ESE EE 2019

Questions with Solutions (Paper-2)

gradeup

GATE 2019 ESE (IES) EE PAPER WITH SOLUTIONS

Q1. What are the value of k for which the system of equations
(3k – 8)x + 3y + 3z = 0
3x + 3(k – 8) y + 3z = 0
3x + 3y + (3k – 8) z = 0
Has a not-trivial solution?

A. $k=\frac{2}{3},\frac{11}{3},\frac{10}{3}$
B. $k=\frac{2}{3},\frac{10}{3},\frac{11}{3}$
C. $k=\frac{11}{3},\frac{11}{3},\frac{11}{3}$
D. $k=\frac{2}{3},\frac{11}{3},\frac{11}{3}$

Ans. D

Sol – For non-trivial solution,
|A| = 0
$C_1 \to C_1 + C_2 + C_3$

$$\begin{vmatrix} 3k-8+3+3 & 3 & 3 \\ 3+3k-8+3 & 3k-8 & 3 \\ 3+3+3k-8 & 3 & 3k-8 \end{vmatrix}=0$$

$$\begin{vmatrix} 3k-2 & 3 & 3 \\ 3k-2 & 3k-8 & 3 \\ 3k-2 & 3 & 3k-8 \end{vmatrix}=0$$

$$(3k-2)\begin{vmatrix} 1 & 3 & 3 \\ 1 & 3k-8 & 3 \\ 1 & 3 & 3k-8 \end{vmatrix}=0$$

$R_2 - R_1$, $R_3 - R_1$

$$(3k-2)\begin{vmatrix} 1 & 3 & 3 \\ 0 & 3k-11 & 0 \\ 0 & 0 & 3k-11 \end{vmatrix}=0$$

$$(3k-2)(3k-11)^2=0$$

$$k=\frac{2}{3},\frac{11}{3},\frac{11}{3}$$

Q2. If $A=\begin{bmatrix} 2+i & 3 & -1+3i \\ -5 & i & 4-2i \end{bmatrix}$, then AA* will be (where A* is the conjugate transpose of A)

A. Unitary matrix
B. Orthogonal matrix
C. Hermitian matrix
D. Skew Hermitian matrix

Ans. C

Sol. $A=\begin{bmatrix} 2+i & 3 & -1+3i \\ -5 & i & 4-2i \end{bmatrix}$,

$$\overline{A}=\begin{bmatrix} 2-i & 3 & -1-3i \\ -5 & -i & 4+2i \end{bmatrix}$$

$$\left(\overline{A}\right)^T=\begin{bmatrix} 2-i & -5 \\ 3 & -i \\ -1-3i & 4+2i \end{bmatrix}$$

$$A\times A^*=A\times\left(\overline{A}\right)^T$$

$$=\begin{bmatrix} 5+9+10 & -10-5i-3i-4-2i+12i-6 \\ -10+5i+3i-4-12i+2i-6 & 25+1+16+4 \end{bmatrix}$$

$$=\begin{bmatrix} 24 & -20+2i \\ -20-2i & 46 \end{bmatrix}$$

Which is Hermitian, for all i, j and a_{jj} are real

Q3. If $y = 2x^3 - 3x^2 + 3x - 10$, the value of will be (where Δ is forward differences operator)

A. 10
B. 11
C. 12
D. 13

Ans. C

Sol. $\Delta^3 y = D^3 y$

$$= \frac{d^3}{dx^3}\left[2x^3 - 3x^2 + 3x - 10\right] = 12$$

Q4. The solution of the differential equation $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + y = \log x$ is

A. $y = (c_1 + c_2 x)\log x + 2\log x + 3$
B. $y = (c_1 + c_2 x^2)\log x + \log x + 2$
C. $y = (c_1 + c_2 x)\log x + \log x + 2$
D. $y = (c_1 + c_2 \log x)x + \log x + 2$

Ans. D

Sol. $x^2y'' - xy' + y = \log x$

$[x^2D^2 - xD + 1]y = \log x$

Put $x = e^z$

$xD = D_1$

$x^2D^2 = D_1(D_1 - 1)$

$[D_1(D_1 - 1) - D_1 + 1]y = z$

$[D_1^2 - 2D_1 + 1]\, y = z$

A.E. is $m^2 - 2m + 1 = 0$

$m = 1, 1$

$Y_c = [C_1 + C_2 Z]\, e^z$

$$y_p = \frac{1}{(D_1 - 1)^2} z = (1 - D_1)^{-2}$$

Expanding using Binomial expansion and ignoring powers of order greater than 1

$= [1 + 2D_1]z$

$y_p = [z + 2]$

Solution is

$y = y_c + y_p$

$y = [C_1 + C_2 z]\, e^z + (z + 2)$

Since, $z = \log x$; $e^z = x$

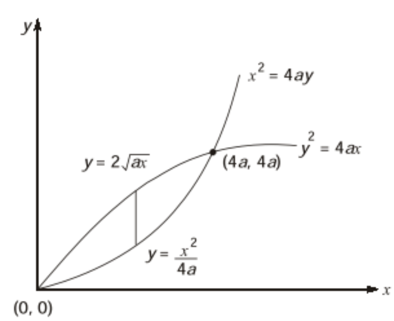
$y = [C_1 + C_2\log x]x + (\log x + 2)$

Q5. The area between the parabolas $y^2 = 4ax$ and $x^2 = 4ay$ is

A. $\frac{2}{3}a^2$
B. $\frac{14}{3}a^2$
C. $\frac{16}{3}a^2$
D. $\frac{17}{3}a^2$

Ans. C

Sol.



$$\text{Areal} = \int_0^{4a}\int_{y=\frac{x^2}{4a}}^{2\sqrt{ax}} dydx = \int_0^{4a}\left[y\right]_{\frac{x^2}{4a}}^{2\sqrt{ax}} dx$$

$$= \int_0^{4a}\left(2\sqrt{ax}^{1/2} - \frac{x^2}{4a}\right)dx$$

$$= 2\sqrt{a}\times\frac{x^{3/2}}{3/2}\Big|_0^{4a} - \frac{1}{4a}\times\frac{x^3}{3}\Big|_0^{4a}$$

$$= \frac{4\sqrt{a}}{3}(4a)^{3/2} - \frac{1}{12a}(4a)^3$$

$$= \frac{4\sqrt{a}}{3}\times\left(8a\sqrt{a}\right) - \frac{64a^3}{12a} = \frac{32a^2}{3} - \frac{16a^2}{3}$$

$$= \frac{16a^2}{3}$$

Q6. The volume of the solid surrounded by the surface $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} + \left(\frac{z}{c}\right)^{2/3} = 1$ is

A. $\frac{4\pi abc}{35}$

B. $\frac{abc}{35}$

C. $\frac{2\pi abc}{35}$

D. $\frac{\pi abc}{35}$

Ans. A

Sol. $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} + \left(\frac{z}{c}\right)^{2/3} = 1$

Putting,

$\left(\frac{x}{a}\right)^{1/3} = u \Rightarrow x = au^3 \Rightarrow dx = 3au^2du$

$\left(\frac{y}{b}\right)^{1/3} = v \Rightarrow y = bv^3 \Rightarrow dy = 3bv^2dv$

$\left(\frac{z}{c}\right)^{1/3} = w \Rightarrow z = cw^3 \Rightarrow dz = 3cw^2dw$

The equation of solid becomes,

$u^2 + v^2 + w^2 = 1$ ...(i)

$V = \iiint_V dzdydx$ ...(ii)

On putting, the values of dx, dy and dz we get

$V = \iiint_V 27abcu^2v^2w^2dudvdw$ ...(iii)

Equation (i) represents a sphere

By taking spherical co-ordinates

u = r sinθ cos φ, v = rsinθ sinφ, w = r cosθ dudvdw = r^2 sinθ drdθ dφ,

Substituting in equation (iii),

$$V = 27abc\int_{r=0}^{1}\int_{\theta=0}^{\pi}\int_{\phi=0}^{2\pi} r^2\sin^2\theta\cdot\cos^2\phi\cdot r^2$$

$$\sin^2\theta\sin^2\phi\cdot r^2\cos^2\theta\ r^2\sin\theta\ drd\theta d\phi$$

$$= 216abc\int_{r=0}^{1} r^8 dr \int_{\phi=0}^{\pi/2} \sin^2\phi \cos^2\phi d\phi$$

$$\int_{\phi=0}^{\pi/2} \sin^2\theta \cdot \cos^2\theta d\theta$$

$$= 216abc\left[\frac{r^9}{9}\right]_0^1 \left[\frac{1\times1}{4\times2}\times\frac{\pi}{2}\right]\times\left[\frac{(4\times2)(1)}{7\times5\times3\times1}\right]$$

$$= \frac{4}{35}abc\pi$$

Q7. The solution of the partial differential equation $x^2\frac{\partial z}{\partial x} + y^2\frac{\partial z}{\partial y} = (x+y)z$ is

A. $f\left(\frac{1}{x}-\frac{1}{y}-\frac{xy}{z}\right)=0$

B. $f\left(\frac{1}{xy},\frac{xy}{z}\right)=0$

C. $f\left(\frac{1}{x}-\frac{1}{y},xyz\right)=0$

D. $f\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z},\frac{xy}{z}\right)=0$

Ans. A

Sol – Auxiliary equation of the given equation is

$$\frac{dx}{x^2}=\frac{dy}{y^2}=\frac{dz}{(x+y)z}$$

Consider, $\frac{dx}{x^2}=\frac{dy}{y^2}\Rightarrow -\frac{1}{x}=-\frac{1}{y}+C$

$$\frac{1}{x}-\frac{1}{y}=C_1$$

Also, $\frac{dx/x}{x}=\frac{dy/y}{y}=\frac{dz/z}{x+y}=\frac{\frac{dx}{x}+\frac{dy}{y}-\frac{dz}{z}}{(x+y)-(x+y)}$

$\therefore \quad \frac{dx}{x}+\frac{dy}{y}-\frac{dz}{z}=0$

$\Rightarrow \quad \ln x+\ln y+\ln z=\ln C_2$

Or $\frac{xy}{z}=C_2$

$\therefore \quad f\left(\frac{1}{x}-\frac{1}{y},\frac{xy}{z}\right)=0$

Q8. The complex number $\left(\frac{2+i}{3-i}\right)^2$ is

A. $\frac{1}{2}\left(\cos\frac{\pi}{4}+i\sin\frac{\pi}{4}\right)$

B. $\frac{1}{2}\left(\cos\frac{\pi}{2}+i\sin\frac{\pi}{2}\right)$

C. $\frac{1}{2}(\cos\pi+i\sin\pi)$

D. $\frac{1}{2}\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)$

Ans. B

Sol –

$$\frac{(2+i)^2}{(3-i)^2}=\frac{4-1+4i}{9-1-6i}=\frac{3+4i}{8-6i}$$

$$=\frac{3+4i}{2(4-3i)}\times\frac{4+3i}{4+3i}$$

$$=\frac{12-12+25i}{2(16+9)}=\frac{i}{2}=\frac{1}{2}\left[e^{j\pi/2}\right]$$

Q9. If n is a positive integer then $\left(\sqrt{3}+i\right)^n+\left(\sqrt{3}-i\right)^n$ is

A. $2^n\sin\frac{n\pi}{6}$ B. $2^n\cos\frac{n\pi}{6}$

C. $2^{n+1}\cos\frac{n\pi}{6}$ D. $2^{n+1}\sin\frac{n\pi}{6}$

Ans. C

Sol –

$$2^n\left[\frac{\sqrt{3}}{2}+\frac{i}{2}\right]^n+2^n\left[\frac{\sqrt{3}}{2}-\frac{i}{2}\right]^n$$

$$=2^n\left[\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right]^n+2^n\left[\cos\frac{\pi}{6}-i\sin\frac{\pi}{6}\right]^n$$

$$=2^n e^{in\pi/6}+2^n e^{-in\pi/6}$$

$$=2^n\left[2\cos\frac{n\pi}{6}\right]=2^{n+1}\cos\frac{n\pi}{6}$$

Q10. The nature of singularity of function $f(z)=\frac{1}{\cos z-\sin z}$ at $z=\frac{\pi}{4}$ is

A. Removable singularity B. Isolated singularity

C. Simple pole D. Essential singularity

Ans. C

Sol –

$$\lim_{z\to\frac{\pi}{4}}\left\{\left(z-\frac{\pi}{4}\right)\times\frac{1}{\cos z-\sin z}\right\}\quad\left(\frac{0}{0}\text{form}\right)$$

$$=\lim_{z\to\frac{\pi}{4}}\left\{\frac{1}{-\sin z-\cos z}\right\}=\frac{1}{-1-1}=-\frac{1}{2}\neq 0$$

$\therefore$ $z=\frac{\pi}{4}$ Is a simple pole.

