EE-Objective Paper-II (2017)

1. If a square matrix of order 100 has exactly 15 distinct eigen values, then the degree of the minimal polynomial is

(A) At least 15 (B) At most 15
(C) Always 15 (D) Exactly 100

Key: (A)

Sol: Since the given matrix of order 100 has exactly 15 distinct eigen values.
∴ The degree of the minimal polynomial is ≥ 15
i.e. at least 15 .

2. The solution of the differential equation $y\sqrt{1-x^2}dy + x\sqrt{1-y^2}dx = 0$ is

(A) $\sqrt{1-x^2} = c$
(B) $\sqrt{1-y^2} = c$
(C) $\sqrt{1-x^2} + \sqrt{1-y^2} = c$
(D) $\sqrt{1-x^2} + \sqrt{1+y^2} = c$

Key: (C)

Sol: D.E can be written as

$$\frac{x}{\sqrt{1-x^2}}dx + \frac{4}{\sqrt{1-y^2}}dy = 0$$

Integrating, we get

$$-\frac{1}{2}\int \frac{-2x}{\sqrt{1-x^2}}dx + \left(-\frac{1}{2}\right)\int \frac{-2y}{\sqrt{1-y^2}}dy = -C$$

$$\Rightarrow -\sqrt{1-x^2} - \sqrt{1-y^2} = -C$$

$$\Rightarrow \sqrt{1-x^2} + \sqrt{1-y^2} = C \text{ is the solution}$$

3. The general solution of the differential equation

$$\frac{d^4y}{dx^4} - 2\frac{d^3y}{dx^3} + 2\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0 \text{ is}$$

(A) $y = (c_1 - c_2x)e^x + c_3\cos x + c_4\sin x$
(B) $y = (c_1 + c_2x)e^x - c_3\cos x + c_4\sin x$
(C) $y = (c_1 + c_2x)e^x + c_3\cos x + c_4\sin x$
(D) $y = (c_1 + c_2x)e^x + c_3\cos x - c_4\sin x$

Key: (C)

Sol: A.E is $m^4 - 2m^3 + 2m^2 - 2m + 1 = 0$

$\Rightarrow (m-1)(m-1)(m^2+1) = 0$

$\Rightarrow m = 1, 1, \pm i$

$\therefore$ The general solution is $y =$

$C.F = (C_1 + C_2x)e^x + C_3\cos x + C_4\sin x$

4. Given the Fourier series in $(-\pi, \pi)$ for f(x) = x cos x, the value of a_0 will be

(A) $-\frac{2}{3}\pi^2$ (B) 0
(C) 2 (D) $\frac{(-1)^n 2n}{n^2-1}$

Key: (B)

Sol: $f(x) = x\cos x$ is odd function $\therefore a_0 = 0$

5. The Fourier series expansion of the saw-toothed waveform f(x) = x in $(-\pi, \pi)$ of period 2π gives the series,

$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + ...$ The sum is equal to

(A) $\frac{\pi}{2}$ (B) $\frac{\pi^2}{4}$ (C) $\frac{\pi^2}{16}$ (D) $\frac{\pi}{4}$

Key: (D)

Sol: $f(x) = x$ is odd function $= 0$

$\therefore$ Fourier series is $f(x) =$

$$\sum_{n=1}^{\infty} b_n \sin nx \qquad ...(1)$$

$$\text{where } b_n = \frac{2}{\pi}\int_0^{\pi} f(x)\sin nx.dx$$

$$= \frac{2}{\pi}\left[x\left(\frac{-\cos nx}{n}\right) + \frac{\sin nx}{n^2}\right]_0^{\pi}$$

$$= \frac{2}{\pi}\left(\frac{-\pi\cos n\pi}{n}\right) = \frac{-2\cos n\pi}{n}$$

$$\therefore (1) \to f(x) = -2\sum_{n=1}^{\infty}\frac{\cos n\pi \sin nx}{n}$$

$$= -2\left[\frac{-\sin x}{1} + \frac{\sin 2x}{2} - \frac{\sin 3x}{3} + ...\right] \quad ...(2)$$

putting $x = \pi/2$, we get

$$\frac{\pi}{2} = -2\left[-1 + \frac{1}{3} - \frac{1}{5} + ...\right]$$

$$\Rightarrow 1 - \frac{1}{3} + \frac{1}{5} - ... = \pi/4$$

6. What is the value of m for which $2x - x^2 + my^2$ is harmonic?

(A) 1 (B) –1 (C) 2 (D) –2

Key: (A)

Sol: Let $\phi = 2x - x^2 + my^2$ be harmonic function

$$\therefore \frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0 \Rightarrow -2 + 2m = 0 \Rightarrow m = 1$$

7. Evaluate $\int_c \frac{dz}{z\sin z}$, where c is $x^2 + y^2 = 1$.

(A) 1 (B) 2 (C) 0 (D) –1

Key: (C)

Sol: Clearly z=0 is a pole of order 2 lies inside $C: x^2 + y^2 = 1$

$$\therefore \operatorname{Res}_{z=0} f(z) = \operatorname{Lt}_{z\to 0}\frac{d}{dz}\left\{(z-0)^2.f(z)\right\}$$

$$= \operatorname{Lt}_{z\to 0}\frac{d}{dz}\left\{\frac{z}{\sin z}\right\} = \operatorname{Lt}_{z\to 0}\left\{\frac{\sin z - z\cos z}{\sin^2 z}\right\}$$

$$\left(\because \frac{0}{0}\text{ form}\right)$$

$$= \operatorname{Lt}_{z\to 0}\left\{\frac{z\sin z}{z\sin z\cos z}\right\} = 0$$

$$\therefore \int_C \frac{1}{z\sin z}dz = 2\pi i \times \operatorname{Res}_{z=0} f(z) = 0$$

8. The sum of residues of $f(z) = \frac{2z}{(z-1)^2(z-2)}$ at its singular point is

(A) –8 (B) –4 (C) 0 (D) 4

Key: (C)

Sol: Z=1 is a pole of order 2 and z = 2 is a pole of order 1

$$\therefore \operatorname{Res}_{z=1} f(z) = \operatorname{Lt}_{z\to 1}\frac{d}{dz}\left\{(z-1)^2.f(z)\right\}$$

$$= \operatorname{Lt}_{z\to 1}\frac{d}{dz}\left(\frac{2z}{z-2}\right) = \operatorname{Lt}_{z\to 1}\left(\frac{(z-2)(2) - 2z(1)}{(z-2)^2}\right) = -4$$

$$\text{and } \operatorname{Res}_{z=2} f(z) = \operatorname{Lt}_{z\to 2}(z-2).f(z) = \operatorname{Lt}_{z\to 2}\frac{2z}{(z-1)^2} = 4$$

$\therefore$ sum of the residues is 0

9. A bag contains 7 red and 4 white balls. Two balls are drawn at random. What is the probability that both the balls are red?

(A) $\frac{28}{55}$ (B) $\frac{21}{55}$ (C) $\frac{7}{55}$ (D) $\frac{4}{55}$

Key: (B)

Sol: Total balls = 11

$$n(s) = 11_{C_2}$$

$$\therefore P_r(\text{both balls are red}) = \frac{7_{C_2}}{11_{C_2}} = \frac{21}{55}$$

10. A random variable X has the density function $f(x) = K\frac{1}{1+x^2}$, where $-\infty < x < \infty$. Then the value of K is

(A) π (B) $\frac{1}{\pi}$ (C) 2π (D) $\frac{1}{2\pi}$

Key: (B)

Sol: $\int_{-\infty}^{\infty} f(x)dx = 1 \Rightarrow 2K\int_0^{\infty}\frac{1}{1+x^2}dx = 1$

$\Rightarrow 2K\left(\tan^{-1}x\right)_0^{\infty} = 1 \Rightarrow K = \frac{1}{\pi}$

11. A random variable X has a probability density function

$$f(x) = \begin{cases} k\,x^n\,e^{-x}; & x \geq 0 \\ 0; & \text{otherwise} \end{cases}$$

(n is an integer) with mean 3. The values of {k, n} are

(A) $\left\{\frac{1}{2}, 1\right\}$ (B) $\left\{\frac{1}{4}, 2\right\}$

(C) $\left\{\frac{1}{2}, 2\right\}$ (D) {1, 2}

Key: (C)

Sol: $\int_0^{\infty} f(x)dx = 1 \Rightarrow K(n!) = 1 \Rightarrow K = \frac{1}{n!}$

and $E(X) = 3 \Rightarrow \int_0^{\infty} x.f(x)dx = 3$

$\Rightarrow K.(n+1)! = 3 \Rightarrow n+1 = 3 \Rightarrow n = 2$

$\therefore K = 1/2$

12. What is the probability that at most 5 defective fuses will be found in a box of 200 fuses, if 2% of such fuses are defective?

(A) 0.82 (B) 0.79 (C) 0.59 (D) 0.52

Key: (B)

Sol: Let $P = P_r(\text{defective fuse}) = 2\% = 0.02$

$n = 200 \Rightarrow \lambda = n \times P = 4$

and $P(X = x) = \frac{e^{-\lambda}\lambda^x}{x!}$ is poisson probability

$\therefore P_r(\text{at most 5 defective fuses}) = P_r(x \leq 5)$

$= P_r(0) + P_r(1) + P_r(2) + P_r(3) + P_r(4) + P_r(5)$

$= e^{-4}\left(1 + 4 + \frac{16}{2} + \frac{64}{6} + \frac{256}{24} + \frac{1024}{120}\right) \approx 0.79$

13. If X is a normal variate with mean 30 and standard deviation 5, what is probability $(26 \leq X \leq 34)$, given A (z = 0.8) = 0.2881?

(A) 0.2881 (B) 0.5762

(C) 0.8181 (D) 0.1616

Key: (B)

Sol: $X \sim N(30, 25)$ and $Z = \frac{X - 30}{5}$

for $x = 26 \Rightarrow z = -0.8$ and for $x = 34 \Rightarrow z = 0.8$

$\therefore P_r(26 \leq X \leq 34) = P_r(-0.8 \leq Z \leq 0.8)$

$= 2 \times A(z = 0.8) = 0.576z$

14. For high speed reading and storing of information in a computer, the core shall be of

(A) Ferrite

(B) Piezoelectric

(C) Pyroelectric

(D) Ferromagnetic above 768°C

Key: (A)

15. Soft magnetic materials should have

(A) Large saturation magnetization and large permeability

(B) Low saturation magnetization and large permeability

(C) Large saturation magnetization and low permeability

(D) Low saturation magnetization and low permeability

Key: (A)

16. Gauss's theorem states that total electric flux ϕ emanating from a closed surface is equal to

(A) Total current density on the surface

(B) Total charge enclosed by that surface

(C) Total current on the surface

(D) Total charge density within the surface

Key: (B)

17. Orbital magnetic moment of an electron, in an atom, is of the order of

(A) 0.1 Bohr magneton
(B) 1.0 Bohr magneton
(C) 10 Bohr magneton
(D) 100 Bohr magneton

Key: (B)

18. When the temperature of a ferromagnetic material exceeds the Curie temperature, it behaves similar to a

(A) Diamagnetic material
(B) Ferrimagnetic material
(C) Paramagnetic material
(D) Antiferromagnetic material

Key: (C)

19. Photoconductivity is a characteristic of semiconductors. When light falls on certain semiconductors, it

(A) Sets free electrons from some of the atoms, increasing the conductivity
(B) Ejects electrons into space
(C) Establishes a potential difference creating a source of EMF
(D) Produces heat raising the temperature.

Key: (A)

20. The resistivity of intrinsic germanium at 30°C is $0.46\,\Omega-\text{m}$. What is the intrinsic carrier density n_i at 30°C, taking the electron mobility μ_n as 0.38 m^2/V-s and hole mobility μ_p as $0.18 m^2/V-s$?.

