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India's Best Institute for IES, GATE & PSUs

ESE 2019

Preliminary Examination

Detailed Solutions of

Electrical Engineering

(Set-A)

Scroll down for detailed solutions

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Expected Cutoff of ESE 2019 Prelims					Actual Cutoff of ESE 2018 Prelims				
Branch	Gen	OBC	SC	ST	Branch	Gen	OBC	SC	ST
CE	180-190	170-180	150-160	150-160	CE	207	194	169	188
ME	190-200	180-190	160-170	160-170	ME	256	255	220	223
EE	230-240	220-230	190-200	190-200	EE	230	218	190	191
E&T	210-220	200-210	170-180	170-180	E&T	213	206	173	155

Electrical Engineering Paper Analysis
ESE 2019 Prelims Exam

Sl.	Subjects	Number of Questions
1	Engineering Mathematics	12
2	Materials Science	14
3	Network Theory	12
4	Signals and Systems	13
5	Power Systems	14
6	Measurements	11
7	Computer Fundamentals	8
8	Digital Electronics	6
9	Microprocessos	6
10	Analog Electronics	12
11	Communications	7
12	Control Systems	11
13	Electrical Machines	14
14	Power Electronics	10
15	EMT	0

UPSC ESE/IES Prelims 2019

Electrical Engineering analysis and expected cutoff by MADE EASY faculty

https://youtu.be/Ik8Ah8GwOsg

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Mains Exclusive Batches for ESE 2019

Conventional Questions Practice Programme

Commencing from **20th Feb, 2019**

These batches are offered only at **Delhi** Centre.

+

Mains Test Series for ESE 2019

(Offline Mode / Online Mode)

Commencing from **17th Mar, 2019**

Test series will be conducted at **all MADE EASY** centres across India.

Features :

- Very useful to develop numerical solving approach & improving writing skills.
- Special focus on improving answer layout specially for theory questions.
- Classes will be delivered by senior faculties.
- Updated Mains workbook for every subject having varied practice question sets.
- Test series will be conducted on every Sunday in synchronisation with the subject taught in class.
- Discussion on probable questions.
- Comprehensive and in-depth discussion on variety of conventional questions, thus strengthening fundamental concepts.

Batch Details	Course Duration	Class Duration	Test Series
	90 days | 300 - 350 hours	5-6 days a week and 6-7 hours a day	Every Sunday

Streams	Batch Code	Batch Commencing Date	Venue (Delhi)	Timing
ME	A	20-Feb-2019	Ghitorni Centre	7:30 AM to 1:30 PM
ME	B	20-Feb-2019	Ghitorni Centre	3:00 PM to 9:00 PM
ME	C	20-Feb-2019	Saket Centre	7:30 AM to 1:30 PM
CE	A	21-Feb-2019	Ignou Road Centre	7:30 AM to 1:30 PM
CE	B	21-Feb-2019	Kalu Sarai Centre	3:00 PM to 9:00 PM
EE	A	22-Feb-2019	Lado Sarai Centre	7:30 AM to 1:30 PM
EE	B	22-Feb-2019	Kalu Sarai Centre	3:00 PM to 9:00 PM
EC	A	22-Feb-2019	Lado Sarai Centre	7:30 AM to 1:30 PM

Program	Ex. MADE EASY Students Enrolled in Postal, Rank Improvement, Mains, GS, Post-GATE, ESE+ GATE, GATE Batches	Non MADE EASY students
Mains Exclusive Batch (Inclusive of ESE-2019 Mains Offline Test Series)	₹ 18,500	₹ 22,500
ESE 2019 Mains Offline Test Series	₹ 2,500	₹ 3,500

All Fees are inclusive of GST

Hostel facility will be arranged

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1. What are the value of k for which the system of equations

$(3k - 8)x + 3y + 3z = 0$

$3x + (3k - 8)y + 3z = 0$

$3x + 3y + (3k - 8)z = 0$

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)**

For non trivial solution,

$$|A| = 0$$

$C_1 \rightarrow C_1 + C_2 + C_3$

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

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

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

$R_2 - R_1,\ R_3 - R_1$

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

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

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

End of Solution

2. 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)

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

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

$$A \times A^* = A \times (\bar{A})^T = \begin{bmatrix} 5+9+10 & -10-5i-3i-4-2i+12i-6 \\ -10+5i+3i-4-12i+2i-6 & 25+1+16+4 \end{bmatrix}$$

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

Which is Hermitian,

$$a_{ij} = \bar{a}_{ji} \text{ for all } i, j \text{ and } a_{ii} \text{ are real}$$

End of Solution

---

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

(a) 10 (b) 11

(c) 12 (d) 13

Ans. (c)

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

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

End of Solution

---

4. 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)

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

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

Put $x = e^z$

$$xD = D_1$$

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

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

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

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

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

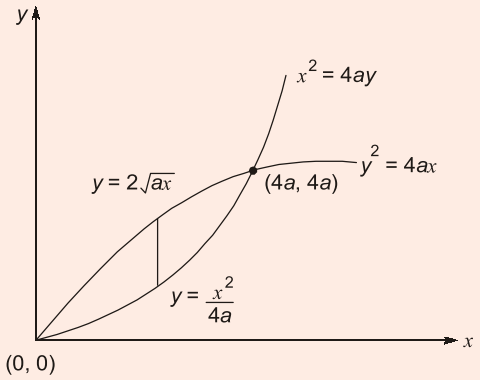
End of Solution

5. 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)



$$\text{Areal} = \int_0^{4a}\int_{y=\frac{x^2}{4a}}^{2\sqrt{ax}} dy\,dx = \int_0^{4a} [y]\Big|_{\frac{x^2}{4a}}^{2\sqrt{ax}}\, dx$$

$$= \int_0^{4a}\left(2\sqrt{a}x^{1/2} - \frac{x^2}{4a}\right)dx = 2\sqrt{a} \times \frac{x^{3/2}}{3/2}\Big|_0^{4a} - \frac{1}{4a} \times \frac{x^3}{3}\Big|_0^{4a}$$