Similarly for pole of order n

$\lim_{z\to a}\left[(z-a)^n\times f(z)\right]\neq 0$, Then z = a is a pole of order 'n'

Q11. If X is a discrete random variable that follows Binomial distribution, then which one of the following response relations is correct?

A. $P(r+1)=\frac{n-r}{r+1}P(r)$ B. $P(r+1)=\frac{p}{q}P(r)$

C. $P(r+1)=\frac{n+r}{r+1}\frac{p}{q}P(r)$ D. $P(r+1)=\frac{n-r}{r+1}\frac{p}{q}P(r)$

Ans. D

Sol –

$$p(r)=n_{C_r}.p^r.q^{n-r}$$

$$P(r+1)=n_{C_{r+1}}.p^{r+1}.q^{n-r-1}$$

$$=\frac{n!}{(r+1)!(n-(r+1))!}\times p^r\times q^{n-r}\times\frac{p}{q}$$

$$=\frac{n!}{r!\times(n-r)!}\times\frac{n-r}{r+1}\times\frac{p}{q}\times p^r\times q^{n-r}$$

$$=\frac{n-r}{r+1}\times\frac{p}{q}\left[\frac{n!}{r!\times(n-1)!}\times p^r\times q^{n-r}\right]$$

$$=\frac{n-r}{r+1}\times\frac{p}{q}P(r)$$

Q12. If the probability that an individual suffers a bad reaction from a certain infection is 0.001, what is the probability that out of 2000 individuals, more than 2 individuals will suffer a bad reaction?

A. $\frac{1}{2}-\frac{5}{e^2}$

B. $1.2-\frac{5}{e^2}$

C. $1-\frac{5}{e^2}$

D. $\frac{5}{e^2}$

Ans. C

Sol –

$$n = 2000, p = 0.001, \lambda = np = 2000(0.001)$$
$$= 2$$
$$P(x>2) = 1 - P(x \le 2)$$
$$= 1 - [P(x=0) + P(x=1) + P(x=2)]$$
$$= 1 - \left[\frac{e^{-\lambda}\lambda^0}{0!} + \frac{e^{-\lambda}\lambda^1}{1!} + \frac{e^{-\lambda}\lambda^2}{2!}\right]$$
$$= 1 - e^{-\lambda}\left[1 + \lambda + \frac{\lambda^2}{2}\right]$$
$$= 1 - e^{-2}(1+2+2)$$
$$= 1 - \frac{5}{e^2}$$

Q13. Materials in which the atomic order extends uninterrupted over the entirely of the specimen; under some circumstances, they may have flat faces and regular geometric shapes, are called

A. Anisotropy

B. Crystallography

C. Single crystals

D. Crystal system

Ans. C

Sol –

Anisotropy: Anisotropy is the property of substances to exhibit variations in physical properties along different molecular axes. It is seen in crystals, liquid crystals and, less commonly, in liquids.

Crystallography: Crystallography is a branch of science that deals with discerning the arrangement and bonding of atoms in crystalline solids and with the geometric structure of crystals lattices.

Single Crystals: Materials in which the atomic order extends uninterrupted over the entirely of the specimen; under some circumstances, they may have flat faces and regular geometric shapes.

Crystal System: Crystal System is any of the six or sometimes seven main groups into which crystals are commonly classified according to the relative lengths and inclinations of their axes or according to their respective symmetries.

Q14. Which material possesses the following properties?

1. Shining white color with lustre
2. Soft, malleable and can be drawn into wires
3. Poor in conductivity and tensile strength
4. Used in making alloys with lead and copper
5. Used for fuses and cable sheathing

A. Silver

B. Tin

C. Nickel

D. Aluminium

Ans. C

Sol –

The properties of the materials are:

1. Silver:
- Silver is lustrous
- Silver is soft
- Ductile and malleable metal
- Does not oxidize in air

2. Tin:
- Tin is soft
- Silvery white metal
- Does not oxidize in air and resists corrosion

3. Nickel:
- Shining white color with lustre
- Soft, malleable and can be drawn into wires
- Poor in conductivity and tensile strength
- Used in making alloys with lead and copper
- Used for fuses and cable sheathing

4. Aluminium:
- Light weight
- Corrosion resistance
- Good electrical and thermal conductivity
- Ductile and impermeable

Q15. The saturation magnetization for Fe_3O_4, given that each cubic unit cell contains 8 Fe^{2+} and 16 Fe^{3+} ions, where Bohr magneton is 9.274×10^{-24} A.m^2 and that the unit cell edge length is 0.839 mm, will be

A. 1.25×10^5 A/m
B. 5×10^5 A/m
C. 10×10^5 A/m
D. 20×10^5 A/m

Ans. B

Sol –

Each Fe_3O_4 molecule has $4p_B$ magnetic dipole moment,

$$\vec{m} = 4\vec{p}_B$$

Density of Fe_3O_4 molecules

$$= N = \frac{\text{Number of molecules}}{\text{Volume}}$$

$$N = \frac{8}{(0.839 \times 10^{-9})^3}\left(\frac{1}{m^3}\right)$$

$\vec{M}$ = Magnetization;

$$\vec{M} = N\ \vec{m}$$

$$\vec{M} = N\ 4\vec{p}_B$$

$$M = \frac{8}{(0.839)^3 \times 10^{-27}}(4)(9.274 \times 10^{-24})$$

$$M = 5.024 \times 10^5\ (\text{A/m})$$

Q16. Consider the following applications of the materials:

1. Bismuth strontium calcium copper oxide used as a high temperature superconductor.
2. Boron carbide used in helicopter and tank armor.
3. Uranium oxide used as fuel in nuclear reactor.
4. Bricks used for construction.

The materials used in these applications can be classified as

A. Ceramic
B. Constantan
C. Manganin
D. Tantalum

Ans. A

Sol –

The applications of the Ceramic are as follows:

- Bismuth strontium calcium copper oxide used as a high temperature superconductor.
- Boron carbide used in helicopter and tank armor.
- Uranium oxide used as fuel in nuclear reactor.
- Bricks used for construction.

Q17. The saturation flux density for Nickel having density of 8.90 g/cm^3, atomic number 58.71 and net magnetic moment per atom of 0.6 Bohr magnetons is nearly

A. 0.82 tesla
B. 0.76 tesla
C. 0.64 tesla
D. 0.52 tesla

Ans. C

Sol –

Atomic density $= N = \frac{\rho N_A}{A_{Ni}}\left(\frac{\text{atoms}}{m^3}\right)$

ρ = density $= 8.9 \times 10^6\left(\frac{g}{m^3}\right)$

N_A = Avogadro number = 6.02 × 10^{23} (atoms/mole)

A_{Ni} = Atomic number of nickel = 58.71 (g/mole)

$N = \frac{\rho N_A}{A_{Ni}} = \frac{(8.9 \times 10^6)(6.02 \times 10^{23})}{58.7}$

= 9.127 × 10^{28} (atoms/m^3)

M = Nm

M = Magnetization

m= Magnetic dipole moment = 0.6 p_B

M_S = Nm

$M_S = (9.127 \times 10^{28})(0.6)(9.27 \times 10^{-24})$

$M_S = 50.764 \times 10^4$ (A.m^2)

$B_S = \mu_0 M_S$

$B_S = 4\pi \times 10^{-7} (50.764 \times 10^4)$

B_S = 0.637 Tesla

Q18. The Temperature at which iron ceases to be ferromagnetic and becomes para-magnetic is

A. Curie-Weiss point
B. Thermo-magnetic point
C. Ferro-paramagnetic point
D. Curie point

Ans. D

Sol –

Curie point is the point at which temperature at which iron ceases to be ferromagnetic and becomes para-magnetic.

Q19. Fick's laws refer to

A. Finding whether a semiconductor in n or p type
B. Diffusion
C. Crystal imperfections
D. Electric breakdown

Ans. B

Sol –

Fick's Law relates the diffusive flux to the concentration under the assumption of steady state. It postulates that the flux goes from regions of high concentration to regions of low concentration, with a magnitude that is proportional to the concentration gradient (spatial derivative), or in simplistic terms the concept that a solute will move from a region of high concentration to a region of low concentration across a concentration gradient. In one (spatial) dimension, the law is:

$$J = -D\frac{d\varphi}{dx}$$

Where

- J is the **diffusion flux**, of which the dimension is amount of substance per unit area per unit time, so it is expressed in such units as mol m^{-2} s^{-1}. J measures the amount of substance that will flow through a unit area during a unit time interval.
- D is the **diffusion coefficient** or diffusivity. Its dimension is area per unit time, so typical units for expressing it would be m^2/s.
- φ (for ideal mixtures) is the concentration, of which the dimension is amount of substance per unit volume. It might be expressed in units of mol/m^3.
- x is position, the dimension of which is length. It might thus be expressed in the unit m.

Q20. A magnetic field applied perpendicular to the direction of motion of a changed particle exerts a force on the particle perpendicular to both the magnetic field and the direction of motion of the particle. This phenomenon results in

A. Flux effect B. Hall effect
C. Magnetic field effect D. Field effect

Ans. B

Sol –

Hall effect refers to the magnetic field applied perpendicular to the direction of motion of a changed particle exerts a force on the particle perpendicular to both the magnetic field and the direction of motion of the particle.

Q21. An electric kettle is marked 500 W, 230V and is found to take 15 minutes to bring 1 kg of water at 15°C to 100°C, If the specific heat of water is 4200 J/kg°C, the heat efficiency of the kettle will be

A. 87.3% B. 83.6%
C. 79.3% D. 75.6%

Ans. C

Sol –

Heat = mCΔt
m- Mass
C- Specific heat
Δt = Change in temperature
Output heat=$1 \times 10^3 \times 4.2 \times (100 - 15)$
= 397000 Joule
Output power,

$$P = \frac{\text{Output heat}}{\text{Time}} = \frac{357000}{15 \times 60} = 396.67 \text{ Watt}$$

Input power = 500 Watt

Heat efficiency $= \frac{396.67}{500} \times 100 = 79.3\%$

Q22. With reference to nano materials, the prefix nano stands for

A. Nano centimeter B. Nanometer
C. Nano micrometer D. Nano millimeter

Ans. B

Sol – Nano means 10^{-9} *metre*.

Q23. Consider the following applications

1. High temperature heat engines
2. Nuclear fusion reactors.
3. Chemical processing industry
4. Aeronautical and space industry

Which one of the materials will be used for these applications?

A. Zironia B. Alumina
C. Ceramic D. Silicon carbide

Ans. D

Sol –

The applications of the Silicon carbide are as follows:

- High temperature heat engines
- Nuclear fusion reactors.
- Chemical processing industry
- Aeronautical and space industry

Q24. The machine used for the preparation of nano particle of alumina is

A. Attrition mill B. Grinding machine

C. Vending machine D. Welding machine

Ans. A

Sol –

The attrition mill is a device for mechanically reducing solid particle size by intense agitation of a slurry of material being milled and coarse milling media.

