GATE 2025

Memory based

QUESTION & SOLUTION

ELECTRICAL ENGINEERING

Exam held on:

2 FEBRUARY 2025

(AFTERNOON SHIFT)

QUESTION-1 — NAT

Find the value of I. If $C : |z| = 1$

$$I = \oint_c iz\,dz$$

SOLUTION: (1)

$$= \int i(e^{i\theta}) ie^{i\theta} d\theta$$

$$= i^2 \int_0^{2\pi} e^{2i\theta} d\theta$$

$$= -\left(\frac{e^{2i\theta}}{2i}\right)_0^{2\pi}$$

$C : |z| = 1 \Rightarrow z = 1 \cdot e^{i\theta}$

(unit circle)

$dz = ie^{i\theta} d\theta$

$0 \le \theta \le 2\pi$

$$-\frac{1}{2i}\left[e^{4\pi i} - e^{0}\right] = \frac{-1}{2i}[1-1] = 0$$

$e^{2\pi i} = 1 \Rightarrow e^{4\pi i} = 1$

QUESTION-2 — MCQ

$\left(\frac{3^{81}}{27^4}\right)^{\frac{1}{3}}$ will be equal to

(a) 3^{23}

(b) 3^{40}

(c) 3^{69}

(d) 3^{46}

SOLUTION: (a)

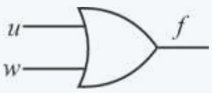
$$\left[\frac{3^{81}}{(3^3)^4}\right]^{\frac{1}{3}} = (3^{81} \div 3^{12})^{\frac{1}{3}}$$

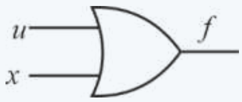
$$(3^{69})^{\frac{1}{3}}$$

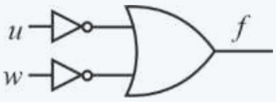
$$= 3^{23}$$

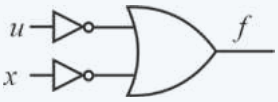
QUESTION-3 — MCQ

$f = (\overline{u}+\overline{v}+\overline{w}+\overline{x})(\overline{u}+\overline{v}+\overline{w}+x)(\overline{u}+v+\overline{w}+\overline{x})(\overline{u}+v+\overline{w}+x)$

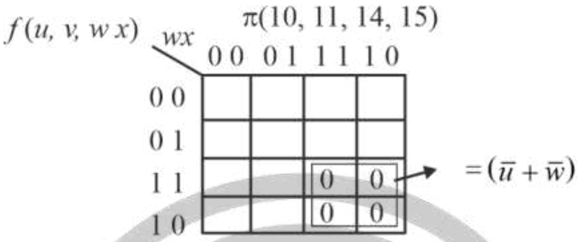
(a) 

(b) 

(c) 

(d) 

SOLUTION: (c)



QUESTION-4 — MCQ

If a signal $x(t) = -t^2\{u(t+4)-u(t-4)\}$ given. Then the value of I.

$$I = \int_{-\infty}^{\infty} x(t).\delta(t+3)dt$$

(a) –9
(b) 9
(c) 1
(d) –1

SOLUTION: (a)

$$I = \int_{-\infty}^{\infty} x(t).\delta(t+3)dt$$

$= -t^2; -4 \le t \le 4$

$= 0;\text{otherwise}$

$$I = \int_{-4}^{4} -t^2.\delta(t+3)dt = -(-3)^2 = -9$$

QUESTION-5 — NAT

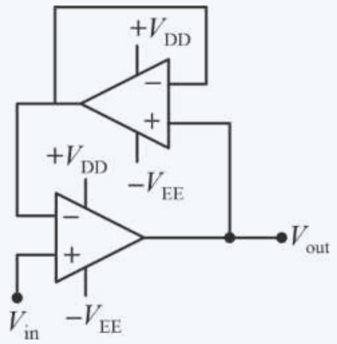
A continuous time periodic signal $x(t) = 1+2\cos(2\pi t)+2\cos 4(\pi t)+2\cos(6\pi t)$ is given, then the value of $\frac{1}{T}\int_T |x(t)|^2\, dt$ will be ________.

SOLUTION: (7)

$$\frac{1}{T}\int_T |x(t)|^2\, dt = (1)^2 + 2 + 2 + 2 = 7$$

QUESTION-6 — MCQ

Assuming ideal op-amp, the circuit represent is a



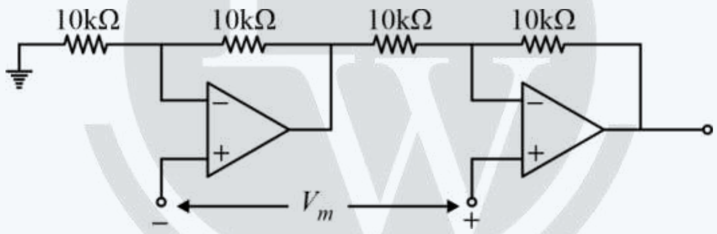
(a) Logarithmic amplifier
(b) Diff. amplifier
(c) Summing amplifier
(d) Buffer

SOLUTION: (D)

Buffer

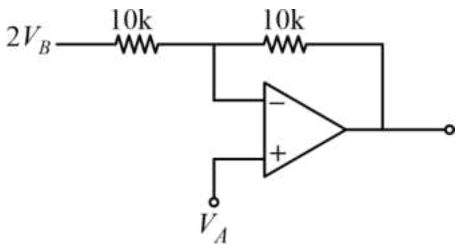
QUESTION-7 — NAT

The op-amp in the following circuit are ideal. The voltage gain of the circuit is _______.



