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TEST SERIES

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ESE-2017 : Prelims Exam

UPSC Engineering Services Examination

E & T ENGINEERING

Answer Key & Solutions

Test 22: Mock Test Technical

Engineering Discipline

1. (c)
2. (d)
3. (c)
4. (b)
5. (d)
6. (d)
7. (b)
8. (c)
9. (d)
10. (d)
11. (a)
12. (a)
13. (a)
14. (b)
15. (b)
16. (b)
17. (c)
18. (d)
19. (c)
20. (d)
21. (c)
22. (d)
23. (b)
24. (b)
25. (b)
26. (d)
27. (d)
28. (c)
29. (c)
30. (c)
31. (d)
32. (c)
33. (d)
34. (b)
35. (c)
36. (c)
37. (b)
38. (d)
39. (b)
40. (c)
41. (b)
42. (b)
43. (d)
44. (a)
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46. (d)
47. (a)
48. (b)
49. (c)
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58. (d)
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61. (a)
62. (d)
63. (c)
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67. (d)
68. (b)
69. (d)
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71. (c)
72. (c)
73. (c)
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83. (d)
84. (c)
85. (c)
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90. (b)
91. (c)
92. (a)
93. (b)
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97. (c)
98. (c)
99. (c)
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101. (d)
102. (b)
103. (a)
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110. (c)
111. (c)
112. (c)
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115. (a)
116. (b)
117. (c)
118. (a)
119. (a)
120. (c)
121. (c)
122. (c)
123. (d)
124. (d)
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143. (c)
144. (a)
145. (b)
146. (b)
147. (d)
148. (a)
149. (a)
150. (a)

DETAILED EXPLANATIONS

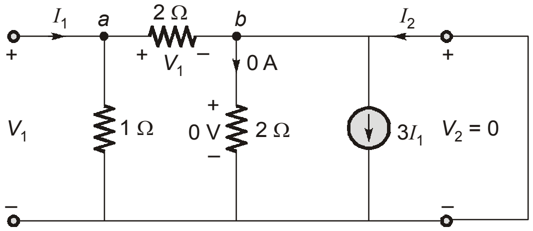
1. (c)

$$\begin{aligned} \text{Power} &= I_{\text{rms}}^2 R \\ &= \left(\sqrt{(2)^2 + \left(\frac{6}{\sqrt{2}}\right)^2}\right)^2 \times 1 = \left(\sqrt{4+18}\right)^2 \\ &= 22 \text{ W} \end{aligned}$$

2. (d)

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

When $V_2 = 0$,



$$I_1 = \frac{V_1}{1\,\Omega} + \frac{V_1}{2\,\Omega} = \frac{3}{2\,\Omega}V_1$$

$$I_2 = 3I_1 - \frac{V_1}{2\,\Omega} = 3\left[\frac{3}{2\,\Omega}V_1\right] - \frac{V_1}{2\,\Omega} = \frac{8}{2\,\Omega}V_1$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = 4\ \mho$$

3. (c)

The average value of the waveform,

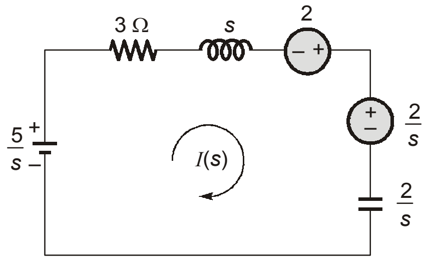
$$\begin{aligned} f_{\text{avg}} &= \frac{1}{T}\int_{-T/2}^{T/2} f(t)\,dt \\ &= \frac{1}{T}(\text{area under } f(t) \text{ for one period}) \\ &= \frac{1}{10}\left[(4\times 2) + \left(2\times\frac{1}{2}\times 2\times 2\right)\right] \\ &= \frac{12}{10} = 1.2 \end{aligned}$$

4. (b)

At $t = 0$; switch is closed

for $t > 0$, the circuit in s-domain becomes

Applying KVL, we get



$$\frac{5}{s}-\frac{2}{s}+2 = \left(3+s+\frac{2}{s}\right)I(s)$$

$$I(s) = \frac{2s+3}{(s+1)(s+2)}$$

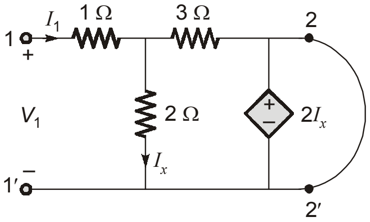
Using partial fractions, $$I(s) = \frac{1}{(s+1)}+\frac{1}{(s+2)}$$

or $$i(t) = L^{-1}[I(s)] = (e^{-t}+e^{-2t})\ \text{A}; \quad \text{for } t>0$$

5. (d)

To obtain the short circuit parameters short circuit is applied at the output port. Under this condition

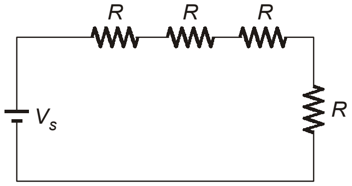
$\therefore\ 2I_x = 0 \Rightarrow I_x = 0$



However, I_x should be a finite quantity as V_1, the voltage applied at the input port is a non zero quantity. This apparent paradox indicates that the solution of the network through Y-parameter concept is not possible.

