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ISRO 2019 Scientist

SC' Electrical Engineering' Questions & Solutions

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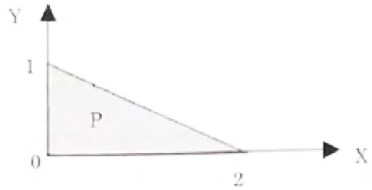
ISRO 2019 EE SCIENTIST "SC" QUESTION WITH SOLUTIONS

Q1. Consider the shaded triangle region P shown in the figure what is $\iint_P xy\,dx\,dy$?

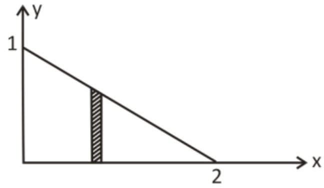


A. $\frac{1}{6}$ B. $\frac{2}{9}$

C. $\frac{7}{16}$ D. 1

Ans A

Sol -



Take a strip along the y axis which moves from x = 0 to x = 2 to cover the region P

$$Area = \int_{x=0}^{2} \int_{y=0}^{\frac{-x}{2}+1} xy\,dx\,dy$$

$$Area = \int_{x=0}^{2} x\left[\frac{y^2}{2}\right]_{y=0}^{\frac{-x}{2}+1} dx$$

$$= \int_{x=0}^{2} \frac{x}{2}\left(\frac{-x}{2}+1\right)^2 dx$$

$$= \int_{x=0}^{2} \left(\frac{x^3}{8}+\frac{x}{2}-\frac{x^2}{2}\right) dx$$

$$= \left[\frac{x^4}{32}+\frac{x^2}{4}-\frac{2^3}{6}\right]_0^2 = \frac{1}{6}$$

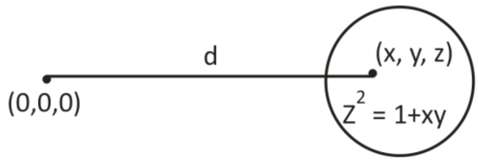
Q2. Distance between origin and the point nearest to it on the surface $z^2 = 1 + xy$ is

A. $\frac{\sqrt{3}}{2}$ B. 1

C. $\sqrt{3}$ D. 2

Ans B

Sol -



$$Distance = \sqrt{(x-0)^2+(y-0)^2+(z-0)^2}$$

$$d = \sqrt{x^2+y^2+z^2}$$

$$d = \sqrt{x^2+y^2+1+xy} \qquad (\because \qquad xy)$$

$$d^2 = x^2+y^2+1+xy \qquad (3)$$

Let $d^2 = f(x,y)$

$$\frac{df}{dx} = 2x+y \qquad \frac{df}{dy} = 2y+x$$

To find the nearest point

$$\frac{\partial f}{\partial x} = 0 \quad and \quad \frac{\partial f}{\partial y} = 0$$

(1) (2)

By solving (1) and (2)

X = 0, y = 0

Substituting there value in (3)

$d^2 = 1$

d = 1

Q3. At x = 0, the function f(x) = |x| has

A. A maximum

B. A point of inflection

C. A minimum

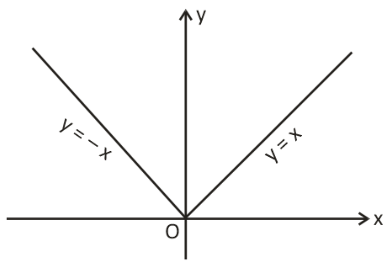
D. Neither maximum nor minimum

Ans C

Sol -

f (x) = |x|

$$f(x) = \begin{cases} x & x > 0 \\ -x & x < 0 \end{cases}$$



At origin there is a point of minima

Q4. General solution of differential equation $\frac{dy}{dx} = \cos(x+y)$ is

A. $\tan\left(\frac{x+y}{2}\right) = y + c$

B. $\sin\left(\frac{x+y}{2}\right) = y + c$

C. $\cos\left(\frac{x+y}{2}\right) = x + c$

D. $\tan\left(\frac{x+y}{2}\right) = x + c$

Ans D

Sol -

$$\frac{dy}{dx} = \cos(x+y) \qquad (1)$$

Let x + y = t

$$1 + \frac{\partial y}{\partial x} = \frac{\partial t}{\partial x}$$

$$\frac{\partial y}{\partial x} = \frac{\partial t}{\partial x} - 1$$

$$substituting\,\frac{\partial y}{\partial x}\,in\ (1)$$

$$\frac{\partial t}{\partial x} - 1 = \cos t$$

$$\frac{\partial t}{1+\cos t} = dx$$

$$\frac{\partial t}{2\cos^2\frac{t}{2}} = dx \qquad (\because \qquad = 2\cos^2 x - 1)$$

Integrating both sides

$$\frac{\cancel{1}/\cancel{2}\,\tan\left(\frac{t}{2}\right)}{\cancel{1}/\cancel{2}} = x + C$$

$$\tan\left(\frac{t}{2}\right) = x + C$$

$\because$ t = x + y

$$\therefore \tan\left(\frac{x+y}{2}\right) = x + C$$

Q5. Minimum number of wattmeter required to measure 3 phase, 3 phase, 3 wire balanced or unbalanced power?

A. 1 B. 2

C. 3 D. 4

Ans B

Sol -

Using Blondal's theorem

For n wire system

(n – 1) wattmeter are required to measure the power

Given 3 wire balanced or unbalanced system therefore 2 wattmeter are required

Q6. An electric motor with constant output power will have Torque Speed characteristics in the form of

A. Straight line through origin

B. Straight line parallel to speed axis

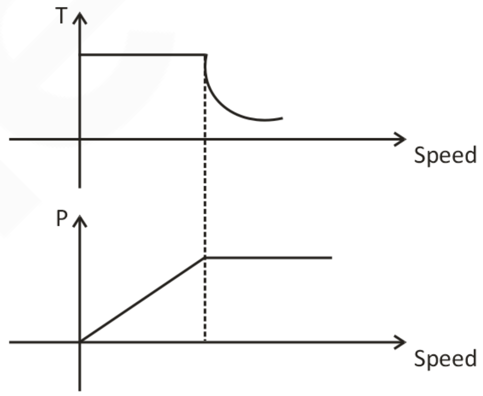
C. Cricle about origin

D. Rectangular hyperbola

Ans D

Sol -

Torque speed characteristic



From above characteristics, for constant power torque speed characteristic in form rectangular hyperbola

Q7. A current impulse 5δ(t) is forced through a capacitor C. The voltage across capacitor $V_c(t)$ is given by?

A. 5t B. 5u(t) – C

C. $\frac{5}{C}t$ D. $\frac{5}{C}u(t)$

Ans D

Sol -

We know that

Voltage across capacitor (V)

$$V = \frac{1}{C}\int_{-\infty}^{+} idt$$

i (t) = 5 δ (t)

$$\therefore V(t)=\frac{1}{C}\int_{-\infty}^{t}5\delta(t)dt$$

$$V(t)=\frac{5}{C}\int_{-\infty}^{t}\delta(t)dt$$

$$\because \quad \int_{-\infty}^{t}\delta(t)dt$$

$$V(t)=\frac{5\;\;u(t)}{C}$$

Q8. Total instantaneous power supplied by Three phase AC supply to a balanced R-L load is?