(A) $2.4\times10^{19}/m^3$ (B) $4.2\times10^{19}/m^3$
(C) $2.4\times10^{10}/m^3$ (D) $4.2\times10^{10}/m^3$

Key: (A)

Sol: $\rho=\dfrac{1}{ne.\mu_n+p.e\mu_p}$

$$\rho=\frac{1}{n_i\left[\mu_n+\mu_p\right]e}$$

$\left[\because n=\rho=n_i \text{ for an intrinsic semiconductor}\right]$

$$n_i=\frac{1}{\rho\left[\mu_n+\mu_p\right]e}$$

$$=\frac{1}{0.46\left[0.38+0.18\right]\times1.602\times10^{-19}}$$

$$n_i=2.4\times10^{19}/m^2$$

21. For intrinsic gallium arsenide, conductivity at room temperature is $10^{-6}(\Omega-m)^{-1}$, the electron and hole mobilities are, respectively 0.85 and 0.04 m^2/V–s. The intrinsic carrier concentration n at room temperature is.

(A) $7.0\times10^{12}m^{-3}$ (B) $0.7\times10^{12}m^{-3}$
(C) $7.0\times10^{-12}m^{-3}$ (D) $0.7\times10^{-12}m^{-3}$

Key: (A)

Sol: $n_i=\dfrac{\sigma}{\left[\mu_n+\mu_p\right]e}$

$$=\frac{10^{-6}}{0.89\times1.602\times10^{-19}}$$

$$=7.0137\times10^{12}/m^3$$

22. A copper conductor has a resistance of $15.5\,\Omega$ at 0°C. What is its percentage conductivity at 16°C (to nearest unit value) assuming the temperature coefficient of copper as 0.00428 per °C at 0°C?

(A) 54% (B) 68% (C) 94% (D) 98%

Key: (C)

Sol: $R_T=Ro(1+\alpha.\Delta T)$

23. At temperatures above a limiting value, the energy of lattice vibrations, in a conductor, increases linearly with temperature so that resistivity increases linearly with temperature.

In this region, this limiting value of temperature is called.
(A) Bernoulli temperature
(B) Curie temperature
(C) Debye temperature
(D) Neel temperature

Key: (C)

24. Consider the following statements :
1. The critical magnetic field of a superconductor is maximum at absolute zero.
2. Transition temperature of a superconductor is sensitive to its structure.
3. The crictical magnetic field of a superconductor is zero at its critical temperature.
4. Superconductors show very high conductivity below the critical temperature.

Which of the above statements are correct?
(A) 1,2 and 3 only (B) 1,2 and 4 only
(C) 2,3 and 4 only (D) 1,3 and 4 only

Key: (D)

25. What is the correct sequence of the following materials in ascending order of their resistivity?
1. Iron 2. Silver 3. Constantan
4. Mica 5. Aluminium

Select the correct answer using the codes given below:
(A) 2,5,1,3 and 4 (B) 4,5,3,1 and 2
(C) 2,3,1,5 and 4 (D) 4,5,1,3 and 2

Key: (A)

26. In the first Cauer network, with a pole at infinity, the first element must be
(A) Series capacitor (B) Series inductor
(C) Shunt capacitor (D) Shunt inductor

Key: (B)

Sol: Pole of Infinity means 'S' term by synthetic division is Inductor

27. The total magnetic moment
1. is called saturation magnetization.
2. depends on the number of magnetic dipoles per unit volume, the instant electric current and the area of the current loop.

Which of the above statements is/are correct?
(A) 1 only (B) 2 only
(C) Both 1 and 2 (D) Neither 1 nor 2

Key: (B)

28. Which of the following statements are correct regarding dot product of vectors?
1. Dot product is less than or equal to the product of magnitudes of two vectors.
2. When two vectors are perpendicular to each other, then their dot product is non-zero.
3. Dot product of two vectors is positive or negative depending whether the angle between the vectors is less than or greater than $\frac{\pi}{2}$.
4. Dot product is equal to the product of one vector and the projection of the vector on the first one.

Select the correct answer using the codes given below:
(A) 1,2 and 3 only (B) 1,3 and 4 only
(C) 1,2 and 4 only (D) 2,3 and 4 only

Key: (B)

29. Susceptibility of a diamagnetic material is
1. Negative
2. Positive
3. Dependent on the temperature
4. Independent of the temperature

Select the correct answer using the codes given below:

(A) 1 and 3 only (B) 2 and 3 only
(C) 1 and 4 only (D) 2 and 4 only

Key: (C)

30. Consider the following statements :

1. The susceptibility χ of diamagnetic materials is small and negative.

2. The susceptibility of para and anti ferromagnetic materials is small but positive.

3. The susceptibility has a finite value for free space or air.

Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (A)

31. Eddy current losses in transformer cores can be reduced by the use of

1. Solid cores
2. Laminated cores
3. Ferrites

Select the correct answer using the codes given below:

(A) 2 and 3 only (B) 1 and 2 only
(C) 1 and 3 only (D) 1,2 and 3

Key: (A)

Sol: → Eddy current losses can be reduced by having thin laminated construction

$\left(\because R = \frac{\rho l}{a}\right)$ if $a \downarrow \Rightarrow R \Uparrow \Rightarrow I_e \Downarrow$.

→ Ferrite material will possess more magnetic properties than conducting properties, Therefore electron conduction will be less and hence Eddy losses also less.

32. The phenomenon of magnetostriction occurs when a ferromagnetic substance is magnetized resulting in

(A) Heating
(B) Small changes in its dimensions
(C) Small changes in its crystal structure
(D) Some change in its mechanical properties

Key: (B)

33. What type of defect causes F-centers in a crystal?

(A) Stoichiometric defect
(B) Metal excess defect due to anion vacancies
(C) Metal excess defect due to extra cations
(D) Frenkel defect

Key: (B)

Sol: Schottky Defects

34. Consider the following statements :

1. Superconductors exhibit normal conductivity behavior above a transition temperature T_c.

2. Superconductors lose their super-conducting nature in an external magnetic field, provided the external magnetic field is above a critical value.

3. High T_c superconductors have T_c values in the range 1 to K.

Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1,2 and 3

Key: (A)

Sol: $T > T_c \Rightarrow$ Loss of Super Conductivity

$H > H_c \Rightarrow$ Loss of Super Conductivity

35. Superconductivity is a material property associated with

(A) Changing shape by stretching
(B) Stretching without breaking
(C) A loss of thermal resistance
(D) A loss of electrical resistance

Key: (D)

36. An atom in a crystal vibrates at a frequency, determined by

1. Crystal heat current
2. Crystal temperature
3. The stiffness of the bonds with neighbour atoms

Select the correct answer using the codes given below:

(A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (D)

37. Consider the following statements:

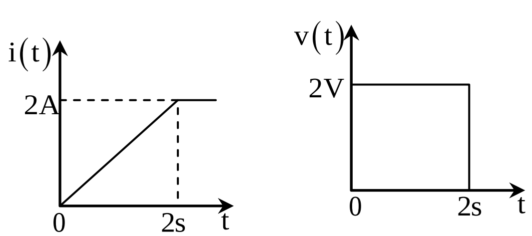
1. Nano means 10^{-9} so that nano materials have an order of dimension higher than the size of atom and come in the form of rods, tubes, spheres or even thin sheets/films.
2. Nano materials have enhanced or changed structural property.
3. Nano elements lend themselves to mechanical processing like rolling, twisting, positioning.
4. Nano elements show important electrical, magnetic and optical characteristics that are useful in electrical industry.

Which of the above statements are correct?

(A) 1,2 and 3 only (B) 1,2,3 and 4
(C) 3 and 4 only (D) 1,2 and 4 only

Key: (B)

38. The voltage and current waveforms for an element are shown in the figure.



The circuit element and its value are

(A) Capacitor, 2F (B) Inductor, 2H
(C) Capacitor, 0.5F (D) Inductor, 0.5H

Key: (B)

Sol: By comparing V(t) and i(t) we can say that

$$V(t) = K\frac{di(t)}{dt}$$

So it is inductor, but $\frac{di(t)}{dt} = 1$

$$\Rightarrow V(t) = L\frac{di(t)}{dt}$$

$$\Rightarrow 2 = L1 \Rightarrow L = 2H$$

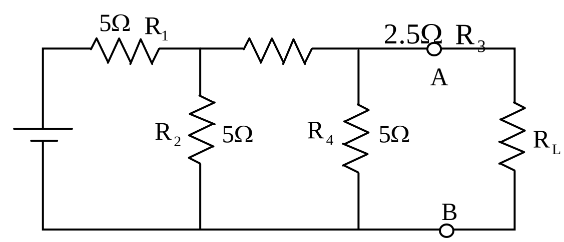
39. In a connected graph, the total number of branches is b and the total number of nodes is n. Then the number of links L of a co-tree is.

(A) b – n (B) b – n – 1
(C) b + n – 1 (D) b – n + 1

Key: (D)

Sol: Number of links =[No of branch] – [(no of nodes) -1]
= b-(n-1) = b- n+1

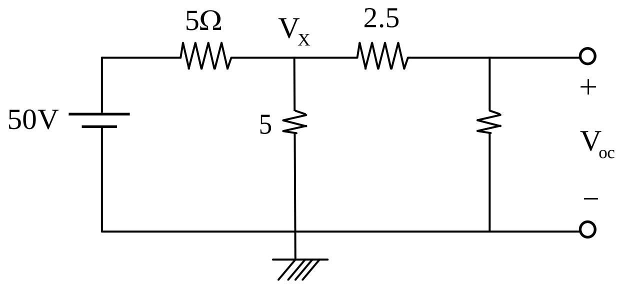
40. For the circuit shown, Thevenin's open circuit voltage V_{oc} and Thevenin's equivalent resistance R_{eq} at terminals A – B are, respectively,



(A) 6.25 V and 2.5 Ω
(B) 12.5V and 5 Ω
(C) 6.25V and 5 Ω
(D) 12.5V and 2.5 Ω

Key: (D)

Sol: To find V_{OC} , remove R_L and measure V_{OC}



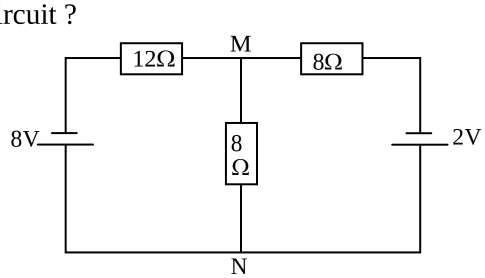
$$\frac{V_X-50}{5}+\frac{V_X}{5}+\frac{V_X}{7.5}=0\Rightarrow V_X=\frac{75}{4}V$$

$$V_{oc}=\frac{5}{2.5+5}V_X=\frac{5}{7.5}\times\frac{75}{4}=12.5V$$

$$\rightarrow R_{th}=5//\left[2.5+(5//5)\right]=5//$$

$$[2.5+2.5]=5//5=2.5$$

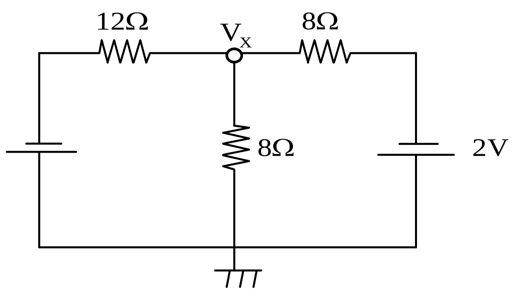
41. What is the current through the $8\,\Omega$ resistance connected across terminals, M and N in the circuit ?



