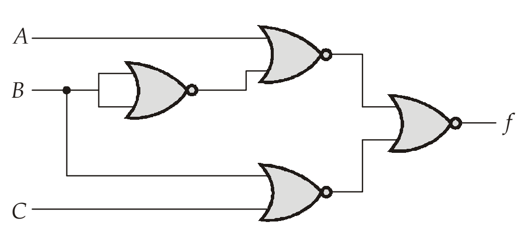
A \ BC	00	01	11	10
0	0	1	0	0
1	0	1	1	1

$(A + \bar{B})$

$(B + C)$

$$f = (A + \bar{B})(B + C)$$

Thus, the circuit can be drawn as



So, minimum 4 NOR gates are required.

❍❍❍❍