6. (d)

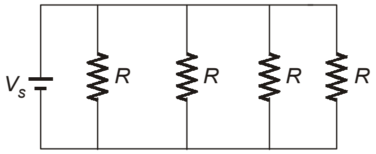
When connected in series:



$$P = \frac{V_s^2}{4R} = 25\text{ W}$$

$$\Rightarrow \quad \frac{V_s^2}{R} = 100\text{ W} \qquad \text{...(i)}$$

When connected in parallel:

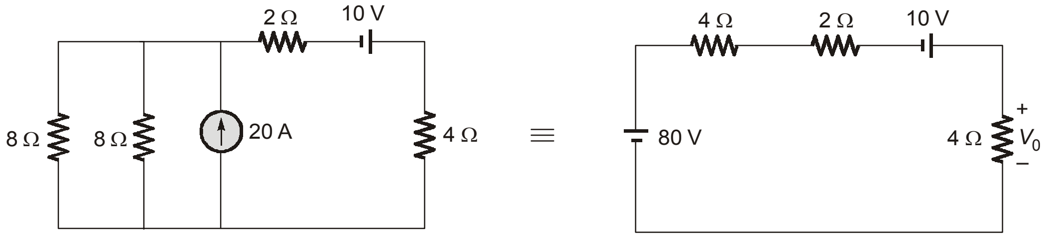


$$P = \frac{V_s^2}{(R/4)} = 4\left(\frac{V_s^2}{R}\right)$$

$$= 4(100)\text{ W}$$

$$= 400\text{ W}$$

7. (b)



Using voltage division rule,

$$V_0 = \left(\frac{4}{4+4+2}\right)\times(80+10)\text{ V} = \frac{4}{10}\times 90\text{ V} = 36\text{ V}$$

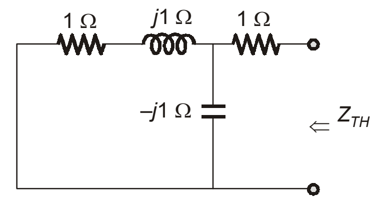
8. (c)

Fundamental cutset consists only one tree branch.

9. (d)

For maximum power transfer

$$Z_L = Z^*_{Th}$$



$$Z_{Th} = (1 + j) \,||\, (-j) + 1\ \Omega$$

$$= \frac{(1+j)(-j)}{1} + 1\,\Omega = -j + 1 + 1$$

$$= (2 - j)\ \Omega$$

$$Z_L = Z^*_{Th} = (2 + j)\ \Omega$$

10. (d)

Super position theorem is applicable to linear networks which comprises independent sources, linear dependent source and linear passive elements.

11. (a)

h-parameters :

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

ABCD parameters:

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

Here we can conclude,

(a) h_{12} and h_{21} are dimensionless.

(b) h_{11} and B have dimensions of Ω.

(c) BC is dimensionless.

(d) C has dimensions of $\mho$.

12. (a)

The closed loop transfer function,

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

$$T(s) = \frac{16}{s^2+4.8s+16}$$

By comparing with standard transfer function,

$$\omega_n = \sqrt{16} = 4 \text{ rad/sec}$$

$$2\xi\omega_n = 4.8 \text{ rad/sec}$$

or $$\xi = \frac{4.8}{2\times 4} = 0.6$$

∴ damping frequency, $$\omega_d = \omega_n\sqrt{1-\xi^2} = 4\sqrt{1-(0.6)^2} \text{ rad/sec}$$

$$= 4\sqrt{0.64} = 4\times 0.8 \text{ rad/sec}$$

$$= 3.2 \text{ rad/sec}$$

13. (a)

The lead compensator is analogous to high pass filter, thus option (a) is the correct choice.