SOLUTION: (2)

First op-amp is non inverting amplifier, so that output will be two times of the input.



$\left((I+1)V_A - 2V_B\right)$

$V_0 = 2V_A - 2V_B$

$= 2(V_A - V_B) = 2V_{in}$

QUESTION-8 — NAT

A low pass filter is given in frequency domain $H(\omega)=\begin{cases}1, & |\omega|\leq 200\pi \\ 0, & else\end{cases}$. If $h(t)$ is the time domain signal of the filter then the value of $h(0)$ will be

SOLUTION: (200)

$$h(t)=\frac{1}{2\pi}\int_{-\infty}^{\infty}H(\omega)e^{j\omega t}d\omega$$

$$h(0)=\frac{1}{2\pi}\int_{-\infty}^{\infty}H(\omega)d\omega$$

$$=\frac{1}{2\pi}\int_{-200\pi}^{200\pi}1d\omega$$

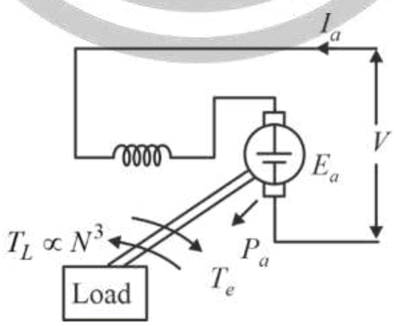
$$h(0)=\frac{400\pi}{2\pi}=200$$

QUESTION-9 — MCQ

400 volt D.C series motor with zero series resistance, If load torque ($T_L \propto N^3$). If initially motor draws 40A. Now, if motor speed is half of rated speed then the value of required series resistance [$I_{se} = I_a \propto \phi$]

(a) 4.82Ω
(b) 46.7Ω
(c) 23.22Ω
(d) 0Ω

SOLUTION: (c)



$T_e = T_L$ (under S.S condition)

$T_e = k' \phi I_a$

$$\boxed{T_e \propto I_a^2}$$

$T_L \propto N^3$

$I_a^2 \propto N^3$

$$I_{a_2} = \left|\sqrt{\left|\frac{1}{2}\right|^3}\right| \times 40 = 14.1421\text{A}$$

$E_a = k\phi N = V - I_a(R_a + R_{se})$

$$N = \frac{V - I_a(R_a + R_{se})}{k\phi}$$

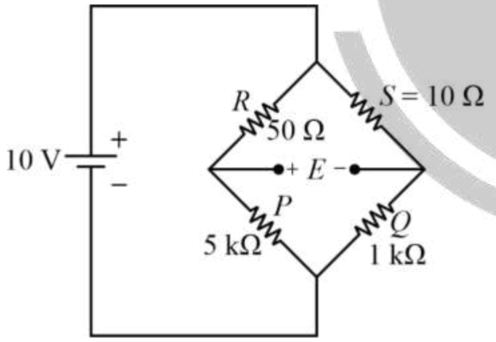
$$\frac{0.5N_1}{N_1} = \left|\frac{400 - 14.142 \times R_{ext}}{400 - 0}\right| \times \left|\frac{40}{14.142}\right|$$

$R_{ent} = 23.2\Omega$

QUESTION-10 — NAT

For the given wheat stone bridge, determine the sensitivity of the E if the value of R is changed in ________ mV/Ω.

SOLUTION: (1.96)



$V_{Bri} = V^+ - V^-$

$$= 10\left[\frac{1000}{1000+10} - \frac{5000}{5000+51}\right]$$

$V_{Bri} = 1.96$ mV for $\Delta R = 1\Omega$

$$S_{Bri} = 1.96\frac{mV}{\Omega}$$

QUESTION-11 — NAT

$y[n] = s\{x[n]\}$ s is disc LTI system

$s[\delta[n]] = \begin{cases} 1; & n \in \{0,1,2\} \\ 0; & \text{otherwise} \end{cases}$. For the input signal $x[n]$, the output $y[n]$ is

SOLUTION: (b)

$$h[n] = \delta[n] + \delta[n-1] + \delta[n-2]$$

$$y[n] = x[n] * h[n]$$

$$\boxed{y[n] = x[n] + x[n-1] + x[n-2]}$$

QUESTION-12 — MCQ

$V(t) = 300 \sin \omega t$

$I(t) = 10\sin\left(\omega t - \frac{\pi}{6}\right) + 2\sin\left(3\omega t + \frac{\pi}{6}\right) + \sin\left(5\omega t + \frac{\pi}{2}\right)$

Input Power factor

(a) 0.887
(b) 0.867
(c) 0.847
(d) 1.0

SOLUTION: (c)