A. Zero

B. Constant

C. Pulsating with zero average

D. Pulsating with non-zero average

Ans B

Sol -

Power supplied to a balanced R – L load is

$$P=\sqrt{3}V_L I_L\cos\phi$$

Where V_L = line voltage of supply

I_L = line current taken by load

Cos φ power factor

As V_L, I_L and power factor are constant for given R – L load

Therefore total power is constant

Q9. RMS value of Voltage u(t) = 8 + 6 cos(3t)?

A. 10 V B. $\sqrt{82}\ V$

C. $2\sqrt{2}+\sqrt{6}\,V$ D. $\frac{6}{\sqrt{2}}V$

Ans B

Sol -

V(t) = 8 + 6 cos (3t)

$$RMS=\sqrt{\frac{1}{T}\int V^2(t)dt}$$

$$RMS=\sqrt{\frac{1}{T}\int_{o}^{T}(8+6\cos 3t)^2\,dt}$$

$$=\sqrt{\frac{1}{T}\int_{o}^{T}(64+36\cos^2 3t+96\cos 3t)dt}$$

$$=\sqrt{64+18}=\sqrt{82V}$$

Q10. IF is electric field intensity then is?

A. $\overline{E}$ B. $|\overline{E}|$

C. Null vector D. Zero

Ans D

Sol -

$$\nabla.(\nabla\times\vec{E})$$

As we know, (div. curl = 0

$$\therefore \nabla(\nabla\times\vec{E})=0$$

Q11. Plant Use Factor is

A. $\frac{\text{Maximum demand}}{\text{Connected load}}$

B. $\frac{\text{Number of units generated}}{\text{Plant capacity}\times\text{Number of hours plant operated}}$

C. $\frac{\text{Average demand}}{\text{Plant capacity}}$

D. $\frac{\text{Average load}}{\text{Maximum load}}$

Ans B

Sol -

Plant use factor

$$=\frac{\textit{number of units generated}}{\textit{plant capacity}\times\textit{number of hours plant operated}}$$

Q12. Two identical synchronous machines A and B running at same speed are connected to each other through an inductor. Machine A is supplying an active power to Machine B and Machine B is supplying reactive power to Machine A, then which among the following is correct?

A. $|V_a|>|V_b|$

B. $|V_a|<|V_b|$

C. $|V_a|=|V_b|$

D. None of the above

Ans B

Sol -

As we know, active power ɑ δ

Reactive power ɑ V

As machine B is supplying reactive power to machine A

∴ $|V_B| > |V_A|$

Q13. A 90 MW, 11 kV generator has an inertia constant H = 3s. The stored energy in the rotor at synchronous speed is

A. 30 kJ B. 270 kJ

C. 270 MJ D. 30 MJ

Ans C

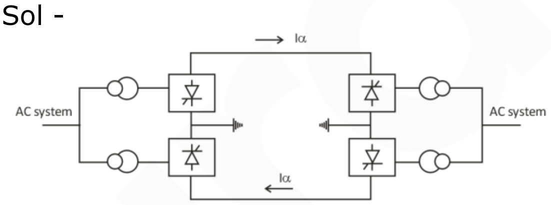
Sol -

$$H = \frac{kinetic\ energy\ stored}{S}$$

H = inertia constant
S = machine rating
∴ KE = H × S
= 270 MJ

Q14. MHO relays are used for protection of
A. Long transmission lines
B. Power transformer
C. Busbars
D. Short transmission lines
Ans A
Sol -
As long lines are subjected to power swings and we know that mho relays can protect from power swings better than simple impedance relay or reactance relay. Therefore mho relays are used for protection of long lines.

Q15. HVDC Homo polar links uses
A. One conductor usually of negative polarity
B. One conductor usually of positive polarity
C. Two conductors of positive and negative polarity
D. Two conductors of negative polarity
Ans D
Sol -



In homopolar, two conductors of same polarity which is negative polarity are used.

Q16. Due to low internal generation in GTO, the GTO has
A. Lower latching current
B. Lower holding current
C. Lower latching and holding current
D. Higher latching and holding current
Ans D
Sol -
GTO has higher latching and holding currents

Q17. In a 3 phase semiconductor, firing angle = 120° and sextinction angle = 110°. Each SCR and freewheeling diode conducts respectively for
A. 60°, 50°
B. 30°, 50°
C. 60°, 10°
D. 30°, 40°
Ans A
Sol -
For a 3 phase semi converter
SCR conducts for (π – α) period
Where α is the firing angle
∴ SCR conduction = π – 120° = 60°
And freewheeling diode conducts for

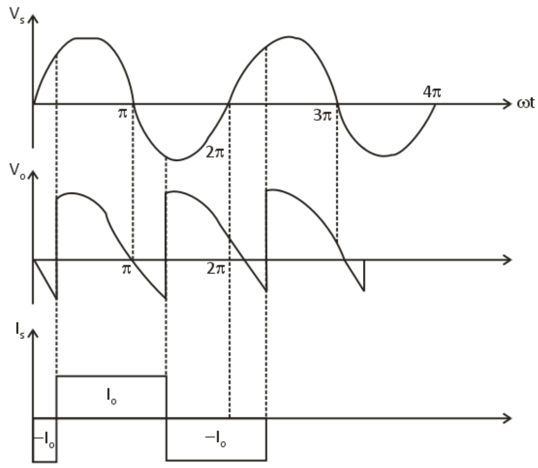
$\left(\beta - \frac{\pi}{3}\right)$ period

Where β is extinction angle

Freewheeling diode conduction = $\beta - \frac{\pi}{3}$

= 110° – 60° = 50°

Q18. A single phase full wave bridge diode rectifier delivers a constant current of 10 A to the load. Average and RMS values of source current are
A. 5 A, 10 A
B. 10 A, 10 A
C. 10 A, 7.07 A
D. 0 A, 10 A
Ans D
Sol -



Io = 10A
From the above waveform of I_S (source current)
$I_{\text{average of source current}} = 0$
$I_{rms} = 10A$

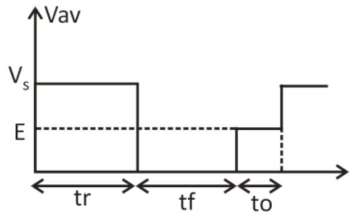
Q19. A step down chopper operates from a DC voltage source V_s and feeds a DC motor armature with counter emf E_b. From oscilloscope traces it is found that current increases for time t_r,s falls to zero over a time t_f and remains zero for a time t_o in every chopping cycle. Then the average voltage across the motor would be