14. (b)

From given block diagram, we have

$$\text{OLTF} = G(s) = \frac{D(s)}{s(s+1)}$$

Given, $$D(s) = K$$

and $$K_V = 12$$

Now, $$K_V = \lim_{s\to 0}\{sG(s)\} = \lim_{s\to 0}\left\{\frac{sK}{s(s+1)}\right\} = 12$$

or, $$\frac{K}{1} = 12$$

or, $$K = 12$$

15. (b)

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

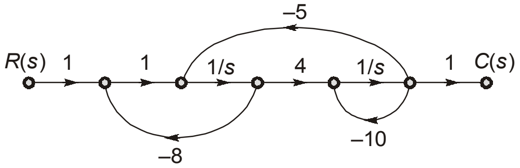
$$\frac{(s+1)}{(s+2)} = \frac{1}{(s+2)}+G$$

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

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

16. (b)

The signal flow graph of the system given is



$$\text{The forward path gain} = 4/s^2$$

$$\text{Feedback loops} = -\frac{8}{s}, -\frac{10}{s}, -\frac{20}{s^2}$$

$$\text{Non touching loops} = -\frac{8}{s}\times-\frac{10}{s} = \frac{80}{s^2}$$

$$\therefore \quad \frac{C(s)}{R(s)} = \frac{4/s^2}{1-\left(-\frac{8}{s}-\frac{10}{s}-\frac{20}{s^2}\right)+\frac{80}{s^2}} = \frac{4/s^2}{1+\left(\frac{18s+20}{s^2}\right)+\frac{80}{s^2}}$$

$$= \frac{4}{s^2+18s+100}$$

17. (c)

- The Routh stability criterion ascertains absolute stability of system by determining if all the roots of the characteristic equation lie in the left half of s-plane or not.
- Relative stability is concerned with the attributes of transient behavior of the system.
- Absolute stability is concerned with the roots of the characteristic equation lying in the left half of s-plane.
- Stability margin (gain margin, phase margin) are commonly used as frequency domain measures of relative stability.

18. (d)

The closed loop transfer function

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)} = \frac{100}{s^2+100(s+1)}$$

$$\frac{C(s)}{R(s)} = \frac{100}{s^2+100s+100}$$

For unit step input, the output $C(s) = \frac{100}{s^2+100s+100}\times\frac{1}{s}$

$\therefore$ Steady state value of $c(t)$

$$c(\infty) = \lim_{s\to 0} s\cdot C(s)$$

$$= \lim_{s\to 0}\frac{s}{s}\times\frac{100}{s^2+100s+100}$$

$$= \frac{100}{100} = 1$$

19. (c)

$$L(s) = \frac{K}{s}$$

$$L(j\omega) = \frac{K}{j\omega}$$

$$\phi(\omega) = -90^\circ$$

$$\phi(\omega_{gc}) = -90^\circ$$

$$\text{PM} = 180^\circ + \phi(\omega_{gc}) = 180^\circ - 90^\circ$$

$$= 90^\circ$$

20. (d)

For minimum phase transfer function any of the zeros or poles should not lie on right side of s-plane. For non minimum T.F. at least one zero lie on RHS and all poles lie on LHS.

21. (c)

By comparing the given transfer function with standard second order system,

we get, $\omega_n^2 = 4 \quad \Rightarrow \omega_n = 2 \text{ rad/sec}$

and $2\xi\omega_n = 2.4 \quad \Rightarrow \xi = \frac{2.4}{2\times 2} = 0.6$

The peak time $t_p = \frac{n\pi}{\omega_d}$ where $n = 1, 2, 3, 4$ .....

for first undershoot $n = 2$

$$\Rightarrow \quad t_p = \frac{2\pi}{\omega_n\sqrt{1-\xi^2}} = \frac{2\pi}{2\sqrt{1-(0.6)^2}}$$

$$= \frac{\pi}{0.8} = 1.25\,\pi \text{sec}$$

22. (d)

The steady state error for ramp input

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

where, $A = \text{Gain} = 1$

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

$$= \lim_{s\to 0}\frac{s\cdot K}{s(s+a)} = \frac{K}{a}$$

$$\therefore \quad e_{ss} = \frac{a}{K} \qquad \text{...(i)}$$

The sensitivity of e_{ss} to changes in parameter 'K' is

$$S_K^{e_{ss}} = \frac{\partial e_{ss}}{\partial K}\times\frac{K}{e_{ss}}$$

$$= \frac{K}{a/K}\times\frac{-a}{K^2} = -1$$

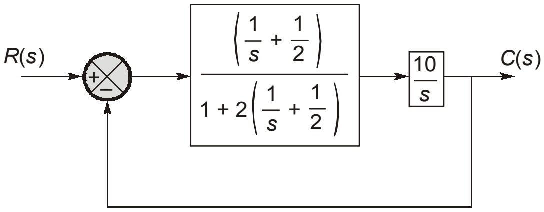
The sensitivity of e_{ss} to changes in parameter 'a'.