(A) 0.34 A from M to N
(B) 0.29 A from M to N
(C) 0.29 A from N to M
(D) 0.34 A from N to M

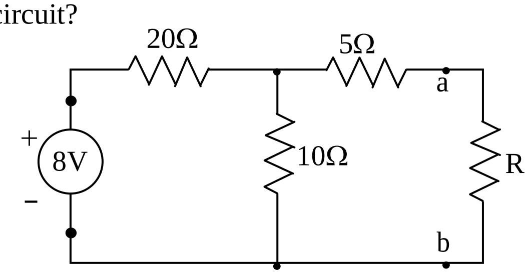
Key: (D)

Sol: $\frac{V_X+8}{12}+\frac{V_X}{8}+\frac{V_X+2}{8}=0\Rightarrow V_X=-11/4$



$$I_{MN}=\frac{-11}{32};\quad I_{NM}=\frac{11}{32}=0.34A$$

42. What is the value of resistance R which will allow maximum power dissipation in the circuit?



(A) $11.66\,\Omega$ (B) $10.33\,\Omega$
(C) $8.33\,\Omega$ (D) $7.66\,\Omega$

Key: (A)

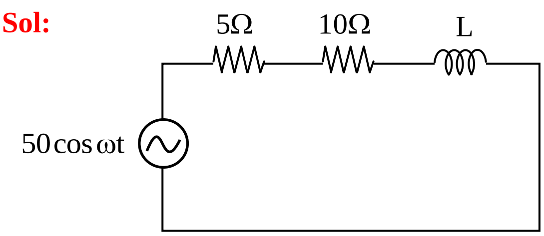
Sol: R for maximum power transfer $R = R/r_{th}$

43. Two resistors of $5\,\Omega$ and $10\,\Omega$ and an inductor L are connected in series across a $50\cos\omega t$ voltage source. If the power consumed by the $5\,\Omega$ resistor is 10W, the power factor of the circuit is

(A) 1.0 (B) 0.8 (C) 0.6 (D) 0.4

Key: (C)

Sol:



$$P_{5\Omega}=10W\Rightarrow I_{rms}^{\ 2}R=10$$

$$\Rightarrow |I_{rms}|=\sqrt{\frac{10}{5}}=\sqrt{2}\rightarrow |V_{rms}|=\frac{50}{\sqrt{2}}$$

$$\rightarrow |Z|=\left|\frac{V_{rms}}{I_{rms}}\right|=\frac{50}{2}=25\rightarrow R=|Z|\cos\phi$$

$$\Rightarrow \cos\phi=\frac{R}{|Z|}=\frac{5+10}{25}=\frac{15}{25}=\frac{3}{5}=0.6$$

44. A two-element series circuit is connected across an AC source given by $e=200\sqrt{2}\sin(314t+20)V$. The current is then found to be $i = 10\sqrt{2}\cos(314t - 25)$A.

The Parameters of the circuit are

(A) R = 20 Ω and C = 160 μ F

(B) R = 14.14 Ω and C = 225 μ F

(C) L= 45mH and C = 225 μ F

(D) L = 45mH and C = 160 μ F

Key: (B)

Sol: $e = 200\sqrt{2}\sin(314t + 20)$

$\Rightarrow \bar{e} = 200\sqrt{2}\angle{-70^o}$

$\rightarrow i = 10\sqrt{2}\cos(314t - 25^o)$

$\bar{I} = 10\sqrt{2}\angle{-25}$

$\rightarrow \bar{Z} = \frac{\bar{e}}{\bar{I}} = \frac{200\sqrt{2}\angle{-70}}{10\sqrt{2}\angle{-25}} = 20\angle{-85}$

$= 20[\cos 45 - j\sin 45] = 20\frac{1}{\sqrt{2}} - j20\frac{1}{\sqrt{2}}$

$= 10\sqrt{2} - j10\sqrt{2}$

$Z = R - j\frac{1}{\omega C}; \quad R = 10\sqrt{2} = 14.14$

$\frac{1}{\omega C} = 10\sqrt{2}$

$\Rightarrow C = \frac{1}{\omega \times 10\sqrt{2}} = \frac{1}{314 \times 10\sqrt{2}} = 225\mu f$

45. How fast can the output of an OP Amp change by 10V, if its slew rate is 1V/ μs?

(A) 5 μ s (B) 10 μ s (C) 15 μ s (D) 20 μ s

Key: (B)

Sol: dv_o = Change of output voltage = 10V

δ = Slew rate = 1V/μs = 10^6 V/S

dt = change of time

$\delta = \left.\frac{dv}{dt}\right|_{max} \Rightarrow dt = \frac{dv}{s} = \frac{10}{10^6} = 10\mu s$

46. A three phase star connected load is operating at a power factor angle ϕ, with ϕ being the angle between

(A) Line voltage and line current

(B) Phase voltage and phase current

(C) Line voltage and phase current

(D) Phase voltage and line current

Key: Both (B) and (D)

47. For a two-part reciprocal network, the three transmission parameters are A = 4, B = 7 and C = 5. What is the value of D?

(A) 9.5 (B) 9.0 (C) 8.5 (D) 8.0

Key: (B)

Sol: For reciprocal network AD - BC = 1

$\Rightarrow 4D - 35 = 1 \Rightarrow 4D = 36 \Rightarrow D = 9$

48. Consider the following as representations of reciprocity in terms of z – parameters:

1. $z_{11} = z_{12}$ **2.** $z_{12} = z_{22}$

3. $z_{12} = z_{21}$

Which of the above representations is/are correct?

(A) 1 only (B) 2 only

(C) 3 only (D) 1,2 and 3

Key: (C)

Sol: $Z_{12} = Z_{21}$

49. A parallel plate capacitor is made of two circular plates separated by a distance of 5mm and with a dielectric with dielectric constant of 2.2 between them. When the electric field in the dielectric is 3×10^4V/m, the charge density of the positive plate will be, nearly.

(A) 58.5×10^4 C/m^2 (B) 29.5×10^4 C/m^2

(C) 29.5×10^{-4} C/m^2 (D) 58.5×10^{-4} C/m^2

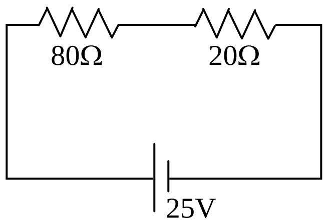
Key: (*)

Sol: $Q = CV = \frac{EA}{d} \times \frac{E}{d}$

$\Rightarrow \frac{Q}{A} = \frac{E \times E}{d^2} = \frac{1}{36\pi} \times \frac{10^{-9} \times 2.2 \times 3 \times 10^4}{25 \times 10^{-6}}$

$= 23.34 mC/m^2$

50. What is the potential drop across the $80\,\Omega$ resistor in the figure?



(A) 20V (B) 15V (C) 10V (D) 5V

Key: (A)

Sol: $V_{80\Omega} = \frac{80}{80+20}25 = \frac{80}{100}25 = \frac{86}{4} = 20$

51. When 7/0.029 V.I.R cable is carrying 20A, a drop of 1 V occurs every 12m. The voltage drop in a 100m run of this cable when it is carrying 10A is nearly

(A) 4.2V (B) 3.2V (C) 1.2V (D) 0.42V

Key: (A)

Sol: If 20 A current carrying Voltage drop is 1V for 12m

If 10 A current carrying Voltage drop is 0.5V for 12m

So for 100m (100/12)*0.5=4.2V

52. Consider the following statements:

If a high Q parallel resonant circuit is loaded with a resistance

1. The circuit impedance reduces.
2. The resonant frequency remains the same.
3. The bandwidth reduces.

Which of the above statements is/are correct?

(A) 3 only (B) 2 only
(C) 1 only (D) 1, 2 and 3

Key: (D)

Sol: For parallel Resonant Circuit $\omega_o = \frac{1}{\sqrt{LC}}$

$Q = \omega_o RC$

$\rightarrow$ since ω_o is independent of R_1, it will not change

$\rightarrow B\omega = \frac{1}{RC}$, so when R↑, B.W ↓↓

53. A drawn wire of resistance $5\,\Omega$ is further drawn so that its diameter becomes one-fifth of the original. What is its resistance with volume remaining the same?

(A) $25\,\Omega$ (B) $125\,\Omega$
(C) $625\,\Omega$ (D) $3125\,\Omega$

Key: (C)

Sol: Since volume remains same, we can write

$\frac{4}{3}\pi r_1^2 h_1 = \frac{4}{3}\pi r_2^2 h_2$

$\Rightarrow d_1^2 h_1 = d_2^2 h_2 \Rightarrow h_2 = \left(\frac{d_1}{d_2}\right)^2 h_1$

it is given that $d_2 = \frac{d_1}{5}$

$\Rightarrow h_2 = 25h_1$

$\rightarrow$ We know $R = \rho\frac{L}{A}$

$= \rho\frac{L^2}{AL} = \frac{\rho}{V}L^2 \Rightarrow R\alpha l^2$

$\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$

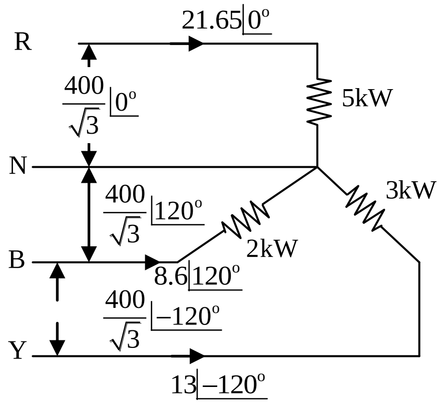
$\Rightarrow R_2 = R_1\left(\frac{l_2}{l_1}\right)^2 = 5(25)^2 = 625\Omega$

54. The three non-inductive loads of 5kW, 3kW and 2kW are connected in a star network between R, Y and B phases and neutral. The line voltage is 400V. The current in the neutral wire is nearly

(A) 11A (B) 14A (C) 17A (D) 21A

Key: (A)

Sol: $P_{RN} = V_R.I_R$



$$I_{RN}=\frac{P_R}{V_R}=\frac{5\times10^3}{\frac{400}{\sqrt{3}}}=21.65\angle 0^\circ$$

$$I_{BN}=\frac{P_B}{V_B}=\frac{2\times10^3}{\frac{400}{\sqrt{3}}}=8.6\angle +120^\circ$$

$$I_{YB}=\frac{P_Y}{V_Y}=\frac{3\times10^3}{\frac{400}{\sqrt{3}}}=13\angle -120^\circ$$

$$I_N=I_{RN}+I_{BN}+I_{YB}$$

$$=21.65\angle 0^\circ+8.6\angle 120^\circ+13\angle -120^\circ=11.45\angle 19.11^\circ$$

55. Kirchhoff's current law is applicable to

1. Closed loops in a circuit
2. Junction in a circuit
3. Magnetic circuits

Which of the above is/are correct?

(A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (B)

56. Which of the following are satisfied in a non-linear network?

1. Associative **2.** Superposition
3. Homogeneity **4.** Bilaterality

Select the correct answer using the codes given below:

(A) 1 and 3 only (B) 1 and 4 only
(C) 2 and 3 only (D) 2 and 4 only

Key: (B)

57. $\nabla\times\overline{H}=\sigma E+\varepsilon\left(\frac{\partial E}{\partial t}\right)$ is

(A) Modified Faraday's law
(B) Gauss's law
(C) Biot – Savart law
(D) Modified Ampere's law

Key: (D)

58. Consider the following statements:

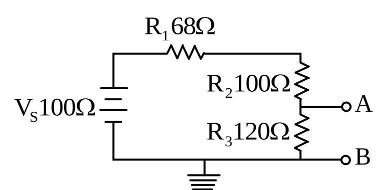
1. Network theorems are not derivable from Kirchhoff's law.
2. To get the Norton current, one has to short the current source.
3. Thevenin's theorem is suitable for a circuit involving voltage sources and series connections.