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

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

End of Solution

6. 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)**

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

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,

$$u^2 + v^2 + w^2 = 1 \quad \text{... (i)}$$

$$V = \iiint_V dzdydx \quad \text{... (ii)}$$

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

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

Equation (i) represents a sphere,

By taking spherical co-ordinates

$$u = r\sin\theta\cos\phi,\ v = r\sin\theta\sin\phi,\ w = r\cos\theta$$

$$dudvdw = r^2\sin\theta drd\theta d\phi$$

Substituting in equation (iii),

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

$$= 216abc\int_{r=0}^{1} r^8 dr \int_{\phi=0}^{\pi/2} \sin^2\phi\cos^2\phi d\phi \int_{\theta=0}^{\pi/2} \sin^5\theta\cdot\cos^2\theta d\theta$$

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

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

End of Solution

7. 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)**

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

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

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

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

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

End of Solution

8. 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)**

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

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

End of Solution

9. 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)**

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

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

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

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

End of Solution

10. 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

General Studies & Engineering Aptitude Batches for ESE 2020

(Preliminary Examination)

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Syllabus Covered

1. Current issues of national and international importance relating to social economic and industrial development.
2. Engineering Aptitude covering Logical reasoning and Analytical ability.
3. Engineering Mathematics and Numerical Analysis.
4. General Principles of Design, Drawing, Importance of Safety.
5. Standards and Quality practices in production, construction, maintenance and services.
6. Basic of Energy and Environment : Conservation, Environmental pollution and degradation, Climate Change, Environmental impact assessment.
7. Basic of Project Management.
8. Basics of Material Science and Engineering.
9. Information and Communication Technologies (ICT) based tools and their applications in Engineering such as networking, e-governance and technology based education.
10. Ethics and values in engineering profession.

Course Duration

Regular Batches : 2.5 months
Weekend Batches : 4 months

Timings

Regular : 6 to 7 days a week and 4-6 hours a day
Weekend : Sat, Sun & public holiday, 8 hours each day

Teaching Hours

250-300 hours

Batch Type	Commencing Dates	Venue	Timing
Regular Batch	20th Feb, 2019	Ghitorni (Delhi)	8:00 AM to 12:00 PM
Weekend Batch	24th Feb, 2019	Ghitorni (Delhi)	8:00 AM to 5:00 PM
Weekend Batch	24th Feb, 2019	Noida Centre	8:00 AM to 5:00 PM

Fee Structure

Non-MADE EASY Students	Ex. MADE EASY Students Enrolled in Postal, Rank Improvement, Mains, GS, GATE, GATE + ESE Batches
₹ 25,000 • GS & Engg Aptitude Books will be issued.	₹ 18,000 • GS & Engg Aptitude Books will NOT be issued. • Interested students can avail books by paying the fee of Rs. 2,000/-

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Ans. (c)

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

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

$\therefore$ $z = \dfrac{\pi}{4}$ is a simple pole.

Similarly, for pole of order n

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

End of Solution

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

(a) $P(r+1) = \dfrac{n-r}{r+1}P(r)$

(b) $P(r+1) = \dfrac{p}{q}P(r)$

(c) $P(r+1) = \dfrac{n+r}{r+1}\dfrac{p}{q}P(r)$

(d) $P(r+1) = \dfrac{n-r}{r+1}\dfrac{p}{q}P(r)$

Ans. (d)

$$P(r) = {}^{n}C_{r}\cdot p^{r}\cdot q^{n-r}$$

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

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

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

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

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

End of Solution

12. 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)

$n = 2000,\ p = 0.001,\ \lambda = np = 2000\ (0.001) = 2$

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

End of Solution

13. 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)

End of Solution

14. Which material possesses the following properties?

- Shining white colour 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

(a) Silver (b) Tin

(c) Nickel (d) Aluminium

Ans. (b)

End of Solution

15. The saturation magnetization for Fe_3O_4, given that each cubic unit cell contains 8 Fe^{2+} and 16Fe^{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)

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

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

- Density of Fe_3O_4 molecules $= N = \dfrac{\text{Number of molecules}}{\text{Volume}}$

$$N = \frac{8}{(0.839\times10^{-9})^3}\left(\frac{1}{m^3}\right)$$

- $\vec{M}$ = Magnetization;

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

$$\vec{M} = N4\vec{p}_B$$

$$M = \frac{8}{(0.839)^3\times10^{-27}}(4)\,(9.274\times10^{-24})$$

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

End of Solution

16. Consider the following applications of the materials:

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

The materials used in these applications can be classified as

(a) Ceramic (b) Constantan

(c) Manganin (d) Tantalum

Ans. (a)

End of Solution

17. 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)

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

$$\rho = \text{density} = 8.9\times10^6\left(\frac{g}{m^3}\right)$$

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

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

$$N = \frac{\rho N_A}{A_{Ni}} = \frac{(8.9\times10^6)(6.02\times10^{23})}{58.7}$$