A. $\frac{V_s t_r}{t_r + t_f + t_o}$ B. $\frac{V_s t_r + E_b t_f}{t_r + t_f + t_o}$

C. $\frac{V_s t_r + E_b t_f}{t_r + t_f + t_o}$ D. $\frac{V_s t_r + E_b (t_f - t_o)}{t_r + t_f + t_o}$

Ans C

Sol -



$$Vav = \frac{Vstr + Ebto}{tr + tf + to}$$

Q20. In a single phase inverter using single pulse modulation for control of output voltage, Harmonics of the order 'n' can be eliminated by making the pulse width equal to

A. 4 п/n B. 2 п/n

C. п/n D. п/2n

Ans B

Sol -

$$van = \frac{4vs}{n\pi}\sin(nd)\sin(nwt)$$

Van = 0

nd = п, 2п

$$d = \frac{\pi}{n}, \frac{2\pi}{n}$$

$$pulse\ width = 2\alpha = \frac{2\pi}{n}$$

Q21. In a 132 kV system, Phase to Ground capacitance is 0.01 μF and inductance is 4H. Calculate the critical resistance to be connected in order to eliminate restriking if a magnetizing current of 5 A is interrupted by the circuit

A. 20 kΩ B. 10 kΩ

C. 100 kΩ D. 200 kΩ

Ans B

Sol -

Critical resistance

$$R = \frac{1}{2}\sqrt{\frac{L}{C}} = \frac{1}{2}\sqrt{\frac{4}{0.01\times 10^{-6}}}$$

= 10 kΩ

Q22. Making capacity of Circuit breaker is

A. Lesser than the asymmetrical breaking capacity

B. Greater than the asymmetrical breaking capacity

C. Equal to the symmetrical breaking capacity

D. Equal to the asymmetrical breaking capacity

Ans D

Sol –

$(\text{Making Capacity})_{\text{Peak}}$ = 2.55 x $(\text{Breaking Capacity})_{\text{rms}}$

Q23. What is simplified Booleam equation of a logic circuit. If the circuit output is 1 for following inputs?

ABCD = 0010

ABCD = 0110

ABCD = 1000

ABCD = 1100

And output is zero for all other inputs

A. $\bar{A}C\bar{D} + A\bar{C}\bar{D}$ B. $\bar{A}CD + AC\bar{D}$

C. $AC\bar{D} + \bar{A}C\bar{D}$ D. $\bar{A}C\bar{D} + AC\bar{D}$

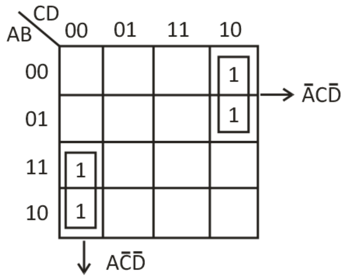
Ans D

Sol -

$(\text{Making capacity})_{\text{Peak}}$ = 2.55 × $(\text{Breaking capacity})_{\text{cms}}$

Ans A

Sol -



$$simplied\ equation = \bar{A}C\bar{D} + A\bar{C}\bar{D}$$

Q24. The output frequency of a decade counter that is clocked from 50 kHz signal is.

A. 12.5 kHz
B. 50 Hz
C. 5 kHz
D. 500 kHz
Ans C
Sol -

$$output\ frequency = \frac{f_{clock}}{modvalue}$$

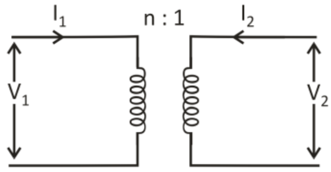
As decade counter is given∴ Mod value=10

$$fo = \frac{f_{clock}}{10} = \frac{50khz}{10} = 5khz$$

Q25. What is transition matrix of ideal transformer with turns ratio n : 1 (ie. $V_1 = nV_2$)

A. $\begin{bmatrix} n & 0 \\ 0 & 1/n \end{bmatrix}$
B. $\begin{bmatrix} 1/n & 0 \\ 0 & n \end{bmatrix}$
C. $\begin{bmatrix} n & 0 \\ 0 & -1/n \end{bmatrix}$
D. $\begin{bmatrix} 1/n & 0 \\ 0 & -n \end{bmatrix}$

Ans A
Sol -



$V_1 = nV_2$

$$\frac{V_1}{V_2 = n} \Rightarrow V_1 = nV_2 \quad (1)$$

$$\frac{I_1}{I_2} = \frac{1}{n} \Rightarrow I_1 = \frac{I_2}{n} \quad (2)$$

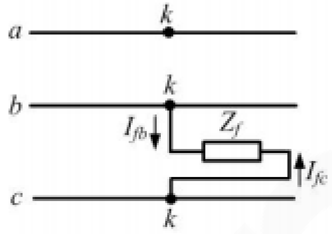
Transmission parameter equation
$V_1 = AV_2 + BI_2$
$I_1 = CV_2 + DI_2$
From (1) and (2)
A = n, B = 0

$$C = 0, D = \frac{1}{n}$$

$$[T] = \begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} n & 0 \\ 0 & \frac{1}{n} \end{bmatrix}$$

Q26. At the terminals of a 3φ, 6.6 kV, 10 MVA alternator, a load R = 200 Ω is connected between two phases and other phase is kept open. The sequence impedance of the alternator is $Z_1 = Z_2 = j5\ \Omega$ and $Z_0 = j2\ \Omega$. What is the current through the load resistance?

A. 50 A
B. 66 A
C. 75 A
D. 32 A
Ans D
Sol –
This is the case of line to line fault



$I_{fa} = 0$ (Open circuited)
From the formula of double line fault,

$$I = \frac{V}{Z_1 + Z_2 + Z_f}$$

$$I = \frac{6.6KV}{(5+5+200)\Omega} = \frac{6600}{210} = 31.43 \approx 32\,\text{A}$$

Q27. Transfer function of a system is $TF\ \frac{s^3 + 2s^2 + 3s + 1}{s^3 + s^2 + 2s + 1}$. How many roots are lying on the right half side of S-Plane for numerator and denominator for the transfer function?

A. 0, 0
B. 1, 0
C. 0, 1
D. None of the above
Ans A
Sol -

$$T.F = \frac{S^3 + 2S^2 + 3S + 1}{S^3 + S^2 + 2S + 1}$$

For numerator → $S^3 + 2S^2 + 3S + 1$
Applying R – H criteria

S^3	1 3
S^2	2 1
S^1	5/2 0
S^0	1

As the first column is positive, so no roots lie on the right side of s plane.
For denominator – $S^3 + S^2 + 2S + 1$

S^3	1 2
S^2	1 1
S^1	1 0
S^0	1

No roots on right side of s plane for denominator also

Q28. Which among the following is a method of absolute measurement of resistance?
A. Voltmeter ammeter method
B. Wheatstone bridge method
C. Lorentz method
D. None of the above
Ans C
Sol –
Wheatstone bridge method is used for measurement of resistance.