Which of the above statements is/are correct?

(A) 1, 2 and 3 (B) 1 only
(C) 2 only (D) 3 only

Key: (D)

59. What are the Thevenin's equivalent voltage V_{TH} and resistance R_{TH} between the terminals A and B of the circuit?



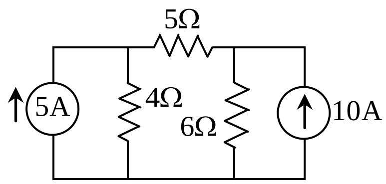
(A) 4.16 V and 120 Ω
(B) 41.67 V and 120 Ω
(C) 4.16 V and 70 Ω
(D) 41.67 V and 70 Ω

Key: (D)

Sol: $V_{th}=\frac{120}{68+100+120}160=41.67V$

$R_{th}=168//120=70\Omega$

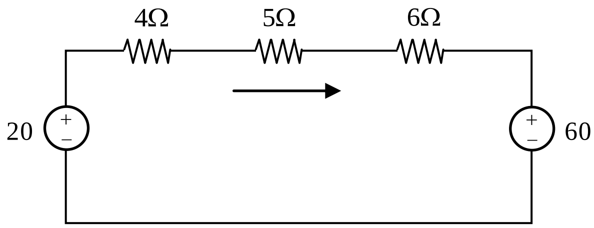
60. What is the current through the 5 Ω resistance in the circuit shown?



(A) 5.33A (B) 4.66A (C) 2.66A (D) 1.33A

Key: **(C)**

Sol: Using source transformation



$$I = \frac{60-20}{15} = \frac{40}{15} = 2.66A$$

61. Consider the following statements with regard to Lissajous pattern on aCRO:

1. It is stationary pattern on the CRO.

2. It is used for precise measurement of frequency of a voltage signal.

3. The ratio between frequencies of vertical and longitudinal voltage signals should be an integer to have a steady Lissajous pattern.

Which of the above statements is/are correct?

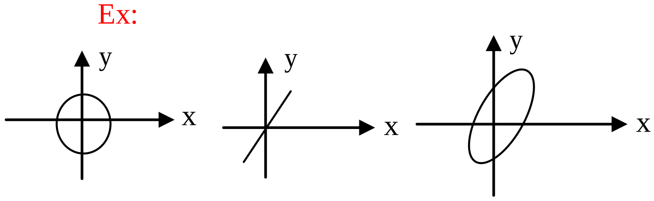
(A) 1 only (B) 2 only

(C) 3 only (D) 1, 2 and 3

Key: **(D)**

Sol: Lissajous pattern is a stationary pattern.

Ex:



All the patterns are independent of time.

Lissajous pattern can be used for measurement of frequency of an unknown signal.

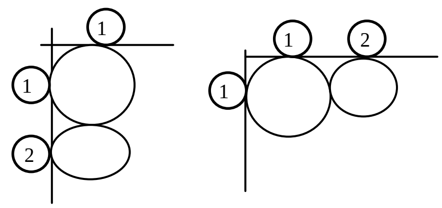
If f_x = frequency of known signal

f_y = frequency of unknown signal

then

$$\frac{f_y}{f_x} = \frac{\text{no.of horizontal tangencies}}{\text{no.of vertical tangencies}} (\text{an integer})$$

Ex:



$$\frac{f_y}{f_x} = \frac{1}{2} \qquad \frac{f_y}{f_x} = \frac{2}{1}$$

62. "Electric flux enclosed by a surface surrounding a charge is equal to the amount of charge enclosed." This is the statement of

(A) Faraday's law

(B) Lenz's law

(C) Modified Ampere's law

(D) Gauss's law

Key: **(D)**

63. If a positively charged body is placed inside a spherical hollow conductor, what will be the polarity of charge inside and outside the hollow conductor?

(A) Inside positive, outside negative

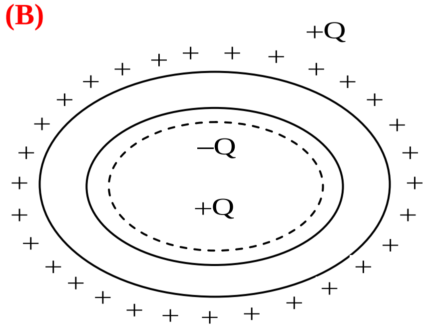
(B) Inside negative, outside positive

(C) Both negative

(D) Both positive

Key: **(B)**

Sol:



64. Consider the following statements regarding Peer-to-Peer computing environment:

1. In this system, clients and servers are not distinguished from one another.

2. All nodes distributed throughout the system (within) are considered Peers and each may act as either a client or a server.

3. Peer-to-Peer system assuredly offers certain advantages over the traditional client server system.

4. Peer-to-Peer system is just a replica of the file server system.

Which of the above statements are correct?

(A) 1, 2, 3 and 4 (B) 1,2 and 3 only
(C) 1 and 4 only (D) 2,3 and 4 only

Key: (A)

65. What is the octal equivalent of $(5621.125)_{10}$?

(A) 11774.010 (B) 12765.100
(C) 16572.100 (D) 17652.010

Key: (B)

Sol:

		Remainder ↑
8	5621	
8	702	5
8	87	6
8	10	7
	1	2

	Integral part
$0.125 \times 8 = 1.0$	1
$0.000 \times 8 = 0.0$	0

66. What is the hexadecimal representation of $(657)_8$?

(A) 1 AF (B) D 78 (C) D 71 (D) 32 F

Key: (A)

Sol: Octal $\rightarrow$ to $\rightarrow$ Binary

$(657)_8 \leftrightarrow 110101111$

Binary $\leftrightarrow$ Hexa decimal

$\underbrace{1}\underbrace{1010}\underbrace{1111}$ $\qquad (1AF)_{16}$

67. In potential transformers, the secondary turns are increased slightly and the primary and secondary windings are wound as closely as possible to compensate for

(A) Phase angle and ratio error, respectively

(B) Ratio and phase angle error, respectively.

(C) Any eddy current loss and hysteresis loss, respectively

(D) The hysteresis loss and eddy current loss, respectively

Key: (B)

Sol: In potential transformer, $n = kn$, $R > kn$. So ratio error is present due to $R > n$. (n= turns ratio).To reduce ratio error, actual ratio (R) is reduced so for reducing R , n has to be reduced.

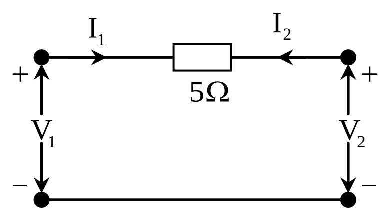
$\rightarrow$ If secondary winding turns are increased, turns ratio n decreases, $\left(n = \frac{N_P}{N_S}\right)$.

$\rightarrow$ Phase angle error (d) is directly proportional to magnetizing current (I_m).

$\therefore$ if θ reduced, I_m also reduces.

If primary and secondary windings are very close together, leakage flux is reduced, then I_m also reduced.

68. The y-parameters for the network shown in the figure can be represented by



(A) $[y]=\begin{bmatrix} -\frac{1}{5} & \frac{1}{5} \\ \frac{1}{5} & -\frac{1}{5} \end{bmatrix}\mho$

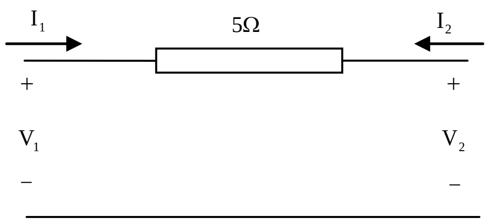
(B) $[y]=\begin{bmatrix} \frac{1}{5} & -\frac{1}{5} \\ -\frac{1}{5} & \frac{1}{5} \end{bmatrix}\mho$

(C) $[y]=\begin{bmatrix} -5 & 5 \\ 5 & -5 \end{bmatrix}\mho$

(D) $[y]=\begin{bmatrix} 5 & -5 \\ -5 & 5 \end{bmatrix}\mho$

Key: (B)

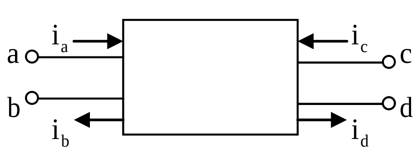
Sol:



$$I_1 = \frac{V_1}{5} + \frac{-V_2}{5};\quad I_2 = \frac{-V_1}{5} + \frac{V_2}{5}$$

$$\Rightarrow Y = \begin{bmatrix} 1/5 & -1/5 \\ -1/5 & 1/5 \end{bmatrix}$$

69. In the two-port network shown, which of the following is correct?



(A) $i_b = i_c$ (B) $i_a=i_d$ (C) $i_c=i_d$ (D) $i_a=i_b$

Key: (D)

70. A $4\frac{1}{2}$ digit voltmeter is used for voltage measurement. How would 0.7525V be displayed in 1 V range?

(A) 0.7525V (B) 0.752V

(C) 0.075V (D) 0.0752V

Key: (A)

Sol: $R = \frac{1}{10^n}$, n is no of full digits

$R = \frac{1}{10^4} = 10^{-4}$

On IV scale, $R = 10^{-4}V = 0.0001V$

$\therefore$ 0.7525V displayed as 0.7525 V $\rightarrow$4 digits

71. Which of the following equations represent gauss's law adapted to a homogeneous isotropic medium?

1. $\oint_s \bar{D}.d\bar{s} = \oint_v \rho dv$ 2. $\nabla\times\bar{H} = \bar{D}$

3. $\nabla.\bar{J} + \rho = 0$ 4. $\nabla.\bar{E} = \frac{\rho}{\varepsilon}$

5. $\nabla^2\phi = 0$

Select the correct answer using the codes given below:

(A) 1 and 4 only (B) 2 and 3 only

(C) 3 and 5 only (D) 1, 2, 4 and 5only

Key: (A)

Sol: Gauss's law

$\oint_s \bar{D}.\bar{ds} = Q_{enc} = \int_U \rho.dv$

By applying divergence theorem

$\int_V (\nabla.\bar{D})dv = \int_\theta \rho.dv$

$\Rightarrow \nabla.\bar{D} = \rho$

$\Rightarrow \nabla.\bar{E} = \frac{\rho}{\varepsilon}$ – for isotropic medium

72. Consider the following statements with regard to Moving Iron (MI) instruments:

1. These instruments possess high operating torque.

2. These instruments can be used in ac and dc circuits.

3. Power consumption in these instruments is lower for low voltage range.

Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

Sol: For MI instrument, $T_d = \frac{1}{2} I^2 \frac{dL}{d\theta}$

$\therefore T_d \, \alpha \, I^2$

If I is high, T_d is high.

The range can be extended by shunts/multipliers; which consume extra power

73. A current of $(10 + 5\sin\omega t + 3\sin 2\omega t)$ is measured using a moving iron instrument. The reading would be

(A) 08.82A (B) 10.00A
(C) 10.82A (D) 12.75A

Key: (C)

Sol: MI meter measures RMS value.

$$I_{rms} = \sqrt{10^2 + \left(\frac{5}{\sqrt{2}}\right)^2 + \left(\frac{3}{\sqrt{2}}\right)^2} = 10.82\,A$$

74. Which one of the following methods is used for the measurement of high resistance?

(A) Carey – Foster bridge method
(B) Substitution method
(C) Loss of charge method
(D) Potentiometer method

Key: (C)

Sol: For high resistance measurement, loss of charge method is used.

75. Consider the following statements with regard to induction type wattmeter:

1. Can be used on both ac and dc systems.
2. Power consumption is relatively low.
3. It is accurate only at stated frequency and temperature.

