TEST ID: 211

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ESE- 2018 (Prelims) - Offline Test Series-Test- 22

ELECTRICAL ENGINEERING

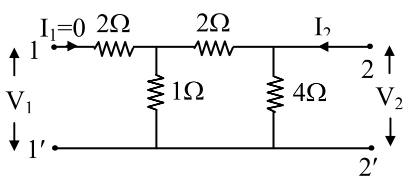
FULL LENGTH MOCK TEST – 1 (PAPER – II)

SOLUTIONS

01. Ans: (a)

Sol: $V_1 = h_{11}I_1 + h_{12}V_2$

$I_2 = h_{21}I_1 + h_{22}V_2$



$$h_{12} = \left.\frac{V_1}{V_2}\right|_{at\, I_1=0}$$

$$V_1 = 1\left(\frac{4}{7}\right)I_2 \quad \& \quad V_2 = 4\left(\frac{3}{7}\right)I_2$$

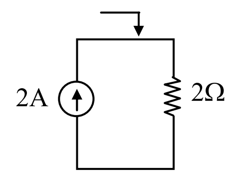
$$\frac{V_1}{V_2} = \frac{1}{3}$$

02. Ans: (d)

Sol: **Step1:** $t < 0$

Before switch is closed

C ⇒ No source so $V_C(0^-) = V_C(0^+) = 0V$

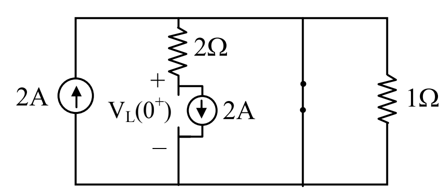


Inductor is short circuited.

$I_L(0^-) = i_L(0^+) = 2$ A

Step2: inductor doesn't allow sudden change in current and capacitor doesn't allow sudden change in voltage.

At $t = 0^+$



$\Rightarrow -V_L(0^+) - 4 = 0$

$\Rightarrow V_L(0^+) = -4$ V

03. Ans: (d)

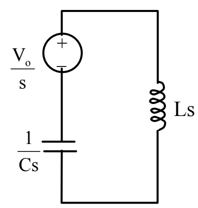
04. Ans: (b)

Sol: To find $R_{th,}$ suppress the independent sources 1A are O.C. and 1 V is S.C.

$R_{th} = 2\ \Omega$

05. Ans: (b)

Sol:



Applying KVL in s-domain,

$$I(s) = \frac{V_o/s}{\frac{1}{Cs} + Ls}$$

$$= \frac{V_oC}{LCs^2 + 1}$$

$$\Rightarrow\ i(t) = V_o\sqrt{\frac{C}{L}}\sin\frac{1}{\sqrt{LC}}t$$

$$\Rightarrow\ i(max) = V_o\sqrt{\frac{C}{L}}$$

$$= 10\sqrt{\frac{10^{-6}}{0.1\times10^{-3}}} = 1A$$

06. Ans: (d)

Sol: Current in the original network is directly becoming voltage in its dual networks and hence 'r' in the original network with automatically becomes the conductance same value in its dual network.

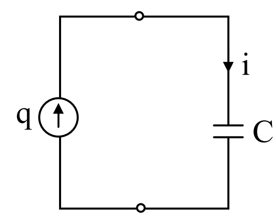
07. Ans: (d)

Sol: For dc i.e. a unit step signal, the inductor will act as a short circuit in steady state. So the source current entirely flows through 'L' only and hence the 1 A current.

08. Ans: (c)

09. Ans: (d)

Sol:



$$\Rightarrow i = \frac{dq}{dt}$$

$$\Rightarrow q = \int_{-\infty}^{t} i(t).dt$$

$$\Rightarrow q = \int_{0}^{t} i(t)dt$$

$$= \int_{0}^{t}(10t).dt\ = 5t^2\ C$$

At t = 1 sec $\Rightarrow$ q = 5 C

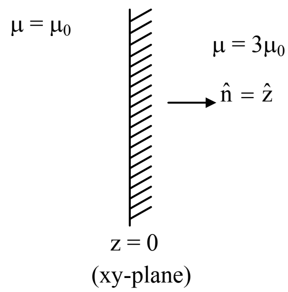
$$\text{So, } E_C\Big|_{t=1sec} = \frac{q(1)^2}{2C}\ J$$

$$= \frac{5^2}{2\times100\times10^{-6}}\ J$$

$$= 125kJ$$

10. Ans: (d)

Sol:



$$\bar{B}_{n2} = \bar{B}_{n1} \Rightarrow \bar{H}_{n2} = \frac{1}{3}\bar{H}_{n1} = \frac{1}{3}\times 12 = 4\hat{z}$$

$$\left(\bar{H}_{t2} - \bar{H}_{t1}\right) = \bar{I}_s \times \hat{n}$$

$$\left[\bar{H}_{t2} - (10\hat{x} + \hat{y})\right] = (4\hat{x} + 3\hat{y})\times\hat{z}$$

$$\bar{H}_{t2} = -4\hat{y} + 3\hat{x} + (10\hat{x} + \hat{y})$$

$$\bar{H}_{t2} = 13\hat{x} - 3\hat{y}$$

$$\bar{H}_z = \bar{H}_{t2} + \bar{H}_{n2} = 13\hat{x} - 3\hat{y} + 4\hat{z}$$

The magnetic field is $13\hat{x} - 3\hat{y} + 4\hat{z}$

11. Ans: (b)

Sol: Equating the energies involved in one cycle surge and half cycle surges, $I_1^2 t_1 = I_2^2 t_2$

$I_1 = 2000$ A

$I_2 = 2000\sqrt{2} = 2828$ A

12. Ans: (d)

Sol: A) Turn on time of thyristor depends on junction capacitance

B) Transistor turn on process does not consists of any spread time

C) Rate of rise of gate current effects delay time.

D) If gate pulse is removed before latching current, there is no guarantee for turn on of SCR.

