ESE- 2020 (Prelims) - Offline Test Series Test- 9

ELECTRONICS & TELECOMMUNICATION ENGINEERING

SUBJECT: MATERIALS SCIENCE AND NETWORK THEORY

SOLUTIONS

01. Ans: (a)

Sol: Miller index of a plane in the lattice can be determined by taking the reciprocal distances of the plane w.r.t X, Y, Z axes.

02. Ans: (d)

Sol: Pure silica $\rightarrow$ sodium silicate $\rightarrow$ doped silicon $\rightarrow$ nickel

$10^4 \rightarrow 2 \rightarrow 10^{-4} \rightarrow 10^{-7}$

(Resistivity value in decreasing order)

03. Ans: (d)

Sol: For BCC-Iron material, $4R = \sqrt{3}\,a$

Where, a = lattice parameter

R = radius of atom

$$\Rightarrow a = \frac{4R}{\sqrt{3}} = \frac{4\times 0.173}{\sqrt{3}} \approx 0.4 \text{ nm}$$

04. Ans: (b)

Sol: Metals have low ionization energies, due to loosely bounded valence electrons. The electrostatic attraction between the free electrons and the positive metal ions keeps the metal stable.

05. Ans: (d)

Sol: The hall coefficient, $R = \frac{1}{n.e}$ where 'n' is the carrier concentration. Hall coefficient & charge carrier concentration are inversely rated.

$$R \propto \frac{1}{n}$$

n = Charge carrier concentration

$$\frac{R_A}{R_B} = \frac{4\times 10^{21}}{1\times 10^{21}} = \frac{4}{1}$$


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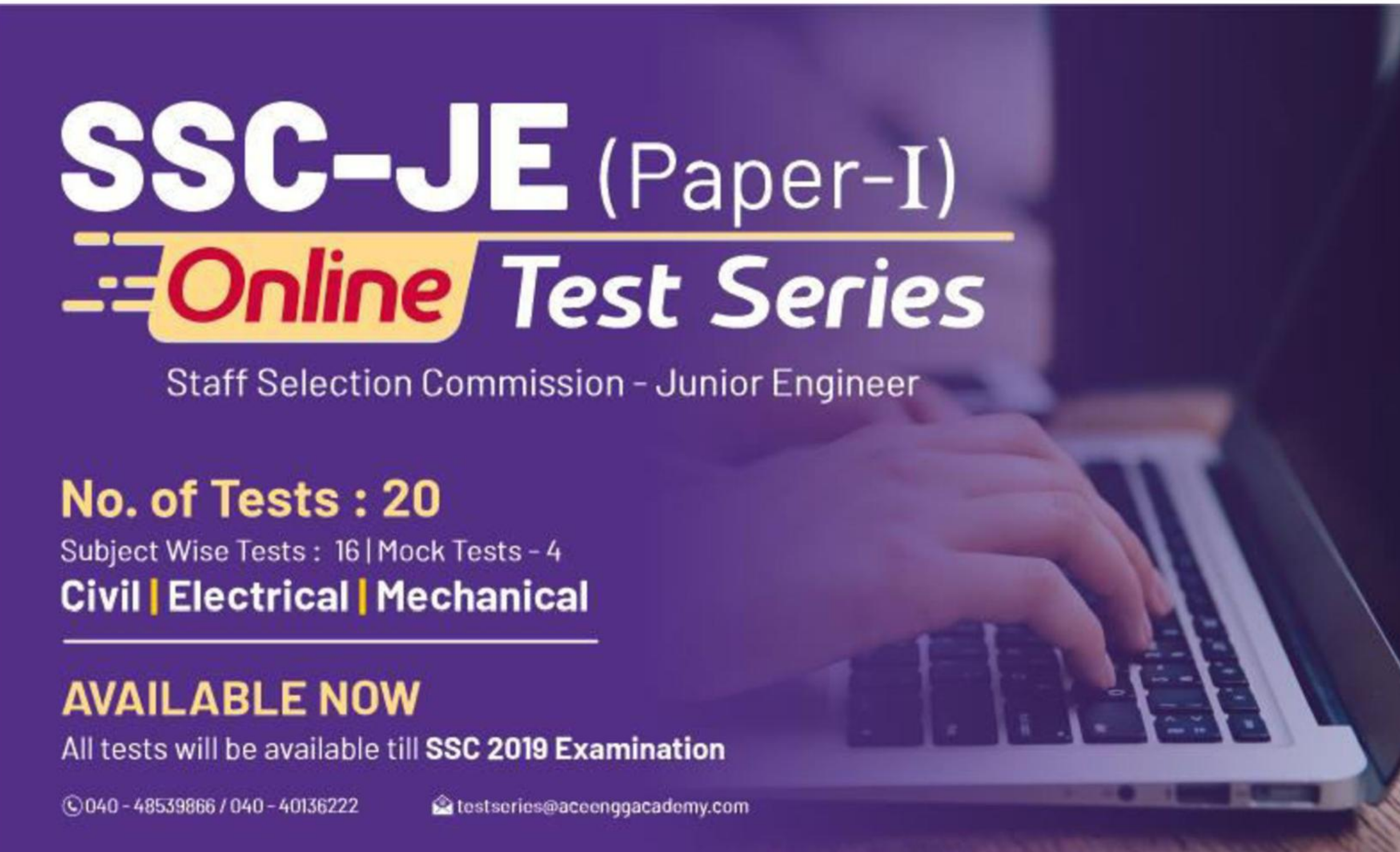
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06. Ans: (a)

Sol: Atomic packing factor for SC = 52% , BCC = 68 %, FCC = 74 % and DC = 34 %.