$= 9.127 \times 10^{28}$ (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

End of Solution

18. The Temperature at which iron ceases to be ferromagnetic and becomes paramagnetic is

(a) Curie-Weiss point
(b) Thermo-magnetic point
(c) Ferro-paramagnetic point
(d) Curie point

Ans. (d)

End of Solution

19. 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)

End of Solution

20. A magnetic field applied perpendicular to the direction of motion of a charged 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)

End of Solution

21. An electric kettle is marked 500 W, 230 V 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)

$$\text{Heat} = mC\Delta t$$

m - Mass
C - Specific heat
Δt - Change in temperature

$$\text{Output heat} = 1 \times 10^3 \times 4.2 \times (100 - 15)$$
$$= 397000 \text{ Joule}$$

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

$$\text{Input power} = 500 \text{ Watt}$$

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

End of Solution

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

(a) Nano centimeter
(b) Nanometer
(c) Nano micrometer
(d) Nano millimeter

Ans. (b)

End of Solution

23. Consider the following applications:

- High temperature heat engines.
- Nuclear fusion reactors.
- Chemical processing industry.
- 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)

End of Solution

24. The machine used for the preparation of nano particles of alumina is
(a) Attrition mill
(b) Grinding machine
(c) Vending machine
(d) Welding machine

Ans. (a)

End of Solution

25. 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)

$V \propto I$ from Ohm's law

$V = RI$

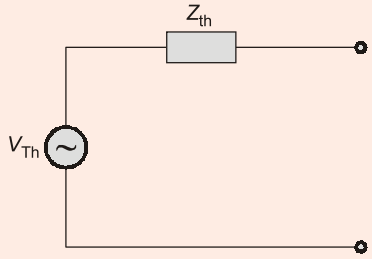
R is resistor

End of Solution

26. 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)

Thevenin equivalent



V_{Th} = Voltage source
Z_{Th} = Impedance (Ω)

End of Solution

27. 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)

Superposition theorem

End of Solution

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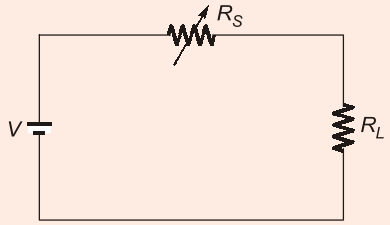
28. The maximum power is delivered from a source to a load when the source resistance is

(a) Greater than the load resistance (b) Equal to zero

(c) Less than the load resistance (d) Equal to the load resistance

Ans. **(b)**

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.

End of Solution

29. 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)**

From maximum power Transfer Theorem, when load resistance is equal to Thevenin equivalent resistance then the maximum power is delivered to the load.

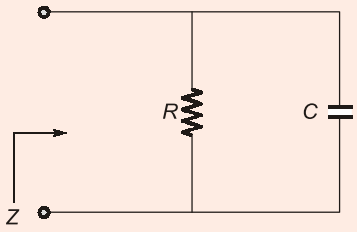
End of Solution

30. The impedance of a parallel circuit is $(10 - j30)\ \Omega$ 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)**



$$Z = 10 - j30$$

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

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

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

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

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

$C = 4.7$ nF

End of Solution

31. 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 $Z_{21}I_1 + Z_{22}I_2$

(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)

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

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

End of Solution

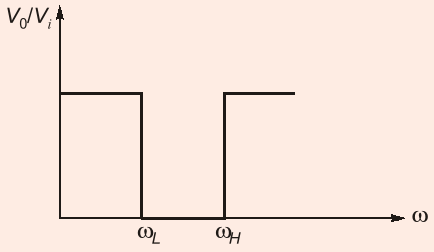
32. A filter that allows high and low frequencies to pass but attenuates any signal with a frequency between two corner frequencies is a

(a) Notch filter (b) Band pass filter

(c) Band stop filter (d) Multiband filter

Ans. (c)

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



End of Solution

33. When a number of two-port 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)

End of Solution

34. 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 lagging 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)

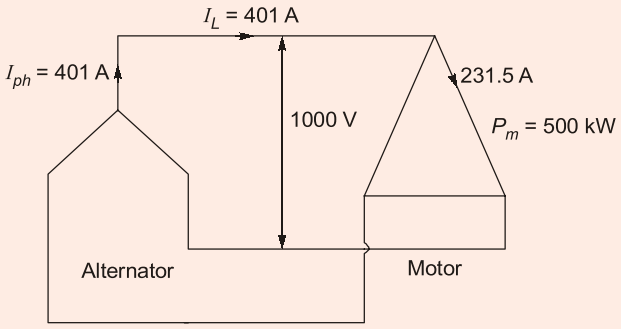
$$\text{Input of motor} = \frac{\text{Output}}{\eta} = \frac{500}{0.9} = 555.55\,\text{kW}$$

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

$$555.55\ \text{kW} = \sqrt{3}\times 1k \times I_L \times 0.8$$

$$I_L = 401\ \text{A}$$

$$\Rightarrow \quad I_{Ph} = \frac{401}{\sqrt{3}} = 231.5\,\text{A}$$



Correct answer is 401 A for alternator and 231.5 A for motor

End of Solution

35. 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 $k = \dfrac{M}{\sqrt{L_1 + L_2}}$.

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)

The coupling coefficient is

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

$\therefore$ 3rd statement is wrong.

End of Solution

36. 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)

End of Solution

37. 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)

End of Solution

38. 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)

End of Solution

39. 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.