$$S_a^{e_{ss}} = \frac{\partial e_{ss}}{\partial a} \times \frac{a}{e_{ss}}$$

$$= \frac{1}{K} \times \frac{a}{a/K} = 1$$

23. (b)

Reducing the block diagram



$$G(s) = \frac{2+s}{2s+2(2+s)} \times \frac{10}{s} = \frac{10(s+2)}{s[(2s+4)+2s]} = \frac{10(s+2)}{s(4s+4)}$$

$$H(s) = 1$$

The loop transfer function $= G(s)H(s)$

$$= \frac{10(s+2)}{4s(s+1)}$$

∴ Type-1 system.

24. (b)

By observing the signal flow graph

$$\dot{x}_1 = x_2 \quad \text{...(i)}$$

$$\dot{x}_2 = -\frac{21}{4}x_2 - 5x_1 + u \quad \text{...(ii)}$$

and $y = 5x_1 + 4x_2$

∴ The state model

$$[\dot{x}] = \begin{bmatrix} 0 & 1 \\ -5 & -\frac{21}{4} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad \text{...(iii)}$$

$$y = [5 \quad 4] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad \text{...(iv)}$$

from equation (iii), the state matrix $A = \begin{bmatrix} 0 & 1 \\ -5 & -\frac{21}{4} \end{bmatrix}$

25. (b)

Ferromagnetic material	T_C
Fe	1043 K
Co	1404 K
Ni	631K
Gd	289 K

26. (d)

The susceptibility of a paramagnetic material varies inversely with the temperature.

i.e,
$$\chi_{para} = \frac{C}{T} \quad \text{Curie Law}$$

Given
$$\chi_{para} = 3.7 \times 10^{-3}$$
$$T = 300\text{ K}$$

∴
$$C = \chi_{para} \times T$$
$$= 3.7 \times 10^{-3} \times 300\text{ K}$$
$$C = 1.11\text{ K}$$

32. (c)

Orientational polarization is given by Debye's Law.

$$P = \frac{N\mu^2 E}{3kT}$$

37. (b)

Let us assume that the MOSFET is biased in saturation region.

Then the DC drain current is

$$I_D = k_N(V_{gs} - V_{TN})^2 = k_N(0 - V_{TN})^2$$

∵ In a depletion mode MOSFET, the device is normally ON at a zero gate-source voltage.

$$I_D = (0.1)\,(-(-2))^2 = 0.4\text{ mA}$$

The DC drain to source voltage is

$$V_{DS} = V_{DD} - I_D \cdot R_s$$
$$= 5 - 0.4 \times 10^{-3} \times 5 \times 10^3$$
$$V_{DS} = 3\text{ V}$$

Then, $V_{DS\,(sat)} = V_{gs} - V_{TN} = 0 - (-2) = 2\text{ V}$

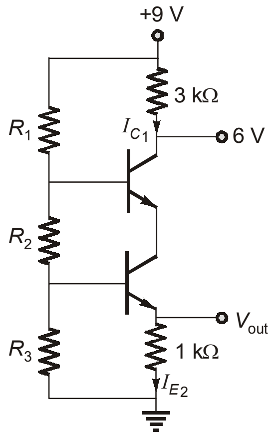
Since $V_{DS} > V_{DS\,(sat)}$, the MOSFET is biased in the saturation region.

40. (c)

The current gain of the transistor

$$\alpha = \frac{\Delta I_C}{\Delta I_E} = \frac{0.95 \times 10^{-3}}{0.96 \times 10^{-3}} = 0.989$$

42. (b)



$\because$ $\beta >> 1$, thus $I_B = 0$

$$I_{C_1} = \frac{9-6}{3}\text{ mA} = 1\text{ mA}$$

$\because$ $I_{B_1} = I_{B_2} = 0$

thus $I_{E_2} = I_{C_1} = 1\text{ mA}$

$\therefore$ $V_0 = 1\text{ k}\Omega \times 1\text{ mA}$

$$= 1 \times 10^3 \times 1 \times 10^{-3}$$

$$= 1\text{ V}$$

43. (d)

- PROM contains a fixed AND-array and a programmable OR-array.
- PAL contains a programmable AND-array and a fixed OR-array.