07. Ans: (c)

Sol: 1 mole of cu = 6.023×10^{23} atoms & cu weights 63.5 gm

$\therefore$ Mass of 1 cu atom = $\dfrac{6.35}{6.023\times10^{23}}$ gram

FCC contains 4 atoms per unit cell

For FCC, $a = 2\sqrt{2}\, r$

$$\therefore\ \rho = \frac{4\times\dfrac{63.5}{6.023\times10^{23}}\times10^{-3}\,\text{kg}}{\left(2\sqrt{2}\times1.28\times10^{-10}\right)^3 \text{m}^3}$$

$$= 8891\,\text{kg/m}^3 \simeq 8.9\times10^3\ \text{kg/m}^3$$

08. Ans: (d)

Sol:

Model	**Particle properties**	**Examples**
1.Maxwell-Boltzmann	Distinguishable unlimited particles per quantum state	Ideal gas, Molecules
2.Bose Einstein	Indistinguishable unlimited particles per quantum state	Photon, phonon
3.Fermi Dirac	Indistinguishable, identical one particle Per quantum state (Pauli exclusion principle)	Electron, protons

09. Ans: (d)

Sol: The bullet proof jocket is made up of aramid fiber reinforced polymer (AFRB) with reinforcement phase is Aramid and matrix phase is polymer.

10. 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 that resistivity of metal increases.

11. Ans: (a)

Sol: Tuning frequency $f \propto \sqrt{\dfrac{Y}{\rho}}$

Where, Y = Young's modulus of the crystal

ρ = density of crystal

$\rho \propto M$

$f \propto \dfrac{1}{\sqrt{M}}$

Hence, upon solving f = 8.165 kHz

12. Ans: (d)

Sol: The overall mobility of a semiconductor, the present both impurity scattering (μ_I) and phonon scattering (μ_p) is $\mu_0 = \dfrac{\mu_I \times \mu_p}{\mu_I + \mu_p}$

13. Ans: (b)

Sol: The coupling coefficient (K) = 0.42

Output mechanical energy = 9.06×10^{-3}J

= 9.06 mJ

$\therefore$ The applied electric field

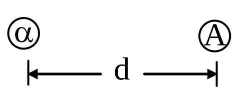
E = (1–0.42) ×9.06

= 5.25mJ

14. Ans: (d)

15. Ans: (b)

Sol:



Given the atom A at a distance

$\alpha = 30A^o$ from an α -particle

The α- particle is helium molecules. It carries 2 units

of positive charge $q = 2\times1.6\times10^{-19}$C

The electric field intensity at the site of the atom $A = \dfrac{1}{4\pi\varepsilon_0}.\dfrac{q}{d^2}$

The dipole moment induced in the atom = $\alpha.\dfrac{1}{4\pi\varepsilon_0}.\dfrac{q}{d^2}$

$= 10^{-40}\times\dfrac{9\times10^9\times3.2\times10^{-19}}{900\times10^{-20}}$

Dipole moment induced

= 3.2×10^{-32} coulomb-m

16. Ans: (b)

17. Ans: (a)

Sol: Stripped metal nanowires of alternative metal like Au & Ag can be used as barcode. Au as '0' and Ag as '1', so 0001010, 01011101, 11010001 there are all different barcodes.

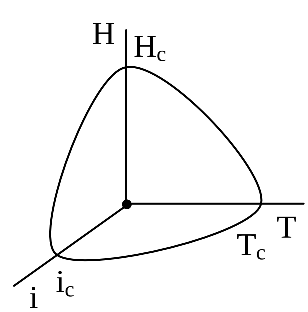
18. Ans: (c)

19. Ans: (d)

Sol: Superconductivity can not be exceeded by the application of electric field.

20. Ans: (a)

Sol: The critical current for superconductor is given as $i_c = 2\pi r H_c$ and $j_c = \dfrac{i_c}{\pi r^2} = \dfrac{2H_c}{r}$



So, critical current density depends on

1. Critical magnetic field
2. Temperature
3. Critical temperature also depends on penetration depth. With increasing in temperature, penetration depth increases.

21. Ans: (a)

Sol: The ceramics are high temperature super conductors. YBCO (Yithum Barium Copper Oxide) is a high temperature ceramic super conductor.