Q25. If the voltage across an element in a circuit is linearly proportional to the current through it, then it is a

A. Capacitor B. Transformer

C. Resistor D. Inductor

Ans. C

Sol. $V \infty I$ from Ohm's law

$V = RI$

R is resistor

Q26. Thevenin's equivalent circuit consists of

A. Current source and series impedance

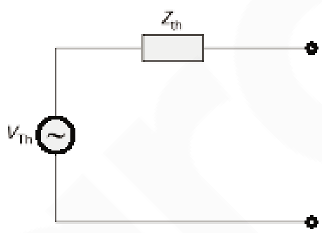
B. Voltage source and series impedance

C. voltage source and shunt impedance

D. Current source and shunt impedance

Ans. B

Sol. Thevenin equivalent



V_{Th} = Voltage source

Z_{Th} = Impedance (Ω)

Q27. When the voltage sources are replaced with short circuits and current sources are replaced with open circuits, leaving dependent sources in the circuit, the theorem applied is

A. Superposition B. Thevenin

C. Norton D. Millman

Ans. A

Sol. Superposition theorem

Q28. The maximum power is delivered from a source to a load when the source resistance is

A. Greater than the load resistance

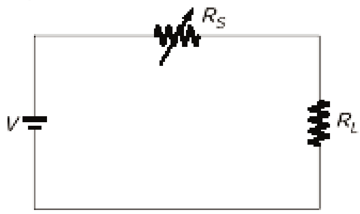
B. Equal to zero

C. Less than the load resistance

D. Equal to the load resistance

Ans. B

Sol. Equal to zero



$$I = \frac{V}{R_S + R_L}$$

When $R_S = 0$

The current is maximum and power delivered to load is maximum.

Q29. A network delivers maximum power to the load resistance when it is

A. Greater than Norton's equivalent resistance of the network.

B. Equal to Thevenin's equivalent resistance of the network.

C. Less than source resistance.

D. Less than Norton's equivalent resistance of the network.

Ans. B

Sol. From maximum power Transformation Theorem, when load resistance is equal to Thevenin equivalent resistance than maximum power delivers to the load.

Q30. The impedance of a parallel circuit is (10 – j30)Ω at 1 MHz. The values of circuit elements will be

A. 10 Ω and 6.4 mH

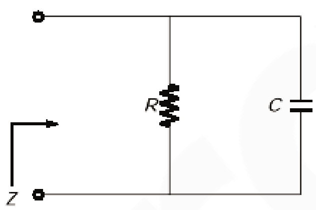
B. 100 Ω and 4.7 nF

C. 10 Ω and 4.7 mH

D. 100 Ω and 6.4 nF

Ans. B

Sol –



$$Z = 10 - j30$$

$$Y = \frac{1}{10 - j30} \times \frac{10 + j30}{10 + j30} = \frac{10}{1000} + \frac{j30}{1000}$$

$$= \frac{1}{100} + j30 \times 10^{-3} = \frac{1}{R} + \frac{1}{-jX_C}$$

$$R = 100\ \Omega, \qquad \frac{1}{X_C} = 30 \times 10^{-3}$$

$$2\pi fC = 30 \times 10^{-3}$$

$$2\pi \times 1 \times 10^6 \times C = 30 \times 10^{-3}$$

$$C = 4.7\ \text{nF}$$

Q31. The defining equations for V_1 and V_2 analyzing a two-port network in terms of its impedance parameters are respectively

A. $Z_{12}I_1 + Z_{12}I_2$ and $Z_{21}I_1 + Z_{21}I_2$

B. $Z_{11}I_1 + Z_{12}I_2$ and $Z_{21}I_1 + Z_{21}I_2$

C. $Z_{21}I_1 + Z_{21}I_2$ and $Z_{12}I_1 + Z_{12}I_2$

D. $Z_{12}I_1 + Z_{12}I_2$ and $Z_{22}I_1 + Z_{22}I_2$

Ans. B

Sol – $V_1 = Z_{11}I_1 + Z_{12}I_2$

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

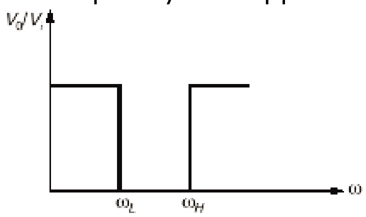
Q32. A filter that allows high and low frequencies to pass but attenuates any signal with a frequency between two corner frequencies is a

A. Notch filter B. Band pass filter

C. Band stop filter D. Multiband filter

Ans. C

Sol. Band stop filter attenuates any signal between two frequency components (lower cut-off frequency and upper cut-off frequency).



Q33. When a number of two-part networks are cascaded then,

A. z-parameters are added up

B. y-parameters are added up

C. h-parameters are multiplied

D. ABCD-parameters are multiplied

Ans. D

Sol –

Cascade Connection

For network X,

$V_{1X} = A_X V_{2X} - B_X I_{2X}$

$I_{1X} = C_X V_{2X} - D_X I_{2X}$

and for network Y,

$V_{1Y} = A_Y V_{2Y} - B_Y I_{2Y}$

$I_{1Y} = C_Y V_{2Y} - D_Y I_{2Y}$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} A_X & B_X \\ C_X & D_X \end{bmatrix} \begin{bmatrix} A_Y & B_Y \\ D_Y & D_Y \end{bmatrix}$$

Q34. A 3-phase star-connected 1000 volt alternator supplied power to a 500 kW delta-connected induction motor. If the motor power factor is 0.8 tagging and its efficiency 0.9, then the current in each alternator and motor phase respectively are nearly

A. 321 A and 231.5 A B. 401 A and 231.5 A

C. 321 A and 185.4 A D. 401 A and 185.4 A

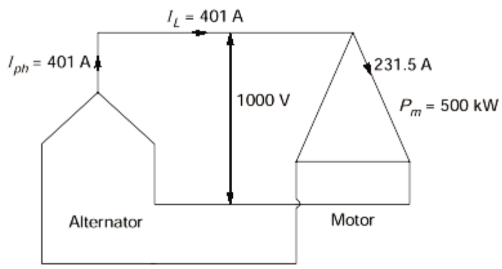
Ans. B

Sol –

Input of motor $= \dfrac{\text{Output}}{\eta} = \dfrac{500}{0.9} = 555.55$ kW

For motor, $P_{3\phi} = \sqrt{3} V_L I_L \cos\theta$

$$555.55\ kW = \sqrt{3} \times 1k \times I_L \times 0.8$$
$$I_L = 401\ A$$
$$\Rightarrow \quad I_{Ph} = \frac{401}{\sqrt{3}} = 231.5\ A$$



Q35. Consider the following statements:

1. Mutual inductance describes the voltage induced at the ends of a coils due to the magnetic field generated by a second coil.
2. The dot convention allows a sign to be assigned to the voltage induced due to mutual inductance term.
3. The coupling coefficient is given by $k = \frac{M}{\sqrt{L_1 + L_2}}$.

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

Ans. C

Sol –

The coupling coefficient is

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

$\therefore$ 3rd statement is wrong

Q36. Consider the following statements:

1. The rules for series and parallel combinations of capacitors are opposite to those for resistors.
2. The rules for series and parallel combinations of inductors are same as those for resistors.
3. An inductor is a short circuit to dc currents.

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

Ans. D

Sol –

Notes:

- The rules for series and parallel combinations of capacitors are opposite to those for resistors.
- The rules for series and parallel combinations of inductors are same as those for resistors.
- An inductor is a short circuit to dc currents.

Q37. The standard resistor is a coil of wire of some alloy having the properties of
Which of the above statements are correct?

A. Low electrical resistivity and high temperature coefficient of resistance.
B. High electrical resistivity and high temperature coefficient of resistance.
C. Low electrical resistivity and low temperature coefficient of resistance.
D. High electrical resistivity and low temperature coefficient of resistance.

Ans. D

Sol – The standard resistor is a coil of wire of some alloy having the properties of High electrical resistivity and low temperature coefficient of resistance.

Q38. Which one of the following material is used for the swamping resistance of moving coil instruments?

A. Carbon
B. Manganin
C. Silver
D. Brass

Ans. B

Sol – Manganin is used for the swamping resistance of moving coil instruments.

Q39. In a PMMC instrument, the swamping resistor is used to

A. Increase the damping of the instrument.
B. Reduce the current within the limits.
C. Compensate for temperature variations.
D. Increase the full-scale sensitivity.

Ans. C

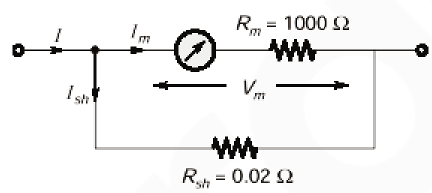
Sol – In a PMMC instrument, the swamping resistor is used to compensate for temperature variations.

Q40. A moving coil ammeter has a fixed shunt of 0.02Ω. With a coil resistance of R = 1000Ω and a potential difference of 500 mV across it, full scale deflection is obtained. The current through the moving coil to give full scale deflection will be

A. 25 A
B. 0.5×10^{-2} A
C. 0.25×10^{-3} A
D. 0.5×10^{-3} A

Ans. A

Sol –



$$m = 1 + \frac{R_m}{R_{sh}} = 1 + \frac{1000}{0.02} = 5001$$

$$I_m = \frac{V_m}{R_{sh}} = \frac{500 \times 10^{-3}}{1000}$$

$$= 0.5 \times 10^{-3} \text{ A}$$

$$m = \frac{I}{I_m} \Rightarrow \boxed{I = m \times I_m}$$

$$I = 50{,}001 \times 0.5 \times 10^{-3}$$

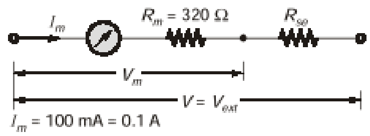
$$= 25.0005\ A = 25\ A$$

Q41. A moving iron instrument has full scale current of 100 mA. It is converted into a 250V voltmeter by using a series resistance made of a material having negligible resistance temperature coefficient. The meter has a resistance of 320 Ω at 20°C. After carrying a steady current of 100 mA for a long time, the resistance of the coil increases to 369 due to self heating. When a voltage of 250 V is applied continuously, the error due to self-heating will be nearly.

A. -1.1%
B. -1.9%
C. -2.5%
D. -3.3%

Ans. B

Sol –



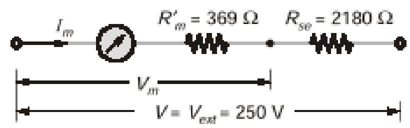
I_m = 100 mA = 0.1 A

$V_m = I_m R_m = 320 \times 0.1 = 32$ Volt

$$R_{se} = R_m[m-1] = R_m\left[\frac{V}{V_m} - 1\right]$$

$$R_{se} = 320\left[\frac{250}{32} - 1\right] = 2180\ \Omega$$

With Temperature 20oC :



$$I'_m = \frac{250}{2180 + 369} = 0.098077$$

Calibrated as ⇒ 0.1 A → 250 V

0.98 A → ?

$$\Rightarrow \quad \frac{250}{0.1} \times 0.0980877 = 245.19\ \text{V}$$

True value = 250 volt

$$\%\ \text{Error} = \frac{245.19 - 250}{250} \times 100 = -1.924\%$$

Q42. There will be serious errors if power factor of non-sinusoidal waveform is measured by electrodynamometer power factor meter. This is true for

A. Single-phase meters alone

B. 3-phase meters only

C. Both Single-phase meters and 3-phase meters

D. 3-phase meters with balanced loads

Ans. A

Sol – Single phase meters may have series errors if the power factor of non-sinusoidal waveform is measured by electrodynamometer power factor meter.

Q43. The ramp type digital voltmeter can measure accurately with

A. A positive going ramp voltage only

B. A negative or positive going linear ramp voltage

C. A negative going ramp voltage only

D. An asymptotic ramp voltage only

Ans. B

Sol –

Q44. The self-capacitance of a coil is measured by the resonating capacitor. The measurement gives the value of tuning capacitor as C_1 = 460 pF at a frequency. f_1 = 2 MHz. The second measurement at f_2 = 4 MHz yields a new value of tuning capacitor, C_2 = 100 pf. The distributed capacitance C_d will be

A. 10 pF
B. 20 pF
C. 30 pF
D. 40 pF

Ans. B

Sol –

$f_2 = 2f_1 \Rightarrow$ double frequency $\Rightarrow n = 2$

$$C_d = \frac{C_1 - n^2C_2}{n^2 - 1} = \frac{C_1 - 4C_2}{3} = \frac{460 - 4 \times 100}{3}$$

$= 20$ pF

Q45. Vertical delay line in CRO

A. Gives proper time for thermionic emission of electrons.

B. Delays the signal voltage by 200 ns.

C. Allows the horizontal sweep to start prior to vertical deflection

D. Delays the generation of sweep voltage.

Ans. B

Sol – Vertical delay line in CRO delays the signal voltage by 200 ns.