13. Ans: (c)

Sol: If $\alpha \le 60$, the diode and thyristor both will be conducting for a duration of 120^0. But freewheeling diode will not conduct.

14. Ans: (b)

Sol: $I_0 = \frac{V_m}{2\pi R}(1 + \cos\alpha)$

$$= \frac{220\sqrt{2}}{2\times\frac{22}{7}\times 7}(1 + \cos 60)$$

$$= \frac{10\times 1.414}{2}\times 1.5$$

$= 10 \times 0.7 \times 1.5$

$\simeq$ 10.5 A

15. Ans: (c)

Sol: A fully controlled converter, we can operate in rectifier mode and inverter mode.

A half controlled converter, we can operate only in one mode either in rectifier or inverter.

For controlling the speed of blower half controlled converter is enough.

16. Ans: (c)

Sol: E.m.f constant K_b= 0.5 V/r.p.m (given)

For separately excited d.c motor

$E_a = K_b N$

and $E = V_0 - I_a R_a$

$$= \frac{V_m}{\pi}(1+\cos\alpha) - 5(2)$$

$$= \frac{230\times\sqrt{2}}{\pi}(1+\cos 30^\circ) - 10$$

E = 183.20

$$\therefore N = \frac{E}{K_b} = \frac{183.20}{0.5} = 366.4 \text{ rpm}$$

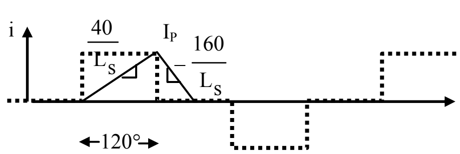
17. Ans: (c)

Sol: Voltage across thyristor = E – 2E = –E

18. Ans: (d)

19. Ans: (a)

Sol:



$$\frac{40}{L_s} = \frac{I_p}{\left(\frac{120}{180}\right)\times 10\,\text{ms}}$$

$$I_p = \frac{6.66\,\text{ms}}{6.66\,\text{mH}}\times 40$$

Peak value of load current I_p = 40 A

20. Ans: (a)

Sol: $Z = R + j\left(\omega L - \frac{1}{\omega C}\right)$

$$= 6 + j\left(100\pi\times\frac{10}{\pi}\times 10^{-3} - \frac{1}{100\pi\times\frac{10}{7\pi}\times 10^{-3}}\right)$$

= 6 + j(1 – 7)

= 6 – j6

So, Current leads the voltage by 45°

So, Condition time of each transistor

= 180° – 45°

= 135°

So, Conduction time of each diode = 45°

21. Ans: (d)

Sol: By using electronic instruments we can detect dynamic changes in parameters, and the response is very fast on account of small inertia of electrons and they have a higher degree of reliability than their mechanical and purely electrical counter parts.

22. Ans: (d)

Sol: In a measurement system ideal situation, when an element used for any purpose may be for signal sensing, conditioning or detection is introduced the original signal must remain undistorted. But in practical conditions that any introduction of element in a system results in extraction of energy form the system, there by distorting the original signal. This distortion may be attenuation, waveform distortion or phase shift. This effect is known as loading effect.

23. Ans: (c)

Sol: Generally swamping resistances are used in series with measuring meters to eliminated the effect of temperature variations. So the swamping resistance should have low temperature coefficient such that change in resistance is small for large temperature variations and they should have the value of 20 to 30 times the coil resistance.

24. Ans: (d)

Sol: As the braking magnet is move away from the disc it will bypass lesser and large amount of flux will cut disc, resulting larger braking torque (as $T_B \alpha \phi^2$) and speed is inversely proportional to braking torque so speed will be reduced.

25. Ans: (d)

Sol: 50 cm $\rightarrow$ 1.0185V

65cm $\rightarrow$?

$$\frac{65\times1.0185\text{V}}{50} = 13\times1.0185 = 1.324$$

$$\%\ \text{error} = \frac{A_m - A_t}{A_t}\times100$$

$$= \frac{1.324-1.33}{1.33}\times100$$

$$= -0.45\%$$

26. Ans: (c)

Sol: $$\text{Resolution} = \frac{\text{full scale reading}}{2^n}$$

$$5\text{mV} = \frac{10}{2^n} \Rightarrow 2^n = 2000$$

Minimum number of bits =11

27. Ans: (b)

28. Ans: (c)

Sol: The transducer is used for flow rate measurement of air in aeroplane is hot wire anemometer.

29. Ans: (d)

Sol: EMFM output is dependent on conductivity of fluid and EMFM output voltage is directly proportional to average velocity of fluid. Hence both

30. Ans: (b)

Sol: Residue effect is observed in inductive transducer.

31. Ans: (b)

32. Ans: (c)

Sol: Rhodium-Indium thermocouple used for high temperature measurement in power plant.

33. Ans: (c)

Sol: $3I_{a0} = j\,6 \Rightarrow I_{a0} = j\,2$ p.u., $I_{a1} = -j\,3$ p.u.

LLG $\Rightarrow I_{a1} + I_{a2} + I_{a0} = 0$, $I_{a2} = j\,1$ p.u.