$P(t) = V(t)\, I(t)$

$$\Rightarrow P_{av} = \frac{1}{2\pi}\int_0^{2\pi} P(t)d(\omega t) = \frac{300 \times 10 \times \cos\left(\frac{\pi}{6}\right)}{2} = 150 \times 10\left(\frac{\sqrt{3}}{2}\right) = 750\sqrt{3}\ \text{W}$$

$$V_{rms} = \frac{300}{\sqrt{2}}$$

$$I_{rms} = \sqrt{\left(\frac{100}{2} + \left(\frac{4}{2}\right) + \frac{1}{2}\right)} = \sqrt{\frac{105}{2}}$$

$$S = V_{rms} I_{rms} = \frac{300 \times \sqrt{105}}{2}$$

$$\cos\theta = \frac{P}{|S|} = \frac{750\sqrt{3}}{150\sqrt{105}} = \frac{5\sqrt{3}}{\sqrt{105}} = 0.847$$

QUESTION-13 — MCQ

Table 1st order LTI System

T	0.6	1.6	2.6	10	∞
Output	0.78	1.65	2.18	2.98	3

(a) 1
(b) 2
(c) 3
(d) 4

SOLUTION: (b)

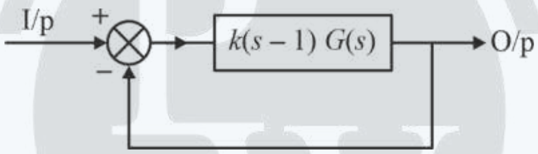
Output $= V_\infty(1-e^{-t/\tau}) = 3(1-e^{-t/\tau})$

$0.78 = 3(1-e^{-0.6/\tau})$

$\tau = 2$

QUESTION-14 — MCQ

$G(s) = \dfrac{1}{(s+1)(s+2)}$, then closed loop system is stable for



(a) Stable for $k > 2$
(b) Unstable for $k > 2$
(c) Stable for $k > 1$
(d) Unstable for $k < 1$

SOLUTION: (b)

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

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

$s^2 + 3s + 2 + ks - k = 0$

$s^2 + s[k+3] + (2-k) = 0$

$2 - k > 0$

$k < 2$

Hence the system is unstable for $k > 2$

QUESTION-15 — MCQ

$$A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix} B=\begin{bmatrix}0\\ 1\end{bmatrix} C=\begin{bmatrix}1 & 0\end{bmatrix}$$

$$\dot{x}(t)=Ax(t)+Br(t),\ y(t)=cx(t)$$

Sum of magnitude of poles ______.

(a) 2 (b) 3

(c) 4 (d) 5

SOLUTION: (b)

$$A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix} B=\begin{bmatrix}0\\ 1\end{bmatrix} C(1,0)$$

|Poles|

$|SI-A|=0$

$\lambda^2+3\lambda+2=0$

$\lambda=-1,-2$

$\lambda_1=-1$

$\lambda_2=-2$

$\lambda_1+\lambda_2=-3$

$|\lambda_1+\lambda_2|=3.$

QUESTION-16 — MCQ

A 3-phase, 400 V, 4 pole, 50 Hz star connected induction motor has the following parameters referred to the stator:

$R_r'=1\Omega, X_S=X_r'=2\Omega$

Stator resistance, magnetizing reactance and core loss of the motor are neglected. The motor is running with constant V/f control from a drive. For maximum starting torque, the voltage and frequency output respectively from the drive is closest to,

(a) 400 V and 50 Hz (b) 300 V and 37.5 Hz

(c) 200 V and 25 Hz (d) 100 V and 12.5 Hz

SOLUTION: (d)

$$s_{T(\max)} = \frac{R_r}{\left(X_s + X_r^{'}\right)}$$

$$s_{T(\max)} = \left(\frac{1}{4}\right) s_{T(\max)} \propto \frac{1}{f}$$

$$\frac{s_{T(\max)_2}}{s_{T(\max)_1}} = \frac{f_1}{f_2} = \frac{50}{f_2}$$

$$f_2 = 50 \times \frac{1}{4} = 12.5Hz$$

$$\frac{V}{f} = \text{Constant } V \propto f$$

$$V_2 = \left(\frac{f_2}{f_1}\right) \times V_1$$

$$= \frac{T2.5}{50} \times 400 = 100 \text{ V}$$

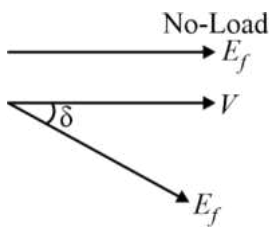
QUESTION-17 — NAT

The induced emf in a 3.3 kV, 4-pole, 3-phase star connected synchronous motor is considered to be equal and in phase with the terminal voltage under no load condition on application of a mechanical load, the induced emf phasor is deflected by angle 2° mechanical with respect to the terminal phasor voltage. If synchronous reactance is 2Ω and stator resistance is negligible, then the motor armature current magnitude in a ampere during load condition is ________.