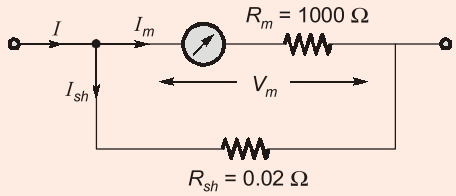
Ans. (c)

End of Solution

40. A moving coil ammeter has a fixed shunt of 0.02 Ω. With a coil resistance of R = 1000 Ω 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. (d)



$$m = 1+\frac{R_m}{R_{sh}} = 1+\frac{1000}{0.02} = 50001$$

$$I_m = \frac{V_m}{R_{sh}} = \frac{500\times10^{-3}}{1000}$$

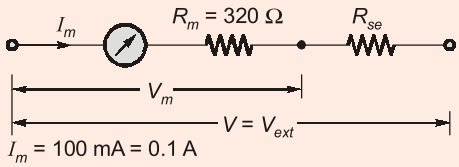
$$= 0.5 \times 10^{-3} \text{ A}$$

End of Solution

41. A moving iron instrument has full scale current of 100 mA. It is converted into a 250 V 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 Ω 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)



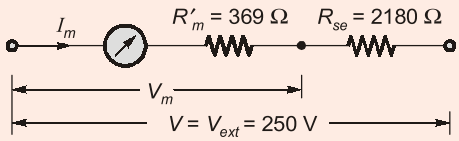
$$I_m = 100 \text{ mA} = 0.1 \text{ A}$$

$$V_m = I_m R_m = 320 \times 0.1 = 32 \text{ Volt}$$

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

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

With Temperature 20°C:



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

Calibrated as $\Rightarrow$ 0.1 A $\rightarrow$ 250 V

0.098 A $\rightarrow$?

$$\Rightarrow \quad \frac{250}{0.1} \times 0.098077 = 245.19 \text{ V}$$

True value = 250 volt

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

End of Solution

42. 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)

End of Solution

43. 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)

End of Solution

44. 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

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Ans. (b)

$$f_2 = 2f_1 \Rightarrow \text{double frequency} \Rightarrow n = 2$$

$$C_d = \frac{C_1 - n^2 C_2}{n^2 - 1} = \frac{C_1 - 4C_2}{3} = \frac{460 - 4\times 100}{3} = 20\ \text{pF}$$

End of Solution

45. 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)

End of Solution

46. 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)

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

End of Solution

47. The variations in the measured quantity due to sensitivity of transducer to any plane other than the required plane is
(a) Cross sensitivity (b) Sensitivity
(c) Interference (d) Distributed sensitivity

Ans. (a)

End of Solution

48. 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)

$$G_f = 2$$
$$\text{Stress} = 1050\ \text{kg/cm}^2$$
$$Y = 2.1 \times 10^6\ \text{kg/cm}^2$$

$$\text{Strain} = \epsilon = \frac{\text{Stress}}{Y} = \frac{1050}{2.1\times10^{6}} = 500\times10^{-6} = \epsilon$$

$$\Delta R = G_f \epsilon R$$

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

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

End of Solution

49. 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)

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

End of Solution

50. The decimal equivalent of binary number 1001.101 is

(a) 9.750 (b) 9.625
(c) 10.750 (d) 10.925

Ans. (b)

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

End of Solution

51. Convert decimal 41.6875 into equivalent binary:

(a) 100101.1011 (b) 100101.1101
(c) 101001.1011 (d) 101001.1101

Ans. (c)

41.6875

$$41 \Rightarrow \begin{array}{cccccc} 32 & 16 & 8 & 4 & 2 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 \end{array}$$

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

.1011

$41.6875 \Rightarrow 101001.1011$

End of Solution

52. 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)
CPU contains ALU, CU and registers and internal buses.

End of Solution

53. 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)

End of Solution

54. 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)

Seek time = T_s

"r" revolution $\Rightarrow$ 1 sec

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

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

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

Transfer time:

1 revolution time $\Rightarrow$ 1 track data (N bytes)

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

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

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

End of Solution

55. 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)**

CM line size = 64 B

Memory access time = 20 cycles/2 byte transfer

Total time required to fetch the cache line is,

$\Rightarrow$ (Memory referred number of times) $\times$ (Memory access time)

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

$\Rightarrow$ 640 cycles

End of Solution

56. 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)**

SRAM is faster than DRAM and more expensive.

End of Solution

57. 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)

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.

End of Solution

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

(a) –223 (b) –184

(c) –104 (d) –23

Ans. (d)

11101000 (–23)

11101000 → 00010111 (23)

Option (d) is correct.

End of Solution

59. 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)

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

End of Solution

60. 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)

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

RET: Indirect/Implied

End of Solution

61. 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)**

$$I_E = I_B + I_C$$

I_B is in μA,

$$I_E \approx I_C$$

End of Solution

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

(a) $I_D = I_S(e^{V_D^2/nV_T} - 1)$ (b) $I_D = I_S(e^{V_D/nV_T} - 1)$

(c) $I_D = I_S(e^{nV_D/nV_T} - 1)$ (d) $I_D = I_S(e^{V_T/nV_D} - 1)$

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)**

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

End of Solution

63. 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)**

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

End of Solution

64. 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)**
The disadvantage of a typical MOSFET compared to BJT is reduced power handling levels.