Which of the above statements is/are correct?

(A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (C)

Sol: Induction type wattmeter works only for AC because for DC, induction is not possible. Due to presence of more weight of moving system, power consumption is relatively high. Since pressure coil is highly inductive the meter copper shading bands are calibrated at supply frequency only. So if any other frequency is used reading will change. Due to temperature, winding resistance increased, so eddy currents decreased, then driving torque T_d is decreased and simultaneously braking torque decreased. Hence temperature effect is almost nullified.

76. A computer system has a cache with a cache access time T_C = 10ns, a hit ratio of 80% and an average memory access time T_M=20ns. What is the access time for physical memory T_P?

(A) 90ns (B) 80ns (C) 60ns (D) 20ns

Key: (C)

Sol:

$$EAT = 0.80(10) + (0.20)T_p$$

$$20 = \frac{80}{100} \times 10 + \frac{20}{100} T_p$$

$$20 = 8 + 0.2T_p$$

$$T_p = \frac{12}{0.2} = \frac{120}{2} = 60$$

77. If n has the value 3, then the C language statement : a [+ + n] = n + + ; assigns

(A) 3 to a[5] (B) 4 to a[5]
(C) 4 to a[4] (D) 5 to a[5]

Key: (*)

Sol: Modifying an object between two sequence point more than once produces undefined behaviour

None of the option matching

78. The minimum number of arithmetic operations required to evaluate the polynomial $P(X)=X^5+8X^3+X$ for a given value of X using only one temporary variable is

(A) 8 (B) 7 (C) 6 (D) 5

Key: (D)

Sol:

$$x^5+8x^3+x=x\left(x^4+8x^2+1\right)$$
$$=x\left(x\left(x^3+8x\right)+1\right)$$
$$=x\left(x\left(x\left(x^2+8\right)+1\right)\right)$$
$$=x\left(x\left(x\left(x\left(x\right)+8\right)+1\right)\right)$$

79. A freewheeling diode in phase- controlled rectifiers

(A) enables inverter operation

(B) is responsible for additional reactive power

(C) improves the line power factor

(D) is responsible for additional harmonics

Key: (C)

Sol: Due to freewheel diode, V_{out} is always positive and inductor discharges the energy through freewheeling diode to load. Hence load gets more power, V_{out} increases and input power factor improves.

80. Consider the following statements regarding electrical conductivity σ:

1. It increases with temperature in semiconductors.

2. Its increase with temperature is exponential.

3. It increases in metals and their alloys, linearly with temperature.

Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only

(C) 2 and 3 only (D) 1, 2 and 3

Key: (A)

81. What is the effect on the natural frequency (ω_n) and damping factor (δ) in the control systems when derivative compensation is used?

(A) ω_n increases and δ decreases

(B) ω_n remains unchanged and δ increases

(C) ω_n remains unchanged and δ decreases

(D) ω_n decreases and δ increases

Key: (B)

Sol: W_n remains unchanged and δ increase

Let $G(s)=\dfrac{W_n^2}{S(S+2\xi W_n)}$ and $H(s)=1$

For derivative controller

$G_1(s)=(1+K_DS)$

$C.E=1+G_1(s)H(s)G(s)=0$

$$1+\frac{W_n^2(1+K_DS)}{S(S+2\xi W_n)}=0$$

$S^2+\left(2\xi W_n+W_n^2T_D\right)S+W_n^2=0$

$W_n\rightarrow$ unchanged

$'S'\rightarrow$ coefficient increases

$\therefore\xi$ increases

82. Consider the following components in a multistage R-C coupled amplifier:

1. Parasitic capacitance of transistor

2. Coupling capacitance

3. Stray capacitance

4. Wiring capacitance

Which of the above components effectively control high frequencies?

(A) 1, 2 and 3 (B) 1, 2 and 4
(C) 1, 3 and 4 (D) 2,3 and 4

Key: (C)

Sol: The components effectively control high frequencies are parasitic, stray and wiring capacitors. But for low frequency control, coupling capacitor is used.

83. A Wien Bridge Oscillator is suitable for
1. Audio frequency applications
2. Radio frequency applications
3. Very low frequency applications
Which of the above frequency applications is/are correct?
(A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (A)

Sol: The most suitable oscillator for audio and sub audio frequency (20 to 20 kHz) is Wein bridge oscillator.

84. In an R-C phase shift oscillator using FET and 3 section R-C phase shift network, the condition for sustained oscillation is
(A) $\beta > 6n$ (B) $\beta > 29$
(C) $\beta > 4n + 23 + \frac{29}{n}$ (D) $\beta > 23 + \frac{29}{n}$
Where, $n = \frac{R_d}{R}$

Key: (C)

85. A tuned collector oscillator has a fixed inductance of $100\,\mu H$ and has to be tunable over the frequency band of 500 kHz to 1500 kHz. What is the range of variable capacitor to be used?
(A) 115 – 1021 pF (B) 113 – 1015 pF
(C) 93 - 1015 μF (D) 110-1021 μF

Key: (D)

Sol: Given,

$L = 100\,\mu H$; f = 500 kHZ-1500 kHZ

Frequency of tuned collector oscillator is

$$f = \frac{1}{2\pi\sqrt{LC}} \; ; \; c = \frac{1}{4\pi^2 L f^2}$$

when $f = 500\text{kHZ}$

$$c = \frac{1}{4\pi^2 \times 100 \times 10^{-6}\left(500 \times 10^3\right)^2} = 1013\text{pF}$$

When $f = 1500\,\text{kHZ}$

$$c = \frac{1}{4\pi^2 \times 100 \times 10^{-6} \times \left(1500 \times 10^3\right)^2} = 112.57\,\text{pF}$$

86. The logical expression, $AB\overline{C} + A\overline{B}C + A\overline{B}\,\overline{C}$ is equivalent to
(A) $\overline{A}(B + C)$ (B) $\overline{A} + \overline{B} + \overline{C}$
(C) $\overline{A}\,\overline{B}\,\overline{C}$ (D) $A\left(\overline{C} + \overline{B}\right)$

Key: (D)

Sol: $AB\overline{C} + A\overline{B}C + A\overline{B}\,\overline{C}$

$AB\overline{C} + A\overline{B}\left(C + \overline{C}\right) \Rightarrow AB\overline{C} + A\overline{B}$

$A\left(B\overline{C} + \overline{B}\right) \Rightarrow A\left(B + \overline{B}\right)\left(\overline{C} + \overline{B}\right) \Rightarrow A\left(\overline{C} + \overline{B}\right)$

87. What is the analog output for a 4-bit R-2R ladder DAC when input is $(1000)_2$, for $V_{ref} = 5V$?
(A) 2.3333 V (B) 2.4444 V
(C) 2.5556 V (D) 2.6667 V

Key: (D)

Sol: $\text{Resolution} = \frac{V_{ref}}{2^n - 1} = \frac{5}{2^4 - 1} = \frac{1}{3}$

$\text{Analog output} = \text{Resolution} \times D$

where D = decimal equivalent of binary input

$= \frac{1}{3} \times 8 = 2.667$ volt.

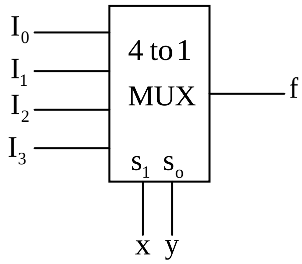
88. Which logic inputs should be given to the input lines I_0, I_1, I_2 and I_3, if the MUX is to behave as two input XNOR gate?

(A) 0110

(B) 1001

(C) 1010

(D) 1111



Key: (B)

Sol: Truth table of XNoR

X	Y	F
0	0	$1 \leftarrow I_0$
0	1	$0 \leftarrow I_1$
1	0	$0 \leftarrow I_2$
1	1	$1 \leftarrow I_3$

89. Fourier series of any periodic signal x(t) can be obtained if

1. $\int_0^T |x(t)| dt < \infty$

2. Finite number of discontinuities within finite time interval t

3. Infinite number of discontinuities

Select the correct answer using the codes given below:

(A) 1, 2 and 3 (B) 1 and 3 only

(C) 1 and 2 only (D) 2 and 3 only

Key: (C)

Sol: Dirichlet conditions describe the conditions for the existence of Fourier series.

Weak Dirichlet condition:If a signal is absolutely integrable over a period then Fourier series exists.

Strong Dirchlet condition:

A signal must have finite number of maxima & minima and / or finite number of discontinuities over a period for the existence of Fourier series.

90. Which one of the following statements is correct?

LTI system is causal

(A) If and only if its impulse response is non-zero for negative values of n.

(B) If and only if its impulse response is non-zero for positive values of n.

(C) If its impulse response is zero for negative values of n.

(D) If its impulse response is zero for positive values of n.

Key: (C)

Sol: LTI System is causal if its impulse response is zero for negative values of n.

91. Consider the following statements with respect to Discrete Fourier Transform (DFT):

1. It is obtained by performing a sampling operation in the time domain.

2. It transforms a finite duration sequence into a discrete frequency spectrum.

3. It is obtained by performing a sampling operation in both time and frequency domains.

Which of the above statements is/are correct?

(A) 1 and 2 only (B) 2 and 3 only

(C) 1 only (D) 3 only

Key: (C)

Sol: DFT is applicable for discrete-time, periodic signal whose Spectrum is discrete – frequency and periodic. Thus, DFT is obtained by performing a sampling operation in both time and frequency domains.

92. The Laplace transform of the below function is

(A) $F(s) = 8s\left(1 - e^{-s}\right)$

(B) $F(s) = \frac{8}{s}\left(1 + e^{-s}\right)$

(C) $F(s)=8s\left(1+e^{-s}\right)$

(D) $F(s)=\frac{8}{s}\left(1-e^{-s}\right)$

Key: (D)

Sol: Define $f(t)=8\left[u(t)-u(t-1)\right]$

Apply Laplace transform on both sides

$$u(t)\xleftrightarrow{L}\frac{1}{S}$$

$$F(S)=8\left[\frac{1}{S}-\frac{1}{S}e^{-S}\right]$$

$(\text{By time}-\text{shifting Property})$

$$\therefore F(S)=\frac{8}{S}\left[1-e^{-S}\right]$$

93. The number of complex additions and multiplications in direct DFT are, respectively

(A) N (N–1) and N^2

(B) N (N+1) and N^2

(C) N $(N+1)^2$ and N

(D) N and N^2

Key: (A)

Sol: $X[K]=\sum_{n=0}^{(N-1)}x[n]e^{\frac{-j2\pi Kn}{N}};K=0,1,2,......(N-1)$

For one value of 'K', 'N'–Multiplications & (N-1) additions are required.

$\therefore$ K ranges from 0 to (N–1)

i.e 'N' Values exist for X[K] thus N^2 multiplications & N(N–1) additions are required.

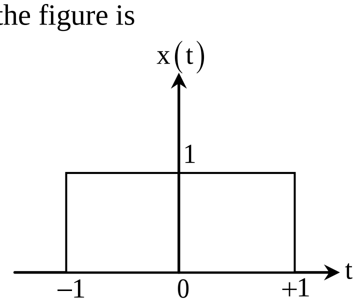
94. The Fourier transform of a unit rectangular pulse shown in the figure is

(A) $\omega\sin\omega$

(B) $\frac{2\sin\omega}{\omega}$

(C) $\frac{\omega}{\sin\omega}$

(D) $\frac{\cos\omega}{2\omega}$



Key: (B)

Sol: Stand Fourier transform of a rectangular pulse is,

$$\text{rect}\left(\frac{t}{\tau}\right)\xleftrightarrow{F}\tau\,\text{sa}\left(\frac{\omega\tau}{2}\right)$$

For given x(F),

$\tau=2$

$$x(t)=\text{rect}\left(\frac{t}{2}\right)\xleftrightarrow{F}2\,\text{sa}(\omega)=\frac{2\sin\omega}{\omega}$$

95. The number of complex additions and multiplications in FFT are, respectively,

(A) $\frac{N}{2}\log_2 N$ and $N\log_2 N$

(B) $N\log_2 N$ and $\frac{N}{2}\log_2 N$

(C) $\frac{N}{2}\log_2 N$ and $\log_2 N$

(D) $\log_2 N$ and $\frac{N}{2}\log_2 N$

Key: (A)

Sol: In radix-2 Decimation in time FFT No of complex additions are $\frac{N}{2}\log_2 N$, and number of complex multiplications are $N\log_2 N$.