SOLUTION: (66.49)

$$\delta = \frac{P}{2} \times S_{mech} = \frac{4}{2} \times 2 = 4°$$

$$I_a X_s = \sqrt{E_f^2 + V^2 - 2VE_f \cos\delta}$$



$$E_{fph} = V_{ph} = \frac{3.3\times10^3}{\sqrt{3}}$$

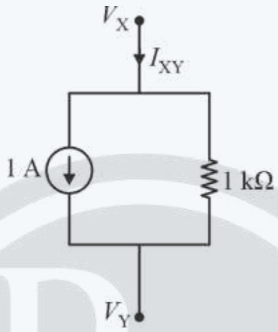
$$I_a X_s = V \times \sqrt{2 - 2\cos\delta}$$

$$I_a = \frac{3.3\times10^3}{\sqrt{3}\times2} \times \sqrt{2 - 2\cos 4°}$$

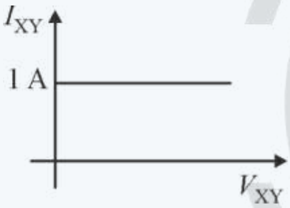
$I_a = 66.49\text{A}$

QUESTION-18 — MCQ

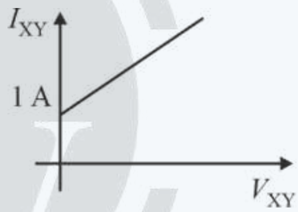
The I-V characteristics of the elements between the nodes X and Y is best depicted



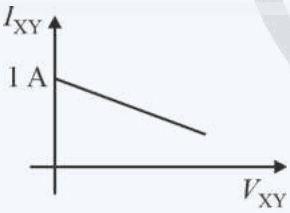
(a)



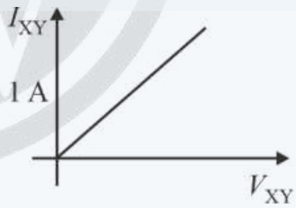
(b)



(c)



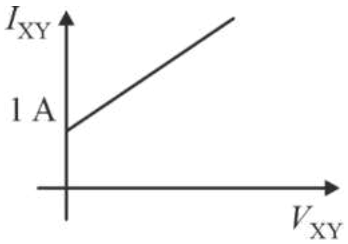
(d)



SOLUTION: (b)

$$V_{XY} = (I_{XY} - 1)1\ \text{k}\Omega$$

$$I_{XY} = 1 + \frac{V_{XY}}{1\ \text{k}\Omega}$$



QUESTION-19 — NAT

$V = x^2 + x + y^2 + 1$

Determine the value of rate of change of V at origin in the direction of (1, 2).

(Round off to nearest integer)

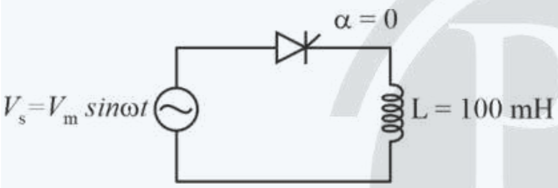
SOLUTION: (0)

$\dot{A} = \hat{a}_x + 2\hat{a}_y$, $\quad\quad \hat{A} = \dfrac{\hat{a}_x + 2\hat{a}_y}{\sqrt{5}}$

$\dot{\nabla} V = (2x+1)\hat{a}_x + 2y\hat{a}_y$

$D \cdot D = \vec{\nabla} V \cdot \hat{A} = \dfrac{(2x+1)+4y}{\sqrt{5}}\Bigg|_{\substack{x=0\\y=0}} = \dfrac{1}{\sqrt{5}} = 0.45 \sim 0$

QUESTION-20 —NAT



The value of peak inductor current will be___

SOLUTION: (c)

$V_m \sin \omega t = L\dfrac{di}{dt}$

$di = \dfrac{V_m}{\omega L} \sin \omega t \quad\quad d\omega t$

$\int di \int \dfrac{V_m}{\omega L} \sin \omega t \;\; d(\omega t)$

$i = \dfrac{V_m}{\omega L}[-\cos \omega t] + k$ $\quad\quad$ Where $\omega t = 0$

$i = 0$

$0 = \dfrac{V_m}{\omega L}[-1] + k$

$k = \dfrac{V_m}{\omega L}$

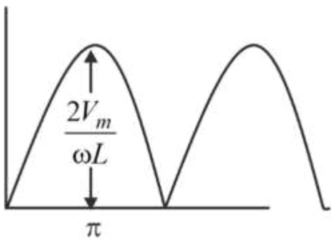
$i = \frac{V_m}{\omega L}[1 - \cos \omega t]$

Max^m current will occur when ωt = π

$(i)_{mx} = \frac{2V_m}{\omega L}$

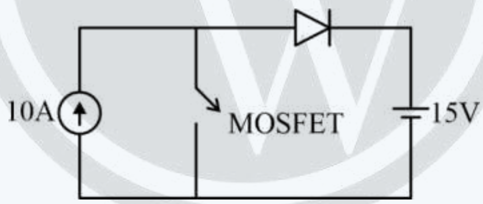
$= \frac{2 \times 230 \times \sqrt{2}}{2\pi \times 50 \times 10010}$

= 20.707 Amp.



QUESTION-21 — NAT

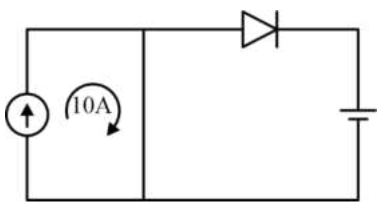
In the circuit with ideal devices power MOSFET is turn ON for $D = 0.4$. If input current is constant then the power delivered by the current source.