Q29. A second order system has poles at -1 ± j2 and zero at 1. What is the transfer function of the system if the steady state output to an input of unit step is c(t) = 3?

A. $\frac{(s-1)}{s^2+2s+5}$ B. $\frac{-15(s-1)}{s^2+2s+5}$

C. $\frac{(s-1)}{s^2+2s+4}$ D. $\frac{5(s-1)}{s^2+2s+5}$

Ans B
Sol -
$P_1 = -1 + j^2$
$P_2 = -1 - j^2$
Z = 1
Let the gain of system be k

$$T.F = \frac{k(s-1)}{(s+1-j_2)(s+1+j_2)} = \frac{k(s-1)}{(s+1)^2+4}$$

$$\frac{C(s)}{R(s)} = \frac{K(s-1)}{(s+1)^2+4}$$

if C(t) = 3 → given
Applying final value theorem

$$\underset{t\to\infty}{it}\ c(t) = \underset{s\to 0}{it}\ S\,c(s) = 3$$

$$3 = \underset{s\to 0}{it}\ \frac{k(s-1)}{(s+1)^2+4} \times s\ \ R(s)$$

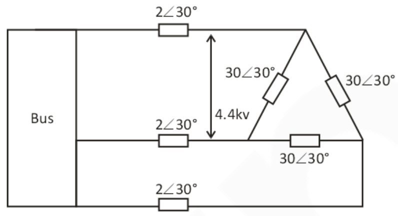
$$R(s) = \frac{1}{S}$$

$$3 = \frac{-k}{5}$$

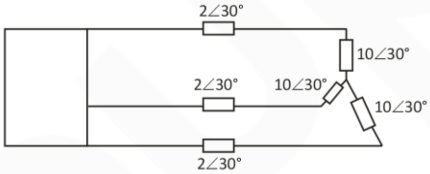
K = – 15

$$T.F = \frac{-15(s-1)}{(s+1)^2+4}$$

Q30. The terminal voltage of a delta connected load consisting of 3 equal impedances of 30∠30° Ω is 4.4 kV line to line. Line impedance of each of the three lines connecting the load to bus is Z_L = 2∠30°Ω. Find the line to line voltage at the bus.
A. 4.62 kV B. 5.28 kV
C. 4.4 kV D. 4.69 kV
Ans B
Sol -



Converting delta to star



Phase voltage at load = $\frac{4.4\,kv}{\sqrt{3}} = 2.54\ kv$

$$I_{ph} = \frac{2.54\ kv}{10\angle 30} = 254.03\angle -30°A$$

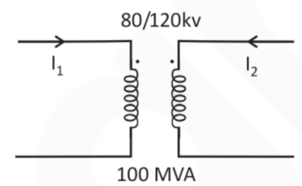
Drop across the impedance 2∠30 is
V = 2∠30 × 254.03 ∠–30° = 508.06 V
Voltage at bus = V + V_{laod}
= 508.06 + 2.54 × 10^3
= 3048.40
Line to line voltage at bus $= \sqrt{3} \times 3048.40$
=5.28 kv

Q31. A single phase inductive load draws 10 MW at 0.6 power factor lagging What is the value of the capacitor to be connected in parallel with the load to raise the power factor to 0.89? System voltage is 1000 V and system frequency is 50 Hz.
A. 30 mF B. 40 mF
C. 19 mF D. 23 mF
Ans C
Sol –
P = 10 Mw
cos φ_1 = 0.6 cos φ_2 = 0.8
tan φ_1 = 1.33 tan φ_2 = 0.75
Qc = P(tan φ_1 – tan φ_2)
= 10 (1.33 – 0.75) = 5.8 MVAR

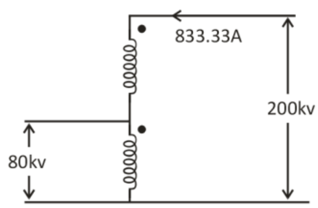
$C = \frac{Q_c}{2\pi f V_2} = \frac{5.8\times 10^6}{2\pi \times 50 \times (1000)^2}$ = 19 mF

Q32. Which among the following statement is true?
A. Electric charge con produce electric field and magnetic field when stationary
B. Electric charge can produce electric field when stationary and both electric and magnetic field when moving
C. Electric charge can produce electric field when moving and magnetic held when stationary
D. Electric charge can produce electric field and magnetic field while stationary and while moving
Ans B
Sol -
Stationary charge cannot produce magnetic field but it can produce electric field

Q33. A 100 MVA single phase transformer rated 80/120 kV is connected as an auto transformer in such a way that the doted terminal of LV side is connected to the un-doted terminal of HV side. Un-doted terminal of LV side is taken as common for both LV and HV. The rated voltage of 80 kV is applied to the low voltage winding of the transformer. Consider the transformer to be ideal and load to be such that the rated current flows through both primary and secondary windings. What is the kVA rating of the autotransformer?
A. 200 MVA B. 250 MVA
C. 172 MVA D. 167 MVA
Ans D
Sol -



$$I_{2\,rated} = \frac{100\times10^6}{120\times10^3}$$
= 833.33A
Auto transforms



As the auto transforms is in additive polarity
∴ V_2 = 80 + 120 = 200 kv
KVA rating = 200 kv × 833.33 A = 167 MVA

Q34. A graph has 8 nodes and 5 independent loops. The number of branches in the graph is.
A. 10 B. 14
C. 12 D. 8
Ans C
Sol -
e = b – (n – 1)
c = independent loops
b = number of branches
n = nodes
5 = b – (8 – 1)
B = 12

Q35. The transfer function of a second order system is $TF = \frac{32}{s^2+15s+32}$ The nature of the system is.
A. Over damped B. Under damped
C. Critically damped D. Oscillatory
Ans A
Sol –
$$T.F = \frac{32}{S^2+15S+32} = \frac{wn^2}{s^2+2\xi wnS+wn^2}$$
$wn = \sqrt{32}$
2ζwn = 15
$$\xi = \frac{15}{2\sqrt{32}} = 1.32$$
ζ > 1 ∴ system is overdamped

Q36. The value of directional derivative of a function φ(x, y, z) = $xy^2 + yz^2 + zx^2$ at point (2, -1, 1) along the direction vector p = I + 2j + 2k is.
A. 3 B. 5
C. 8 D. -1
Ans A
Sol -
φ (x, y, z) = $xy^2 + yz^2 + zx^2$
$$\vec{\nabla}\psi = \frac{\partial\phi}{\partial x}\hat{i} + \frac{\partial\phi}{\partial y}\hat{j} + \frac{\partial\phi}{\partial z}\hat{k}$$
$$= (y^2+2zx)\hat{i} + (2yx+z^2)\hat{j} + (2zy+x^2)\hat{k}$$

At (2, −1, 1)

$\vec{r}$ [illegible] $\hat{i} + 2\hat{k}$

$\vec{\nabla}\psi.\vec{r} = ($[illegible]$\hat{j} + 2\hat{k}) - (\hat{i} + 2\hat{j} + 2\hat{k})$

= 5 − 6 + 4 = 3

Q37. A MOSFET is.
A. Minority carrier device
B. Majority carrier device
C. Both majority and minority carrier device
D. None of the above
Ans B
Sol -
MOSFET is a majority carrier devices

Q38. A system is having $TF = \dfrac{25s}{s^2 + 8s + 25}$ what is the time taken to reach maximum peak overshoot for a step input?