Q46. A 0 - 150 V voltmeter has a guaranteed accuracy of 1% full scale reading. The voltage measured by this instrument is 83 V. The limiting error will be nearly.

A. 1.2%

B. 1.8%

C. 2.4%

D. 3.2%

Ans. B

Sol. $\%\text{ L.E.} = \frac{150}{83} = 1.81\%$

Q47. The variations in the measured quantity due to sensitivity of transducer to any plane other man the required plane is

A. Cross sensitivity

B. Sensitivity

C. Interference

D. Distributed sensitivity

Ans. A

Sol – The variations in the measured quantity due to sensitivity of transducer to any plane other man the required plane is Cross sensitivity.

Q48. A resistance strain gauge with a gauge factor of 2 is fastened to a steel member subjected to a stress of 1050 kg/cm^2. The modulus of elasticity of steel is 2.1×10^6 kg/cm^2. The change in resistance ΔR of the strain gauge element due to applied stress will be

A. 0.1%

B. 0.2%

C. 0.3%

D. 0.4%

Ans. A

Sol – $G_f = 2$

Stress = 1050 kg/cm^2

Y = 2.1 106 kg/cm^2

$$\text{Strain} = \in = \frac{\text{Stess}}{Y} = \frac{1050}{2.1 \times 10^6} = 500 \times 10^{-6} = \in$$

$$\Delta R = G_f \in R$$

$$\% \frac{\Delta R}{R} = G_f \in \times 100$$

$$\% \frac{\Delta R}{R} = 2 \times 500 \times 10^{-6} \times 100 = 0.1\%$$

Q49. In which one of the following classes of computers, is the relationship between architecture and organization very close?

A. Microcomputers

B. Mini computers

C. Mainframe computer

D. Super computers

Ans. A

Sol. Microcomputer is a personal computer. So, architecture and organization is very close.

Q50. The decimal equivalent of binary number 1001,101 is

A. 9.750 B. 9.625

C. 10.750 D. 10.925

Ans. B

Sol. $1001.101 = 1 \times 2^3 + 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-3} = 9.625$

Q51. Convert decimal 41.6875 into equivalent binary:

A. 100101.1011 B. 100101.1101

C. 101001.1011 D. 101001.1101

Ans. C

Sol. 41.6875

41 ⇒ 32	16	8	4	2	1	
	1	0	1	0	0	1

0.6875 × 2 =	1.375
0.375 × 2 =	0.75
0.75 × 2 =	1.50
0.50 × 2 =	1.00

.1011

41.6875 ⇒ 101001.1011

Q52. The Central Processing Unit (CPU) consists of

A. ALU and control unit only

B. ALU, control unit and Resisters only

C. ALU, Control unit and System bus only

D. ALU, Control unit, Registers and Internal bus

Ans. D

Sol. CPU contains ALU, CU and registers and internal buses.

Q53. When enough total memory space exists to satisfy a request, but it is not contiguous, then this problem is known as

A. Internal Fragmentation

B. External Fragmentation

C. Overlays

D. Partitioning

Ans. B

Sol – External Fragmentation: It is defined as the when enough total memory space exists to satisfy a request, but it is not contiguous.

Q54. The total average read of write time T_{total} is

A. $T_s + \frac{1}{2r} + \frac{b}{N}$

B. $T_s + \frac{1}{2r} + \frac{b}{rN}$

C. $\frac{T_s}{rN} + \frac{b}{N}$

D. $T_s + 2r + \frac{b}{rN}$

Where,

T_s = Average seek time

b = Number of bytes to be transferred

N = Number of bytes on a track

r = Rotation speed, in revolution per second

Ans. B

Sol –

Seek time = T_s

"r" revolution ⇒ 1 sec

1 revolution $\Rightarrow \frac{1}{r}$ sec

$\therefore$ Rotational latency $= \frac{1}{2}$ revolution time

$= \frac{1}{2} * \frac{1}{r} \sec = \frac{1}{2r} \sec$

Transfer time :

1 revolution time 1 track data (N bytes)

Time required for b bytes $= \frac{\frac{1}{r}\sec * b}{N} = \frac{b}{rN}$

Total time = Seek time + Average rotational latency + Transfer time

$$= T_s + \frac{1}{2r} + \frac{b}{rN}$$

Q55. If a cache has 64-byte cache lines, how long does it take to fetch a cache line if the main memory takes 20 cycles to respond to each memory request and returns 2 bytes of data in response to each request?

A. 980 cycles

B. 640 cycles

C. 320 cycles

D. 160 cycles

Ans. B

Sol –

CM line size = 64 B

Memory access time = 20 cycles/2 byte transfer

Total time required to fetch the cache line is,

⇒ (Memory referred number of times) × (Memory access time)

$\Rightarrow \frac{64}{2} \times 20$ cycles

$\Rightarrow$ 640 cycles

Q56. Which of the following statements are correct about SRAM?

1. It provides faster access as compared to DRAM.
2. It is cheaper than DRAM.
3. It is more expensive than DRAM.
4. It has higher bit density than DRAM.

A. 1 and 4 only

B. 1 and 3 only

C. 1, 3 and 4 only

D. 2 and 4 only

Ans. B

Sol. SRAM is faster than DRAM and more expensive.

Q57. Features of solid state drives (SSDs) are

1. High-performance in input/output operations per second
2. More power consumption than comparable size HDDS
3. Lower access times and latency rates
4. More susceptible to physical shock and vibration

A. 2 and 3 only

B. 2 and 4 only

C. 1 and 3 only

D. 1 and 4 only

Ans. C

Sol. SSD's uses software instructions to go directly to the location where data is stored to access, therefore time required to access the data is low.
Where as in the hard disk drive mechanically move its read/write head across a spinning platter to locate data to access.

Q58. The decimal value of signed binary number 11101000 expressed in 1's complement is

A. -223
B. -184
C. -104
D. -23

Ans. D

Sol. 1 1 1 0 1 0 0 0 (-23)
1 1 1 0 1 0 0 0 → 0 0 0 1 0 1 1 1 (2 3)
Option (D) is correct.

Q59. The memory management function of virtual memory includes

1. Space allocation
2. Program relocation
3. Program execution
4. Code sharing

A. 1, 2 and 3 only
B. 1, 2 and 4 only
C. 1, 3 and 4 only
D. 2, 3 and 4 only

Ans. B

Sol. Program execution is a CPU function. Virtual memory concept is used to increase the address space.

Q60. Which of the following instructions of 8085 are the examples of implied addressing?

1. CMA
2. IN byte
3. RET

A. 1, 2 and 3
B. 1 and 2 only
C. 2 and 3 only
D. 1 and 3 only

Ans. D

Sol. **CMA:** Implicit/Implied as the instruction does not have any operands and address of operand in mnemonics itself
RET: Indirect/Implied

Q61. The important fact about the collector current is:

A. It is greater than emitter current.
B. It equals the base current divided by the current gain.
C. It is small.
D. It approximately equals the emitter current.

Ans. D

Sol. $I_E = I_B + I_C$
I_B is in μA,
$I_E \simeq I_C$

Q62. What is Shockely's equation of a semiconductor diode in the forward bias regions?

A. $I_D = I_S\left(e^{V_D^e/nV_T} - 1\right)$

B. $I_D = I_S\left(e^{V_D/nV_T} - 1\right)$

C. $I_D = I_S\left(e^{nV_D/n\,V_T} - 1\right)$

D. $I_D = I_S\left(e^{V_T/n\,V_D} - 1\right)$

Where,
I_S is reverse saturation current
V_D is applied forward-bias voltage across the diode
V_T is thermal voltage
n is an ideality factor

Ans. B

$$I_D = I_S\left[e^{V/\eta V_T} - 1\right]$$

Q63. The thermal voltage V_T, of a semiconductor diode at 27°C temperature is nearly
A. 17 mV
B. 20 mV
C. 23 mV
D. 26 mV

Ans. D

Sol. $V_T = \frac{T}{11600} = \frac{300}{11600} = 26\text{ mV}$

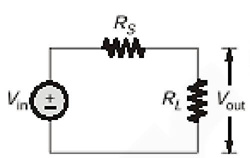
Q64. The disadvantage of a typical MOSFET as compared to BJT is
A. Increased power-handling levels
B. Reduced power-handling levels
C. Increased voltage-handling levels
D. Reduced voltage-handling levels

Ans. B

Sol. The disadvantage of a typical MOSFET compared to BJT is reduced power handling levels.

Q65. Which of the following conditions will be satisfied for an impedance matched system?
A. The decibel power gain is equal to twice the decibel voltage gain.
B. The decibel power gain is equal to the decibel voltage gain.
C. The decibel power gain is half the decibel voltage gain.
D. The decibel power gain is equal to the thrice the decibel voltage gain.

Ans. C



$$V_{out} = \frac{V_{in}}{2}$$

$$\frac{V_{out}}{V_{in}} = A_V = \frac{1}{2}$$

$$|A_V|_{dB} = 20\log\frac{1}{2} = -6\,\text{dB}$$

$$A_P = \frac{P_{out}}{P_{in}} = \frac{I^2R_L}{I^2(R_S + R_L)}$$

$$|A_V|_{dB} = 10\log A_P = 10\log\frac{1}{2} = -3\,\text{dB}$$

Q66. For most FET configurations and for common-gate configurations, the input impedances are respectively
A. High and high
B. High and low
C. Low and low
D. Low and high

Ans. B

Sol. For CS and CD the input impedance Z_i is high, for CG the input impedance Z_i is low.

Q67. The dB gain of cascaded system is simply

A. The square of the dB gain of each stage

B. The sum of the dB gains of each stage

C. The multiplication of the dB gains of each stage

D. The division of the dB gains of each stage

Ans. B

Sol –

$A_V = A_{V1} \,.\, A_{V2} \ldots A_{V/n}$

$20 \log A_V = 20 \log A_{V1} \,.\, A_{V2} \ldots. A_{V/n}$

$= 20 \log A_{V1} + 20 \log A_{V2} + \ldots. 20 \log A_{V/n}$

Q68. The Miller effect input capacitance C_{Mi} is

A. $\left(1 - A_V^2\right) C_f$

B. $\left(1 - A_V\right) C_f$

C. $\left(1 - C_f\right) A_V$

D. $\left(1 - C_f^2\right) A_V$

Where,

C_f = feedback capacitance

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

Ans. B

Miller's input capacitance

$C_{Mi} = \left(1 - A_V\right) C_M$

Q69. For an op-amp having a slew rate of 2 V/μs, if the input signal varies by 0.5 V in 10 μs, the maximum closed-loop voltage gain will be

A. 50

B. 40

C. 22

D. 20

Ans. B

Sol – $\text{S.R.} = A_{CL} . \frac{\Delta V_i}{\Delta t} = A_{CL} . \frac{0.5}{10 \times 10^{-6}}$

$A_{CL} = 40$

Q70. A negative feedback amplifier where an input current controls an output voltage is called

A. Current amplifier

B. Transconductance amplifier

C. Transresistance amplifier

D. Voltage amplifier

Ans. C

Sol – CCVS,

$A = \frac{V_o}{I_i} \left(\text{Transfer } f_n\right)$

= Transresistance amplifier

Q71. In emergency lighting system, the component used for maintaining the charge on the battery is

A. LED

B. Shockley diode

C. Thermistor

D. SCR

Ans. A

Sol. LED is used in emergency lighting system.