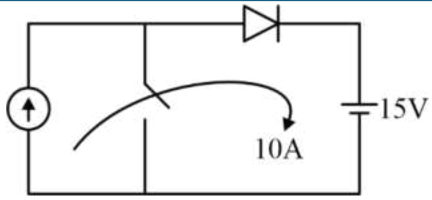
SOLUTION: (90)

Mode-1

SW → ON



Power loss = 0



Energy loss $10 \times 15 \times T_{OFF}$

$= 150(1-\alpha)T$

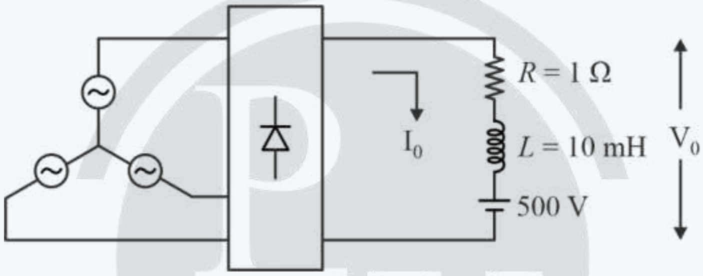
Average power loss $= \dfrac{0+150(1-\alpha)T}{T}$

$= 150(1-0.4)$

$= 150 \times 0.6$

$= 90$ W

QUESTION-22 — MCQ



$$V_1 = 400\left(1+\frac{\cos\alpha}{3}\right)$$

Power loss in resistor = 64W. The value of firing angle is

(a) 0°

(b) 35.9°

(c) 40.5°

(d)

SOLUTION: (b)

Power loss $= I_0^2 R$

$$64 = I_0^2(1)$$

$$I_0 = \sqrt{64} = 8 \text{ Amp}$$

$$I_0 = \frac{V_0 - E}{R}$$

$$8 = \frac{400\left(1+\frac{\cos\alpha}{3}\right)-500}{1}$$

$$8 = 400\left(1+\frac{\cos\alpha}{3}\right)-500$$

$$508 = 400\left(1+\frac{\cos\alpha}{3}\right)$$

$$1.27 = 1+\frac{\cos\alpha}{3}$$

$$\frac{\cos\alpha}{3} = 0.27$$

$$\cos\alpha = 0.81$$

$$\alpha = 35.9^\circ$$

QUESTION-23 — MCQ

V_1 and V_2 are Eigen vectors of real symmetric matrix of 3×3 corresponding to distinct Eigen values then

(a) $V_1^T V_2 = 0$

(b) $V_1 - V_2 = 0$

(c) $V_1^T V_2 \neq 0$

(d) $V_1 + V_2 = 0$

SOLUTION: (a)

We know that Eigen vectors of real symmetric matrix for different Eigen values are orthogonal i.e $V_1 - V_2 = 0$ and we know that dot product is $V_1 \cdot V_2 = V_1^T V_2$, so $V_1^T V_2 = 0$.

QUESTION-24 — MCQ

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 1 & 1 \end{bmatrix},\ B = \begin{bmatrix} 1/3 \\ -1/3 \\ 0 \end{bmatrix}$$, then $AX = B$ has

(a) No solution

(b) Infinite solutions

(c) Unique solution

(d) Two solutions

SOLUTION: (b)

$$[A:B] = \begin{bmatrix} 1 & 1 & 1 & : & 1/3 \\ -1 & -1 & -1 & : & -1/3 \\ 0 & 1 & 1 & : & 0 \end{bmatrix} \xrightarrow{R_2 \leftrightarrow R_3} \begin{bmatrix} 1 & 1 & 1 & : & 1/3 \\ 0 & 1 & 1 & : & 0 \\ -1 & -1 & -1 & : & -1/3 \end{bmatrix}$$

$$\xrightarrow{R_3 \to R_3 + R_1} \begin{bmatrix} 1 & 1 & 1 & : & 1/3 \\ 0 & 1 & 1 & : & 0 \\ 0 & 0 & 0 & : & 0 \end{bmatrix}$$

$\because$ $\rho(A) = 2$ and $\rho(A : B) = 2$

i.e., $\rho(A) = \rho(A : B) <$ Number of variables. It means infinite solutions exist.

QUESTION-25 — MCQ

If $S : (x, y) \in R^2$ and $Z = x^2 + x + y^2 + 1$ then set of points S for which Z will be minimum is

(a) S is finite
(b) S contains only one point
(c) S is empty
(d) S is finite but it has more than one point

SOLUTION: (b)

$Z_x = 2x + 1, Z_{xx} = 2, Z_y = 2y, Z_{yy} = 2, Z_{xy} = 0.$

For critical points: $Z_x = 0$ and $Z_y = 0 \rightarrow \left(-\frac{1}{2}, 0\right)$ will be critical point.

Now, $rt - s^2 = (2)(2) - (0)^2 = 4 - 0 = 4 > 0$ and $r = 2 > 0$.

So, point will be point of minima.

Hence, set S contains only one point.