End of Solution

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65. 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. **(b)**

Voltage gain, $A_V = \frac{V_o}{V_i}$

$$\text{Power gain} = \frac{P_o}{P_i} = \frac{V_o^2/R_o}{V_i^2/R_i} = A_V^2 \times \frac{R_i}{R_o}$$

$$\text{Power gain} = 10\log\left(A_V^2 \frac{R_i}{R_o}\right) = 2\times 10\log A_v + 10\log\left(\frac{R_i}{R_o}\right)$$

wheren, $R_i = R_o$

$$\left|\text{Power gain}\right|_{\text{dB}} = 2 \times 10\log A_v + 10\log 1 = 20\log A_v = \left|\text{Voltage gain}\right|_{\text{dB}}$$

End of Solution

66. 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)**
For CS and CD the input impedance Z_i is high, for *CG* the input impedance Z_i is low.

End of Solution

67. 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)**

$$A_V = A_{V1} \cdot A_{V2} \ldots . A_{Vn}$$

$$20 \log A_V = 20\log A_{V1} \cdot A_{V2} \ldots . A_{Vn}$$

$$= 20\log A_{V1} + 20\log A_{V2} + \ldots . 20\log A_{Vn}$$

End of Solution

68. The Miller effect input capacitance C_{M_i} is
(a) $(1 - A_V^2)C_f$ (b) $(1 - A_V)C_f$
(c) $(1 - C_f)A_V$ (d) $(1 - C_f^2)A_V$
Where,
C_f = feedback capacitance

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

Ans. **(b)**
Miller's input capacitance,

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

End of Solution

69. 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)**

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

$$A_{CL} = 40$$

End of Solution

70. 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)**

CCVS, $A = \frac{V_0}{I_i}$ (Transfer f_n)

= Transresistance amplifier

End of Solution

71. 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)**
LED is used in emergency lighting system.

End of Solution

72. 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)**

For RC phase shift oscillator,

$$|A_v| = 29$$

End of Solution

73. 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)**

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

End of Solution

74. The time delay Δt 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)**

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 = $N \times \frac{1}{f_c}$

End of Solution

75. 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)

$$V_0 = K \text{ [Decimal equivalent of binary data]}$$
$$= 1[1001]_2 = [9]_{10}$$

End of Solution

76. 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)

End of Solution

77. The maximum number of input or output devices that can be connected to 8085 microprocessor are

(a) 8 (b) 16
(c) 40 (d) 256

Q.77

Ans. (d)

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.

End of Solution

78. The contents of the accumulator and register *C* are 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

Q.78

Ans. (b)

Content of accumulator = 2*E*
Content of register *C* = 6*C*
After addition operation result is 9*A*
Binary equivalent of 9*A* is $(10011010)_2$

S	*Z*	*X*	*AC*	*X*	*P*	*X*	*CY*
1	0	0	1	0	1	0	0

→ Flag register format

$\therefore$ *AC* = 1
P = 1

End of Solution

79. 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)

End of Solution

80. 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)

$$\mu = 0.5$$

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

End of Solution

81. 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)

End of Solution

82. The discrete samples of an analog signal are to be uniformly quantized for 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)

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

A_m = Peak amplitude of signal

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

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

$$2^n \ge 1000$$

$$n = 11$$

Option (c) is correct.

End of Solution

83. A signal : $m(t) = 2\cos 6000\pi t + 4\cos 8000\pi t + 6\cos 1000\pi t$ 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) 15000 Hz (d) 20000 Hz

Ans. (a)

$$m(t) = 2\cos\underset{f_1=3000\text{Hz}}{\underset{\downarrow}{6000\pi t}} + 4\cos\underset{f_2=4000\text{Hz}}{\underset{\downarrow}{8000\pi t}} + 6\cos\underset{f_3=5000\text{Hz}}{\underset{\downarrow}{10000\pi t}}$$

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,

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

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

$\Rightarrow$ $K = 2$

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

End of Solution

84. 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)

Number of signals = N
Message bandwidth = f_m
Sampling rate = $2f_m$
Bit rate (R_b) = $N \times 2f_m$

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

Since signal BW = Nf_m, channel BW need not be larger than Nf_m.
Option (b) is correct.

End of Solution

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

(a) Shift invariant
(b) Shift variant
(c) Scale invariant
(d) Scale variant

Ans. **(a)**

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, $n = n + K$

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

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.

End of Solution

86. 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)**

$x_a(t) = 3 \cos 100\pi t$
$f_0 = 50$ Hz
$f_{s\,\min} = 2f_0 = 2 \times 50 = 100$ Hz (to avoid aliasing)

End of Solution

87. 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)**

Since, $y(n) = x(n)$

Therefore, response or system output will be exactly same as the input.

End of Solution

88. The complex exponential Fourier representation for the signal $x(t) = \cos \omega_0 t$ 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)**

End of Solution

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89. The continuous LTI system is described by

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

Using the Fourier transform, for $x(t) = e^{-t}\,u(t)$, the output $y(t)$ 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)**

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:

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

$$\downarrow LT$$

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

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

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

Taking inverse Laplace transform of $Y(s)$,

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

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

Hence, option (c) is correct.