Q72. For RC phase shift oscillator using FET, the gain of the amplifier stage must be practically somewhat greater than

A. 27

B. 28

C. 29

D. 30

Ans. C

Sol. For RC phase shift oscillator,

$|A_V| = 29$

Q73. The time delay in a look-ahead carry adder is independent of

A. Number of operands only

B. Propagation delay only

C. Number of bits in the operand only

D. Bits in the operand, number of operands and propagation delay

Ans. C

Sol. Time delay in a look ahead carry adder is independent of number of bits in the operand only.

Q74. The time delay introduced by a SISO shift register in digital signals is given by

A. $N^2 \times \frac{1}{f_c}$

B. $N^2 \times f_c$

C. $\frac{f_c}{N}$

D. $N \times \frac{1}{f_c}$

Where,

N is the number of stages

f_c is the clock frequency

Ans. D

Sol –

Given:

Number of flip-flops in SISO = N

Clock frequency = f_c

Clock time period $= \frac{1}{f_c}$

Time delay for a bit to pass through a single flip-flop stage $= \frac{1}{f_c}$

Therefore time delay for a signal to pass through N flip-flop stages $= N \times \frac{1}{f_c}$

Q75. A analog output voltage for the input 1001 to a 4 bit D/A converter for all possible inputs assuming the proportionality factor K = 1 will be

A. 9

B. 6

C. 3

D. 1

Ans. A
Sol. V_0 = K [Decimal equivalent of binary data]
= $1[1001]_2 = [9]_{10}$

Q76. In microprocessor interface, the concept of detecting some error condition such as 'no match found' is called
A. Syntax error
B. Semantic error
C. Logical error
D. Error trapping

Ans. D
Sol – In microprocessor interface, the concept of detecting some error condition such as 'no match found' is called Error trapping.

Q77. The maximum number of input or output devices that can be connected to 8085 microprocessor are
A. 8
B. 16
C. 40
D. 256

Ans. D
Sol. In the instruction IN 8-bit port address and OUT 8-bit port address.
I/O has 8-bit value so therefore $2^8 \rightarrow 256$ devices can be connected.

Q78. The contents of the accumulator and register Care 2EH and 6CH respectively. The instruction ADD C is used. The values of AC and P flags are
A. 0 and 0
B. 1 and 1
C. 0 and 1
D. 1 and 0

Ans. B
Sol. Content of accumulator = 2E
Content of register C = 6C
After addition operation result is 9A
Binary equivalent of 9A is (10011010)2

S	Z	X	AC	X	P	X	CY	← Flag register format
1	0	0	1	0	1	0	0	

∴ AC = 1
P = 1

Q79. When an information signal is multiplied by an auxiliary sinusoidal signal to translate its frequency, the modulation is called
A. Phase modulation
B. Frequency modulation
C. Amplitude modulation
D. Quadrature amplitude modulation

Ans. C
Sol – Amplitude modulation: Amplitude modulation is modulation technique used in electronic communication, most commonly for transmitting information via a radio carrier wave. In amplitude modulation, the amplitude (signal strength) of a carrier wave is varied in proportion to that of the message signal being transmitted.

Q80. The transmission power efficiency for a tone modulated signal with modulated index of 0.5 will be nearly
A. 6.7%
B. 11.1%
C. 16.7%
D. 21.1%

Ans. B

Sol. μ = 0.5

Transmission efficiency

$$= \frac{\mu^2}{2+\mu^2} = \frac{(0.5)^2}{2+(0.5)^2} = 11.1\%$$

Q81. For practical purpose, the signal to noise ratio for acceptable quality transmission of analog signals and digital signals respectively are

A. 10-30 dB and 5-08 dB

B. 40-60 dB and 10-12 dB

C. 60-80 dB and 20-24 dB

D. 70-90 dB and 30-36 dB

Ans. B

Sol – For practical or commercial purposes,

The signal to noise ratio for acceptable quality of transmission of analog signals and digital signals are respectively:

Analog Signals: 40-60 dB

Digital Signals: 10-12 dB

Q82. The discrete samples of an analog signal are to be uniformly quantized transmission of PCM system. If the maximum value of the analog sample is to be represented within 0.1% accuracy, then minimum number of binary digits required will be nearly

A. 7

B. 9

C. 11

D. 13

Ans. C

Sol – Given, $[Q_e]_{max} \le 0.1\%\ A_m$

A_m = Peak amplitude of signal

$$\frac{\Delta}{2} = \frac{1}{2}\left[\frac{2A_m}{2^n}\right] \le \frac{0.1}{100} \times A_m$$

$$\frac{1}{2^n} \le \frac{1}{1000}$$

$$2^n \ge 1000$$

$$n = 11$$

Q83. A signal: m (t) = 2 cos6000πt + 4cos8000 πt + 6 cos 1000πt is to be truthfully represented by its samples. The minimum sampling rate using band pass consideration will be

A. 5000 Hz

B. 10000 Hz

C. 15000Hz

D. 20000 Hz

Ans. A

Sol –

m (t) = 2cos6000πt + 4cos8000 πt + 6 cos 1000πt

f_L = lower cutoff frequency = f_1 = 3000 Hz

f_H = higher cut off frequency = f_3 = 5000 Hz

Bandwidth = Bandwidth of signal

= $f_H - f_L$ = 5000 – 3000 = 2000 Hz

For bandpass sampling,

$f_{s\,\min} = \frac{2f_H}{K}$ ...(i)

Where, K = greatest integer value $\leq \frac{f_H}{BW} = \frac{5000}{2000} = \frac{5}{2} = 2.5$

⇒ K = 2

From (i), $f_{s\ \min} = \frac{2f_H}{K} = \frac{2 \times 5000}{2} = 5000$ Hz

Q84. If 'N signals are multiplexed using PAM band limited to f_m, the channel bandwidth need not be larger than

A. $N \cdot \frac{f_m}{2}$

B. $N \cdot f_m$

C. $2N \cdot f_m$

D. $N^2 \cdot f_m$

Ans. B

Sol –

Number of signals = N

Message bandwidth = f_m

Sampling rate = $2f_m$

Bit rate (R_b) = N × $2f_m$

Signal bandwidth $= \frac{R_b}{2} = Nf_m$

Since signal BW = Nf_m channel BW need not be larger than Nf_m.

Q85. A linear discrete-time system is characterized by its response $h_k(n) = (n - k)\, u\,(n - k)$ to a delayed unit sample δ(n - k). The system will be

A. Shift invariant

B. Shift variant

C. Scale invariant

D. Scale variant

Ans. A

Sol – Given that

$x(n) = \delta(n-K) \xrightarrow{\text{sys.}} y(n) = h_k(n)$

$h_k(n) = (n-k)u(n-K)$

By putting n = n + K

$x(n+K) = \delta(n) \xrightarrow{\text{sys.}} y(n+K) = u(n)$

Here, input is time-advanced by 'K' time units.

Then output will be also time advanced by K times unit.

Hence the system is shift invariant.

Q86. Consider the analog signal $x_a(t) = 3 \cos 100\pi t$

The minimum sampling rate F_s required to avoid aliasing will be

A. 100 Hz

B. 200 Hz

C. 300 Hz

D. 400 Hz

Ans. A

Sol – $x_a(t) = 3 \cos 100\pi t$

$f_0 = 50$ Hz

$f_{s\,\min} = 2f_0 = 2 \times 50 = 100$ Hz

(to avoid aliasing)

Q87. The response of the system y(n) = x(n) to the following input signal

$$x(n) = \begin{cases} |n|, & -3 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$

A. Is delayed from input
B. Is exactly same as the input
C. Leads the input
D. Varies with signal

Ans. B

Sol – Since, y(n) = x(n)
Therefore, response or system output will be exactly same as the input.

Q88. The complex exponential Fourier representation for the signal x(t)=cos ω_0t is

A. $\sum_{k=-\infty}^{\infty} c_k e^{-jk\omega_0 t}$
B. $\sum_{k=-\infty}^{\infty} c_k e^{-j\omega_0 t}$
C. $\sum_{k=-\infty}^{\infty} c_k e^{2jk\omega_0 t}$
D. $\sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t}$

Ans. D

Sol – The complex exponential Fourier representation for the signal x (t) = cos ω_0t is given as

$$x(t) = \sum_{k=-\infty}^{\infty} C_k e^{jk\omega_o t}$$

Q89. The continuous LTI system is described by

$$\frac{dy(t)}{dy} + 2y(t) = x(t)$$

Using the Fourier transform for the output will be

A. $(e^{-t} - e^{2t})u(t)$
B. $(e^{t} + e^{-2t})u(t)$
C. $(e^{-t} - e^{-2t})u(t)$
D. $(e^{t} + e^{2t})u(t)$

Ans. C

Sol –

From given differential equation,

$$sY(s) + 2Y(s) = X(s)$$

$$\Rightarrow \quad H(s) = \frac{Y(s)}{X(s)} = \frac{1}{s+2}$$

Now, system output:

$$y(t) = x(t) * H(t)$$

$$Y(s) = X(s)H(s)$$

$$\Rightarrow \quad Y(s) = \frac{1}{s+1} \cdot \frac{1}{s+2} = \frac{1}{s+1} - \frac{1}{s+2}$$

$$\left[\because x(t) = e^{-t}u(t) \xrightarrow{LT} X(s) = \frac{1}{s+1}\right]$$

Taking inverse Laplace transform of Y(s).

$$y(t) = e^{-t}u(t) - e^{-2t}u(t)$$

$$= \left[e^{-t} - e^{-2t}\right]u(t)$$

Q90. The discrete Fourier series representation for the following sequence $x(n) = \cos\frac{\pi}{4}n$ is

A. $\frac{1}{2}e^{j\Omega_0 n} + \frac{1}{2}e^{-j\Omega_0 n}$ and $\Omega_0 = \frac{\pi}{8}$

B. $\frac{1}{2}e^{-j\Omega_0 n} + \frac{1}{2}e^{-j\Omega_0 n}$ and $\Omega_0 = \frac{\pi}{4}$

C. $\frac{1}{2}e^{-j\Omega_0 n} + \frac{1}{2}e^{-j\Omega_0 n}$ and $\Omega_0 = \frac{\pi}{6}$

D. $\frac{1}{2}e^{j\Omega_0 n} + \frac{1}{2}e^{j7\Omega_0 n}$ and $\Omega_0 = \frac{\pi}{4}$

Ans. D

Sol –

$x(n) = \cos\frac{\pi}{4}n,$

$\Omega_0 = \frac{\pi}{4} = \cos\Omega_0 n$

$= \frac{1}{2}e^{j\Omega_0 n} + \frac{1}{2}e^{-j\Omega_0 n}$

$= C_1 e^{j\Omega_0 n} + C_{-1}e^{-j\Omega_0 n}$ ...(i)

Now, $C_K = C_{K + mN}$

Where m = an integer = ± 1, 2, ...

$N = \text{FTP of } x(n) = \frac{2\pi}{\Omega_0} = \frac{2\pi}{\pi/4} = 8$

Put K = - 1 :

$C_{-1} = C_{1+m_8,}m$

$= \underset{\text{form}=1}{C_7} = \underset{\text{form} = 12}{C_{15}} = \dots$

From equation (i), $x(n) = C_1 e^{j\Omega_0 n} + C_7 e^{-j\Omega_0 n}$

$\Rightarrow \quad x(n) = \frac{1}{2}e^{j\frac{\pi}{4}n} + \frac{1}{2}e^{-j\frac{\pi}{4}n}.e^{j2\pi n}$

$[\because \; e^{j2\pi n} = 1]$

$\Rightarrow \quad x(n) = \frac{1}{2}e^{j\frac{\pi}{4}n} + \frac{1}{2}e^{j\left(2-\frac{1}{4}\right)\pi n}$

$= \frac{1}{2}e^{j\frac{\pi}{4}n} + \frac{1}{2}e^{j\frac{7\pi}{4}n}$

Q91. Consider the discrete-time sequence, $x(n) = \cos\left(\frac{n\pi}{8}\right)$. When sampled at frequency f_s = 10 kHz, then f_0, the frequency of the sampled continuous time signal which produced this sequence will at least be

A. 625Hz

B. 575Hz

C. 525 Hz

D. 475 Hz

Ans. A

Sol –

Given that,

$$x(t) \longleftrightarrow x(n) = \frac{\cos \pi}{8} n$$

$$\omega = \frac{\pi}{8}$$

$$f_s = 10 \text{ kHz}$$

Continuous time sinusoidal frequency = Ω rad/sec (or f_0 Hz)

Since,

$$\omega = \frac{\pi}{8} \times 10000 = 1250\pi \text{ rad/sec}$$

$$f_0 = \frac{\Omega}{2\pi} = \frac{1250\pi}{2\pi} = 625 \text{ Hz}$$

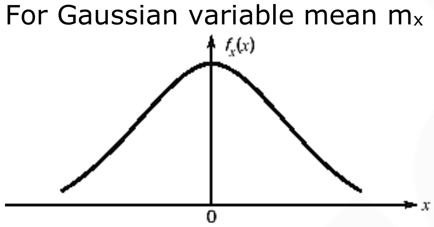
Q92. How many bits are required in an A/D converter with a B + 1 quantizer to get a signal-to-quantization noise ratio of at least 90 dB for a Gaussian signal with range of $\pm 3\sigma_x$?