QUESTION-26 — NAT

Evaluate: $\oint_c iZdz$, where $C : |Z| = 1$

SOLUTION: (0)

$$C : |Z| = 1 \Rightarrow Z = 1 \cdot e^{i\theta},\ dZ = ie^{i\theta}d\theta,\ 0 \le \theta \le 2\pi$$

$$I = \oint_c iZdZ = i\int_0^{2\pi} e^{i\theta}\cdot(ie^{i\theta})d\theta = i^2\int_0^{2\pi}(e^{2i\theta})d\theta$$

$$= -\left(\frac{e^{2i\theta}}{2i}\right)_0^{2\pi} = -\frac{1}{2i}\left[e^{4\pi i} - e^0\right] = -\frac{1}{2i}[1-1] = 0$$

QUESTION-27 — MCQ

If $P = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then P^2 will be

(a) P
(b) $P + I$
(c) I
(d) $2P - I$

SOLUTION: (d)

$$P^2 = P\cdot P = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 2 & 0 \\ -2 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \ldots(1)$$

Taking option (d)

$$2P - I = 2\begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 2 & 0 \\ -2 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \ldots(2)$$

By (1) and (2)

$P^2 = 2P - I$

i.e. (d) is correct.

QUESTION-28 — NAT

Rate of change of $V = x^2 + x + y^2 + 1$ at origin in the direction of point (1, 2) is ________ ?

SOLUTION: (0.447)

Grad $V = \dot{\nabla} v = i\frac{\partial v}{\partial x} + \hat{j}\frac{\partial v}{\partial y} + \hat{k}\frac{\partial v}{\partial z}$

$= (2x+1)\hat{i} + 2y\hat{j} + 0\hat{k}$

(Grad $V)_{P(0,\,0)} = \hat{i} + 0\hat{j} + 0\hat{k}$

Now, $P(0, 0)$ and $Q(1, 2)$

So, $\bar{a} = \overrightarrow{PQ} = \hat{i} + 2\hat{j}$ and $|\bar{a}| = \sqrt{5}$

Required rate of change = $(\hat{i}) \cdot \hat{a} = \hat{i} \cdot \left(\frac{\hat{i} + 2\hat{j}}{\sqrt{5}}\right) = \frac{1}{\sqrt{5}} = 0.447$

QUESTION-29 — NAT

In the distribution feeder, the value of $\frac{R}{X} = 5$. Then the value of power factor if maximum voltage drop in the feeder. (Upto three decimal places)

SOLUTION: (0.981)

Maximum voltage drop in the feeder leads to maximum voltage regulation.

The power factor angle in the case of maximum voltage regulation is $\theta = \tan^{-1}\left(\frac{X}{R}\right)$

So, power factor = cos θ = $\cos\left(\tan^{-1}\left(\frac{X}{R}\right)\right) = \cos\left(\tan^{-1}\left(\frac{1}{5}\right)\right) = 0.981$

QUESTION-30 — NAT

The Z-bus matrix is given, if a symmetrical fault (LLLG) occurred at bus-2. Then the voltage as bus-1 after fault. Assume pre-fault no-load.

$$\begin{bmatrix} j0.059 & j0.061 & j0.038 \\ j0.061 & j0.093 & j0.066 \\ j0.038 & j0.066 & j0.116 \end{bmatrix} Z_f = j0.007\ p.u.$$

SOLUTION: (0.39)

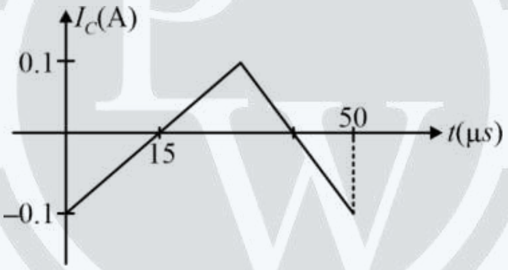
$$Z_{f(2)} = \frac{E}{Z_{En} + Z_f} = \frac{E}{Z_{22} + Z_f} = \frac{1}{j0.093 + j0.007} = \frac{1}{j0.10} = -j10\ p.u.$$

$$V_1 = E - Z_{12} I_{f(20)}$$

$$= 1 - (j0.061)(-j10) \ = 1 + (-0.93) \ = 0.39 \text{ p.u.}$$

QUESTION-31 — NAT

Supply voltage is 30 V. The capacitor current wave form of a buck converter is given below. Then the value of inductor if convert is operating in CCM.



SOLUTION: (1.8)

$$V_s = 30\text{V}$$

$$\Delta I_C = \Delta I_L = 0.1A$$

$$D = \frac{15+15}{50} = 0.6$$

$$\Delta I_L = \frac{D(1-D)V_S}{FL}$$

$$f = \frac{1}{50 \times 10^{-6}} = 20kHz$$

$$0.2 = \frac{0.6 \times 0.4 \times 30}{20 \times 10^3 \times L}$$

$$L = 1.8 \text{ mH}$$

QUESTION-32 —NAT

$\dot{x}_1(t) = 2x_2(t)$

$\dot{x}_2(t) = u(t)$

$x_1(0) = 1, x_2(0) = 0$

$x_1(t)/_{t=1} = ?$

SOLUTION: (2)

$$A = \begin{bmatrix} 0 & 2 \\ 0 & 0 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$X(s) = (SI - A)^{-1} X(0) + (SI - A)^{1} B \cdot U(s)$$