22. Ans: (b)

Sol: Given magnetic moment per atom $=2.22\mu_B$

Magnetic moment per 28 grams $=N\ 2.22\mu_B$

Where N= no. of atoms of Fe in 28 grams

56 grams of Fe contains 6.023×10^{23}atoms

28grams of Fe contains $N=\frac{6.023\times10^{23}}{2}$

$= 3\times10^{23}$

Magnetic moment per 28grams

$= 3\times10^{23}\times2.22\times\mu_B$

$= 3\times10^{23}\times2.22\times9.27\times10^{-24}$

23. Ans: (a)

Sol: Properties of Ferrites (Ferri magnetic materials)

1. Ferrite's possess permanent dipoles with anti parallel and unequal magnitudes they generate large magnetization.
2. Ferrites are ceramic in nature and they are high resistivity materials.
   Eg: Mn,Fe,O_4, Zn Fe_2O_4
3. Ferrite's have low eddy current losses due to high resistivity and hence there are used in high frequency transformers.

24. Ans: (d)

Sol: The hardness of a magnetic material is given by the value of the applied coercive field or even on the product of B and H_{max} called as energy product which gives area of the largest rectangle in the second quadrant of the hysteresis loop.

25. Ans: (c)

Sol: Given data:

$\chi_m = 6.8\times10^{-5}$

Relative permeability $\mu_r = 1+\chi_m$

$\mu_r = 1+6.8\times10^{-5}$

$\mu_r = 1.000068$

Permeability $\mu = \mu_r\ \mu_0$

$= (1.000068)(4\pi\times10^{-7})$

$= 1.256\times10^{-6}$

$\mu = 12.56\times10^{-7}$

26. Ans: (c)

27. Ans: (c)

Sol: Permalloy is a soft magnetic material. If the temperature of material is more than curie's temperature, then the para magnetic material converts into dia magnetic material.

28. Ans: (b)

Sol: $\mu_r = \chi + 1$ for paramagnetic materials susceptibility is positive but very small hence relative permeability slightly greater than unity.

29. Ans: (d)

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

30. Ans: (d)

Sol: The maximum average power transfer to the load, $P_{max} = \frac{|V_{Th}^2|}{4R_{Th}}$

$$P_{max} = \frac{(20)^2}{4\times 10} = 10\,W$$

31. Ans: (d)

Sol: V(t) = 120 cos (100πt –20°)

$\Rightarrow V = 120\angle -20°$

$i(t) = 4\cos(100\pi t + 10°) \Rightarrow I = 4\angle 10°$

$$\therefore\ Z = \frac{V}{I} = \frac{120\angle -20°}{4\angle 10°} = \frac{120}{4}\angle -30°$$

$Z = 30\angle -30°$

$Z = 30\cos(30°) - j30\sin(30°)$

$Z = 15\sqrt{3} - j15$

Resistor and capacitor connected in series

$\therefore\ R = 15\sqrt{3}\,\Omega$

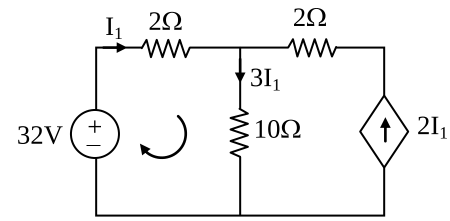
$$X_C = \frac{1}{\omega C} = 15\Omega$$

$$\Rightarrow C = \frac{1}{15\times\omega}$$

$$C = \frac{1}{15\times 100\pi} = \frac{1}{1500\pi}F$$

32. Ans: (d)

Sol:



By KVL, $32 - 2I_1 - 30I_1 = 0$

$\Rightarrow 32 = 32I_1 \Rightarrow I_1 = 1A$

Power dissipated in 10Ω resistor

$= (3I_1)^2 \times 10$

$= 9 \times 10$

= 90 watts

33. Ans: (d)

Sol: We know that for parallel resonance circuit impedance is maximum at resonance frequency.

$\therefore$ Here at 2.5 kHz the impedance is maximum.

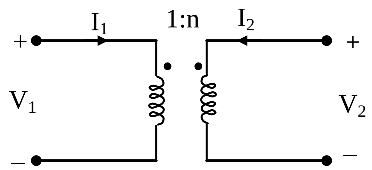
So, $f_0 = 2.5 \times 10^3$ Hz

$\therefore \omega_0 = 2\pi f_0 = 2\pi \times 2.5 \times 10^3$

$= 5000\pi$ rad/sec

34. Ans: (a)

Sol:



For ideal transform, $\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{1}{n}$ &

$\frac{I_1}{I_2} = \frac{-N_2}{N_1} = -n$

$\Rightarrow \frac{V_1}{V_2} = \frac{1}{n}$ $\Rightarrow \frac{I_1}{I_2} = -n$

$\Rightarrow V_1 = \frac{1}{n}V_2$ ..... (1) $\Rightarrow I_2 = -\frac{1}{n}I_1$ .....(2)