End of Solution

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90. 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) $\frac{1}{2}e^{-j\Omega_0 n} + \frac{1}{2}e^{-2j\Omega_0 n}$ 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)**

$$x(n) = \cos\frac{\pi}{4}n \ldots\ldots \quad \left(\Omega_0 = \frac{\pi}{4}\right)$$

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

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

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 $K = -1$:

$$C_{-1} = C_{-1+8m}$$

$$= \underset{\text{(for m = 1)}}{C_7} = \underset{\text{(for m = 2)}}{C_{15}} = \ldots$$

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

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

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

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

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

End of Solution

91. 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) 625 Hz (b) 575 Hz

(c) 525 Hz (d) 475 Hz

Ans. (a)

Given that,

$$x(t) \xrightarrow[\text{sampling}]{} x(n) = \frac{\cos\pi}{8} n \qquad \omega = \frac{\pi}{8}$$

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

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

Since, $\omega = \Omega T_s$

$$\Rightarrow \quad \Omega = \frac{\omega}{T_s} = \omega . f_s$$

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

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

End of Solution

92. 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 $\pm 3\sigma_x$?

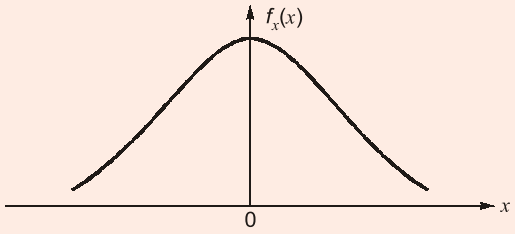
(a) $B + 1 = 12$ bits (b) $B + 1 = 14$ bits

(c) $B + 1 = 15$ bits (d) $B + 1 = 16$ bits

Ans. (d)

$$V_{P-P} = 6\sigma_x$$

For Gaussian variable mean $m_x = 0$



Signal power = Mean square value

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

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

$$\Delta = \frac{V_{P-P}}{2^n} = \frac{6\sigma_x}{2^n}$$

$$\text{Noise power} = \left[\frac{36\sigma_x^2}{2^{2n}} / 12\right] = \frac{3\sigma_x^2}{2^{2n}}$$

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

$$\text{SNR in dB} = 10 \log_{10} 2^{2n} - 10 \log_{10} 3$$
$$= (6n - 4.8) \text{ dB}$$

Given that SNR $\geq$ 90 dB

$$6n - 4.8 \geq 90$$
$$n \geq 15.8$$
$$n = 16$$

Number of bits required = 16

End of Solution

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

(a) 0 (b) 2
(c) 3 (d) 4

Ans. (b)

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

Where, $x(n) = 0,\ n > 0$ i.e $x(n)$ is left sided sequence.

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

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

$$\underline{-\ +\ -}$$

$$2 - 2z + 6z^2$$

$$5z - 6z^2$$

$$\vdots$$

$$X(z) = 2 + 5z + \ldots.$$

$$= x(0) + x(-1)z + \ldots.$$

Hence, $x(0) = 2$

End of Solution

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

(a) 40% (b) 50%
(c) 60% (d) 70%

Ans. (a)

By considering the noise having zero mean, variance = power

Given, $H(z) = \dfrac{0.5z}{z - 0.6}$

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

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

End of Solution

95. 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)

$$N = 1024$$
$$\text{Time for one multiplication} = 1\ \mu\text{sec}$$
$$\text{Total time for DFT} = N^2 \times 1\ \mu\text{sec}$$
$$= 1024^2 \times 10^{-6}\ \text{sec}$$
$$= 1.05\ \text{sec}$$

End of Solution

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

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

Stop band ripple, $\delta_s = 0.002$

Transition bandwidth no larger than 0.1 π. Kaiser window parameters β 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)

$$\alpha_s = \text{stop band deviation}$$
$$= -20 \log (\delta_s)$$
$$= -20 \log 0.002 = 53.979$$

Since, $\alpha_s > 50$,

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

and $N = \frac{\alpha_s - 7.95}{14.36 \cdot \Delta f}$; where, $\Delta\omega = 0.1\pi$

So, $N = 65$

End of Solution

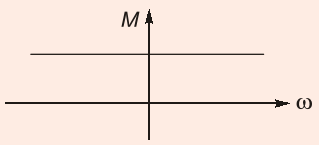
97. A transfer function $G(s) = \frac{1 - sT}{1 + sT}$ has a phase angle of $(-2 \tan^{-1}\omega T)$ which varies from 0° to –180° as ω is increased from 0 to ∞. It is the transfer function for

(a) All pass system (b) Low pass system
(c) High pass system (d) Band pass system

Ans. (a)

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

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



Magnitude is constant for all ω

$\therefore$ All pass system.

Alternative method:

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

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

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

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

End of Solution

98. 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)

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

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

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

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

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

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

End of Solution

99. 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)**

$$\text{OLTF} = G = T_1$$

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

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

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

End of Solution

100. 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)**

Type-1: $GH(s) = \frac{1}{s}$

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

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

End of Solution

101. 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)**

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

Hence, option is (b).

End of Solution

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102. 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)

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

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

For stability,

$K > -1$

$K > 0.3$ $(\therefore K > 0.3)$

$K > 0.05$

End of Solution

103. 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)

In lag compensator,

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

$\therefore$ pole is to the right of zero.

End of Solution

104. 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 right half of the s-plane.

Ans. (a)

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

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 roots lie in left side.