A. B+ 1 = 12bits
B. B+1 = 14 bits
C. B+1 = 15 bits
D. B+1 = 16 bits

Ans. D

Sol – $V_{P-P} = 6\sigma_x$

For Gaussian variable mean $m_x = 0$



Signal power=Mean square value

$$S = m_x^2 + \sigma_x^2 = \sigma_x^2$$

Noise power $= \frac{\Delta^2}{12}$

$$\Delta = \frac{V_{P-P}}{2^n} = \frac{6\sigma_x}{2^n} = \left[\frac{36\sigma_x^2}{2^{2n}} / 12\right] = \frac{36\sigma_x^2}{2^{2n}}$$

$$\text{SNR} = \frac{\sigma_x^2}{\left(\frac{36\sigma_x^2}{2^{2n}}\right)} = \frac{2^{2n}}{3}$$

SNR in dB = 10 log1022n – 10 log103

= (6n – 4.8) dB

Given that SNR ≥ 90 dB

6n – 4.8 ≥ 90

n ≥ 15.8

n = 16

Number of bits required = 16

Q93. Let x(n) be a left-sided sequence that is equal to zero for n > 0. If $X(z) = \frac{3z^{-1} + 2z^{-2}}{3 - z^{-1} + z^{-2}}$, then x(0) will be

A. 0
B. 2
C. 3
D. 4

Ans. B

Sol –

$$X(z) = \frac{3z^{-1} + 2z^{-2}}{3 - z^{-1} + z^{-2}} X \frac{z^2}{z^2}$$

Where, x(n) = 0, n > 0

i.e. x(n) is left sided sequence.

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

$$1 - z + 3z^2 \overline{)\, 2 + 3z \,}\,(2 + 5z + \ldots$$

$$\underline{\;2 - 2z + 6z^2\;}$$
$$\;\;\; - \;\; + \;\; -$$

$$5z - 6z^2$$

$$\vdots$$

X(z) = 2 + 5z + ….

= x(0) + x(-1)z + …..

Hence, x(0) = 2

Q94. The noise variance σ_ε^2 at the output of $H(z) = \frac{0.5z}{z - 0.6}$ with respect to input will be nearly

A. 40%

B. 50%

C. 60%

D. 70%

Ans. A

Sol – Given, $H(z) = \frac{0.5z}{z - 0.6}$

$H(n) = 0.5\,(0.6)^n\,u(n)$

If input $x(n) = \delta(n)$

Then output, $y(n) = h(n) = 0.5\,(0.6)^n\,u(n)$

Input energy, $\sum_{n=-\infty}^{\infty} x^2(n) = \sum_{n=-\infty}^{\infty} \delta^2(n) = 1$

Output energy, $\sum_{n=-\infty}^{\infty} y^2(n) = \sum_{n=-\infty}^{\infty} h^2(n)$

$$= \sum_{n=0}^{\infty} 0.25 \times (0.36)^n = \frac{0.25}{1 - 0.36} = \frac{0.25}{0.64} = 0.4$$

Output energy = 40% of input energy

Output power = 40% of input power

Q95. If the complex multiply operation takes 1 μs, the time taken to compute 1024-point DFT directly will be nearly

A. 3.45 s

B. 2.30 s

C. 1.05 s

D. 0.60 s

Ans. C

Sol –

N = 1024

Time for one multiplication = 1 μsec

tal time for DFT = $N^2 \times 1$ μsec

= $1024^2 \times 10^{-6}$ sec

= 1.05 sec

Q96. Consider the following data to design a low-pass filter

Cut-off frequency, $\omega_c = \frac{\pi}{2}$

Stop band ripple $\delta_2 = 0.002$

Transition bandwidth no larger than 0.1 π. Kaiser window parameters and N respectively are

A. 2.99 and 45

B. 4.99 and 45

C. 2.99 and 65

D. 4.99 and 65

Ans. D

Sol –

a_s = stop band deviation

$= - 20 \log (\delta_s)$

$= - 20 \log 0.002 = 53.979$

Since, $a_s > 50$,

So $\beta = 0.1102 (\alpha_s - 8.7) = 4.99$

and $N = \frac{\alpha_s - 7.95}{14.36.\Delta f}$;

where, $\Delta\omega = 0.1\pi$

So, N = 65

Q97. A transfer function $G(s) = \frac{1 - sT}{1 + sT}$ has a phase angle of ($-2 \tan^{-1} \omega T$) which varies from 0° to -180° as ω is increased from 0 to ∞. It is the transfer function for

A. All pass system

B. Low pass system

C. High pass system

D. Band pass system

Ans. A

Sol –

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

$$M = \left|\frac{1 + j\omega T}{1 + j\omega T}\right| = 1$$

Magnitude is constant for all ω

∴ All pass system

Alternative method:

G(s) = Transfer function $= \frac{1 - sT}{1 + sT}$

$$\text{Pole} : s = \frac{-1}{T}$$

$$\text{Zero} : s = \frac{1}{T}$$

Since pole and zero are mirror image of each-other. Thus the filter will be all pass type.

Q98. The open-loop and closed-loop transfer functions of a system are respectively given by

$$G(s) = \frac{K}{j\omega\tau + 1};(\text{open loop})$$

$$G(s) = \frac{\frac{K}{(1+K)}}{j\omega\tau_c + 1};(\text{closed loop})$$

The ratio of the bandwidth of closed loop to open loop system is

A. K

B. (1 + K)

C. $(1 + K)^2$

D. $\frac{K^2}{(1+K)}$

Ans. B

Sol –

$$\text{OLTF} = \frac{K}{j\omega T + 1}$$

$$\text{CLTF} = \frac{\frac{K}{1+K}}{j\omega T_C + 1}$$

$$\text{B.W} \propto \frac{1}{\text{gain}}$$

$$\therefore \quad \text{B.W}_{\text{OL}} = \frac{1}{K}$$

$$\therefore \quad \text{B.W}_{\text{CL}} = \frac{K+1}{K}$$

$$\frac{\text{B.W}_{\text{CL}}}{\text{B.W}_{\text{OL}}} = \frac{\frac{K+1}{K}}{1/K} = K + 1$$

Q99. The system sensitivity of open loop and closed loop system are respectively

A. 1 and $\frac{1}{1+GH}$

B. $\frac{1}{1+GH}$ and 1

C. $\frac{1}{GH}$ and 1

D. 1 and $\frac{1}{GH}$

Ans. A

Sol –

OLTF = G = T_1

$$\text{CLTF} = \frac{G}{1+GH} = T_2$$

$$S_G^{T_1} = \frac{G}{T_1} \cdot \frac{\delta T_1}{\delta G} = 1$$

$$S_G^{T_2} = \frac{G}{T_2} \cdot \frac{\delta T_2}{\delta G} = \frac{1}{1+GH}$$

Q100. The steady state error of a type-1 system to a unit step input is

A. $\frac{1}{(1+K_p)}$

B. 0

C. ∞

D. $\frac{1}{K_v}$

Ans. B

Sol –

Type-1:

$$GH(s)=\frac{1}{s}$$

$$R(s)=\frac{1}{s}$$

$$\Rightarrow \quad e_{ss}=\underset{s\to 0}{LT}\frac{s\times\frac{1}{s}}{1+\frac{1}{s}}=0$$

Q101. The direction of the net encirclements of the origin of Real-Imaginary plane in a Nyquist plot for the system to be stable is

A. Clockwise of the origin

B. Counter-Clockwise of the origin

C. Left hand side s-plane

D. Right hand side s-plane

Ans. B

Sol. According to Nyquist criterion if N = P, ACW then system is stable.

Q102. A unity negative feedback control system has an open-loop transfer function as

$$G(s)=\frac{K(s+1)(s+2)}{(s+0.1)(s-1)}$$

The range of values of K for which the closed loop system is stable will be

A. 0 < K < 0.3

B. K > 0.3

C. K > 3

D. K < 0.3

Ans. B

Sol –

$$g(s)=1+\frac{K(s+1)(s+2)}{(s+0.1)(s-1)}=0$$

$q(s) = s^2(1 + K) + s(3K - 0.9) + (2K - 0.1) = 0$

for stability,

K > - 1

K > 0.3 (∴ K > 0.3)

K > 0.05

Q103. The lag system of a 'lag-lead compensator' has one pole and one zero. Then pole and zero are

A. Real and pole is to the left of zero.

B. Real and pole is to the right of zero.

C. Imaginary and pole is above zero.

D. Imaginary and pole is below zero.

Ans. B

Sol. In lag compensator,

$$G_C = \frac{S+Z}{S+P}; \frac{Z}{P} > 1$$

∴ pole is to the right of zero.

Q104. A system with characteristic equation:

$F(s) = s^4 + 6s^3 + 23s^2 + 40s + 50$

will have closed-loop poles such that.

A. all poles lie in the left half of the s-plane and no pole lies on imaginary axis.

B. two poles lie symmetrically on the imaginary axis of the s-plane.

C. all four poles lie on the imaginary axis of the s-plane.

D. all four poles lie in the night half of the s-plane.

Ans. A

Sol –

$F(s) = s^4 + 6s^3 + 23s^2 + 40s + 50 = 0$

s^4	1	23	50
s^3	6	40	
s^2	16.33	50	
s^1	21.6		
s^0	50		

No sign changes among elements of 1st column and no row becoming zero. Hence all roofs lie in left side.

Q105. A unity feedback (negative) system has open-loop transfer function $G(s) = \frac{K}{s(s+2)}$. The closed-loop system has a steady-state unit ramp error of 0.1. The value of gain K should be

A. 20

B. 30

C. 40

D. 50

Ans. A

Sol –

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

$$\text{type} = 1$$

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

$$\Rightarrow \quad e_{ss} = \frac{1}{K_v} = \frac{2}{K} = 0.1$$

$$\therefore \quad K = 20$$

Q106. Transfer function of discrete time system derived from state model is given by

A. $C(ZI - A)^{-1} B + D$

B. $C(ZI - A)^{-1} D + B$

C. $B(ZI - A)^{-1} D + C$

D. $D(ZI - A)^{-1} B + C$

Ans. A

Sol –

Transfer function = $C[(sI - A)^{-1} B] + D$

Replacing 's' with 'Z'

∴ Transfer function = $C[(ZI - A)^{-1} B] + D$

Q107. The closed-loop response of a system subjected to a unit step input is

$C(t) = 1 + 0.2\ e^{-60t} - 1.2\ e^{-10t}$

The expression for the closed-loop transfer function is

A. $\frac{100}{(s+60)(s+10)}$

B. $\frac{600}{(s+60)(s+10)}$

C. $\frac{60}{(s+60)(s+10)}$

D. $\frac{10}{(s+60)(s+10)}$

Ans. B

Sol – Step Response = $1 + 0.2\ e^{-60t} - 1.2\ e^{-10t}$

$$\text{T.F.} = \frac{600}{(s+60)(s+10)}$$

Q108. If it is possible to transfer the system state $x(t_0)$ to any desired state $x(t)$ in specified finite time by a control vector $u(t)$, then the system is said to be

A. completely observable

B. completely state controllable

C. random stage system

D. steady-state controlled system

Ans. B

Sol. A system is defined to be controllable (or) slate controllable if it is possible to transform given state to desired state in finite time.