44. (a)

$$\begin{aligned} Y &= (A + AB)(B + BC)(C + AB) \\ &= A(1 + B)B(1 + C)(C + AB) \\ &= AB(C + AB) \\ &= ABC + AB \\ &= AB \end{aligned}$$

47. (a)

k-map for $f(A, B, C)$ is

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1	3	2 1
A	4	5 1	7 1	6 1

Hence $f(A, B, C) = \Sigma m(2, 5, 6, 7)$

48. (b)

Clk	PS		T_1	T_0	NS	
	Q_1	Q_0			Q_1	Q_0
1	0	0	0	1	0	1
2	0	1	0	1	0	0

49. (c)

- In a Johnson counter with n-flip flop there are $2n$ states i.e. MOD number is $2n$.

So a MOD-6 Johnson counter requires number of flip-flops = $2n/2 = n$.

Here $n = 3$

50. (a)

Let input = x

for $x = 0$,
$$\begin{aligned} 0 \oplus Q_n &= Q_n \\ S &= Q_n \qquad R = \bar{Q}_n \\ Q_{n+1} &= Q_n \end{aligned}$$

for $x = 1$,
$$\begin{aligned} 1 \oplus Q_n &= \overline{Q_n} \\ S &= \bar{Q}_n \; ; \qquad R = Q_n \\ Q_{n+1} &= \bar{Q}_n \end{aligned}$$

Hence it acts as a T-flip flop.

51. (b)

Here base (r) of the given number = 15

r's complement = ($r - 1$)'s complement + 1

So, 15's complement = 14's complement + 1

$$\begin{array}{cccc} \text{E} & \text{E} & \text{E} & \text{E} \\ \text{A} & \text{B} & \text{C} & \text{D} \\ \hline 4 & 3 & 2 & 1 \\ + & & & 1 \\ \hline (4 & 3 & 2 & 2)_{15} \end{array}$$

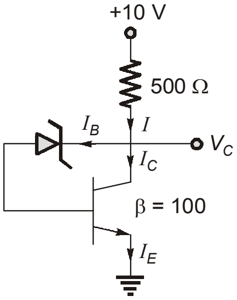
53. (b)

$\because$ $$1024 \times 8 = 2^{10} \times 8$$

$\therefore$ Number of Address lines required to access 2^{10} locations = 10

54. (d)

$$I_E = I_C + I_B = I$$



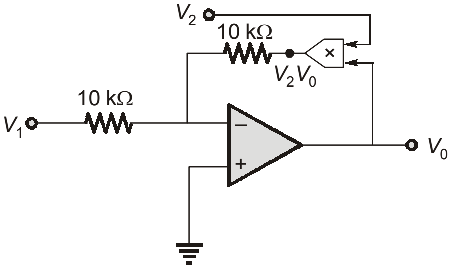
$$\begin{aligned} V_C &= V_Z + V_{BE} \\ &= 4.3 + 0.7 \\ &= 5\text{ V} \end{aligned}$$

$$I = \frac{10-5}{500} = 10\text{ mA}$$

55. (b)

$$\begin{aligned} I_D &= 0.8\text{ mA} \\ V_o &= V_{DD} - RI_D \\ R &= \frac{V_{DD}-V_o}{I_D} = \frac{5}{0.8}\times 10^3 = \frac{50}{8}\text{ k}\Omega \\ &= 6.25\text{ k}\Omega \end{aligned}$$

56. (c)



By applying KCL,

$$\frac{V_2V_0}{10\text{ k}\Omega} = -\frac{V_1}{10\text{ k}\Omega}$$

so,
$$V_0 = -\frac{V_1}{V_2}$$

57. (b)
Soft handoff generally takes place in CDMA system.

63. (c)

$$\begin{aligned} Y(z) &= X(z)\,H(z) \\ &= 6z^{-5} + 4z^{-4} + 6z^{-2} - 8z^{-1} + 4 \end{aligned}$$

$y(n)$ for $n \geq 0$ is

[4, –8, 6, 0, 4, 6]

64. (d)

$$\begin{array}{lll} -z^{-2} + 1\big) & 1 & \big(-z^{2} - z^{4} \\ & \underline{1 - z^{2}} & \\ & z^{2} & \\ & \underline{z^{2} - z^{4}} & \end{array}$$

$x(-1) = 0,\ x(-2) = -1$

66. (b)

$$Y(\omega) = \frac{1}{2}\left[X(\omega) + e^{-j\omega}X(\omega)\right]$$

$$Y(\omega) = \frac{1}{2}X(\omega)\left[1 + e^{-j\omega}\right] = e^{\frac{-j\omega}{2}}\left[\frac{e^{\frac{j\omega}{2}} + e^{\frac{-j\omega}{2}}}{2}\right]$$

$$= \left(\cos\frac{\omega}{2}\right)e^{-\frac{j\omega}{2}}$$

67. (d)

$$\begin{aligned} \text{Linear convolution length} &= L_1 + L_2 - 1 \\ &= 6 + 6 - 1 = 11 \\ \text{Circular convolution length} &= L_1 = L_2 = 6 \end{aligned}$$