A. π/5 B. π/3
C. π/2 D. None of the above

Ans B
Sol -

$$T.F = \frac{25s}{S^2 + 8s + 25}$$

$Wn^2 = 25$
Wn = 5
2ζwn = 8
ζ = 0.8

$$tp = \frac{x}{wd} = \frac{\pi}{wn\sqrt{1-\xi^2}} = \frac{\pi}{5\sqrt{1-0.8^2}} = \frac{\pi}{3}$$

Q39. In an RISC series circuit R_t = 100 Ω, L = 5H, C = 5F. Output voltage is measured across the capacitor. The system is
A. Over damped
B. Under damped
C. Critically damped
D. Oscillatory
Ans A
Sol -
R = 10Ω, L = 5H, C = 5F
For series RLC, Circuit

$$\xi(damping\ ratio) = \frac{R}{2}\sqrt{\frac{C}{L}}$$

$$= \frac{10}{2}\sqrt{\frac{5}{5}}$$

= 5
ζ > 1
∴ overdamped

Q40. A box contains 2 blue, 3 black and 4 red balls. Balls are drawn from the box at random one at a time without replacement. The probability of drawing 2 blue balls first followed by 3 black balls and subsequently 4 red balls is

A. $\frac{2}{350}$ B. $\frac{1}{629}$
C. $\frac{1}{1260}$ D. $\frac{1}{24}$

Ans C
Sol -
P(2 blue, 3 block, 4 red)

$$= \frac{2}{9} \times \frac{1}{8} \times \frac{3}{7} \times \frac{2}{6} \times \frac{1}{5} \times 1$$

$$= \frac{1}{1260}$$

Q41. Using trapezoidal rule and dividing the interval of integration into three equal sub intervals, the definite integral $\int_{-1}^{+1} |x|dx$ is

A. 1.11 B. 2.22
C. 3.33 D. 4.44

Ans A
Sol -

$$I = \int_{-1}^{1} |x|dx$$

$$\int_a^b f(x)dx = \frac{h}{2}[(y_o + y_n) + 2(y_1 + y_2 + ...y_n)]$$

$$f(x) = |x| \begin{cases} -x & x < 0 \\ x & x > 0 \end{cases}$$

X	−1	−1/3	1/3	1
F(x)	1	1/3	1/3	1

$$h = \frac{b-a}{n} = \frac{2}{3}$$

$$\int_{-1}^{1} |x|dx = \frac{2}{3 \times 2}\left[1 + 1 + 2 \times \frac{2}{3}\right] = \frac{10}{9} = 1.11$$

Q42. A circular ring of radius 42 cm is cut and bent into the form of a rectangle whose sides are in the ratio of 6 : 5. The small side of the rectangle is
A. 80 cm B. 30 cm
C. 120 cm D. 60 cm
Ans D
Sol -
Radius = 42 cm
Let the sides of rectangle be l and b

$$Given, \frac{l}{b} = \frac{6}{5} \quad \therefore l = 6x,\ b = 5x$$

Perimeter of both circular ring and rectangle should be same
2πr = 2 (l + b)
2π × 42 = 2 × || x
X = 11.98 cm
Small side of rectangle = b = 5x = 5 × 11.98 cm = 60 cm

Q43. A tank is normally filled in 8 hours but takes 2 hours longer to fill because of a leak at the bottom. If the tank is full and due to leakage alone, the tank will get empty in ___________ hours (Assume no further filling happens)
A. 20 B. 40
C. 30 D. 50
Ans B
Sol -
Time taken by tank to normally fill = 8 hrs
Time taken if there is a leak = 10 hrs
Let the time taken to empty the tank if by leak only = x hrs

$$\therefore \frac{1}{8} + \frac{1}{x} = \frac{1}{10}$$

x = 40 hours

Q44. From a circular sheet of paper having radius 50 cm, a sector of 40% area is removed in the shape of an arc section. If the remaining part is used to make a conical surface, then the ratio of the radius to height of the cone is
A. $\frac{4}{3}$ B. $\frac{5}{4}$
C. $\frac{3}{4}$ D. $\frac{7}{8}$
Ans C
Sol -

$$\text{Angle of cutout sector } = \frac{40}{100} \times 360 = 144^\circ$$

$$\text{Left over perimeter } = \frac{60}{100} \times 2\pi \times 50 = 60\pi$$

$$\text{Radius of cone bottom } = \frac{60\pi}{2\pi} = 30cm$$

Slopping side of cone = radius of original shut = 50 cm
height^2 = 50^2 – 30^2 = 1600
height = 40 cm

$$\frac{radius}{height} = \frac{30}{40} = \frac{3}{4}$$

Q45. For an induction motor operating at a slip 's' the ratio of gross power output to air gap power is?
A. $(1 - s)^2$ B. $(1 - s)$
C. $\sqrt{(1-s)}$ D. $\frac{1-s}{s}$
Ans B
Sol -
We know that
P_{airgap} = $P_{copper\ loss}$ = P_{gross} = 1: S = (1 –S)

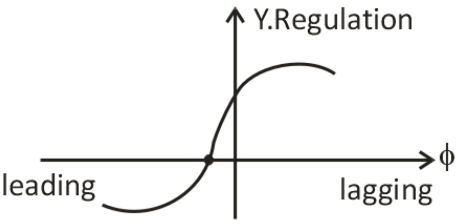
$$\therefore \frac{P_{gross}}{P_{air\ gap}} = 1 - S$$

Q46. Which of the following statement is true for divergence of electric and magnetic flux densities?
A. Both are zero
B. Both are zero for static field densities and lion-zero for tune varying field density
C. It is zero for electric flux density
D. It is zero for magnetic flux density
Ans D
Sol -
Divergence is zero for magnetic flux density

$$\vec{\nabla} . \vec{B} = 0$$

Q47. In a transformer, zero voltage regulation is achieved at full load when?
A. Load is UPF load
B. Load is lending power factor load
C. Load is lagging power factor load
D. Not possible

Ans B
Sol -



As from the curve we can sce that voltage regulation is zero for leading power factor load.