Q109. Consider the following statements regarding parallel connection of 3-phase transformers:

1. The secondary's of all transformers must have the same phase sequence.
2. The phase displacement between primary and secondary line voltages must be the same for all transformers which are to be operated in parallel.
3. The primaries of all transformers must have the same magnitude of line 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

Ans. A

Sol –

In parallel operation of transformer, the major points are:

- The secondary's of all transformers must have the same phase sequence.
- The phase displacement between primary and secondary line voltages must be the same for all transformers which are to be operated in parallel.
- The primaries of all transformers must have the same magnitude of line voltage.

Q110. A 500 kVA transformer has an efficiency of 95% at full load and also at 60% of full load, both at upf. The efficiency η of the transformer at 3/4th full load will be nearly

A. 98%

B. 95%

C. 92%

D. 87%

Ans. B

Sol –

500 kVA transformer,

η = 0.95 at full load u.p.f.

η = 0.95 at 60% full load u.p.f.

η at full load, $0.95 = \frac{500}{500 + P_{cu} + P_i}$

⇒ $P_{cu} + P_i = 26.316$ ...(i)

η at 60% full load,

$$0.95 = \frac{0.6 \times 500}{0.6 \times 500 + (0.6)^2 P_{cu} + P_i}$$

$0.36 P_{cu} + P_i = 15.79$ ...(ii)

By solving (i) an d(ii),

$P_{cu} = 16.45$ kW

$P_i = 9.87$ kW

Now η at 3/4 full load (assuming u.p.f.)

(∵ Not specified)

$$\eta = \frac{0.75 \times 500 \times 1}{0.75 \times 500 \times 1 + 0.75^2 (16.45) + 9.87}$$

$$= \frac{375}{375 + 9.25 + 9.87} = \frac{375}{394.12} = 0.95148$$

Q111. What is the condition of retrogressive winding in dc machines?

A. $Y_b > Y_f$

B. $Y_b < Y_f$

C. $Y_b = Y_f$

D. $Y_b = 0.5 Y_f$

Ans. B

Sol –

Progressive winding in DC Machines: If the starting end of the loop is connected to the first commutator segment and sending end is connected to that commutator segment that is located next to the previous one, then it is called progressive winding.

Retrogressive winding in DC Machines: If the sending end is connected to the commutator segment that is behind the previous one, then it is retrogressive winding.

Q112. What is the useful flux per pole on no load of a 250V, 6 pole shunt motor having a wave connected armature winding with 110 turns, armature resistance of 0.2 Ω and armature current 13.3 A at no load speed of 908 rpm?

A. 12.4 mWb

B. 22.6 mWb

C. 24.8 mWb

D. 49.5 mWb

Ans. C

Sol. 250 V, 6 pole, wave, 110 turns, Ra = 0.2 Ω

$I_a = 13.3$ A, N = 908 rpm, 220 conductors

$V = E_b + I_a R_a$

$E_b = 250 - 13.3(0.2) = 247.34$ V

$$E_b = \frac{\phi ZNP}{60\ A} \Rightarrow \phi = \frac{E_b \times 60 \times A}{Z\,N\,P}$$

$$\phi = \frac{247.34 \times 60 \times 2}{220 \times 908 \times 6} = 0.02476 \text{ Webers}$$

$\phi \simeq 24.8$ mWb

Q113. The cross-magnetizing effect of the armature reaction can be reduced by
A. making pole shoes flat faced.
B. making the main field ampere-turns larger compared to the armature ampere turns.
C. increasing the flux density under one half of the pole.
D. keeping the direction of rotation of generator in the same direction as motor.

Ans. B

Sol –

The cross-magnetizing effect of the armature reaction can be reduced by making the main field ampere-turns larger compared to the armature ampere-turns.

Q114. A 500 kW, 500 V, 10 pole, dc generator has a lap wound armature with 800 conductors. If the pole face covers 75% of pole pitch, the number of pole face conductors in each pole of a compensating winding will be
A. 12
B. 10
C. 8
D. 6

Ans. D

Sol. 500 kW, 500 V, 10 P, Lap, 800 conductors

$$\frac{\text{Pole arc}}{\text{Pole pitch}} = 0.75$$

Number of C.W. conductors/pole 'Z_c'

$$Z_c = \frac{Z}{A.P}\left(\frac{\text{Pole arc}}{\text{Pole pitch}}\right)$$

$$Z_c = \frac{800}{10 \times 10}(0.75) = 6$$

Q115. Cogging in an induction motor is caused
A. if the number of stator slots are unequal to number of rotor slots.
B. if the number of stator slots are an integral multiple of rotor slots.
C. if the motor is running at fraction of its rated speed.
D. due to 5^{th} harmonic.

Ans. B

Sol –

Sometimes, it happens because of low voltage supply. But the main reason for starting problem in motor is because of cogging in which the slots of the stator get locked up with the rotor slots and it is sometimes called magnetic locking of the induction motor.

Q116. A 500 hp, 6 pole, 3-phase, 440 V, 50 Hz induction motor has a speed of 950 rpm on full load. The full load slip and the number of cycles the rotor voltage makes per minutes will be respectively
A. 10% and 150
B. 10% and 125
C. 5% and 150
D. 5% and 125

Ans. C

Sol. 6 pole, 50 Hz, I.M.

So, $N_s = \frac{120 \times 50}{6} = 1000$ rpm

Full load speed given as 950 rpm

$$\therefore \% \text{slip} = \frac{N_s - N}{N_s} \times 100 = \left(\frac{1000-950}{1000}\right) \times 100$$
$$= 0.05 \times 100 = 5\%$$

Rotor voltage frequency :
s × f = 0.05 × 50 = 2.5 Hz
2.5 cycles/sec.
⇒ 2.5 × 60 cycles/min. = 150 cycles/min.

Q117. Effective armature resistance R_a(eff.)of a synchronous machine is

A. $\frac{\text{Short circuit load loss (per phase)}}{(\text{Short circuit armaure current})^2}$

B. $\frac{\text{Short circuit load loss (per phase)}}{\text{Short circuit load current}}$

C. $\frac{\text{Total short circuit load loss}}{\text{Short circuit armature current}}$

D. $\frac{\text{Total short circuit load loss}}{\text{Short circuit load current}}$

Ans. A

Sol –

The effective resistance R_a(eff.)of a synchronous machine is defined as

$$R_a(\text{eff.}) = \frac{\text{Short circuit load loss (per phase)}}{(\text{Short circuit armaure current})^2}$$

Q118. A 3-phase synchronous motor has 12 poles and operates from 440 V, 50 Hz supply. If it takes a line current of 100 A at 0.8 power factor leading, its speed and torque are nearly

A. 500 rpm and 1165 N-m

B. 1000 rpm and 2330 N-m

C. 500 rpm and 2330 N-m

D. 1000 rpm and 1165 N-m

Ans. A

Sol. 3-phase, synchronous motor has 12 poles, 440 V,50 Hz I_L = 100 A, p.f. = 0.8 lead Synchronous motor runs only at synchronous speed.

$$\therefore \quad N_s = \frac{120f}{P} = \frac{120 \times 50}{12} = 500 \text{ rpm}$$

Power drawn, $P = \sqrt{3}\, VI \cos\phi$

$$= \sqrt{3} \times 440 \times 100 \times 0.8$$
$$P = 60966.4 \text{ watts}$$
$$\therefore \quad T = \frac{60}{2\pi N_s} P = \frac{60}{2\pi(500)} 60966.4$$
$$= 1164.96 \simeq 1165 \text{ N-m}$$

Q119. Which of the following are the advantages of using a stepper motor?

A. Compatibility with transformers and sensors needed for position sensing.

B. Compatibility with digital systems and sensors are not required for position and speed sensing.

C. Resonance effect often exhibited at low speeds and decreasing torque with increasing speed

D. Easy to operate at high speeds and compatible with analog systems.

Ans. B
Sol –

The advantages of using stepper motor are as follows:

- Compatibility with digital systems and sensors are not required for position and speed sensing.
- Low cost
- High torque at low speeds
- Motor has full torque at standstill.
- Excellent response to starting, stopping and reversal.
- Very reliable since there is no contact brushes.
- Wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

Q120. The disadvantages of hunting in synchronous machines is
A. fault occurs in the supply system.
B. causes sudden change in inertia.
C. causes large mechanical stresses and fatigue in the rotor shaft.
D. causes harmonics.

Ans. C
Sol –

The disadvantages of hunting in the synchronous machines are as follows:

- It can lead to loss of synchronism.
- It can cause variations in supply voltage producing undesirable lamp flicker.
- The possibility of resonance condition increases which means that the frequency of the torque component becomes equal to that of the transient oscillations of the synchronous machine.
- Causes large mechanical stresses and fatigue in the rotor shaft.

Q121. Consider the following statements for a large national interconnected grid:
1. Better load frequency control.
2. Same total installed capacity can meet lower demands.
3. Better hydro / thermal / nuclear / renewable co-ordination and energy conservation.
Which of the above statements are correct?
A. 1 and 3 only
B. 1 and 2 only
C. 2 and 3 only
D. 1, 2 and 3

Ans. D
Sol –

In a large national interconnected grid:

- Better load frequency control.
- Same total installed capacity can meet lower demands.
- Better hydro / thermal / nuclear / renewable co-ordination and energy conservation.

Q122. A single-phase transformer is rated 110/440 V, 2.5 kVA. Leakage reactance measured from the low-tension side is 0.06 Ω. The per unit leakage reactance will be
A. 0.0062 per unit
B. 0.0124 per unit
C. 0.0496 per unit
D. 0.1983 per unit

Ans. B

Sol. $x_{\text{p.u.}} = \frac{X_\Omega}{X_b} = X_\Omega \times \frac{S_b}{V_b^2}$

$= \frac{0.6 \times 2.5 \times 10^3}{(110)^2} = 0.0124$ p.u.

Q123. A concentric cable has a conductor diameter of 1 cm and an insulation thickness of 1.5 cm. When the cable is subjected to a test pressure of 33 kV, the maximum field strength will be nearly

A. 41,000 V

B. 43,200 V

C. 45,400 V

D. 47,600 V

Ans. D

Sol. $r = \frac{1}{2} = 0.5$ cm

t = 1.5 cm = (R − r)

R = t + r = 1.5 + 0.5 = 2cm

$E_{max} = \frac{V}{r \ln\left(\frac{R}{r}\right)} = \frac{33}{0.5 \ln\left(\frac{2}{0.5}\right)} = 47.6$ kV

Q124. Radio Influence Voltage (RIV) generated on a transmission line conductor surface is not affected by

A. system voltage

B. corona discharges on the conductors

C. rain

D. nearby radio receivers

Ans. C

Sol. For f > 20 GHz the RIV is influenced by rain. Present system is operating at less than 20 GHz and hence RIV is not affected by rain.

Q125. Consider the following properties regarding insulation for cables:

1. A low specific resistance
2. High temperature withstand
3. High dielectric strength

Which of the above properties of insulation are correct while using cables?

A. 1 and 2 only

B. 1 and 3 only

C. 2 and 3 only

D. 1, 2 and 3

Ans. C

Sol. Insulation of cable requires high temperature with stand and high dielectric strength and high specific resistance.

Q126. Which one of the following faults occur more frequently in a power system?

A. Grounded star-delta

B. Double line faults

C. LLG faults

D. Single line-to-ground (LG) faults

Ans. D

Sol. Sequence of fault currents.

SLG, LL, LLG, LLL, LLLG.