70. (d)

$$\begin{aligned} f_{\max} &= \max(100\text{ Hz}, 200\text{ Hz}) = 200\text{ Hz} \\ f_s &= 2 \times f_{\max} = 400\text{ Hz} \end{aligned}$$

73. (c)

$$\begin{aligned} \omega &= \frac{\sigma}{\epsilon} = \frac{4 \times 10^{-4}}{4 \times \dfrac{10^{-9}}{36\,\pi}} = 113 \times 10^{5} \\ &= 11.3 \times 10^{6}\text{ rad/sec} \end{aligned}$$

74. (d)

$$\begin{aligned} P_{\text{ref}} &= |\Gamma|^{2} P_{\text{inc}} \\ \Gamma &= \frac{150 - 50}{150 + 50} = \frac{1}{2} \\ \Rightarrow \quad P_{\text{ref}} &= \frac{1}{4} \times 900 = 225\text{ W} \end{aligned}$$

75. (b)

$$\tan 2\theta_\eta = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad 2\theta_\eta = 30°$$

$$\theta_\eta = 15°$$

80. (b)

$$RL = -20 \log [s_{11}] = 20 \log 100$$

$$= 40 \text{ dB}$$

81. (a)

$$\frac{q_2 q_1}{4\pi\epsilon_0 d^2}\hat{x} + \frac{q_2 q_3}{4\pi\epsilon_0 (2d)^2}(-\hat{x}) = 0$$

$$\Rightarrow \quad \frac{2q \cdot q}{d^2} = \frac{2q q_3}{4d^2}$$

$$\Rightarrow \quad q_3 = 4q$$

83. (d)

Pre-emphasis circuit present in transmitter but not in receiver.

84. (c)

The spectral spreading is performed by a code that is independent of the message signal. Wide band angle modulation is not a spread spectrum scheme because its spectral spreading is done, not by an independent code, but by the message signal itself.

85. (c)

DPCM is more suitable when the samples are highly correlated.

86. (c)

$$I_t = I_C\sqrt{1+\frac{\mu^2}{2}}$$

$$I_{t1} = I_C\sqrt{1+\frac{\mu_1^2}{2}}$$

$$I_{t2} = I_C\sqrt{1+\frac{\mu_1^2+\mu_2^2}{2}}$$

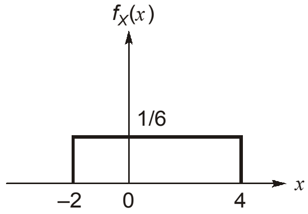
$$\frac{1+\frac{\mu_1^2+\mu_2^2}{2}}{1+\frac{\mu_1^2}{2}} = \frac{2}{1.5} \text{ and } \mu_1 = 1$$

$$\frac{3+\mu_2^2}{3} = \frac{2}{1.5}$$

$$\mu_2^2 = \frac{6}{1.5} - 3 = 1$$

$$\mu_2 = 1$$

90. (b)

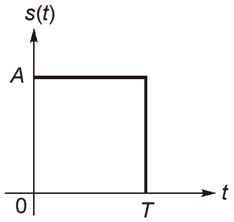


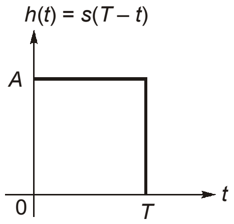
$$\bar{X} = E[X] = \frac{4-2}{2} = 1$$

$$\sigma_X^2 = E[(X-\bar{X})^2] = \frac{6^2}{12} = 3$$

$$E[X^2] = (\bar{X})^2 + \sigma_X^2 = (1)^2 + 3 = 4$$

91. (c)





92. (a)

$$E[X^2] = \sigma_X^2 + (\bar{X})^2 = 2 \qquad \because \text{ given that, } \bar{X} = 0$$

$$\begin{aligned} E[Y^2] &= E[(4X+3)^2] = E[16X^2 + 9 + 24X] \\ &= 16E[X^2] + E[9] + 24E[X] \\ &= 16E[X^2] + 9 \qquad \because E[X] = \bar{X} = 0 \\ &= 16(2) + 9 = 41 \end{aligned}$$

94. (d)

$$\begin{aligned} 4 \times 8 &= (32)_{10} \\ (32)_{10} &= (0020)_{16} \\ &= 0020\text{ H} \end{aligned}$$

95. (d)

Here 5000 H is immediate data. XCHG, should not be used with immediate data.

99. (c)

Consumption of 0.46 μm of silicon results in SiO_2 of 1 μm.