34. Ans: (b)

Sol: $I_c = 90$ A

$V_L = 33$ kV

Power factor, $\sin\delta = 0.02 \Rightarrow \tan\delta = 0.02$

Total dielectric loss $= 3.V_{ph}^2.\omega c\tan\delta$

$= 3\,V_{ph}\,I_c\tan\delta$

$= 3\times\frac{33k}{\sqrt{3}}\times 90\times 0.02$

$= 102.88$ kW

35. Ans: (c)

Sol: $B_{℧} = \frac{1.0}{400} = 0.25\times 10^{-2}\,℧$

36. Ans: (b)

Sol: $V_d = 1.35\,E_{LL}\cos\alpha$

$= 1.35\times 132\times\frac{\sqrt{3}}{2} = 155\text{kV}$

37. Ans: (a)

Sol: Corona starts for, $E = \delta.\,g_0$

$$\delta = \frac{3.92h}{273+t} = \frac{3.92\times 72}{300} = \frac{0.0392\times 72}{3}$$

$= 0.0392\times 24 = 0.941$

$E = 0.941\times 30 = 28.22$ kV/cm Peak

38. Ans: (d)

Sol: $Z_{line} = 400\,\Omega$, $Z_{cable} = 200\,\Omega$

$$i_r = -\frac{Z_{cable} - Z_{line}}{Z_{cable} + Z_{line}} = -\frac{200-400}{200+400}$$

$$= \frac{200}{600} = 0.333$$

$V_r = -0.333$

39. Ans: (b)

Sol: $X_1 = 0.2$ pu

$$X_2 = \frac{0.2+0.15}{2} = 0.175 \text{ pu}$$

40. Ans: (a)

Sol:
(a) Distance relay scheme is used in transmission lines only, since the fault current travels more distance in transmission lines.

(b) Under frequency relay is used at alternator so as to keep the frequency of voltage and current at load side with in the permissible limits i.e, ± 5%

(c) Differential relay scheme is used for bus bar protection by comparing the current of transformer with the current of transformer with the currents of feeder.

(d) Buchholz relay is used for the protection of transformer for internal faults.

41. Ans: (c)

Sol: $Z_{eq} = j0.8 \parallel j0.4 = j\frac{0.8 \times 0.4}{1.2}$

$$= j\frac{0.8}{3} = j0.267 \text{ p.u.}$$

42. Ans: (a)

Sol: $Q = \frac{\Delta V}{X} \Rightarrow Q = (5\%)\ \frac{1}{X}$

$$\Rightarrow Q\ (\text{MVAr}) = 0.05 \times \frac{\text{Base MVA}}{X}$$

$$= 0.05 \times 2000 = 100 \text{ MVAR}$$

43. Ans: (a)

Sol: A special class of ferrites called 'ferrox cubes' are used as computer memory elements.

44. Ans: (c)

45. Ans: (c)

Sol: If the temperature of metal increases, the lattice vibration in the crystal structure increases. Hence collision frequency increases and relaxation time decreases. Due to the resistivity of metal increases.

46. Ans: (b)

Sol: Point defect – Vacancy, interstitial, Substitutional, Frenkel, Skottky

Line defect – Edge and Screw dislocation

Planar defect – Grain boundary, twin boundary, stacking fault.

47. Ans: (b)

Sol: Any impurities will act as scattering centers and resistivity increases (or) conductivity decreases

48. Ans: (b)

Sol: According to Matthiersen's rule $\rho = \rho_r + \rho_T$; ρ_r depends on the structural defects of the material and imperfections. ρ_T is temperature dependent

49. Ans: (c)

Sol: Type I SC are also termed as soft SC which exhibit meissner effect and silsbee's rule.

50. Ans: (d)

Sol: Aluminium metal matrix finds application in aerospace, thermal management areas, industrial products, automotive applications such as engine piston, brake etc.

51. Ans: (d)

Sol: Fibres used as reinforcement in composite is Glass , Boron carbide ,Silicon carbide Carbon (graphite) and Kevlar.

52. Ans: (c)

53. Ans: (b)

Sol: Based on production method internal structure of material will form, which decides the external form of the crystal. In a atom at the centre nucleus will be there and around that electrons will rotate. Nuclear vibration/structure can be studied by mossbauer studies

54. Ans: (a)

Sol: closed loop transfer function = $\frac{3}{s+2}$,

$$\tau = \frac{1}{2} = 0.5$$

55. Ans: (d)

Sol: Unstable system, output is unbounded.

56. Ans: (c)

Sol: C.E is $(s+1)^3+k=0$

$s^3+1+3s^2+3s+k=0$

by RH criteria,

s^3	1	3
s^2	3	k+1
s^1	$\frac{9-k-1}{3}$	0
s^0	k+1	

By RH tabulation,

$$\frac{8-k}{3} > 0, \quad k+1 > 0$$

$k < 8, k > -1$

Maximum value of k =8

Steady state error for unit step input $= \frac{1}{1+k_p}$

$$k_p = \underset{s\to 0}{Lt} \; G(s)$$

$$k_p = \underset{s\to 0}{Lt} \; \frac{k}{(s+1)^3} = k$$

Minimum steady state error

$$= \frac{1}{1+k_{max}} = \frac{1}{1+8} = 0.11$$

57. Ans: (c)

Sol: Inner loop transfer function $= \frac{G(s)}{1+G(s)}$

Characteristic equation 1 + G(s) = 0 stable for k < 30

Total transfer function $= \frac{G(s)}{1+3G(s)}$

Characteristic equation 1 + 3G(s) = 0 stable for 3k < 30

$\Rightarrow k < 10$

$\therefore 0 < k < 10$

58. Ans: (c)

Sol:

s^3	1	3
s^2	k	30
s^1	$\frac{3k-30}{k}$	
s^0	30	

3k– 30 = 0

$\therefore$ k = 10

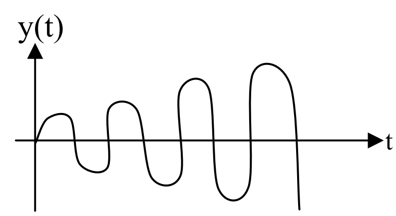
59. Ans: (d)

Sol: CE is $s^2 - 4s + 20 = 0$

Roots of the CE = 2 ±j4

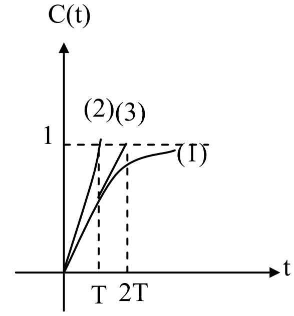
Roots are complex and lie on right-half of the s-plane