Q48. Which one among the following semiconductor devices is not a current triggered device?
A. Thyristor B. GTO
C. Triac D. MOSFET
Sol 48- Correct option is d
MOSFET is voltage triggered device

Q49. Equation of a line normal to $f(x) = (x+4)^{\frac{1}{2}} + 1$ at Q (0, 3) is
A. y = 3 – 4x B. y = 3 + 4x
C. 4y = 12 – x D. 4y = 12 + x
Ans A
Sol -
f(x) = $(x+4)^{1/2}$ + 1 at Q(0,3)

$$f'(x) = \frac{1}{2}(x+4)^{-1/2}$$

$$f'(o) = \frac{1}{2}(4)^{-1/2}$$

$$f'(o) = \frac{1}{4}$$

Slope of line is $f'(o) = \frac{1}{4}$

Slope of line normal to it = $\frac{1}{1/4} = 4$

Equation of line y – y_1 = m (x – x_1)
y – 3 = 4 (x – 0)
y = 4x + 3

Q50. Which among the following Maxwell's equation represents conservation of electric field?
A. $\nabla \times \overline{E} = 0$ B. $\nabla \times \overline{D} = \rho_v$
C. $\nabla \times \overline{B} = 0$ D. $\nabla \times \overline{H} = \overline{J}$
Ans A

Sol -
$\nabla \times \vec{E} = 0$ -is the maxwell's equation which represent the conservation of electric field.

Q51. Inductive load of resistance 20 Ω and inductance 0.1 H is connected in series and switched on to an AC voltage of V = 100 sin(200 t + α). Find the angle such that there is no transients?
A. 45° B. 60°
C. 30° D. 75°
Ans A
Sol -
Solution for the i(t) for R – L load

$$i(t) = \frac{-Vm}{|z|}\sin(\theta-\alpha)e^{\frac{-Rt}{L}} + \frac{Vm}{|z|}\sin(\omega t+\theta-\alpha)$$

For no transient
θ – α = 0
θ = α

$$\theta = \tan^{-1}\frac{\omega L}{R} = \tan^{-1}\left(\frac{200\times 0.1}{20}\right)$$

θ = 45

Q52 What is quality factor of a parallel RLC circuit?
A. $\frac{1}{R}\sqrt{\frac{L}{C}}$ B. $R\sqrt{\frac{L}{C}}$
C. $\sqrt{\frac{1}{LC}}$ D. $\sqrt{LC}$
Ans B
Sol -

$$Q = \frac{\text{Reactive component of current}}{\text{Active component of current}}$$

$$Q = \frac{I_c}{I_R} = \frac{I_L}{I_R} = \frac{V/X_L}{V/R} = \frac{V/X_c}{V/R}$$

$$Q = \frac{R}{X_L} \text{ or } \frac{R}{X_c}$$

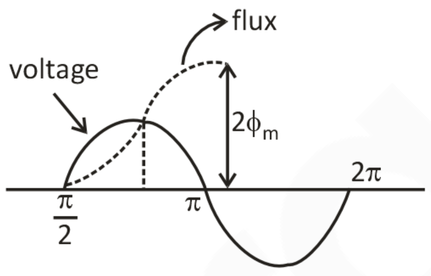
$$Q = \frac{R}{\omega L} = \omega RC$$

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

$$Q = R\sqrt{\frac{C}{L}}$$

Q53. What is analogous to electric field in Magnetic circuits?
A. Magnetic flux density
B. Magneto motive force
C. Reluctance
D. None of the above
Ans D
Sol -
Magnetic flux is analogues to electric field in magnetic circuit.

Q54. A single phase transformer is switched on to an AC supply. In order to have minimum inrush current switch should be closed at?
A. Maximum supply voltage
B. Zero supply voltage
C. $\frac{1}{\sqrt{2}}$ times of the maximum supply voltage
D. $\frac{1}{2}$ times of the maximum supply voltage
Ans A
Sol -



If the transformer is switched on at $\frac{\pi}{2}$ on maximum supply voltage the change in flux will be only φ_m therefore it will have minimum inrush current

Q55. Hysteresis and eddy current losses of single phase transformer working on 200 V, 50 Hz is P_h and P_c respectively. The percentage decrease in P_h and P_c, when the transformer operates on 160 V. 40 Hz supply, will respectively be
A. 32, 16
B. 25, 50
C. 20, 36
D. 40, 80
Ans C
Sol -
We know that
$P_n \propto B^{1-6} f$
$P_e \propto B^2 f^2$

$$\frac{P_{n1}}{P_{n2}} = \frac{B_1^{1.6}}{B_2^{1.6}} \frac{f_1}{f_2}$$

$$As\ B = F / f$$

$$\therefore \frac{P_{n1}}{P_{n2}} = \frac{V_1^{1.6}}{f_1^{0.6}} \times \frac{f_2^{0.6}}{V_2^{1.6}} = \left(\frac{200}{160}\right)^{1.6} \times \left(\frac{40}{50}\right)^{0.6}$$

$$= 1.25$$

$$\frac{P_{n2}}{P_{n1}} = \frac{1}{1.25}$$

$$\frac{P_{n2}}{P_{n1}} - 1 = -0.2$$

Therefore 20% decrease in hysteresis loss

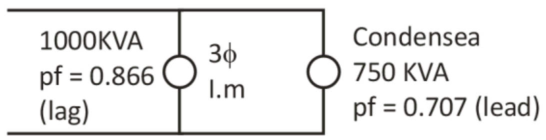
$$\frac{P_{e1}}{P_{e2}} = \frac{B_1^2 f_1^2}{B_2^2 f_2^2} = \frac{V_1^2}{V_2^2} = \left(\frac{200}{160}\right)^2$$

$$\frac{P_{e2}}{P_{e1}} = 0.65$$

$$\frac{P_{e2} - P_{e1}}{P_{e1}} = -0.36$$

∴ 36% decrease in eddy loss

Q56. A 3 phase induction machine draws 1000 kVA at a power factor of 0.866 lag. A synchronous condenser is connected in parallel to draw an additional power of 750 kVA at a leading pf of 0.707. The power factor of the total load supplied by the mains is
A, 0.95 lag
B. 0.99 lead
C. 0.90 lag
D. 0.95 lead
Ans B
Sol -



For induction meter
$P_1 = S \cos \varphi$
$= 1000 \times 0.866 = 866$ kw
$\theta_1 = P \tan \varphi$
$= 866 \tan [\cos^{-1} 0.866] = 500$ KVAR
For condenser
$P_2 = S \cos \varphi$
$= 750 \times 0.707 = 530.25$ kw
$\theta_2 = -P \tan \varphi$ [∵ leading power factor]

$\theta_2 = -530.25 \tan[\cos^{-1} 0.707]$
$\theta_2 = -530.25$
total active power of the system $= P_1 + P_2$
$(P_T) = 1396.25$ kw
Total reactive power $= Q_1 + Q_2$
$(Q_T) = 500 - 530.25 = -30.25$ KVAR
$Q_T = P_T \tan\varphi$
$-30.25 = 1396.25 \tan\varphi$
$\cos\varphi = 0.99$ lead [as reactive power is negative, ∴ leading pf]

Q57. A 3 phase, 4 pole, 400 V, 10 kW slip ring induct ion motor has rotor resistance = 0.16 Ω per phase and stator resistance of 0.27 Ω per phase. The voltage across the slip rings at standstill is 141 V per phase. The motor develops a torque of 62.4 Nm at a slip of 0.08 and the rotor current is 6 A. What is the rotor current if a voltage is injected to the rotor so that the motor runs at slip s = 0.02 and develops same torque?