Q127. The maximum permissible time of de-energization of the faulty circuit is dependent on
A. voltage of the system
B. the number of conductors involved
C. load carried by the faulty circuit
D. fault current and its duration
Ans. D
Sol. In fault analysis the system voltage during fault is assumed constant. The max permissible time of de-energization depends on fault current and its duration.
Q128. Which one of the following is used for communication with the aim of achieving high figure of merit of HVDC circuit breakers?
A. Oil interrupter
B. Air interrupter
C. Vacuum interrupter
D. SF_6 interrupter
Ans. C
Sol. Vacuum interrupter are used to achieve high figure of merit is HVDC breaker.
Q129. Which of the following buses are used to form bus admittance matrix for load flow analysis?
1. Load bus
2. Generator bus
3. Slack bus
A. 1 and 2 only
B. 1 and 3 only
C. 2 and 3 only
D. 1, 2 and 3
Ans. D
Sol. All buses load, gen, slack buses are used to form Y-bus matrix.
Q130. In a 3-phase, 60 Hz, 500 MVA, 15 kV, 32 pole hydroelectric generating unit, the values of ω_{syn} will ω_{msyn} be nearly?
A. 754 rad/s and 47.6 rad/s
B. 377 rad/s and 46.7 rad/s
C. 377 rad/s and 23.6 rad/s
D. 754 rad/s and 23.6 rad/s
Ans. C
Sol.
$$\omega_e = 2\pi f = 2\pi \times 60 = 377 \text{ rad/sec}$$
$$\omega_m = \omega_e \times \frac{2}{P} = 377 \times \frac{2}{32}$$
$$= 23.6 \text{ rad/sec}$$
Q131. The method adopted for improving the steady-state stability of power system are
1. Quick response excitation system
2. Higher excitation voltages
3. Maximum power transfer by use of series capacitor or reactor
A. 1 and 2 only
B. 1 and 3 only
C. 2 and 3 only
D. 1, 2 and 3
Ans. C
Sol –
The methods for improving the steady-state stability of power systems are as follows:
- Quick response excitation system
- Higher excitation voltages
- Maximum power transfer by use of series capacitor or reactor

Q132. The HVDC system uses

A. Rectifier station at sending end and inverter station at receiving end.
B. Inverter station at sending as well as at the receiving end.
C. Rectifier station at sending end as well as at the receiving end.
D. Inverter station at sending end and rectifier station at receiving end.

Ans. A

Sol. Rectifier station at sending end and inverter at receiving end.

Q133. Which one of the following is not required for power diode?

A. High speed operation
B. Fast communication
C. Small recovery time
D. Low on-state voltage drop

Ans. B

Sol. The characteristics of the power diode:

- High speed operation
- Small recovery time
- Low on-state voltage drop

Q134. The reverse recovery time of a diode is t_{rr} = 3 and the rate of fall of the diode current is di/dt = 30 A/μs. The storage charge Q_{RR} and the peak inverse current I_{RR} will be respectively

A. 135 μC and 90 A
B. 270 μC and 90 A
C. 270 μC and 60 A
D. 135 μC and 60 A

Ans. A

Sol. $$t_{rr} = \left(\frac{2Q_R}{di/dt}\right)^{1/2}$$

$$Q_R = \frac{1}{2} \times t_{rr}^2 \times \frac{di}{dt} = \frac{1}{2}\left(3 \times 10^{-6}\right)^2 \times 30 \text{ A/μs}$$

$$Q_R = 135 \text{ μC}$$

$$I_{RM} = \left(2Q_R \frac{di}{dt}\right)^{1/2} = \left(2 \times 137\mu C \times 30 \text{ A/μs}\right)^{1/2}$$

$$I_{RM} = 90 \text{ A}$$

Q135. The i_g – v_g characteristics of a thyristor is a straight line passing through origin with a gradient cl 2.5 × 10^3. If P_g = 0.015 watt, the value of gate voltage will be nearly

A. 5.0 V
B. 6.1 V
C. 7.5 V
D. 8.5 V

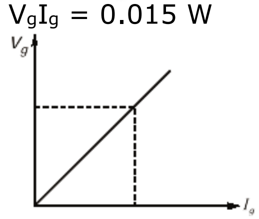
Ans. B

Sol. $$\frac{V_g}{I_g} = 2.5 \times 10^3$$

V_g= 2.5 × 10^3 I_g ...(i)

P_g = 0.015 W

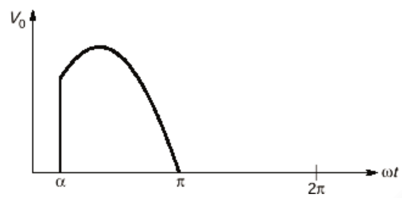
V_gI_g = 0.015 W ...(ii)



$$2.5\times10^3\ I_g^2 = 0.015$$
$$I_g = 2.45\text{ mA}$$
$$V_g = 2.5\times10^3\ I_g$$
$$= 2.5\times10^3\times(2.45\text{ mA})$$
$$V_g = 6.125\text{ V}$$

Q136. A single-phase 220 V, 1 kW heater is connected to half wave controlled rectifier and is fed from a 220 V, 50 Hz ac supply. When the firing angle α = 90°, the power absorbed by the heater will be nearly
A. 1000 W
B. 750 W
C. 500 W
D. 250 W

Ans. D
Sol.



$$V_{or} = \frac{V_m}{\sqrt{2\times2\pi}}\left((\pi-\alpha)+\frac{1}{2}\sin2\alpha\right)^{1/2}$$
$$= \frac{V_m}{2\sqrt{\pi}}\left((\pi-\alpha)+\frac{1}{2}\sin2\alpha\right)^{1/2}$$
$$= \frac{V_m}{2\sqrt{2}} = \frac{200\sqrt{2}}{2\sqrt{2}} = 110$$
$$P = \frac{V^2}{R}$$
$$R = \frac{V^2}{P} = \frac{220^2}{1\times10^3} = 48.4\ \Omega$$
$$P = \frac{V_{or}^2}{R} = \frac{110^2}{48.4} = 250\text{ W}$$

Q137. When we compare the half bridge converter and full bridge converter
1. The maximum collector current of a full bridge is only double that of the half bridge.
2. Full bridge uses 4-power switches instead of 2, as in the double bridge.
3. Output power of a full bridge is twice that of a half bridge with the same input voltage and current.
Which of the above statements are correct?
A. 1, 2 and 3
B. 1 and 2 only
C. 1 and 3 only
D. 2 and 3 only

Ans. (*)

Q138. A single-phase fully controlled bridge converter is connected with RLE load where R = 5 Ω, L = 4mH and E = 50 V. This converter circuit is supplied from 220 V, 50 Hz ac supply. When the firing angle is 60°, the average value of the load current will be nearly
A. 12.2 A
B. 9.8 A
C. 6.4 A
D. 4.2 A

Ans. B

Sol –

Considering continuous conduction,

$$V_0 = \frac{2V_m}{\pi}\cos\alpha = \frac{2\times 220\sqrt{2}}{\pi}\cos 60^o = 99.03V$$

$$I_0 = \frac{V_0 - E}{R} = \frac{99.03-50}{5} = 9.8\ A$$

Note: Practically it is discontinuous conduction (since α > φ)

$$\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

Q139. Consider the following statements regarding ac drives:

1. For the same kW rating, ac motors are 20% to 40% light weight as compared to dc motors.
2. The ac motors are more expensive as compared to same kW rating dc motors.
3. The ac motors have low maintenance as compared to dc motors.

Which of the above statements are correct?

A. 1 and 2 only
B. 2 and 3 only
C. 1 and 3 only
D. 1, 2 and 3

Ans. C

Sol –

AC drives:

- For the same kW rating, ac motors are 20% to 40% light weight as compared to dc motors.
- The ac motors have low maintenance as compared to dc motors.

Q140. A 3-phase induction motor drives a blower where load torque is directly proportional to speed squared. If the motor operates at 1450 rpm, the maximum current in terms of rated current will be nearly

A. 2.2
B. 3.4
C. 4.6
D. 6.8

Ans. (*)

Sol. Data not appropriate.

Q141. Consider the following statements:

1. SMPS generates both the electromagnetic and radio frequency interference due to high switching frequency.
2. SMPS has high ripple in output voltage and its regulation is poor.
3. The output voltage of SMPS is less sensitive with respect to input voltage variation.

Which of the above statements are correct?

A. 1 and 3 only
B. 2 and 3 only
C. 1 and 2 only
D. 1, 2 and 3

Ans. A

Sol –

- SMPS generates both the electromagnetic and radio frequency interference due to high switching frequency.
- The output voltage of SMPS is less sensitive with respect to input voltage variation.

Q142. Consider the following features with respect to the fly back converters:
1. It is used mostly in application below 100 W.
2. It is widely used for high-output voltage.
3. It has low cost and is simple.
Which of the above statements are correct?
A. 1, 2 and 3
B. 1 and 2 only
C. 1 and 3 only
D. 2 and 3 only

Ans. C

Sol –

- It is used mostly in application below 100 W.
- It has low cost and is simple.

Q143. Consider the following statements regarding the function of dc-dc converter in a dc motor:
1. It acts as a regenerative brake.
2. It controls the speed of motor.
3. It controls the armature voltage of a dc motor.
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

Ans. D

Sol –

- It acts as a regenerative brake.
- It controls the speed of motor.
- It controls the armature voltage of a dc motor.

Q144. The power supplies which are used extensively in industrial applications are required to meet:
1. Isolation between the source and the load.
2. High conversion efficiency.
3. Low power density for reduction of size and weight.
4. Controlled direction of power flow.
Which of the above specification are correct?
A. 1, 2 and 3 only
B. 1, 3 and 4 only
C. 1, 2 and 4 only
D. 2, 3 and 4 only

Ans. C

Sol –

- Isolation between the source and the load.
- High conversion efficiency.
- Controlled direction of power flow.

Q145. Statement-I: Soft iron does not retain magnetism permanently.
Statement-II: Soft iron has no retentivity.

Ans. C

Sol –

Soft iron does not retain magnetism permanently.

Q146. Statement-I: Reaction turbines are generally used for sites with high head and lowflow.
Statement-Il: Kaplan and Francis turbines are reaction turbines.
Ans. D
Sol. Reaction turbines are used for low head and high flow/velocity.
Q147. Statement-I: One can formulate problems more efficiently in a high level language and need not have a precise knowledge of the architecture of the computer.
Statement-II: High level languages permit programmers to describe tasks in a form which is problem oriented than computer oriented.
Ans. A
Sol. High level languages are machine independent whereas low level languages are machine dependent.
In H.L.L. programmer does not require knowledge of the processor used.
Q148. Statement-I: Sign magnitude representation is generally used in implementing the integer portion of the ALU.
Statement-II: In sign magnitude representation there are two representation of 0.
Ans. D
Sol. Statement-II is correct and statement-I is false.
Q149. Statement-I: When a non-linear resistor, in series with a linear resistor, both being non-inductive, is connected to a voltage source, the current in the circuit carrot be determined by using Ohm's law.
Statement-II: If the current-voltage characteristic of the non-linear resistor is known, the current-voltage characteristics of the series circuit can be obtained by graphical solution.
Ans. B
Sol –
When a non-linear resistor, in series with a linear resistor, both being non-inductive, is connected to a voltage source, the current in the circuit carrot be determined by using Ohm's law.
If the current-voltage characteristic of the non-linear resistor is known, the current-voltage characteristics of the series circuit can be obtained by graphical solution.
But the above statement does not holds correct explanation.
Q150. Statement-I: Soft magnetic materials, both metallic and ceramic are used for making transformers core, whereas, hard magnetic materials born metallic and ceramic are used for making permanent magnets.
Statement-II: Magnetic materials, both metallic and ceramic are classified as soft or hard according to the magnetic hysteresis loop being narrow or broad.
Ans. A
Sol –

- Soft magnetic materials, both metallic and ceramic are used for making transformers core, whereas, hard magnetic materials born metallic and ceramic are used for making permanent magnets.
Magnetic materials, both metallic and ceramic are classified as soft or hard according to the magnetic hysteresis loop being narrow or broad.

ALL THE BEST FOR YOUR RESULTS