$\therefore$ Response is unbounded with oscillation as below



60. Ans: (a)

Sol: 1^{st} order system with unit step applied, if the initial rate is maintained throughout the journey, then system will reach steady state value 1, at time = Time constant



(1) Represents normal output waveform for unit step applied

(2) Represents slope or rate of c(t) at t = 0,

$\therefore$ If same rate as at t = 0 is maintained throughout the journey, it will reach steady state at t = T

Similarly, at t = T, if c(t) has some rate as shown in (3) and same rate is maintained after t = T, at t = 2T it will reach output 1.

$$\frac{C(s)}{R(s)} = \frac{\frac{1}{2s}}{1+\frac{1}{2s}} = \frac{1}{2s+1}$$ comparing with standard 1st order CLTF, we get T = 2 sec

61. Ans: (c)

Sol: Number of branches terminates at infinity

= Number of Asymptotes

N = P – Z = 5 – 3 = 2

62. Ans: (b)

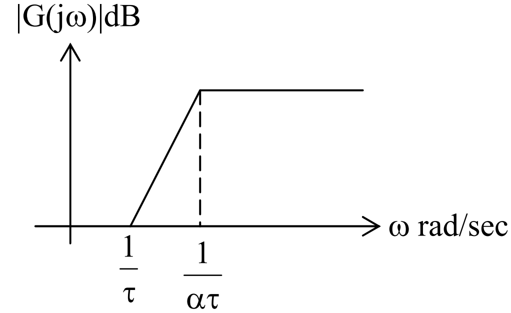
Sol: From D(s) to C(s), one forward path exists and there is a single loop

$$\frac{C(s)}{D(s)} = \frac{\frac{1}{s(s+2)}}{1-\left[\frac{4}{s(s+2)}(-1)\right]}$$

$$= \frac{1}{s^2+2s+4}$$

63. Ans: (c)

Sol: Approximate Bode plot of lead compensator is,



ω_m = The frequency at which maximum phase lead occur.

ω_m=Geometric mean of two corner frequencies

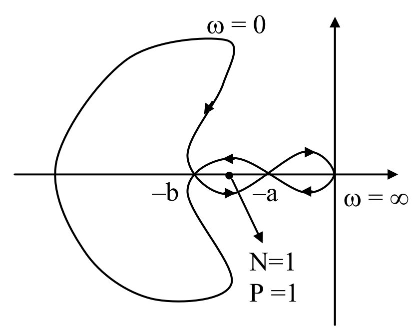
$$\omega_m = \frac{1}{\tau\sqrt{\alpha}} = \sqrt{\frac{1}{\tau}\frac{1}{\alpha\tau}}$$

From the given plot, $\frac{1}{\tau} = 2$, $\frac{1}{\alpha\tau} = 4$ $\therefore$

$$\omega_m = \sqrt{8} = 2.8 \text{ rad/sec}$$

64. Ans: (d)

Sol:



Z = P–N = 1–1= 0

$\therefore$ Stable

65. Ans: (d)

Sol. Y(t) = C X(t)

$\therefore$ Y(t) = CX (t)

$$= \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Y(t) = 0

66. Ans: (b)

Sol: As reactive power output of a synchronous generator is

$$Q = \frac{V_t}{x}\left(E_f \cos\delta - v_t\right)$$

Where δ = load angle

Q is dependent on E and δ *i.e* excitation current and load angle.

67. Ans: (a)

68. Ans: (c)

Sol: During rotor blocked test, the rotor does not rotate. There cannot be any friction and windage loss.

There will be copper losses in stator and rotor, as well as core losses in both stator core and rotor core.

Since the test is usually done at reduced voltage, core losses are usually neglected.

69. Ans: (b)

Sol: While the machine is being driven as a generator, it is running in clockwise direction (given). So the developed torque in the machine must be in anticlockwise direction. The prime mover does mechanical work in driving the generator in clockwise direction, opposing this torque. It is this work (energy) which is delivered to the bus. Statement (1) is false.

Once the prime mover gets disconnected, speed becomes smaller,(but still in clockwise direction) induced emf becomes smaller, and current in the armature reverses. Now, the developed torque will be in clockwise direction, and the machine will run in clockwise direction as a motor.

Statements (2) and (3) also are false.

70. Ans: (d)

Sol: $P_{mech} = E_bI_a$

$= (V-I_aR)I_a$

for max output $\frac{dp}{dI_a} = V - 2I_aR_a = 0$

$$I_a = \frac{V}{2R}$$

$$= \frac{200}{2\times 10} = 10A$$

71. Ans: (b)

Sol: $T \propto N$

$\phi I_a \propto N$

$I_fI_a \propto N$

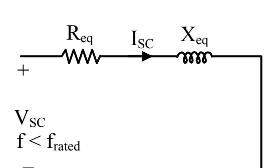
And $E \propto \phi N$

$V_t \propto I_fN$

As V_t & I_f are halved, N remains constant

72. Ans: (c)

Sol:



R_{eq} = constant

X_{eq} decreases as frequency decrease

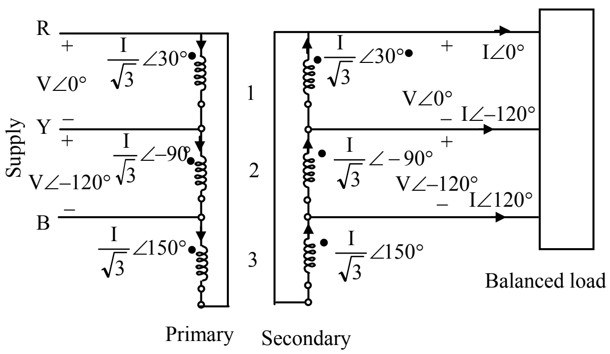
Z_{eq} decreases

$I_{SC} = \frac{V_{sc}}{Z_{eq}}$ increases. Hence copper losses increase.