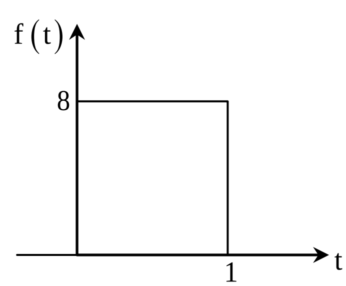
96. Consider the following driving point impedance functions:

$$Z_1(s)=\frac{(s+2)}{(s^2+3s+5)}$$

$$Z_2(s)=\frac{(s+2)}{(s^2+5)}$$

$$Z_3(s)=\frac{(s+2)}{(s^2+2s+1)}$$

$$Z_4(s)=\frac{(s+2)(s+4)}{(s+1)(s+3)}$$



Which one of the above is positive real?

(A) Z_1 (B) Z_2 (C) Z_3 (D) Z_4

Key: (*)

Sol: None of the option is correct

97. The closed loop transfer function of a system is $\frac{C(s)}{R(s)} = \frac{s-2}{s^3+8s^2+19s+12}$

The system is

(A) Stable

(B) Unstable

(C) Conditionally stable

(D) Critically stable

Key: (A)

Sol: Stable

$S^3 + 8S^2 + 19S + 12$

S^3	1	19	No.of R.H.S Pole = 0
S^2	8	12	No.of L.H.S Pole = 3
S^1	$\frac{19\times 8-12}{8}$		$\therefore$ system is stable
S^0	12		

98. A system has 14 poles and 2 zeros in its open-loop transfer function. The slope of its highest frequency asymptote in its magnitude plot is

(A) – 40 dB/dec (B) –240 dB/dec

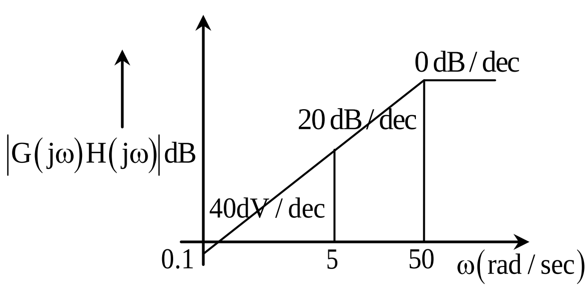
(C) + 40 dB/dec (D) +240 dB/dec

Key: (B)

Sol: At high frequency asymptote plot

Slope = (14-2) (-20 dB/dec) = -240 dB/dec

99. The open-loop transfer function for the Bode's magnitude plot is



(A) $G(s)H(s) = \frac{K}{s^2(1+0.2s)(1+0.02s)}$

(B) $G(s)H(s) = \frac{Ks}{(1+0.2s)(1+0.02s)}$

(C) $G(s)H(s) = \frac{Ks^2}{(s+5)(s+50)}$

(D) $G(s)H(s) = \frac{K}{s^2(s+5)(s+50)}$

Key: (C)

Sol: Initial slope = 40 dB/dec

$\therefore G(s)H(s) = \frac{KS^2}{(S+5)(S+50)}$

100. While forming a Routh array, the situation of a row of zeros indicates that the system

(A) has symmetrically located roots

(B) is stable

(C) is insensitive to variations in gain

(D) has asymmetrically located roots

Key: (A)

Sol: Symmetrical located roots with respect to origin.

101. A linear time – invariant control system with unsatisfactory steady state error is to be compensated. Which is/are the correct type of cascade compensation to be provided?

1. Lead 2. Lag 3. Lag-lead

Select the correct answer using the codes given below:

(A) 1 only (B) 2 only

(C) 3 only (D) 1, 2 and 3

Key: (B)

102. A Phase – lead network has its transfer function $G_C(s) = \frac{(1+0.04s)}{(1+0.01s)}$. What is the frequency at which the maximum phase-lead occurs?

(A) 25 rad/sec (B) 50 rad/sec

(C) 75 rad/sec (D) 100 rad/sec

Key: (B)

Sol: $W_n = \sqrt{\frac{1}{0.04} \times \frac{1}{0.01}} = \sqrt{\frac{100 \times 100}{4}}$

$= 50 \text{ rad/sec}$

103. What is the open-loop transfer function for the system, whose characteristic equation is $F(s) = s^3 + 3s^2 + (K+2)s + 5K = 0$?

(A) $G(s)H(s) = \frac{5K}{s(s+1)(s+3)}$

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

(C) $G(s)H(s) = \frac{K(s+5)}{s(s+1)(s+2)}$

(D) $G(s)H(s) = \frac{5K}{s(s+1)(s+2)}$

Key: (C)

Sol: $1 + G(s)H(s) = 0$

$\Rightarrow S^3 + 3S^2 + (K+2)S + 5K = 0$

$\Rightarrow S^3 + 3S^2 + 2S + K(S+5) = 0$

$\Rightarrow 1 + G(s)H(s) = 0$

$\Rightarrow 1 + \frac{K(S+5)}{S(S+1)(S+2)} = 0$

$G(s)H(s) = \frac{K(S+5)}{S(S+1)(S+2)}$

104. In a system, the damping coefficient is -2. The system response will be

(A) Undamped

(B) Oscillations with decreasing magnitude

(C) Oscillations with increasing magnitude

(D) Critically damped

Key: (C)

Sol: Oscillation with increasing magnitude

105. A dynamic system is described by the following equations:

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } Y = [10 \ \ 0] \, u$$

Then the transfer function relating Y and u is given by

(A) $\frac{Y(s)}{u(s)} = \frac{10s}{s^2 + 4s + 3}$

(B) $\frac{Y(s)}{u(s)} = \frac{10}{s^2 + 4s + 3}$

(C) $\frac{Y(s)}{u(s)} = \frac{s}{s^2 + 2s + 1}$

(D) $\frac{Y(s)}{u(s)} = \frac{s}{s^2 + 3s + 1}$

Key: (B)

Sol: $A = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \quad C = [10 \ \ 0] \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

$\text{Transfer Function} = C[SI - A]^{-1} B$

$= [10 \ \ 0] \begin{bmatrix} S & -1 \\ +3 & S+4 \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \frac{10}{S^2 + 4S + 3}$

106. The characteristics of a mode of controller are summarized:

1. If error is zero, the output from the controller is zero.
2. If error is constant in time, the output from the controller is zero
3. For changing error in time, the output from the controller is |K|% for every 1% sec^{-1} rate of change of error.
4. For positive rate of change of error, the output is also positive.

The mode of controller is

(A) Integral controller

(B) Derivative controller
(C) Proportional derivative
(D) Proportional integral

Key: (B)

107. A 1000V/400V power transformer has a nominal short circuit voltage V_{SC}=40%. Which one of the following statements is correct?

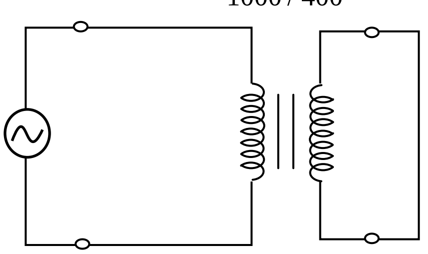
(A) A voltage of 400V appears across the short-circuited secondary terminals.
(B) A voltage of 16V appears across the short circuited secondary terminals
(C) When the secondary terminals are short circuited, the rated current flows at the primary side at a primary voltage of 400V.
(D) The primary voltage drops to 400V, when the secondary terminals are short circuited.

Key: (C)

Sol: A 1000V/400V transformer has Nominal short circuit voltage V_{SC} = 40%

$$V_{SC} = \frac{40}{100} \times \text{H.V.Wdg Voltage}$$

$$= \frac{40}{100} \times 1000 = 400V$$



When the secondary (400V) is short circuited, A 400 V of voltage on H.V. side is enough to drive full load (Rated) current.

108. Consider the following statements regarding three-phase transformers in open – delta $(\nabla - \nabla)$ connections:

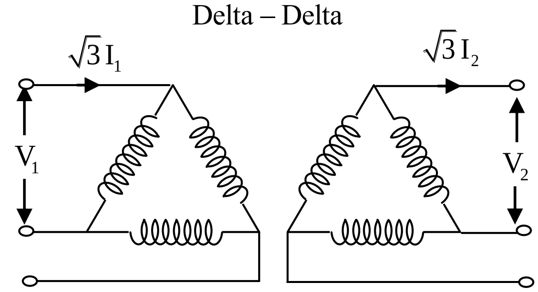
1. Being a temporary remedy when one transformer form of Delta-Delta system is damaged, and removed from service.
2. The Volt Ampere (VA) supplied by each transformer is half of the total VA, and the system is not overloaded.
3. An important precaution is that load shall be reduced by $\sqrt{3}$ times in this case.

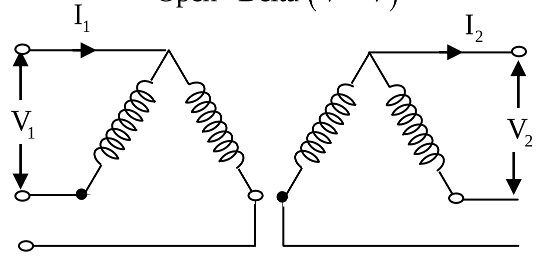
Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

Sol:





1. Open Delta is a temporary arrangement to have continuous supply to a part of the load.
2. Load shared by each transformer is $= \frac{\sqrt{3}}{2}(\text{half of total load})$
3. $\frac{KVA_{OD}}{KVA_{DD}} = \frac{\sqrt{3}V_1I_1}{3V_1I_1} = \frac{1}{\sqrt{3}} = 57.7\%$ reduction

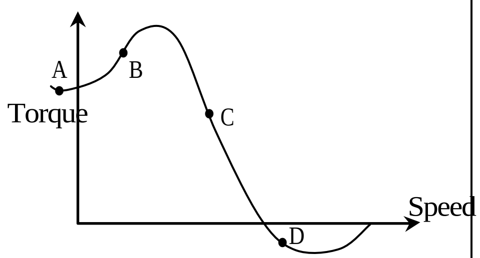
109. On the Torque/speed curve of an induction motor shown in the figure, four points of operation are marked as A,B,C and D.
Which one of them represents the operation at a slip greater than 1?