Now compare equation (1) and (2) with the general equation of h-parameters

i.e., $V_1 = h_{11}I_1 + h_{12}V_2$

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

$\therefore h_{11} = 0,\ h_{12} = \frac{1}{n}$

$h_{21} = -\frac{1}{n}, h_{22} = 0$

$$[h] = \begin{bmatrix} 0 & 1/n \\ -1/n & 0 \end{bmatrix}$$

35. Ans: (d)

Sol: $R_{CB} = 20 + (40 \parallel 40) + 20$

$= 20 + 20 + 20$

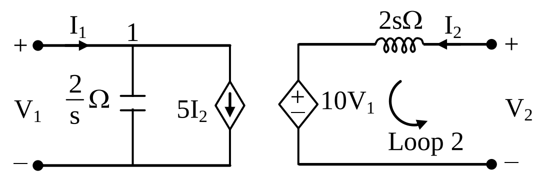
$R_{CB} = 60\ \Omega$

36. Ans: (d)

Sol: The general form of g-parameters are

$I_1 = g_{11}V_1 + g_{12}I_2$

$V_2 = g_{21}V_1 + g_{22}I_2$



Apply KCL at node '1',

$I_1 = \frac{S}{2}V_1 + 5I_2$ .... (1)

Apply KVL to loop '2',

$V_2 = 10V_1 + 2sI_2$ .... (2)

By comparing equation (1) and equation (2)

With general equation

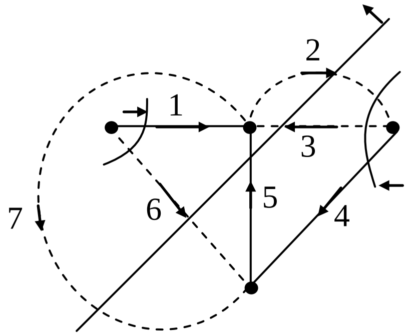
We get, $[g] = \begin{bmatrix} \frac{s}{2} & 5 \\ 10 & 2s \end{bmatrix}$

37. Ans: (a)

Sol: f-cut-set 1: [1, 6]

f-cut-set 4: [2, 3, 4]

f-cut-set 5: [2, 3, 5, 6, 7]



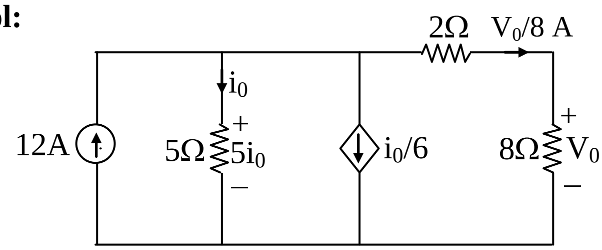
f-cut-set matrix:

f-cut-set ↓	Branches → 1	2	3	4	5	6	7
1	1	0	0	0	0	1	0
4	0	–1	1	1	0	0	0
5	0	–1	1	0	1	–1	–1

38. Ans: (a)

39. Ans: (a)

Sol:



Using voltage division method,

$$V_0 = \frac{5i_0 \times 8}{8+2}$$

$$V_0 = \frac{40i_0}{10}$$

$$\Rightarrow i_0 = \frac{V_0}{4}$$

By KCL,

$$12 = i_0 + \frac{i_0}{6} + \frac{v_0}{8}$$

$$12 = \frac{V_0}{4} + \frac{V_0}{24} + \frac{V_0}{8}\left(\because i_0 = \frac{V_0}{4}\right)$$

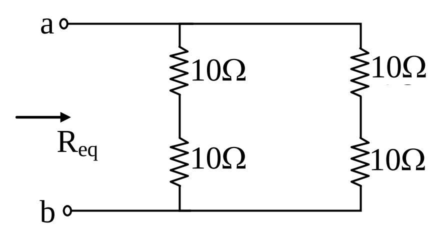
$$12 = \left(\frac{6+1+3}{24}\right)V_0$$

$$V_0 = \frac{12 \times 24}{10}$$

$V_0 = 28.8V$

40. Ans: (c)

Sol: Here the product of opposite arms are same, so using bridge balance condition the circuit can be represented as



$$R_{eq} = \frac{20}{2} = 10\Omega$$

$$G_{eq} = \frac{1}{R_{eq}} = \frac{1}{10} = 0.1℧$$

41. Ans: (b)

Sol: Using voltage division method,

$$V_0 = \frac{V_s(R_2 // 5k)}{R_1 + (R_2 // 5k)}$$

$$\Rightarrow \frac{R_2 // 5k}{R_1 + (R_2 // 5k)} = \frac{V_0}{V_s}$$

$\Rightarrow \dfrac{R_2 // 5k}{R_1 + (R_2 // 5k)} = 0.8$ ……….. (1)

Here, $R_{eq} = R_1 + (R_2//5K)$

$\Rightarrow R_1 + (R_2//5K) = 50K$ ………. (2)

From equation (1) and equation (2)

$\dfrac{R_2 // 5K}{50K} = 0.8$

$R_2//5K = 40K$

$\dfrac{5R_2}{5 + R_2} = 40$

$5R_2 = 40\times5 + 40R_2$

$40R_2 - 5R_2 = -40\times5$

$R_2 = \dfrac{-40\times5}{35} = \dfrac{-40}{7}$

$R_2 = \dfrac{-40}{7}\,k\Omega$

42. Ans: (b)

Sol: We know $R_Y = \dfrac{R_\Delta}{3}$

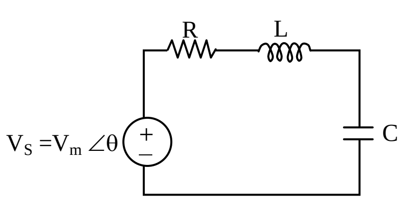
$R_Y = \dfrac{R/2}{3} = \dfrac{R}{6}\Omega$