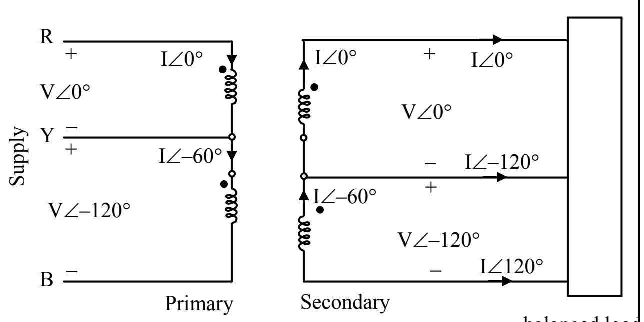
Short circuit power factor = $\frac{R}{Z_{eq}}$ increases

73. Ans: (b)

Sol:



Turns ratio = 1 asumed
for each 1-Ph-transformer
Normal-Δ



open delta

Assuming supply & load to be unchanged, each transformer winding carries $\sqrt{3}$ times its rated current. Hence over loading is 73.2%.

74. Ans: (b)

75. Ans: (b)

Sol: $\frac{T_{fL}}{T_{cm}} = \frac{2}{\frac{s_{mT}}{s_{fL}} + \frac{s_{fL}}{s_{mT}}}$

$\frac{1}{2} = \frac{2}{\frac{0.1}{s_{fL}} + \frac{s_{fL}}{0.1}}$

$s_{fL}^2 - 0.4 s_{fL} + 0.01 = 0$

$s_{fL} = 0.0268 = 2.68\%$

76. Ans: (b)

Sol: slot angle, $\gamma = \frac{P \times 180}{s} = \frac{2 \times 180}{18} = 20°(\text{elec})$

Coil span β = 6 slots ⇒ 6 × 20° = 120°

∴ α = 180° – 120° = 60° (elec)

Coil span factor, $K_p = \cos\frac{\alpha}{2} = \cos 30°$

$= 0.866$

77. Ans: (d)

78. Ans: (d)

79. Ans: (c)

Sol: $P(X = x) = \frac{e^{-\lambda}.\lambda^x}{x!}$

$P(X = 0) = P(X = 2)$

$$e^{-\lambda} = \frac{e^{-\lambda}.\lambda^2}{2\,!} \Rightarrow \lambda = \sqrt{2}$$

$$P(X \le 1.3) = P(X = 0) + P(X = 1)$$

$$= e^{-\sqrt{2}} + e^{-\sqrt{2}}.\left(\sqrt{2}\right)^1$$

$$= e^{-\sqrt{2}}\left(\sqrt{2}+1\right)$$

80. Ans: (c)

Sol: $P(\text{Bonus}) = \frac{1}{3}\times\frac{4}{5}+\frac{4}{9}\times\frac{3}{10}+\frac{2}{9}\times\frac{1}{2} = \frac{23}{45}$

81. Ans: (d)

Sol: $f(z) = \frac{1}{z+1}$ is not (analytic function) at z = –1

$f(z) = \frac{z+3}{(z-1)(z-3)}$ is not analytic at z = 1 & z = 3

f(z) = tan z fails analytic for all cos z = 0

82. Ans: (c)

Sol: f(z) = sin z

f(z) = sin (x + i y)

= sin x cos iy + cos x sin iy

= sin x cos hy + cos x(i sin hy)

= sin x cos hy + i cos x sin hy

imaginary part = cos x sin hy

83. Ans: (d)

Sol: $f(z) = \frac{1-e^{-z}}{z}$

$$= \frac{1}{z}\left\{1-\left(1-z+\frac{z^2}{2!}-\frac{z^3}{3!}+.......\right)\right\}$$

$$= \frac{1}{z}\left\{z-\frac{z^2}{2!}+\frac{z^3}{3!}-..........\right\}$$

$$= 1-\frac{z}{2!}+\frac{z^2}{3!}-.........$$

There are no negative powers of z.

$\therefore$ z = 0 is a removable singularity

84. Ans: (c)

Sol: $|(2A)^{-1}| = \left|\frac{1}{2}.A^{-1}\right| = \frac{1}{2^3}|A^{-1}| = \frac{1}{8}.|A|^{-1}$

$$= \frac{1}{8}.(9)^{-1} = \frac{1}{8\times 9} = \frac{1}{72}$$

85. Ans: (c)

Sol: It is second degree polynomial, so simpson $\frac{1}{3}$ rule gives error is '0'.

86. Ans: (b)

Sol: cos2x, sin2x are linearly independent solutions hence the roots of auxiliary equation are m = ± 2i. $\Rightarrow m^2+4 = 0$

$\Rightarrow$ The differential equation is $\frac{d^2y}{dx^2}+4y=0$

87. Ans: (c)

Sol: Linear differential equation

$$y.e^x = \int (x+1)^2 . e^x + c$$

$$e^x.y = (x^2+1)\ e^x + c$$

$$y(0)=0 \Rightarrow c = 0-1 \Rightarrow y = (x^2+1) - e^{-x}$$

88. Ans: (b)

Sol: In I/O mapped I/O, devices have separate addresses.

89. Ans: (c)

Sol: Based on locality of reference concept one block should be copied to cache when there is a miss.