$$(SI - A)^{-1} = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 2 \\ 0 & 0 \end{bmatrix}$$

$$(SI - A) = \begin{bmatrix} s & -2 \\ 0 & s \end{bmatrix}$$

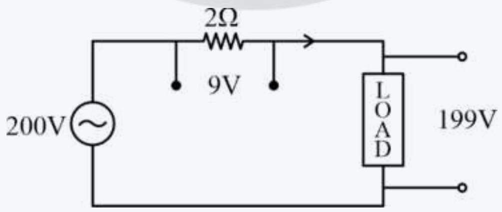
$$(SI - A)^{-1} = \frac{1}{s^2}\begin{bmatrix} s & 2 \\ 0 & s \end{bmatrix}$$

$$X(s) = \frac{1}{s^2}\begin{bmatrix} s & 2 \\ 0 & s \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} + \frac{1}{s^2}\begin{bmatrix} s & 2 \\ 0 & s \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} \cdot \frac{1}{s}$$

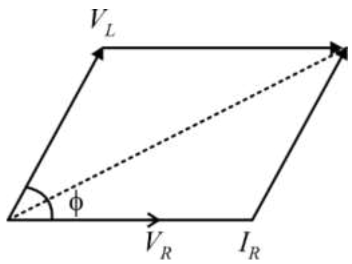
$$X(s)\big|_{t=1} = 2$$

QUESTION-33 — NAT

For the circuit shown below, if load is inductive then the value of power absorbed by the load.



SOLUTION: (79.5)



$P_L = ?$

$I = \frac{9}{2} = 4.5A$

$V_s^2 = V_R^2 + V_L^2 + 2V_R.V_L.\cos\phi$

$200^2 = 9^2 + 199^2 + 2\times 9\times 199\times \cos\phi$

$\cos\phi = 0.08878$

$P = V_L I_L \cos\phi = 79.5W$

QUESTION-34 — MSQ

To synchronize an alternator to the grid, which instruments is/are required?

(a) Voltmeter
(b) Wattmeter
(c) Stroboscope
(d) Synchroscope

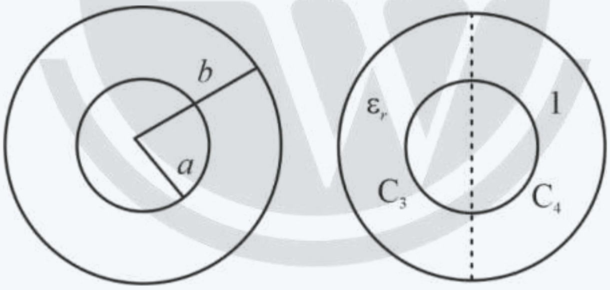
SOLUTION: (a, d)

Among the given options, voltmeter and Synchroscope are required.

QUESTION-35 — NAT

Find the relative permitivity for the given cylindrical capacitor.

Given $C_2 = 5C_1$?



SOLUTION: (9)

$C_1 = \frac{2\pi\varepsilon L}{\ln(b/a)}$ $C_3 = \frac{\pi\varepsilon L}{\ln(b/a)}, C_4 = \frac{\pi\varepsilon_0 L}{\ln(b/a)}$

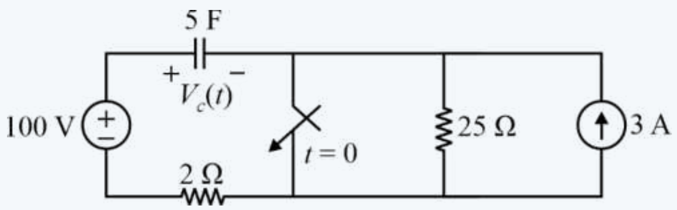
$C_2 = C_3 + C_4$

$\Rightarrow \frac{\pi\varepsilon_0(\varepsilon_r+1)L}{\ln(b/a)} = \frac{5(2\pi\varepsilon_0 L)}{\ln(b/a)}$

$\varepsilon_r + 1 = 10 \Rightarrow \varepsilon_r = 9$

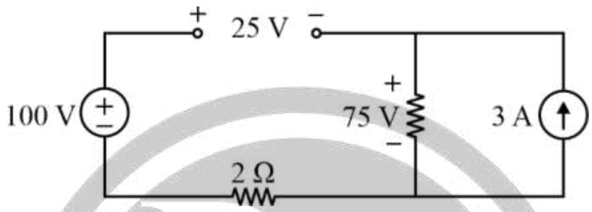
QUESTION-36 — NAT

For given below circuit the switch is will be closed at $t = 0$ find the time (t) at which $V_c(t) = 50$ V.

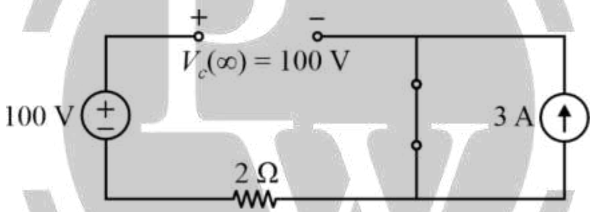


SOLUTION: (?)