43. Ans: (c)

44. Ans: (a)

45. Ans: (c)

Sol: In a series RLC circuit



At resonance condition $I_m = \dfrac{V_m}{R}$

At lower cut off frequency,

$$I = \frac{I_m}{\sqrt{2}}$$

$$\Rightarrow \frac{V_m}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} = \frac{V_m}{\sqrt{2}R}$$

$$\Rightarrow \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{2}\,R$$

$$\Rightarrow \left(\omega L - \frac{1}{\omega C}\right) = \pm R$$

At lower cut off frequency

$$\omega L - \frac{1}{\omega c} = -R$$

Power factor angle $\phi = \tan^{-1}\left(\dfrac{\omega L - \frac{1}{\omega C}}{R}\right)$

$= -45^o$

$\therefore$ Power factor = $\cos\phi$ = 0.707 leading

($\because$ capacitive nature)

46. Ans: (c)

Sol: Here, voltage across capacitor, voltage across resistor

$\Rightarrow V_c(t) = V_R(t) = V_0 e^{-t/\tau}$ Volts

Where V_0 = 5 Volts

τ = time constant

$i_R(t) = \dfrac{V_R(t)}{R} = \dfrac{V_0}{R}e^{-t/\tau}$ amperes

The energy absorbed by the resistor up to time t is $W_R(t)=\int_0^t V_R(t)\, i_R(t) dt$

$$=\int_0^t \frac{V_0^2}{R} e^{-\frac{2t}{\tau}} dt$$

$$=-\frac{\tau V_0^2}{2R} e^{-\frac{2t}{\tau}}\Big|_0^t$$

$$\Rightarrow W_R(t)=\frac{1}{2}CV_0^2\left(1-e^{-\frac{2t}{\tau}}\right)$$

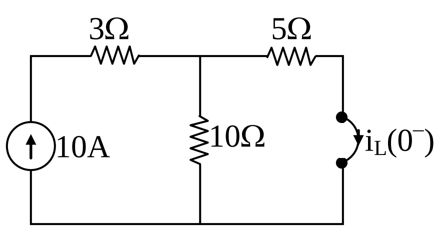
For $t = 2\tau$

$$W_R(2\tau)=\frac{1}{2}\times 25\times 4\left(1-e^{-4}\right)$$

$\Rightarrow W_R(2\tau) = 50\ (1 - e^{-4})$ joules

47. Ans: (d)

Sol: Circuit at $t = 0^-$



Here, $i_L(0^-)=i_L(0^+)=\frac{10\times 10}{10+5}$

$$\Rightarrow i_L(0^+)=\frac{20}{3}$$

$\therefore$ Initial energy stored in the inductor is,

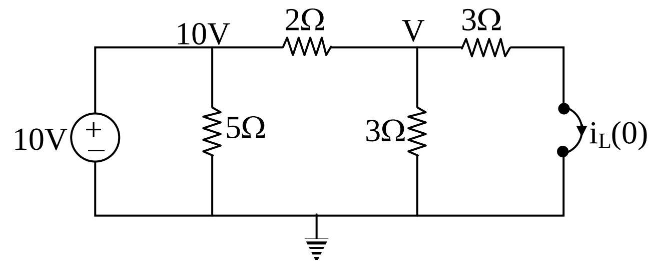
$$W_L(0)=\frac{1}{2}Li^2(0)$$

$$W_L(0)=\frac{1}{2}\times 2\times\left(\frac{20}{3}\right)^2$$

$$\Rightarrow W_L(0)=\frac{400}{9}\text{Joules}$$

48. Ans: (b)

Sol: Circuit at $t = 0^-$



By nodal analysis:

$$\frac{V-10}{2}+\frac{V}{3}+\frac{V}{3}=0$$

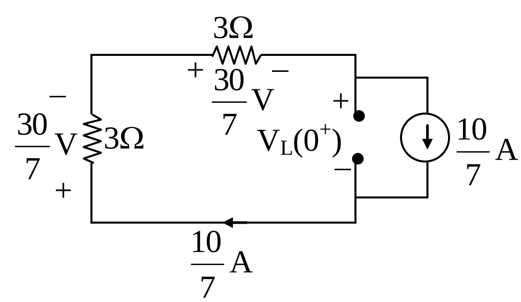
$$\Rightarrow V\left(\frac{1}{2}+\frac{2}{3}\right)=5$$

$$\Rightarrow \frac{7V}{6}=5$$

$$V=\frac{30}{7}$$

$$\therefore\ i_L(0^-)=i_L(0^+)=\frac{30/7}{3}=\frac{10}{7}A$$

Circuit at $t = 0^+$:



By KVL, $-V_L(0^+)-\frac{30}{7}-\frac{30}{7}=0$

$$\Rightarrow V_L(0^+)=-\frac{60}{7}\text{volts}$$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AIR 9 D SABAPARA ME
AIR 9 ANKIT KUMAR CE
AIR 10 ANKITA SHARMA EE
AIR 10 GAURAV SRIVASTAVA E&T
AIR 10 SUMIT BHAMBOO ME
and many more...
TOTAL SELECTIONS in Top 10: 33
(EE: 9, E&T: 8, ME: 9, CE: 7) and many more...