(A) A

(B) B

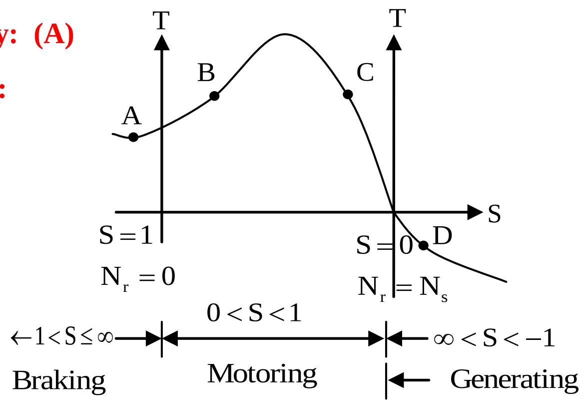
(C) C

(D) D



Key: (A)

Sol:



At point 'A' Rotor rotates in opposite to R.M.F. Therefore the Relative speed is

$$S=\frac{N_S-(-N_r)}{N_s}=\frac{N_S+N_r}{N_r}>1$$

110. A 3-phase, 460V, 6-pole, 60Hz cylindrical rotor synchronous motor has a synchronous reactance of $2.5\,\Omega$ and negligible armature resistance. The load torque, proportional to the square of the speed, is 398 N.m at 1200rpm Unity power factor is maintained by excitation control. Keeping the v/f constant, the frequency is reduced to 36Hz. The torque angle δ is

(A) 9.5° (B) 12.5° (C) 25.5° (D) 30°

Key: (*)

Sol:

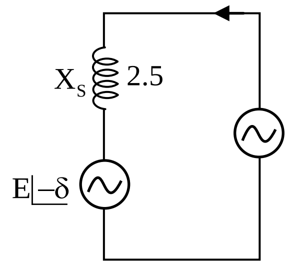
$$\frac{V_2}{f_2}=\frac{V_1}{f_1} \qquad \frac{T_2}{T_1}=\left(\frac{N_2}{N_1}\right)^2$$

$$V_2=\frac{460}{60}\times 36 \qquad T_2=\left(\frac{720}{1200}\right)^2\times 398$$

$$V_2=276\text{ volts} \qquad =143.28\text{ Nm}$$

$$V_{2ph}=159.34\text{ volts}$$

$$P=\frac{2\pi NT}{60}=\frac{2\pi\times 720\times 143.28}{60}=10803.05\text{ Watts}$$



$$V_{ph}=\frac{276}{\sqrt{3}}$$

$$f=36\text{Hz}$$

$$V_{ph}-jI_aX_s=E\angle-\delta \qquad \sqrt{3}\times 276\times I_L\times\cos\phi=10803.05$$

$$159.34-j\,22.59\times 2.5=E\angle-\delta \qquad I_L=\frac{10803.05}{\sqrt{3}\times 276}=22.59\text{Amps}$$

$$159.34-j56.49=E\angle-\delta$$

$$E\angle-\delta=169.05\angle-19.52^{\circ}\leftarrow\text{Torque Angle}$$

111. Consider the following statements regarding capability curves of a synchronous generator:

1. The MVA loading should not exceed the generator rating.

2. The field current should not be allowed to exceed a specified value determined by field heating.

3. The MW loading should not exceed the rating of the prime mover.

4. The load angle must be more than 90°.

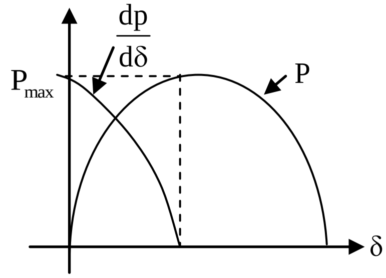
Which of the above statements are correct?

(A) 1, 2, 3 and 4 (B) 1 and 4 only

(C) 1, 2 and 3 only (D) 2, 3 and 4 only

Key: (C)

Sol:



→ From the power curves, we can say that the syn M/C can't be loaded more than the maximum.

→ Field current should be in limits to avoid saturation of field.

→ Any loading shouldn't exceed the supply point Rating's (Generator, prime mover etc)

112. A 12-pole, 440V, 50Hz, 3-phase synchronous motor takes a line current of 100A at 0.8 pf leading. Neglecting losses, the torque developed will be

(A) 705 Nm (B) 1165 Nm
(C) 1058 Nm (D) 525 Nm

Key: (B)

Sol: $P = \frac{2\pi NT}{60}$ $\quad N = \frac{120 \times 50}{12} = 500\text{rpm}$

$$T = \frac{60 \times P}{2\pi N} = \frac{60 \times \sqrt{3} \times 440 \times 100 \times 0.8}{2 \times \pi \times 500} \simeq 1165\,N-m$$

113. Consider the following statements:

1. Salient pole alternators have small diameters and large axial lengths.

2. Cylindrical rotor alternators have a distributed winding.

3. Cylindrical rotor alternators are wound for large number of poles.

4. Salient pole alternators run at speeds slower than cylindrical rotor machines.

Which of the above statements are correct?

(A) 1 and 3 only (B) 2 and 4 only
(C) 1 and 4 only (D) 2 and 3 only

Key: (B)

Sol: 1. Salient pole rotors will have larger Diameter & Smaller axial length.

2. Cylindrical Rotor holds distributed winding, whereas salient pole rotor holds concentrated winding.

3. Cylindrical rotor will possess less number of poles since the diameter of rotor is less, whereas salient pole rotor posses more poles since large diameter.

4. Salient pole rotors runs at low speed because of more poles and less much strength. Whereas cylindrical rotors run at high speed because of less poles and more much strength.

114. A permanent magnet stepper motor with 8 poles in stator and 6 poles in rotor will have a step angle of

(A) 7.5° (B) 15° (C) 30° (D) 60°

Key: (B)

Sol: Step angle of stepper motor

$$\beta = \frac{360}{m.N_r} = \frac{(N_s - N_r)}{N_s.N_r} \times 360^o$$

Where

$m \rightarrow$ No.of stator phases

$N_r \rightarrow$ No.of Rotor teeth (poles)

$N_s \rightarrow$ No.of Stator teeth (poles)

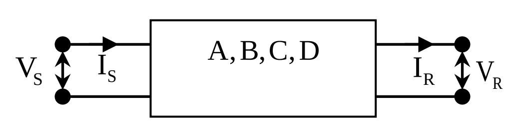
$$\beta = \frac{(8-6)}{8 \times 6} \times 360^o = \frac{2}{8 \times 6} \times 360 = 15^o$$

115. The transmission line is represented as a two-port network as shown in the figure. The sending end voltage and current are expressed in terms of receiving end voltage and current for the network as

$V_s = AV_R + BI_R$

$I_S = CV_R + DI_R$

Where A, B, C and D are generalized circuit constants.



The condition for symmetry for the network is

(A) A = C (B) A = D
(C) B = C (D) B = D

Key: (B)

116. A power system has two synchronous generators having governor turbine characteristics as

$P_1 = 50(50-f)$

$P_2 = 100(51-f)$

Where f represents the system frequency. Assuming a lossless operation of the complete power system, what is the system frequency for a total load of 800MW?

(A) 55.33Hz (B) 50Hz
(C) 45.33Hz (D) 40Hz

Key: (C)

Sol: $P_1 = 50(50-f), P_2 = 100(51-f)$

Total load, $P = 800$ Mw

$P = P_1 + P_2$

$800 = 50(50-f) + 100(51-f)$

$= 2500 - 50f + 5100 - 100f$

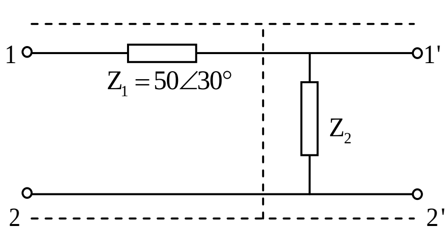
$800 = 7600 - 150f$

$\Rightarrow 150f = 7600 - 800$

$f = 45.33\text{Hz}$

117. Two networks are connected in cascade in the figure. The equivalent ABCD constants are obtained for the combined network having $C = 0.1\angle 90°$.

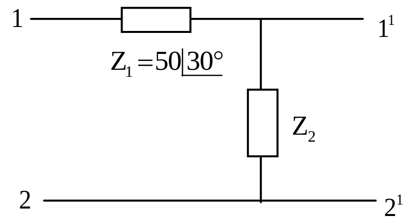
What is the value of Z_2?



(A) $500\angle -60°$ (B) 0.10j
(C) -10j (D) $50\angle -60°$

Key: (C)

Sol:



$C = 0.1\angle 90°$

ABCD of the cascaded network is

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 1/z_2 & 1 \end{bmatrix}$$

$$C = \frac{1}{Z_2};\ Z_2 = \frac{1}{C} = \frac{1}{0.1\angle 90°} = 10\angle -90°$$

$$Z_2 = -j10\ \Omega$$

118. Which one of the following does not have an effect on corona?

(A) Spacing between conductors
(B) Conductor size
(C) Line voltage
(D) Length of conductor

Key: (D)

Sol: Corona is independent on length of conductor

119. Consider the following statements regarding corona:

1. It causes radio interference.
2. It attenuates lightning surges.
3. It causes power loss.
4. It is more prevalent in the middle conductor of a transmission line employing flat conductor configuration.

Which of the above statements are correct?

(A) 1, 2 and 3 only (B) 1, 2 and 4 only
(C) 1,2,3 and 4 (D) 3 and 4 only

Key: (C)

120. The loss formula coefficient matrix for a two plant system is given by

$$B=\begin{bmatrix}0.001 & -0.0001\\ -0.0001 & 0.0013\end{bmatrix} M\omega^{-1}$$

The economic schedule for a certain load is given as P_1=150MW and P_2=275MW.

What is the penalty factor for plant 1 for this condition?

(A) 1.324 (B) 1.515 (C) 1.575 (D) 1.721

Key: (A)

Sol: We have formula for

$$\text{Penalty factor } L_1=\frac{1}{1-\dfrac{\partial p_{loss}}{\partial P_{G1}}}$$

$$P_{loss}=B_{11}P_{G1}^2+B_{22}P_{G2}^2+2P_{G1}P_{G2}B_{12}$$

$$\frac{\partial p_{loss}}{\partial P_{G1}}=2.B_{11}P_{G1}+2P_{G2}.B_{12}$$

$$\text{Given, } B=\begin{bmatrix}0.001 & -0.0001\\ -0.0001 & 0.0013\end{bmatrix}=\begin{bmatrix}B_{11} & B_{12}\\ B_{21} & B_{22}\end{bmatrix}$$

$$P_{G1}=150\,Mw;\ P_{G2}=275\,Mw$$

susbstitutions all the values, we get

$$\frac{\partial p_{loss}}{\partial P_{G1}}=(2\times0.001\times150)+[2\times275\times(-0.0001)]$$

$$=0.245$$

$$\text{Penalty factor for plant}-1\therefore L_1=\frac{1}{1-0.245}=1.324$$

121. A lossless power system has two generators G_1 and G_2; and total load to be served is 200MW. The respective cost curves C_1 and C_2 are defined as

$$C_1=P_{G1}+0.01P_{G1}^2$$

$$C_2=5P_{G2}+0.02P_{G2}^2$$

Assume the minimum loading on any generator to be 30 MW, the most economical loads P_{G1} and P_{G2} for the two generators are, respectively

(A) 170MW and 100MW

(B) 200MW and 100MW

(C) 170MW and 30MW

(D) 200MW and 30MW

Key: (C)

Sol: Total loss = 200 Mw

$$\Rightarrow P_{G1}+P_{G2}=200\,Mw \quad ...(1)$$

$$C_1=P_{G1}+0.01P_{G1}^2$$

$$C_2=5P_{G2}+0.02P_{G2}^2$$

most economic load scheduling,

$$\frac{dc_1}{\partial P_{G1}}=\frac{\partial c_2}{\partial P_{G2}}$$

$$\frac{dc_1}{\partial P_{G1}}=1+0.02P_{G1};\ \frac{dc_2}{\partial P_{G2}}=5+0.04P_{G2}$$

$$\Rightarrow 1+0.02P_{G1}=5+0.04P_{G2}$$

$$\Rightarrow 0.02P_{G1}-0.04P_{G2}=4$$

$$\Rightarrow 2P_{G1}-4P_{G2}=400$$

$$P_{G1}-2P_{G2}=200 \quad ...(2)$$

Solve (1) & (2) equations, we get

$$P_{G1}+P_{G2}=200$$

$$P_{G1}-2P_{G2}=200$$

$$3P_{G2}=0$$

$$P_{G2}=0$$

But given that the minimum loading on any generator is to be 30 Mw

$\therefore P_{G2}$ should be 30 Mw

$\therefore P_{G1}=170$ Mw and $P_{G2}=30$ Mw

122. In a 3-phase ac power transmission system using synchronous generation

(A) The steady state power limits of both round rotor and salient pole machines are reached at $\theta=\dfrac{\pi}{2}$ of their respective power angle characteristics.