So, Consumption of 1 μm of silicon results in SiO_2 of thickness,

$$t_{ox} = \frac{1\,\mu\text{m}}{0.46\,\mu\text{m}} \times 1\,\mu\text{m} = \frac{1}{0.46}\,\mu\text{m} = 2.17\,\mu\text{m}$$

101. (d)

ρ = resistivity of the metal

ε = permittivity of the dielectric material

- To have small interconnect delay, the value of "$\rho\varepsilon$" should be small.
- So we have to select metal with low resistivity and dielectric with low permittivity.
- Given that, $\rho_{Cu} << \rho_{Al}$

  and $\varepsilon_{ox} = 3.9$

  $\varepsilon_{xe} = 2.9$
- So, Copper with Xerogel will produce less interconnect delay.

102. (b)

$$P = I^2R$$

$$\frac{\delta P}{P} = \pm\left[\frac{2\delta I}{I}\% + \frac{\delta R}{R}\right] = \pm[2(1.5)+0.5] = \pm 3.5\%$$

104. (b)

To extend the range of ammeter a multiplier resistance is connected in parallel to the meter resistance to bypass the excess current whose value is given by $R_{sh} = \dfrac{R_m}{(m-1)}$.

where

$$m = \frac{I}{I_m} = \frac{1}{100\times10^{-6}} = 10\times10^3$$

$$R_m = 100\ \Omega$$

$$R_{sh} = \frac{100}{10000-1} \approx 10\ \text{m}\Omega$$

105. (d)

Rotameters are the constant pressure drop, and variable area type flow meters, all other meters like orifice meter, venturi meter and flow nozzle are differential pressure meters.

106. (b)

error = ±(1% of full scale reading + 5 counts)

number of counts from 0 to 1999 are 2000

$$\therefore \quad \text{error} = \pm\left[\left(200\times\frac{1}{100}\right) + 5\times\frac{200}{2000}\right]\text{mA}$$

$$= \pm\ 2.5\ \text{mA}$$

108. (b)

$$\text{Speed} = \frac{\text{Puses recorded per second}}{\text{Number of teeths on the rotor}}\ \text{rps}$$

$$= \frac{120}{60}\ \text{rps} = 2\ \text{rps} = 2 \times 60\ \text{rpm} = 120\ \text{rpm}$$

Hence, (b) option is correct.

109. (b)

$$C_D = \frac{C_1 - n^2 C_2}{n^2 - 1}$$

$$C_1 = 100\ \text{pF}$$

$$C_2 = 10\ \text{pF}$$

$$n = 2$$

$$C_D = \frac{100 - 4(10)}{3} = 20\ \text{pF}$$

110. (c)

LVDT only change the amplitude and phase of the input signal in the output. It does not makes any change in the frequency of the input and signal. i.e. frequency remains same in the input and output signal.

111. (c)

At balance:

$$R_2\left[R_x + \frac{1}{j\omega C_x}\right] = R_1\left[R_3 + \frac{1}{j\omega C_3}\right]$$

$$R_2 R_x + \frac{R_2}{j\omega C_x} = R_1 R_3 + \frac{R_1}{j\omega C_3}$$

Equating the real and the imaginary parts we get,

$$R_x = \frac{R_1 R_3}{R_2}$$

$$C_x = \frac{R_2 C_3}{R_1}$$

$$D = \frac{1}{Q} = \frac{1}{\dfrac{1}{\omega C_x R_x}} = \omega C_x R_x$$

$$= \omega \frac{C_3 R_2}{R_1} \times \frac{R_1 R_3}{R_2}$$

$$= \omega C_3 R_3$$

113. (b)

The flux in core of transformer depends on input voltage and frequency of supply voltage.

114. (b)

$$V_S = \sqrt{3}V_P$$

115. (a)

The armature reactance is represented as synchronous reactance for cylindrical rotor alternator and direct and quadrature axis reactance in salient rotor configuration.

116. (b)

Synchronous speed of alternator $N_s = \frac{120\,f}{P} = \frac{120\times 60}{P}$

minimum number of poles possible is 2

$$\therefore \qquad N_s = \frac{120\times 60}{2} = 3600 \text{ rpm}$$

117. (c)

Large size of salient rotor alternator at high speed generate very large mechanical stress on shaft due to centrifugal force and therefore are unfeasible.

118. (a)

By short pitching the coil it is convenient to attain sinusoidal induced emf. Hence statement 1 and statement 2 are only correct.

119. (a)

By connecting an additional resistance in the armature circuit increases armature drop. Hence E_b get reduced and as speed is directly proportional to back EMF (E_b) keeping flux constant speed also decreases below rated.

120. (c)

Torque is proportional to square of armature current.