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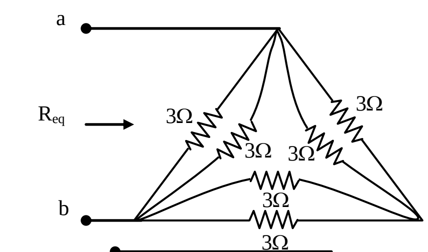
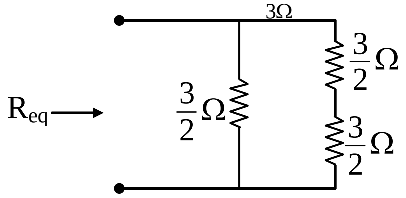
49. Ans: (d)

Sol: We know, $R_Y = \frac{R_\Delta}{3}$ (for three arms have equal resistance)

$\Rightarrow R_\Delta = 3R_Y$

The given circuit is simplified as





$$\therefore\ R_{eq} = \frac{3}{2} \| 3 = \frac{\frac{3}{2}\times 3}{\frac{3}{2}+3}$$

$$R_{eq} = \frac{9}{2}\times\frac{2}{9} = 1\Omega$$

50. Ans: (a)

Sol: Voltage across the capacitor at resonance

$V_c = -jQ\,V_m$

$\Rightarrow V_c = -j25\times 20$

$= -j500$ volts.

51. Ans: (a)

Sol: Complex power, $S = \frac{1}{2}VI^*$

$$= \frac{1}{2}\times 20\angle 30^o \times 50\angle -60^o$$

$$= \frac{20\times 50}{2}\angle 30^o - 60^o$$

$$= 500\angle -30^o$$

Average real power, $P = 500\cos 30^o$

$= 250\sqrt{3}$ watts

52. Ans: (b)

Sol: $v(t) = 225\cos(5t+30^o)$V

$i(t) = 2\cos(5t+60^o-90^o)$A

$= 2\cos(5t-30^o)$A

$\therefore\ V = 225\angle 30^o$

$I = 2\angle -30^o$

$\therefore$ Complex power, $S = \frac{1}{2}VI^*$

$$= \frac{1}{2}\times 225\angle 30^o \times 2\angle 30^o$$

Average real power, $P = \frac{225\times 2}{2}\cos 60^o$

$= 225\cos 60^o$

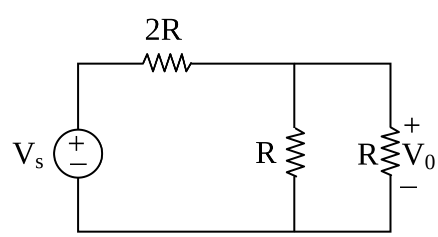
$= 225\times\frac{1}{2}$

= 112.5 watts

53. Ans: (d)

Sol: Let $R_2 = R_3 = R$

So, $R_1 = 2R$ $\quad(\because R_1 = 2R_3)$



Using voltage division method,

$$V_0 = V_s \times \frac{R/2}{\frac{R}{2} + 2R}$$

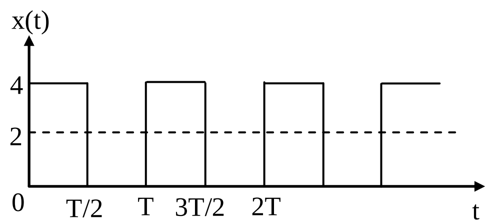
$$\Rightarrow \frac{V_0}{V_S} = \frac{R/2}{\frac{R}{2} + 2R}$$

$$\Rightarrow \frac{V_0}{V_S} = \frac{R}{R + 4R}$$

$$\Rightarrow \frac{V_0}{V_S} = \frac{1}{5} = 0.2$$

54. Ans: (b)

Sol:



$$x(t) = \begin{cases} 4 \;........0 < t < T/2 \\ 0 \;........T/2 < t < T \end{cases}$$

Rms value of x(t) is

$$X_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t)dt}$$

$$X_{rms} = \sqrt{\frac{1}{T}\left[\int_0^{T/2}(4)^2 dt + \int_{T/2}^{T}(0)^2 dt\right]}$$

$$X_{rms} = \sqrt{\frac{1}{T}\left[16\left(\frac{T}{2} - 0\right) + 0\right]}$$

$$X_{rms} = \sqrt{8} = 2\sqrt{2}$$

55. Ans: (c)

Sol: For parallel RLC circuit, resonant frequency is

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

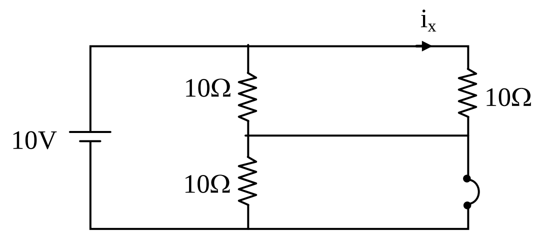
And Bandwidth (BW) = $\frac{\omega_0}{Q}$

$Q = \frac{\omega_0}{BW} = \frac{\omega_0}{1/RC}$ (BW = 1/RC for parallel RLC circuit)

$Q = \omega_0 RC$

56. Ans: (a)

Sol: For $t < 0$, the circuit is



$$i_x(0^-) = \frac{10}{10} = 1A$$

57. Ans: (a)

Sol: The inference can be drawn from Reciprocity theorem.