A. 6 A B. 5 A
C. 4 A D. 3 A

Ans D
Sol –
We know that,

$$torque \; \alpha \frac{3i_2^2 R_2}{sw} \quad [I_2 = rotor\ current]$$

As for que is same,

$$\frac{I_2^2}{S_2} = \frac{I_2^{'2}}{S_2^{'}}$$

$$\frac{6^2}{0.08} = \frac{I_2^{'2}}{0.02}$$

$$I_2^{'2=9}$$

$I_2' = 3A$

Q58. Double cage induction motors are used for
A. High staring torque
B. Better speed control
C. High running torque
D. None of the above
Ans A
Sol -
Double cage induction motors are used for high starting torque

Q59. A salient pole alternator has $X_d = 1.4$ pu and $X_q = 1$ pu and Ra = 0 pu. If the alternator develops rated power at UPF and at rated voltage what is the power angle?

A. 45° B. 60°
C. 30° D. 55°

Ans A
Sol -
Xa = 1.4 Pu, Zq = 1 pu
Ra = O Pu
$\vec{E} = \vec{V} + jI_a X_q$
$\vec{E} = 1\angle 0 + jI_a$
P = $VI_a \cos\varphi$
$1 = 1 \times I_a \times 1$
$I_a = 1A$
$\therefore \vec{E}$
$\vec{E} = \sqrt{2}\angle 45$
Power angle = 45

Q60. Terminal voltage of a DC shunt motor is halved and the load torque is varied as the square of the speed and field flux is kept constant. Assuming armature resistance is zero, what will be the armature current?
A. Unchanged
B. Reduced to half
C. Reduced to one fourth
D. Increased twice
Ans C
Sol -
We know,
E α K φ w_m
$\Phi_1 = \varphi_2$

$$\frac{E_1}{E_2} = 2 \; (given)$$

$$\therefore \frac{E_1}{E_2} = \frac{\omega_1}{\omega_2} = 2 \qquad (1)$$

We know,
T α φ I_a α w^2

$$\frac{\omega_1^2}{\omega_2^2} = \frac{Ia_1^2}{Ia_2^2}$$

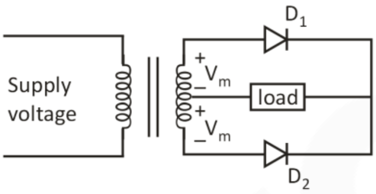
$$(4)^2 = \frac{Ia_1^2}{Ia_2^2}$$

$$Ia_2 = \frac{Ia_1}{(2)^2} = \frac{Ia_1}{4}$$

Q61. In a JK flip flop race around condition occurs when
A. Both J & K inputs are zero
B. Both J & K inputs are one
C. J = 1 and K = 0
D. J = 0 and K = 1
Ans B
Sol -
Race around condition occurs when both J and K inputs are one

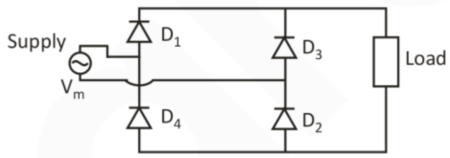
Q62. Which among the following logic family has least propagation delay?
A. TTL
B. CMOS
C. DTL
D. I^2L
Ans A
Sol -
TTL has least propagation delay which is about 1.5 – 33 ns

Q63. What is the ratio of peak inverse voltage across the diode in center tapped full wave rectifier and the bridge rectifier?
A. 2
B. 0.5
C. 0.25
D. 1
Ans A
Sol -



Centre tapped rectifier

PIV across diode = 2Vm



Full wave rectifier (Bridge rectifier)
PIV across diode = Vm
Ratio of PIV across diode in center tapped to bridge rectifier = 2

Q64. When three amplifiers each having higher cut off frequency f_h = 10 kHz are cascaded. What is the higher cut off frequency of cascaded system?
A. 10 kHz
B. 6.4 kHz
C. 5.1 kHz
D. 20 kHz
Ans C
Sol -

$$f_{HC} = f_H\sqrt{2^{1/n} - 1}$$

n = 3, fr = 10 KHz

$$f_{HC} = 10\sqrt{2^{1/3} - 1}$$

f_{HC} = 5.1 KHz

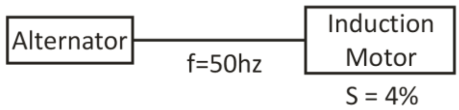
Q65. In 8085 microprocessor how many hardware interrupts are mask able?
A. 2
B. 3
C. 4
D. 5
Ans C
Sol -
Four hardware interrupts are markable i.e INTR, RS77.5, RST.65, RST 4.5

Q66. In 8085 microprocessors, which signal is used to insert wait?
A. READY
B. ALE
C. HOLD
D. INTR
Ans A
Sol -
READ4 signal is used to insert wait
When higher clock pulse at ready → next operation low clock pulse at ready → wait state

Q67. An 8 Pole alternator runs at 750 rpm. It supplies power to 6 pole induction motor, which has full load slip of 4%. Full load speed of the motor is
A. 705 rpm
B. 750 rpm
C. 960 rpm
D. 970 rpm
Ans C
Sol -
For alternator

$$N_s = 750rpm = \frac{120f}{P}$$

P = 8
∴ f = 50Hz



We know, Nr = Ns (1 – S)

$$Ns = \frac{120f}{P} \textit{ for insuction metor}$$

F = 50 Hz [cascaded to alternator]

$$Ns = \frac{120 \times 50}{6} = 1000rpm$$

Nr = 1000 (1 – 0.04) = 960 rpm

Q68. A 220 V DC machine has an armature resistance of 1 Ω. If the full load current is 20 A, what is the difference in induced voltage when the machine is running as generator and motor under full load condition

A. 0 V B. 20 V
C. 40 V D. 60 V

Ans C

Sol –

For the DC motor

V = E + IaRa

220 = E + 20 × 1

E_m = 200V

For generator

E = V + IaRa

E_g = 220 + 20 × 1 = 240V

$E_g - E_m$ = 240 – 200 = 40V

Q69. Use of bundled conductor in EHV lines will

A. Reduce corona loss
B. Increase the inductance of transmission line
C. Reduce the capacitance of transmission line
D. Increase corona loss

Ans A

Sol -

Bundled conductors in EHV lines are used to reduce corona loss

Q70. Surge impedance of 3 Phase, 400 kV transmission line is 200 Ω. The surge impedance loading of the transmission line is

A. 400 MW B. 1600 MW
C. 200 MW D. 800 MW

Ans D

Sol -

Surge impedance loading = $\frac{V^2}{z}$

V = 400 kv

Z = 200 Ω

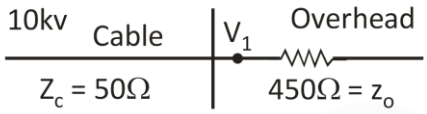
$$SIL = \frac{(400)^2}{200} = 8000mw$$

Q71. A surge voltage of 10 kV travels along a cable towards its junction with overhead lines. The surge impedance of the cable and the overhead line is 50 Ω and 450 Ω respectively. The surge voltage transmitted to the overhead line as

A. 2 kV B. 9 kV
C. 18 kV D. 20 kV

Ans C

Sol -



$$V_T = \frac{2z_o}{z_o + z_c}$$

$$= \frac{2 \times 450}{450 + 50} \times 10 = 18kv$$

Q72. Two single phase transformers T_o and T_b are connected in parallel to supply a load having impedance per phase of 0.8 + j0.6 pu at a load terminal voltage of $1\angle 0^o$ pu. Both transformers T_a and T_b has same impedance of j 0.1 pu. On same base. The second transformer T_b is stepped up to a voltage 1.05 times that of T_a. What is the current supplied by T_a and T_b to the load?