121. (c)

Iron loss are proportional to square of voltage which is producing flux and hence statement 2 is not correct.

122. (c)

$$P_m = 3I_2^2 r_2\left(\frac{1-s}{s}\right) \qquad \text{... (Rotor power output is given by)}$$

where $I_2^2 r_2$ is the rotor copper loss in each of three phases.

Given $P_m = 30$ kW $\qquad s = 4\%$

$$30\times 10^3 = 3I_2^2 r_2\left(\frac{1-0.04}{0.04}\right) \qquad \text{... (for total power three phases)}$$

$\Rightarrow$ Total rotor copper loss = $3I_2^2 r_2$

$$3I_2^2 r_2 = \frac{30\times 10^3\times 0.04}{0.96} = 1250 \text{ W}$$

123. (d)

All the above quantities can be measured from hydrograph.

124. (d)

When an interrupt occurs, operating system decides the request on the fact that the interrupt has higher priority or less priority. If less the interrupted process is resumed only after the execution of process, the interrupt is handled. However if interrupt has higher priority the process is blocked and interrupt is entertained. Hence an operating system may or may not change the state of the interrupted process to "blocked" and schedule another process.

125. (c)

$$\begin{tikzcd} S_2 : T_1 & T_2 \arrow[l] \arrow[r] & T_3 \arrow[ll, bend left] \end{tikzcd} \quad : \quad T_2 \rightarrow T_3 \rightarrow T_1$$

$$\begin{tikzcd} S_3 : T_1 \arrow[rr, bend right] & T_2 \arrow[l] \arrow[r] & T_3 \end{tikzcd} \quad : \quad T_2 \rightarrow T_1 \rightarrow T_3$$

∴ S2 and S3 are serializable. [S1 forms a cycle between T_1 and T_2]

126. (a)

Cache data size = 16 words

Block size = 4 words

$$\text{Number of cache block} = \frac{16}{4} = 4$$

	Cache	
0		
1	13	
2	~~2~~ ~~6~~ ~~10~~	2
3	~~11~~ 3	

2% 4 = 2 ×
13% 4 = 1 ×
6% 4 = 2 ×
16% 4 = 0 ×
11% 4 = 3 ×
3% 4 = 3 ×

10% 4 = 2 ×
2% 4 = 1 ×
13% 4 = 1 ✓

Total # misses = 7 misses

127. (d)

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
I_1	IF	ID	EX	MM	WB					
I_2		IF	ID	EX	MM	WB				
I_3			IF	ID	ID	EX	MM	WB		
I_4				IF	–	ID	EX	MM	WB	
I_5						IF	ID	EX	MM	WB

10 clock cycles used.

128. (c)

2.5 memory reference per instruction $\Rightarrow \frac{1000}{2.5}$ instruction per 1000 reference.

$\Rightarrow$ 400 instructions.

Now

$$200 = \left(\frac{260}{400}\right)x + \left(\frac{120}{400}\right)2x$$

$$x = \frac{400 \times 200}{500}$$

$$x = \frac{80000}{500}$$

$$x = 160$$

$$2x = 320$$

129. (b)

$$\text{Biased exponent} = 18 + 64 = 82$$

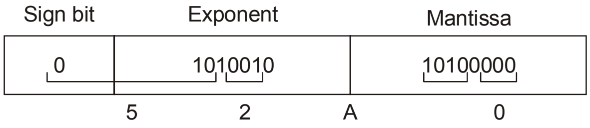
Representing 82 in binary

$$(82)_2 = (1010010)_2$$

Representing mantissa in binary

$$(0.625)_{10} = (0.10100000)$$

Floating point representation is as follows:



130. (b)

(*p) has value 5, which is incremented by 1, then print i.e. 5 + 1 = 6.

131. (b)

(i) Regs $[R_4] \leftarrow$ Regs $[R_4]$ + Regs $[R_3]$
Here contents of Regs $[R_4]$ and $[R_3]$
are added and placed into Register $[R_4]$
which is a register operation.

(ii) Regs $[R_4] \leftarrow$ Regs $[R_4]$ + 3
Here 3 is data instead of address
Hence, it is a immediate mode.
Hence (b) is correct option.

132. (b)

For series RLC circuit, at resonant frequency the circuit impedance, $Z = R$, (purely resistive) and at this frequency the energy stored in inductor and capacitor oscillates between them also.

138. (d)

Demultiplexers can be used to design a decoder.

139. (c)

Gain at high frequency falls due to internal junction capacitances so, (R) is false.

148. (a)

Threshold tailoring is used to get the desired threshold voltage for a MOSFET by changing the doping concentration of the substrate in the channel region.

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