(B) The steady state power limit of round rotor machines occurs at a much smaller angle θ as compared to that of salient pole machine power angle characteristic.

(C) The steady state power limit of salient pole machines occurs at smaller angle θ

as compared to that of round rotor machine power angle characteristic.

(D) The transient state power limits of synchronous generators do not depend on initial load just before the large change in load or on 3-phase fault,

Key: (C)

Sol: Steady state power limit of round rotor machine is $\theta = 90°$ and for salient pole machine is $\theta < 90°$

123. Bulk power transmission over long HVDC lines is preferred because of

(A) Low cost of HVDC terminal
(B) No harmonic losses
(C) Minimum line power losses
(D) Simple protection

Key: (A)

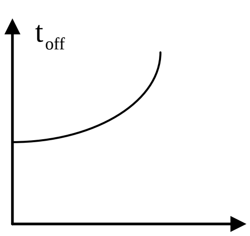
Sol: The cost of HVDC system is less compared to AC system for long transmission of bulk power.

124. The turn off time of a thyristor is $30\,\mu s$ at 50°C. What is its turn-off time at 100°C?

(A) $15\,\mu s$ (B) $30\,\mu s$
(C) $60\,\mu s$ (D) $120\,\mu s$

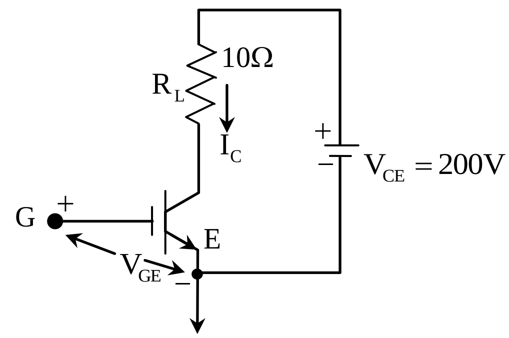
Key: (C)

Sol:



If temperature increases, t_{off} increases, but not linearly. So t_{off} of SCR is more than $30\,\mu sec$, but it is not 4 times at 100^oC. So $60\,\mu sec$ is more suitable t_{off} at 100^oC.

125. The IGBT (Insulated Gate Bipolar Transistor) used in the circuit has the following data: $t_{ON}=3\,\mu s$, $t_{OFF}=1.2\,\mu s$, Duty cycle (D)=0.7, $V_{CE(sat)}=2V$ and $f_s=1kHz$.
What are the switching power losses during turn-on and turn-off, respectively



(A) 1.98W and 1.7 W
(B) 2.2 and 1.7W
(C) 1.98 W and 0.792W
(D) 2.2W and 0.792W

Key: (C)

Sol: $I_c = \dfrac{V_{CC} - V_{CE(sat)}}{R_L}$

$= \dfrac{200-2}{10} = 19.8\,A$

$P_{on} = \dfrac{V_{CC}I_C}{6} t_{on}.f_s$

$= \dfrac{200 \times 19.8}{6} \times 3 \times 10^{-6} \times 1000 = 1.98\,W$

$P_{off} = \dfrac{V_{CC}I_C}{6}.t_{off}.f_s = 0.792\,W$

126. Consider the following statements with regard to a GTO :

1. The turn – off gain of the GTO is large.
2. Large negative gate current pulses are required to turn off the GTO.
3. GTO has large reverse blocking capability.

Which of the above statements is/are correct?

(A) 1 only (B) 2 only
(C) 3 only (D) 1,2 and 3

Key: (B)

Sol: GTO has poor turn off gain and large negative gate current pulses are required to turn off it.

127. Consider the following statements with regard to power diodes:

1. The breakdown voltage is directly proportional to the doping density of the drift region.
2. Losses in the diode are less due to conductivity modulation of the drift region in the on – state.
3. The vertically oriented structure supports large blocking voltages.

Which of the above statements is/are correct?

(A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (B)

Sol: Power diodes and SCRs are minority carrier devices. In these devices, conductivity modulation phenomenon does not exist. Due to this process, when the device enters into conduction state, the ON state losses are less

128. A three phase fully-controlled bridge converter is connected to a 415V supply, having a source resistance of 0.3 Ω and inductance of 1.2 mH per phase. The converter is working in the inversion mode at a firing advance angle of 30°. What is the average generator voltage for the conditions: dc current I_d = 60 A, thyristor drop = 1.5V and f = 50 Hz?

(A) 180 V (B) 210 V
(C) 230 V (D) 240 V

Key: (*)

Sol:
$$\frac{3V_m l}{\pi}\cos(180-\alpha) = -E + 2I_o r_s + 2V_t + \frac{3\omega Ls}{\pi} I_o$$
$$\frac{3\times 415\sqrt{2}}{\pi}\cos 150 = -E + (2\times 60\times 0.3) + (2\times 1.5) + \frac{3\times 100\pi\times 1.2\times 10^3}{\pi}\times 60$$
$$E = 545.96\,V$$

129. A large dc motor is required to control the speed of the blower from a 3-phase ac source. The suitable ac to dc converter is, 3-phase

(A) Fully controlled bridge converter
(B) Fully controlled bridge converter with freewheeling diode
(C) Half controlled bridge converter
(D) Converter pair in sequence control.

Key: (C)

Sol: For motoring operation, half controlled bridge is suitable

130. Consider the following statements:

1. The voltage developed across the OFF switches of the half bridge converter is the maximum dc link voltage.
2. In the full bridge converter, the voltage across the primary of the transformer is the dc link voltage.
3. The voltage developed across the OFF switches of the full bridge converter is half the maximum dc link voltage.

Which of the above statements are correct?

(A) 1, 2 and 3 (B) 1 and 3 only
(C) 1 and 2 only (D) 2 and 3 only

Key: (C)

***Directions:** Each of the next twenty (20) items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)' . Examine these two statements carefully and select the answers to these items using the codes given below:*

Codes:

(A) Both statement (I) and statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(B) Both statement (I) and statement (II) are individually true but statement (II) is not the correct explanation of statement (I)

(C) Statement (I) is true but statement (II) is false.

(D) Statement (I) is false but statement (II) is true

131. Statement (I): A superconductor is a perfect diamagnetic material.

Statement (II): A superconductor is a perfect conductor.

Key: (C)

132. Statement (I): Limiting factor of DC transmission is the high cost of conversion equipment.

Statement (II): Generation of harmonics is used for reactive power transfer only which has the ability to alter voltage levels.

Key: (C)

133. Statement (I): A lattice defect gets created whenever the periodicity or order of the crystal lattice gets disturbed.

Statement (II): Point defect, line defect, surface defect and volume defect create defect in lattice.

Key: (B)

134. Statement (I): To measure power consumed by the load, it is necessary to interchange the pressure coil terminals when the pointer of a wattmeter kicks back.

Statement (II): The pressure coil terminals are interchanged to get upscale reading in a wattmeter without affecting the continuity of power to the load.

Key: (A)

Sol: In two watt meter method, the readings of two wattmeter are

$$W_1 = V_L I_L \cos(30 - \phi)$$

$$W_2 = V_L I_L \cos(30 + \phi)$$

If load power factor is less than 0.5, $\phi > 60^o, W_2$ shows negative reading. To get correct reading watt meter pressure coil terminals are to be interchanged.

135. Statement (I): An instrument manufactured as an ammeter should not be used as a voltmeter.

Statement (II): The high resistance winding of an ammeter will suffer serious damage if connected across a high voltage source.

Key: (C)

Sol: Ammeter can't be used as a voltmeter because ammeter has low resistance. When Ammeter connected in parallel, it draws high current due to its low resistance.

136. Statement (I): Moving iron instruments are used in ac circuits only.

Statement (II): The deflecting torque in moving iron instruments depends on the square of the current.

Key: (D)

Sol: MI can be used for both AC and DC measurements, but with DC accuracy is low.

$$T_d = \frac{1}{2} I^2 \frac{dL}{d\theta}, \quad T_d \,\alpha\, I^2$$

137. Statement (I): PMMC instruments are suitable in aircraft and air space applications.

Statement (II): PMMC instruments use a core magnet which possesses self shielding property.

Key: (A)

Sol: PMMC Meter uses a permanent magnet. For permanent magnet operating magnetic field is very strong and external stray fields have little effects.

138. Statement (I): A ballistic galvanometer is preferred as a detector in an AC bridge to measure inductance supplied by a source at power frequency.

Statement (II): An AC bridge to measure inductance is balanced at the fundamental component.

Key: (D)

Sol: Vibration galvanometers are used as a detector in an AC bridges for power & low audio frequency ranges. The effective inductance and resistance vary with frequency so that a bridge balanced at fundamental frequency is never truly balanced for harmonics.

139. Statement (I): Phase lag network is used to increase stability as well as bandwidth of the system.

Statement (II): Phase lead network increases bandwidth of the system.

Key: (D)

140. Statement (I): The inductor is not used to fabricate a lag network as it produces time delay and hysteresis loss.

Statement (II): A capacitor cannot be used to fabricate a lag network.

Key: (C)

141. Statement (I): Roots of closed – loop control systems can be obtained from the bode plot.

Statement (II): Nyquist criterion does not give direct value of corner frequencies.

Key: (D)

142. Statement (I): The IGBT makes use of the advantages of both powers MOSFET and BJT.

Statement (II): The IGBT has MOS input characteristic and bipolar output characteristic.

Key: (A)

Sol: MOSFET has less switching time and BJT has low conduction loss. IGBT resembles MOSFET on input side and BJT on output side.

143. Statement (I): The power distribution systems are 3-phase 4 wire circuits.

Statement (II): A neutral wire is necessary to supply single phase loads of domestic and marginal commercial consumers.

Key: (A)

144. Statement (I): The maximum torque of an induction motor is independent of rotor resistance.

Statement (II): The slip at which the maximum torque occurs is directly proportional to rotor resistance.

Key: (A)

145. Statement (I): A 3-phase induction motor is a self starting machine.

Statement (II): A star delta starter is used to produce starting torque for the induction motor.

Key: (C)

146. Statement (I): Leakage reactance of the lower cage in a double squirrel cage motor is considerably higher than that of the upper cage.

Statement (II): The lower cage has high permeance for leakage flux.

Key: (A)

147. Statement (I): Superconducting compounds and alloys must have components which are themselves superconducting.

Statement (II): Metals and compounds which are superconducting are rather bad conductors at ordinary temperatures.

Key: (D)

148. **Statement (I):** The relative dielectric constant of an insulator decreases with increase in the frequency of the applied alternating field.

Statement (II): With increase in frequency of the applied field, polarization process increases.

Key: (C)

149. **Statement (I):** One series RC circuit and the other series RL circuit are connected in parallel across an ac supply. The circuit exhibits two resonances when L is variable.

Statement (II): The circuit has two values of L for which the imaginary part of the input admittance of the circuit is zero.

Key: (A)

150. **Statement (I):** The power available from wind is directly proportional to V3, where V is the velocity.

Statement (II): Drag type wind turbines have lower speeds and high torque capabilities.

Key: (B)

Sol: From wind power equation $=\frac{1}{2}K.C_p\,\rho.A.V^3$

So, wind power is directly proportional to velocity V^3 and drag type wind turbines have lower speeds and high torque capabilities.