90. Ans: (d)

Sol: Instruction fetch should be done in 2-steps as follows:

AR ←PC

IR ← M[AR]

91. Ans: (b)

Sol: 'break' keyword is needed as last statement of the cases in switch

92. Ans: (b)

Sol: P = 0.01 (1%)

Effective access time = P × page fault service time + (1 – P) (2 × memory access time)

$= 0.01 \times 500 + 0.99 \times 2 \times 5$

$= 5 + 9.9$

$= 14.9$ msec

Note: 2 memory accesses required ⇒ one for page table and one for data

93. Ans: (b)

Sol: $H(f) = \dfrac{3(j2\pi f)}{2+j2\pi f} \xrightarrow{\text{I.F.T}} h(t) = 3\dfrac{d}{dt}\left[e^{-2t}u(t)\right]$

$= 3\delta(t) - 6e^{-2t}\, u(t)$

94. Ans: (a)

95. Ans: (a)

Sol: (i) for $\alpha_1=1$, $y_1(t)$ is linear, Time invariant, causal and memoryless

(ii) for $\alpha_2=0$, $y_2(t)$ is linear, Time invariant, causal and memoryless

96. Ans: (b)

Sol: The given period signal contains Half-wave symmetry so $a_0=0$, $a_n\neq0$ (only for odd n) and $b_n\neq0$ (only for odd n)

97. Ans: (b)

Sol: $\delta(n) \leftrightarrow 1$

$$(-0.8)^n u(n) \leftrightarrow \frac{1}{1+0.8z^{-1}}$$

$$(-0.8)^{n-1} u(n-1) \leftrightarrow \frac{z^{-1}}{1+0.8z^{-1}}$$

$$H(z) = 0.8 + \frac{0.36z^{-1}}{1+0.8z^{-1}} = \frac{0.8+z^{-1}}{1+0.8z^{-1}}$$

$$H(e^{j\omega}) = \frac{0.8+e^{-j\omega}}{1+0.8e^{-j\omega}}$$

$$|H(e^{j0})| = 1$$

$$\left|H\left(e^{\frac{j\pi}{2}}\right)\right| = 1$$

$$|H(e^{j\pi})| = 1$$

So, it is a all pass filter with non-linear phase.

98. Ans: (b)

Sol: $x(n) \neq 0 \quad N_2 \leq n \leq N_3$

$h(n) \neq 0 \quad N_0 \leq n \leq N_1$

$y(n) = x(n) * h(n) \neq 0 \quad N_4 \leq n \leq N_5$

$N_4 = N_0 + N_2, \; N_5 = N_1 + N_3$

99. Ans: (c)

Sol: $\sin(at)u(t) \leftrightarrow \frac{a}{s^2+a^2}$

$$\frac{\sin(at)}{t} u(t) \leftrightarrow \int_s^\infty \frac{a}{s^2+a^2} ds = a\frac{1}{a}\tan^{-1}\left(\frac{s}{a}\right)\Bigg|_s^\infty$$

`

$$= \frac{\pi}{2} - \tan^{-1}\left(\frac{s}{a}\right)$$

$$X(s) = \cot^{-1}\left(\frac{s}{a}\right)$$

$$X(a) = \cot^{-1}\left(\frac{s}{a}\right)$$

$$X(a) = \cot^{-1}(1) = \frac{\pi}{4}$$

100. Ans: (c)

Sol: Properties:

$S_x(\omega)$ is a real function of ω

$S_x(\omega)$ is even

$S_x(\omega) \geq 0$ for all ω

101. Ans: (c)

Sol: We know

Method: (I)

$$\text{CMRR} = \frac{A_{dm}}{A_{cm}}$$

$$\text{CMRR}_{\text{in dB}} = 20\log_{10}\frac{A_{dm}}{A_{cm}}$$

$$= 20\log_{10} A_{dm} - 20\log_{10} A_{cm}$$

$$20\log_{10} A_{dm} = 35\,\text{dB}, \; 20\log_{10} A_{cm} = 5\,\text{dB}$$

CMRR = 35 – 5 = 30 dB

Method: (II)

$\text{CMRR}_{(dB)} = (A\text{dm})_{dB} - (A\text{ cm})_{dB}$

= 35–5

= 30 dB

102. Ans:(c)

Sol: Given input off set voltage is 5mV

Voltage gain A_v=10000

$$A_V = \frac{V_0}{V_i}$$

$V_0 = A\ V_i = 10000 \times 5 \times 10^{-3}V$

$= 50V$

The output voltage can never be greater than $\pm V_{sat}$. so the Answer is ±15V.

103. Ans: (c)

Sol: A_1, A_2, A_3 in dB

$A_3 = 20 \log_{10} 100$

$= 40dB$

(a) = $A_1+A_2+A_3$ (in dB)

= 20+30+40

= 90dB

104. Ans: (a)

105. Ans: (d)

Sol: As β is very large

$I_B \approx 0$,

V_i=1V

106. Ans: (c)

Sol: When S_1 is opened, i.e., base terminal →Open circuit

Transistor is in cut off region.

107. Ans: (b)

Sol: $P_D=V_{CE}\ I_C=(12-4I_c)I_c$

$$\frac{dP_D}{dI_c} = 0 = 12 - 4\times 2I_c$$

$$I_c = \frac{12}{8} = 1.5\text{Amp}$$

$P_D = [12 - 4(1.5)]\times 1.5 = 9W.$

108. Ans: (d)

Sol: At t = 0, still the diode is in forward biase but polarity of voltage source is changed, so that current is same in magnitude because of stored charge, but in reverse direction.

Hence at t = 0, reverse recovery current: 100mA

109. Ans: (a)

Sol: $\sigma_n = n_n e\mu_n = N_D e\mu_n$

$\sigma_i = n_i(\mu_n + \mu_p)e$

$\mu_n + \mu_p = \mu_n + 0.4\mu_n = 1.4\mu_n$

$$\frac{\sigma_n}{\sigma_i} = \frac{N_D\mu_n}{n_i \times 1.4\mu_n}$$

$$\therefore \frac{\sigma_n}{\sigma_i} = \frac{4.2\times 10^8}{1.5\times 10^4 \times 1.4} = 20000$$

110. Ans: (b)

Sol: $V_{GS} - V_T = 2V$

$\because$ $V_{DS} > V_{GS} - V_T$ the MOSFET is in saturation and has drain current of 0.8 mA.

Now, $V_{GS} - V_T = 1$ V

$\therefore$ $V_{DS} > V_{GS} - V_T$; MOSFET is in saturation.