58. Ans: (a)

Sol: We know, when two, 2-port networks are connected in parallel, their individual Y-parameters gets added.

$\therefore$ First, we need to convert given ABCD parameters to Y-parameters.

For 2-port network

Y-parameters are

$$\left.\begin{aligned} I_1 &= Y_{11}V_1 + Y_{12}V_2 \\ I_2 &= Y_{21}V_1 + Y_{22}V_2 \end{aligned}\right\} (1)$$

ABCD parameters

$$\left.\begin{aligned} V_1 &= AV_2 - BI_2 \\ I_1 &= CV_2 - DI_2 \end{aligned}\right\} (2)$$

Make $V_2 = 0$ to find Y_{11} & Y_{21}

Equation (2) becomes $V_1 = -BI_2$

$I_1 = -DI_2$

$$\therefore Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{D}{B}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-1}{B}$$

Similarly, $V_1 = 0$, to find Y_{12} & Y_{22}

$\therefore$ from equation (2) $AV_2 = BI_2 \Rightarrow$

$$V_2 = \frac{B}{A}I_2$$

$$I_1 = CV_2 - DI_2$$

$$I_1 = C\frac{B}{A}I_2 - DI_2 = \frac{CB - DA}{A}I_2$$

$$I_1 = \frac{BC - AD}{A}I_2$$

But $I_2 = \dfrac{A}{B}V_2$

$$\Rightarrow I_1 = \frac{BC - AD}{A}\frac{A}{B}V_2$$

$$\Rightarrow I_1 = (BC - AD)V_2 \;\ldots\ldots(3)$$

$$\therefore Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{BC - AD}{B}$$

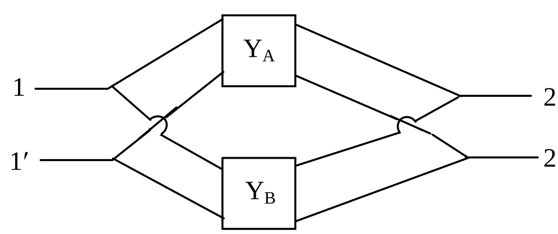
And $I_1 = \dfrac{BC - AD}{B}I_2$ put this value in equation (3)

$$\frac{BC - AD}{A}I_2 = \frac{BC - AD}{B}V_2$$

$$I_2 = \frac{A}{B}V_2 \Rightarrow Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{A}{B}$$

Y-parameter matrix in terms of ABCD parameter is

$$Y_T = \begin{bmatrix} \dfrac{D}{B} & \dfrac{BC - AD}{B} \\ \dfrac{-1}{B} & \dfrac{A}{B} \end{bmatrix}$$



Y_T or $Y_{eq} = Y_A + Y_B$

$$= \begin{bmatrix} \dfrac{D}{B} & \dfrac{BC - AD}{B} \\ \dfrac{-1}{B} & \dfrac{A}{B} \end{bmatrix} + \begin{bmatrix} \dfrac{D}{B} & \dfrac{BC - AD}{B} \\ \dfrac{-1}{B} & \dfrac{A}{B} \end{bmatrix}$$

$$Y_T \text{ or } Y_{eq} = \begin{bmatrix} 2\dfrac{D}{B} & 2\dfrac{(BC - AD)}{B} \\ \dfrac{-2}{B} & \dfrac{2A}{B} \end{bmatrix}$$

Now, again connect back to ABCD parameters

$$\left.\begin{aligned} I_1 &= \frac{2D}{B}V_1 + 2\frac{(BC-AD)}{B}V_2 \\ I_2 &= -\frac{2}{B}V_1 + \frac{2A}{B}V_2 \end{aligned}\right\} (4)$$

Make $V_2 = 0$ $\quad I_1 = \frac{2D}{B}V_1$

$$I_2 = -\frac{2}{B}V_1$$

$$B_T = -\left.\frac{V_1}{I_2}\right|_{V_2=0} = \frac{B}{2} = 0.5B$$

$$D_T = -\left.\frac{I_1}{I_2}\right|_{V_2=0} = \frac{2D/B}{2/B} = D$$

Make $I_2 = 0$, equation (4) becomes

$$V_1 = AV_2 \ \& \ I_1 = \frac{2D}{B}V_1 + 2\frac{(BC-AD)}{B}V_2$$

$$= \frac{2D}{B}AV_2 + \frac{(2BC-2AD)}{B}V_2$$

$$= \left(\frac{2AD+2BC-2AD}{B}\right)V_2$$

$I_1 = 2CV_2$

$$\therefore A_T = \frac{V_1}{V_2} = A$$

$$C_T = \frac{I_1}{V_2} = 2C$$

$$[T] = \begin{bmatrix} A_T & B_T \\ C_T & D_T \end{bmatrix} = \begin{bmatrix} A & 0.5B \\ 2C & D \end{bmatrix}$$