End of Solution

105. 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)

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

type = 1

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

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

$$\therefore \quad K = 20$$

End of Solution

106. 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)

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

Replacing 's' with 'Z'

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

End of Solution

107. 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) $\dfrac{100}{(s+60)(s+10)}$ (b) $\dfrac{600}{(s+60)(s+10)}$

(c) $\dfrac{60}{(s+60)(s+10)}$ (d) $\dfrac{10}{(s+60)(s+10)}$

Ans. (b)

$$SR = 1 + 0.2\ e^{-60t} - 1.2\ e^{-10t}$$

$$T.F. = s \times L\{SR\}$$

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

End of Solution

108. 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)

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

End of Solution

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

1. The secondaries 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)

End of Solution

110. 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 $3/4^{th}$ full load will be nearly

(a) 98% (b) 95%

(c) 92% (d) 87%

Ans. (b)

500 kVA transformer, $\eta = 0.95$ at full load u.p.f.

$\eta = 0.95$ at 60% full load u.p.f.

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

$$\Rightarrow \quad P_{cu} + P_i = 26.316 \qquad \text{...(i)}$$

η at 60% full load,

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

$$0.36\, P_{cu} + P_i = 15.79 \qquad \text{...(ii)}$$

By solving (i) and (ii),

$P_{cu} = 16.45$ kW

$P_i = 9.87$ kW

Now η at 3/4 full load (assuming u.p.f.) ($\because$ Not specified)

$$\eta = \frac{0.75 \times 500 \times 1}{0.75 \times 500 \times 1 + 0.75^2 (16.45) + 9.87} = \frac{375}{375 + 9.25 + 9.87} = \frac{375}{394.12} = 0.95148$$

End of Solution

111. 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)

End of Solution

112. What is the useful flux per pole on no load of a 250 V, 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)

250 V, 6 pole, wave, 110 turns, $R_a = 0.2\ \Omega$

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

$$V = E_b + I_a R_a$$

$$E_b = 250 - 13.3(0.2) = 247.34 \text{ V}$$

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

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

$$\phi \simeq 24.8 \text{ mWb}$$

End of Solution

113. 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)

End of Solution

114. 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)

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'

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

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

End of Solution

115. 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)

End of Solution

116. 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)

6 pole, 50 Hz, I.M.

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

Full load speed given as 950 rpm

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

$$= 0.05 \times 100 = 5\%$$

Rotor voltage frequency:

$$s \times f = 0.05 \times 50 = 2.5\ \text{Hz}$$

2.5 cycles/sec.

$\Rightarrow$ 2.5 × 60 cycles/min. = 150 cycles/min.

End of Solution

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

(a) $\dfrac{\text{Short circuit load loss (per phase)}}{(\text{Short circuit armaure current})^2}$

(b) $\dfrac{\text{Short circuit load loss (per phase)}}{\text{Short circuit load current}}$

(c) $\dfrac{\text{Total short circuit load loss}}{\text{Short circuit armature current}}$

(d) $\dfrac{\text{Total short circuit load loss}}{\text{Short circuit load current}}$

Ans. (a)

End of Solution

118. 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)

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, $P = \sqrt{3} V I \cos\phi$

$$= \sqrt{3} \times 440 \times 100 \times 0.8$$

$$P = 60966.4\ \text{watts}$$

$$\therefore \quad T = \frac{60}{2\pi N_s} P = \frac{60}{2\pi(500)} 60966.4$$

$$= 1164.96 \simeq 1165\ \text{N-m}$$

End of Solution

119. 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)

End of Solution

120. 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)

End of Solution

121. 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)

End of Solution

122. 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)

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

$$= \frac{0.06 \times 2.5 \times 10^3}{(110)^2} = 0.0124 \text{ p.u.}$$

End of Solution

123. 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) 43,200V
(c) 45,400 V (d) 47,600 V

Ans. (d)

$$r = \frac{1}{2} = 0.5 \text{ cm}$$

$$t = 1.5 \text{ cm} = (R - r)$$

$$R = t + r = 1.5 + 0.5 = 2 \text{ cm}$$

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

End of Solution

124. 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)

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.

End of Solution

125. 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)

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

End of Solution

126. Which one of the following faults occurs more frequently in a power system?

(a) Grounded star-delta (b) Double line faults
(c) LLG faults (d) Single line-to-ground (LG) faults

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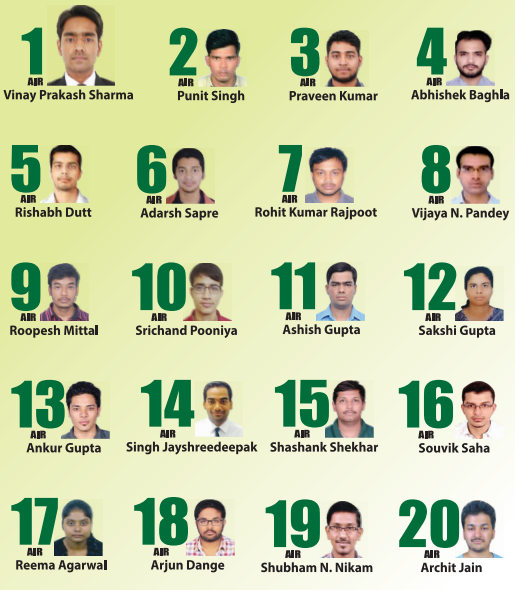

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Ans. (d)

Sequence of fault currents.
SLG, LL, LLG, LLL, LLLG.

End of Solution

127. 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)

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.

End of Solution

128. 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)

Vacuum interrupter are used to achieve high figure of merit is HVDC breaker.

End of Solution

129. 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)

All buses load, gen, slack buses are used to form Y-bus matrix.