When MOSFET is in saturation.

$$\frac{I_{DS_1}}{I_{DS_2}} = \left(\frac{V_{GS_1} - V_T}{V_{GS2} - V_T}\right)^2$$

$$\frac{0.8}{I_{DS2}} = \left(\frac{3-1}{2-1}\right)^2 = 4$$

$I_{DS_2} = 0.2$ mA

111. Ans: (a)

Sol: We know rate of generation for minority carriers

$$\frac{dp}{dt} = \frac{\text{Excess hole concentration}}{\text{minority carrier life time}}$$

At equilibrium (steady state) $\Delta p = \Delta n$

$$\frac{dp}{dt} = \frac{\Delta p}{\tau_p} = \frac{10^{15}}{10\times10^{-6}} = 10^{20}$$ electron hole pairs/cm^3/s

112. Ans: (d)

Sol: $s(t) = A_c \cos\omega_c t$

$$+\frac{1}{2}\mu A_c[\cos(\omega_c+\omega_m)t] + \frac{1}{2}\mu A_c[\cos(\omega_c-\omega_m)t]$$

Comparing with given equation

$$\frac{1}{2}\mu A_c = 6 \quad \& \quad A_c = 20$$

$\mu = 0.6$

113. Ans: (b)

Sol: $x(t) = A_c \cos(\omega_c t + \theta)$

Auto correlation function (ACF) of X(t) is

$$R_X(\tau) = \frac{A_C^2}{2}\cos\omega\tau$$

Power spectrum $(S_X(f))$, which is Fourier transform of $R_X(\tau)$ is

But we know that $F\{\cos\omega_0\tau\} = \frac{1}{2}[\delta(f+f_0)+\delta(f-f_0)]$

$$\therefore S_X(f) = \frac{A_c^2}{4}[\delta(f+f_0)+\delta(f-f_0)]$$

114. Ans: (c)

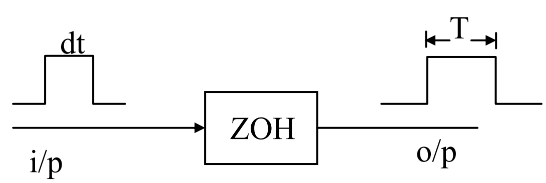
Sol: Peak amplitude of matched filter $= \frac{A^2.T_0}{2}$

$$= \frac{(20)^2.(0.2)}{2} = 40\text{mV}$$

Maximum amplitude occurs at 0.3ms

115. Ans: (b)

Sol: A zero-order hold (ZOH) circuit holds the input signal value for a period of T. i.e., for an input of short duration (dt) pulse, it produces an output pulse of duration T, the sampling period.



i.e., For an input $\delta(t)$, the output is $u(t) - u(t-T)$

i.e., a rectangular pulse

$x(t) = \delta(t) \Rightarrow X(S) = 1$

$y(t) = u(t) - u(t-T)$

$$\Rightarrow Y(s) = \frac{1-e^{-TS}}{S}$$

The transfer function

$$H(s) = \frac{Y(s)}{X(s)} = \frac{1-e^{-TS}}{S}$$

116. Ans: (b)

Sol: $(SNR)_q = (1.8 + 6n)$ dB = 40dB

$\Rightarrow n = 6.37$

We take n = 7bits/sample

$\therefore$ Minimum Storage Capacity = 20 × 8k × 7

= 1.12Mbits = 140Kbytes

117. Ans: (a)

118. Ans: (c)

Sol: $E[Y] = E[2x - 3] = 2\bar{x} - 3 = 2(-3) - 3 = -9.$

$$E[Y^2] = E[(2x-3)^2] = 4\overline{x^2} - 12\bar{x} + 9$$

$= 4(11) - 1\ 2(-3) + 9 = 89$

$$\sigma_Y^2 = \overline{Y^2} - (\overline{Y})^2 = 89 - 9^2 = 8$$

119. Ans: (a)

Sol: I(XY) = H(X) + H(Y)– H(X,Y) ------(1)

(or)

We know,

H(XY) = H(X) + H(Y/X)

H(XY) = H(Y)+ H(X/Y) -------(2)

Substitute (2) in (1) we get

I(XY) = H(X) – H(X/Y)

(or)

I(XY) = H(Y) –H(Y/X)

120. Ans: (b)

Sol: Prime implicant is the one which can not be minimized further i.e. 2^n minterms not a part of 2^{n+1} minterms

$\Rightarrow$ Option b is true but not Option a.

$\Rightarrow$ EPI is the PI with atleast one unique term, but need not to be of all. Hence Option c is wrong.

121. Ans: (a)

Sol: Flash type of ADC require minimum conversion time.

Dual slope ADC minimizes the effect of power supply interference

Successive approximation type ADC requires a DAC inside.

122. Ans: (d)

Sol: Digital ramp conversion time = $(2^n-1)\times$clock pulse

$$= 1023 \times \frac{1}{500\,K}$$

$= 2046\ \mu s$

Conversion time of successive approximation type

= (n)×(clock pulse)

$$= 10 \times \frac{1}{500\,K}$$

$= 20\ \mu s$

So, approximately 100 times slower.

123. Ans: (a)

Sol: $32\ kB = 2^5 \times 2^{10} B$

$= 2^{15}\ B$

This 32kB I.C has 15 address output lines

$\text{byte difference} = \underline{111}\ \underline{1111}\ \underline{1111}\ \underline{1111}$

$= 7\ FFFH$

Starting address = 1000H

Byte difference = 7 FFFH

End address = 8FFFH

124. Ans: (c)

Sol: The logic circuit, we have

$F_1 = \left(\overline{\overline{x} + y}\right) = x\overline{y}$

$F_2 = \left(\overline{\overline{x} + \overline{y}}\right) + \left(\overline{x + y}\right) = xy + \overline{x}\,\overline{y}$

$= x \odot y$

$F_3 = \left(\overline{x + \overline{y}}\right) = \overline{x}\,y$

The truth table for the logic circuit is given below

x	y	F_1	F_2	F_3
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

From the truth table, we deduce the following result.