59. Ans: (d)

Sol: g-parameter for 2-port network

$I_1 = g_{11}V_1 + g_{12}I_2$

$V_2 = g_{21}V_1 + g_{22}I_2$

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

Given equation $V_1 = 20I_1 + 5V_2$

$I_2 = 2I_1 + V_2$

Make $I_2 = 0$ $\quad 2I_1 = -V_2$

$$\Rightarrow I_1 = -\frac{1}{2}V_2$$

$$\therefore V_1 = 20\left(-\frac{1}{2}V_2\right) + 5V_2$$

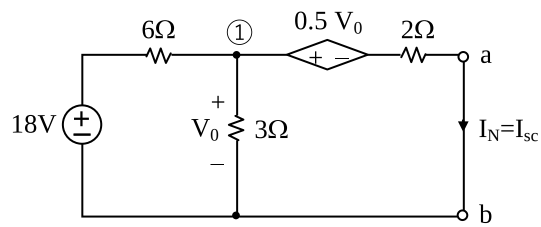
$= (-10 + 5)\,V_2$

$V_1 = -5V_2$

$$\therefore g_{21} = \frac{V_2}{V_1} = \frac{-1}{5} = -0.2$$

60. Ans: (b)

Sol: Dependent current source 0.25V0, converted to voltage source, then circuit becomes



Apply KCL at node (1)

$$\frac{V_1}{3} + \frac{V_1 - 18}{6} + \frac{V_1 - 0.5V_0}{2} = 0$$

But $V_1 = V_0$

$2V_1 + V_1 - 18 + 3V_1 - 1.5\,V_1 = 0$

$4.5\,V_1 = 18$

$V_1 = 4\text{ V}$

But $I_N = Isc = \frac{V_1 - 0.5V_0}{2}$

$= \dfrac{V_1/2}{2} \quad (\because V_1 = V_0)$

$= \dfrac{V_1}{4} = \dfrac{4}{4} = 1$

$I_N = 1A$

61. Ans: (a)

Sol: No. of possible trees $= n^{n-2}$

$= 4^{4-2}$

$= 4^2$

$= 16$

62. Ans: (b)

Sol: R should be minimum in the given options 5 Ω is minimum.

63. Ans: (d)

Sol: In star connection $I_L = I_{ph} = \dfrac{V_L}{\sqrt{3}R} = 12$ A

$\Rightarrow \dfrac{V_L}{R} = \sqrt{3} \times 12$ A

In Δ connection $\sqrt{3}I_{ph} = I_{ph}$; $V_L = V_{ph}$

$I_{ph} = \dfrac{V_L}{R}$

$I_L = \dfrac{\sqrt{3} \times V_L}{R} = \sqrt{3} \times \sqrt{3} \times 12$

$= 36$ A

64. Ans: (d)

Sol: Rated current of each bulb

$= \dfrac{\text{Power}}{\text{Voltage}} = \dfrac{40}{100} = 0.4\,A$

Number of bulbs =

$\dfrac{\text{Triggering Current}}{\text{Rated Current of each bulb}} = \dfrac{4}{0.4} = 10$

65. Ans: (c)

Sol: Statement (I) is correct.

By using substitution theorem, we replace an impedance branch by another branch with different circuit components, without disturbing the voltage-current relationship in the network. So, statement (II) is wrong

66. Ans: (b)

Sol: Let the instantaneous voltage and current are

$v(t) = V_m \cos(\omega t + \theta_v)$

$i(t) = I_m \cos(\omega t + \theta_i)$

$p(t) = v(t) i(t)$

$= V_m I_m \cos(\omega t + \theta_v) \cos(\omega t + \theta_i)$

$P(t) = \dfrac{1}{2} V_m I_m \cos(\theta_v - \theta_i) + \dfrac{1}{2} V_m I_m \cos(2\omega t + \theta_v + \theta_i)$

….(1)

The 2nd part of the above expression is a sinusoidal function whose frequency is 2ω (changes with time)

67. Ans: (d)

Sol: Superposition theorem is applicable to linear networks and system. The system with characteristics equation $y = x^3$ is a non-linear system. So, superposition theorem is not applicable to this system

68. Ans: (b)

69. Ans: (c)

70. Ans: (a)

71. Ans: (d)

Sol: Z_L should be equal to Z_S^* and η=50 %

$\therefore$ A is false but R is true.

72. Ans: (c)

Sol: The internal structure of a material gives the information about the arrangement of atoms in a material. Statement I is correct.

The properties of bulk matter of all kinds are dependent of the nature and distribution of imperfections. Statement II is incorrect.

73. Ans: (a)

Sol: Electrical conductivity of an alloy or solid solution decreases with increasing impurity level because of disturbance in periodicity of atoms and due to that collection of e^- takes place.

74. Ans: (c)

Sol: When dielectric is subjected to alternating field, the polarization (P) varies, so the dielectric constant.

Dielectric constant $\left(\varepsilon_r^*\right) = \varepsilon_r^1 - i\varepsilon_r^{11}$

Where ε_r^{11} is measure of dielectric loss.

75. Ans: (c)