A. T_a=0.4 – j0.3 pu and T_b = 0.4 – j0.3 pu
B. T_a=0.4–j0.05 pu and T_b=0.4 – j0.55 pu
C. T_a = 0.4 – j0.55 pu and T_b = 0.4 – j0.05 pu
D. T_a = 0.4 – j0.55 pu and T_b = 0.4 – j0.35 pu

Ans B

Sol -

T_a = 0.4 – j0.05 pu and T_b = 0.4 – 0.55 pu

Q73. Regarding armature reaction reactance of salient pole synchronous generator Which of the following is correct?

A. Direct axis armature reaction reactance will be greater than quadrature axis armature reaction reactance
B. Quadrature axis armature reaction reactance will be greater than Direct axis armature reaction reactance
C. Quadrature axis armature reaction reactance will be equal to Direct axis armature reaction read once
D. None of the above

Ans A

Sol -
Direct axis armature reaction reactance will be greater than quadrature axis armature reaction reactance

Q74. Loading capability diagram is generally drawn for
A. Induction motor
B. DC Generator
C. Synchronous Generator
D. DC Motor
Ans C
Sol -
Load capability diagram is drawn for synchronous generator

Q75. What is minimum phase system?
A. A System with no zeros on right hail' side of S-plane
B. A System with no zeros on left half side of S-plane
C. A System with no poles on left half side of S-plane
D. A System with no poles on right hail side of S-plane
Ans A
Sol -
Minimum phase system is a system with no zeros on right half of s – plane.

Q76. An air core toroid with 500 turns having a cross section area of 6 cm^2 and a mean radius of 15 cm is carrying a current of 5 A. what is the magnetic flux density at the mean radius?

A. 2653 T	B. 1/300 T
C. 2123 T	D. 1/400 T

Ans B
Sol -
For toroid

$$B = \frac{\mu NI}{2zr}$$

As air core = μ = μ_o = 4π × 10^{-7}
N = 500, I = 5A, r = 15 cm = 15 × 10^{-2} m

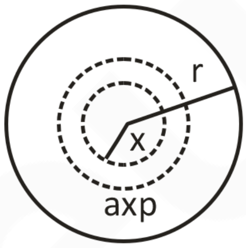
$$B = \frac{4\pi\times10^{-7}\times500\times5}{2\pi\times15\times10^{-2}}$$

$$B = \frac{1}{300}T$$

Q77. The internal inductance per meter (ie. Inductance due to internal magnetic flux linkages) of a long straight wire of circular cross section and uniform current distribution is

A. $\frac{\mu}{\pi}H/m$	B. $\frac{\mu}{4\pi}H/m$
C. $\frac{\mu}{8\pi}H/m$	D. $\frac{\mu}{4\pi}\frac{L}{R}H/m$

Ans C
Sol -
Consider a straight round conductor, the cross section is shown



Mmf = ○

○ $$Hx = \frac{Ix}{2\pi x}$$

Current density uniform over entire conductor

$$\frac{I}{\pi r^2} = \frac{I_x}{\pi r_2} \Rightarrow I_x = \frac{x^2}{r^2}I$$

$$Hr = \frac{I}{2\pi r^2}x$$

$$Bx = \mu_o Hx = \frac{\mu_o I}{2\pi r^2}x$$

$$\partial\phi_x = B_x\partial x\times1 = \frac{\mu_o I}{2\pi r^2}x\,dx$$

$$\partial\lambda_x = \frac{\pi r^2}{\pi r^2}d\phi_x = \frac{\mu_o}{2\pi r^4}Ix^3dx$$

$$\lambda_{int} = \int_o^r \frac{\mu_o I}{2\pi r^4}x^3dx = \frac{I}{2}\times10^{-7}\,\omega b\,t/m$$

$$L_{int} = \frac{1}{2}\times10^{-7}\ H/m = \frac{\mu_o}{8\pi}\ H/m$$

Q78. Any electromagnetic disturbance is bound to travel at a velocity of

A. Velocity of light in vacuum

B. $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

C. $\frac{1}{\mu_0 \varepsilon_0}$

D. $\frac{1}{\sqrt{\mu\ \varepsilon}}$

Ans D

Sol -

Electromagnetic disturbance is bound to travel at a velocity $= \frac{1}{\sqrt{\mu\varepsilon}}$

Q79. In skin effect the skin depth is proportional to (f is frequency)

A. f

B. $\frac{1}{\sqrt{f}}$

C. $\frac{1}{f}$

D. $\sqrt{f}$

Ans B

Sol -

$$skin\ depth = \sqrt{\frac{1}{\pi f \mu \sigma}}$$

$$\therefore \delta \propto \frac{1}{\sqrt{f}}$$

Q80. An electric field is mentioned as E = $(6y^2 z a_x + 12xyz\ a_y + 6xy^2\ a_z)$ V/m an incremental path is represented by ΔL $(3a_x + 5a_y - 2a_z)$μm. What is the work done in moving 2 μC charge along the path if the location of the path is P(0, 2, 5).

A. 360 pJ

B. 540 μJ

C. 720 pJ

D. 360 μj

Ans C

Sol -

$$\partial\omega = -Q\vec{E}\cdot\Delta\vec{L}$$

$$\vec{E} = (6y^2 z\, a_x + 12xyz\ ay + 6xy^2 az)$$

ΔL = (−3ax + 5ay − 2az) μm

$$\partial\omega = -Q[6y^{2]} z\hat{a}_x + 12xyz\ \hat{a}y + 6xy^2\hat{a}z]$$

$$\bullet [-3\hat{a}_x + 5\hat{a}_y - 2\hat{a}_z]$$

$= -\ 2 \times 10^{-6}\ [-\ 18y^2z + 60xyz - 12xy^2] \times 10^{-6}$

At P[0, 2, 5)

$\partial\omega = -\ 2 \times 10^{-12}\ [18 \times 4 \times 5]$

$\partial\omega = -720$ pJ

∴ work done = 720 pJ