If $x > y$; then $F_1 = 1$

If $x = y$; then $F_2 = 1$

If $x < y$; then $F_3 = 1$

Therefore, given logic circuit is a comparator circuit.

125. Ans: (a)

Sol: For RST 6.5 vector address is

$6.5 \times 8 = (52)_{10} = 0034\ H$

126. Ans: (b)

Sol: INR & DCR instructions don't affect carry flag but affect remaining 4 flags.

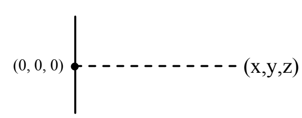
127. Ans: (d)

Sol: There are 8 internal interrupts in 8085 which are all maskable & vectored interrupts i.e software interrupts

128. Ans: (c)

129. Ans: (a)

Sol:



$$\overline{B} = \frac{\mu I}{2\pi}\left(\frac{-\hat{z} \times \left(x\hat{x} + y\hat{y}\right)}{x^2 + y^2}\right)$$

$$= \frac{\mu I}{2\pi}\frac{\left(-x\hat{y} + y\hat{x}\right)}{\left(x^2 + y^2\right)}$$

130. Ans: (a)

Sol: $\vec{E} = -\nabla.V$,

$$\vec{E} = -\left[y(2x+z)\hat{x} + x(x+z)\hat{y} + xy\hat{z}\right] \text{V/m}$$

$$\vec{E}_{(0,1,1)} = -\hat{x}$$

$$\left|\vec{E}\right| = 1$$

131. Ans: (d)

Sol: $\nabla.\vec{D} = \rho_v = 3x^2$

$$\mathbf{Q} = \int_v \rho_v dv$$

$$= \int 3x^2 dv$$

$$= \int_{-1}^{1}\int_{-1}^{1}\int_{-1}^{1} 3x^2 dxdydt$$

$$= 8 \text{ C}$$

132. Ans: (b)

Sol: $\nabla \times H = J$

$$\nabla \times H = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y^2 z & 2(x+1)yz & -(x+1)z^2 \end{vmatrix}$$

$$= -2(x+1)\,\hat{x}\,y - \hat{y}\,(-z^2 - y^2) + \hat{z}\,(2yz - 2yz)$$

$$= \hat{y}$$

Magnitude = 1

133. Ans: (b)

134. Ans: (d)

Sol: Tellegen's theorem states that the sum of power delivered to each branch of any electric network is zero. It is applicable for any lumped network having elements which are linear or non-linear, active or passive, time-varying or time-invariant.

135. Ans: (a)

Sol: For a reactance function, either a pole or zero should occur at the origin.

As $\frac{dX}{d\omega} > 0$, poles and zeros alternate on the jω-axis

136. Ans: (b)

137. Ans: (d)

Sol: The transistor in linear supply acts as an adjustable resistor where the voltage difference between input and the desired output voltage appears across a transistor and causes power loss in it.

In SMPS, the switching elements operate as a switch either completely OFF(or) completely ON. So significant reduction in power losses is achieved. on the negative side proper measure must be taken to prevent EMI due to high frequency switching.

138. Ans: (d)

Sol: The LL fault doesn't associated with ground .Therefore zero sequence components doesn't exists i.e. In case LL fault, the zero sequence voltage is not present.

139. Ans: (a)

Sol: The rectifier voltage is given by

$$V_{d_1} = n\left(\frac{3\sqrt{2}\ V_{Lr}}{\pi}\cos\alpha - \frac{3X_r}{\pi}I_d\right) \text{...... (1)}$$

The inverter voltage is given by

$$V_{d_2} = n\left(\frac{3\sqrt{2}\ V_{Li}}{\pi}\cos\gamma - \frac{3X_i}{\pi}I_d\right) \text{.. ......(2)}$$

where n = number of bridges

V_{Lr} V_{Li} = line to line AC voltages at the rectifier and inverter respectively.

X_{cr}, X_{ci} = commutation reactance at the rectifier and inverter, respectively.

In HVDC systems, DC voltage should be as high as rectifier control angle is low from equation (1). From equation (1) and (2), control of DC voltage is exercised by the rectifier and inverter control angles α and γ respectively.

140. Ans: (c)

Sol: Hard magnetic materials have wide and large and wide hysteresis loop.

141. Ans: (c)

Sol: Gunn metal contains 88% Cu, 10% Sn and 2% Zn.

142. Ans: (a)

Sol: Because of feedback, the closed loop system stability is a major problem in closed loop system

143. Ans: (d)

144. Ans: (b)

145. Ans: (a)

146. Ans: (a)

Sol: $\left(\frac{2}{3}\right)^n u(n) \leftrightarrow \frac{1}{1-\frac{2}{3}z^{-1}}$

$\left(\frac{2}{3}\right)^{n+2} u(n+2) \leftrightarrow \frac{z^2}{1-\frac{2}{3}z^{-1}}$ (From time shifting property of z-transforms $x(n - n_0) \leftrightarrow z^{-n_0} x(t)$)

$\left(\frac{2}{3}\right)^n u(n+2) \leftrightarrow \frac{\frac{9}{4}z^2}{1-\frac{2}{3}z^{-1}}$

147. Ans: (c)

Sol: BJT is a current controlled device. The output current is controlled by the input current. The current in BJT due to both electrons and holes.

148. Ans: (d)

Sol: For same drain current rating p-channel MOSFET occupies more area than n-channel MOSFET.

149. Ans: (d)

Sol: If the receiver is tuned to f_s, the local oscillated frequency (f_ℓ) should be adjusted so that the output of the mixer is always equals to the intermediate frequency (IF)

$\therefore\ f_\ell - f_s = IF$

→ For superheterodyne AM receiver

Tuning range: 550 kHz →1650 kHz

IF : 455 kHz

→ For superheterodyne FM receiver

Tuning range: 88 MHz → 108MHz

IF : 10.7 MHz

150. Ans: (c)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