End of Solution

130. In a 3-phase, 60 Hz, 500 MVA, 15 kV, 32 pole hydroelectric generating unit, the values of ω_{syn} and ω_{msyn} will 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)

$$\omega_e = 2\pi f = 2\pi \times 60 = 377 \text{ rad/sec}$$

$$\omega_m = \omega_e \times \frac{2}{P} = 377 \times \frac{2}{32}$$

$$= 23.6 \text{ rad/sec}$$

End of Solution

131. 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)

End of Solution

132. 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)
Rectifier station at sending end and inverter at receiving end.

End of Solution

133. 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)
W

End of Solution

134. The reverse recovery time of a diode is t_{rr} = 3 μs 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)

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

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

$$Q_R = 135\ \mu\text{C}$$

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

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

End of Solution

135. The $i_g - v_g$ characteristics of a thyristor is a straight line passing through origin with a gradient of 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

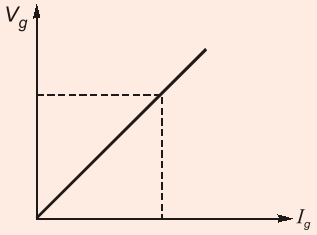
Ans. (b)

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

$$V_g = 2.5 \times 10^3 \, I_g \quad \text{... (i)}$$

$$P_g = 0.015 \text{ W}$$

$$V_g I_g = 0.015 \text{ W} \quad \text{... (ii)}$$



$$2.5 \times 10^3 \, I_g^2 = 0.015$$

$$I_g = 2.45 \text{ mA}$$

$$V_g = 2.5 \times 10^3 \, I_g$$

$$= 2.5 \times 10^3 \times (2.45 \text{ mA})$$

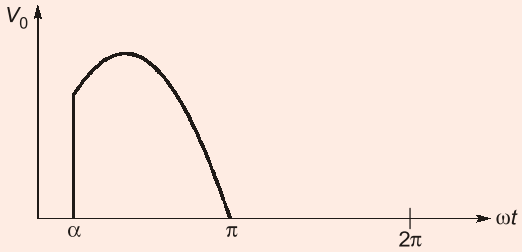
$$V_g = 6.125 \text{ V}$$

End of Solution

136. 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 $\alpha = 90°$, the power absorbed by the heater will be nearly

(a) 1000 W (b) 750 W
(c) 500 W (d) 250 W

Ans. (d)



$$V_{or} = \frac{V_m}{\sqrt{2 \times 2\pi}} \left((\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right)^{1/2}$$

$$= \frac{V_m}{2\sqrt{\pi}} \left((\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right)^{1/2}$$

$$= \frac{V_m}{2\sqrt{2}} = \frac{220\sqrt{2}}{2\sqrt{2}} = 110$$

$$P = \frac{V^2}{R}$$

$$R = \frac{V^2}{P} = \frac{220^2}{1\times 10^3} = 48.4\ \Omega$$

$$P = \frac{V_{or}^2}{R} = \frac{110^2}{48.4} = 250\text{W}$$

End of Solution

137. 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. (*)

Data is ambiguous.

End of Solution

138. A single-phase fully controlled bridge converter is connected with RLE load where $R = 5\ \Omega$, $L = 4$ mH 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)

Considering continuous conduction,

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

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

Note: Practically it is discontinuous conduction (since $\alpha > \phi$)

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

End of Solution

139. 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)

End of Solution

140. 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. (a)

$$T_{em} = KI_2^2 \frac{R_2}{s}$$

$$T_L \propto N_r^2 \propto N_s(1-s)^2 \propto (1-s)^2$$

$$\frac{I_2^2 R_2}{s} \propto (1-s)^2$$

$$I_2 = \sqrt{s}\,(1-s)$$

$$I_1 \propto I_2 \quad [\because \text{Not considering stator impedance and no load current}]$$

$$I_1 \propto \sqrt{s}\,(1-s)$$

For slip at maximum current, $\frac{dI_1}{ds} = 0$

$$\Rightarrow \frac{d}{ds}[\sqrt{s}\,(1-s)] = 0$$

$$= \frac{d}{ds}(\sqrt{s} - s^{3/2}) = \frac{1}{2}\sqrt{s} - \frac{3}{2}\sqrt{s} = 0$$

$$\frac{1}{2}\sqrt{s} = \frac{3}{2}\sqrt{s}$$

Slip at maximum current,

$$s = \frac{1}{3}$$

$$s = \frac{1500-1450}{1500} = 0.0333$$

$$\therefore \quad \frac{I_{max}}{I_{1fl}} = \frac{\sqrt{\frac{1}{3}}\left(1-\frac{1}{3}\right)}{\sqrt{0.0333}\,(1-0.0333)} = 2.2$$

End of Solution

141. 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)

End of Solution

142. Consider the following features with respect to the flyback 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)

End of Solution

143. 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)

End of Solution

144. 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)

End of Solution

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

Ans. (c)

End of Solution

146. **Statement-I:** Reaction turbines are generally used for sites with high head and low flow.
Statement-II: Kaplan and Francis turbines are reaction turbines.

Ans. (d)
Reaction turbines are used for low head and high flow/velocity.

End of Solution

147. **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)
High level languages are machine independent whereas low level languages are machine dependent.
A H.L.L. programmer requires knowledge of logic implementation for the problem.

End of Solution

148. **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)
Statement-II is correct and statement-I is false.

End of Solution

149. **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 cannot 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)

End of Solution

150. **Statement-I:** Soft magnetic materials, both metallic and ceramic are used for making transformers core, whereas, hard magnetic materials both 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)

End of Solution