At $t < 0$ the circuit is :



At $t = \infty$:



R_{eq} and C_{eq} can be calculated as :

$R_{eq} = 2\ \Omega$

$C_{eq} = 5$

$$V_c(t) = 100 + [-75]e^{-t/10}$$

$$50 = 100 - 75e^{-t/10}$$

$$75e^{-t/10} = 50$$

$$\frac{-t}{10} = \ln\left(\frac{50}{75}\right)$$

$t = 4.05$ sec.

QUESTION-37 — MCQ

Find the correct statement for amplifier

(a) *CS* and *CG* both *NI* amp

(b) *CS I CG NI*

(c) *CS NI CG I*

(d) *CS* and *CG* both *I*.

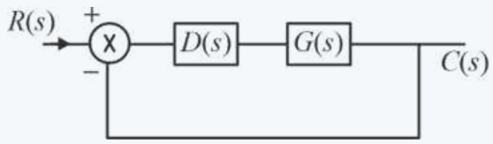
SOLUTION: (b)

Common Source → Inverting amplifier

Common Gate → Non Inverting amplifier

QUESTION-38 — NAT

If the phase margin of the given system is 45° at gain cross over frequency = 10, then the value of K_D.



SOLUTION: (0.1)

$D(s) = 1 + k_D s$

$PM = 45°$

$\omega_{gc} = 10$ rad/sec

$PM = 180° + \phi\,(w_{gc})$

$45° = 180° + \phi\,(w_{gc})$

$\phi\,(\omega_{gc}) = -135°$

$$G(s) = (1 + k_D s)\frac{1000\sqrt{2}}{s(s+10)^2}$$

$$\phi(\omega) = \tan^{-1} k_D\omega - 90° - 2\tan^{-1}\frac{\omega}{10}$$

$$\phi(\omega_{gc}) = \tan^{-1} 10k_D - 90° - 2\tan^{-1}\frac{10}{10}$$

$$\phi(\omega_{gc}) = \tan^{-1} k_D \times 10 - 90 - 90$$

$$\phi(\omega_{gc}) = \tan^{-1} k_D \times 10 - 180°$$

$$-135° = \tan^{-1} k_D \times 10 - 180°$$

$$\tan^{-1} k_D \times 10 = 45°$$

$$\boxed{k_D = 0.1}$$

QUESTION-39 — MCQ

Good : Evil : : Genuine : _______.

(a) Counter fold (b) Counter part

(c) Counterfeit

SOLUTION: (c)

As Good is antonym of Evil

Thus, Genuine is antonym of Counterfeit.

QUESTION-40 — MCQ

Ramya _______ go to office yesterday because she ________ well.

(a) Couldn't, Wasn't (b)

(c) (d)

SOLUTION: (a)

Couldn't, Wasn't

QUESTION-41 — MCQ

In the given figure, EF and HJ is coded as 30 and 80 respectively, then find (i) and (ii).

(a)

(b)

(c)

(d) EG/GE

SOLUTION: (d)

Here the product of alphabet position is the code, like $E \times F = 5 \times 6 = 30$ and $H \times J = 8 \times 10 = 80$

Thus, $F \times G = 6 \times 7 = 42 \rightarrow$ (ii)

and $35 = 5 \times 7 = E \times G$ or $G \times E \rightarrow$ (i)

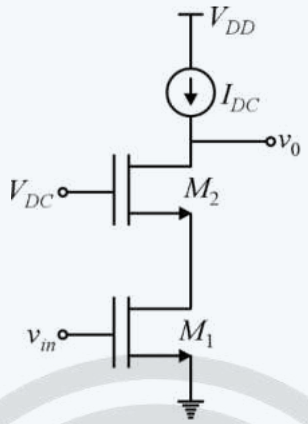
(i) and (ii) is EG/GE and HZ

QUESTION-42 — MCQ

For both M_1 and M_2 shown in the below circuit :

$r_{o_1} = r_{o_2} = R_{ds}$, $g_{m_1} = g_{m_2} = g_m$

The output impedance of the circuit is _____.



(a) $\left(2R_{ds} + g_m R_{ds}^2\right)$

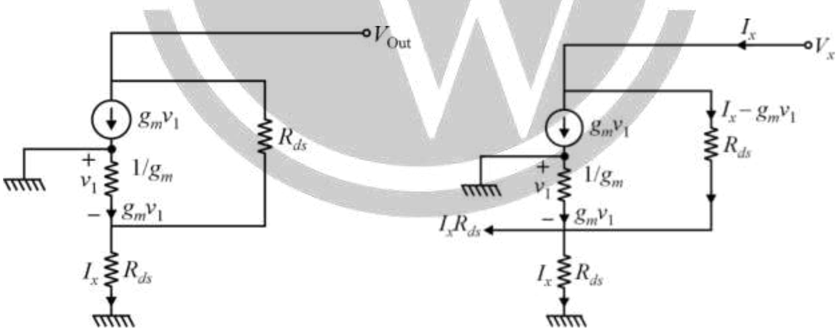
(b) $\left(2R^2 + g_m R_{ds}^2\right)$

(c) $\left(4R + g_m R_{ds}^2\right)$

(d) $\left(2R_{ds} + 2g_m R_{ds}\right)$

SOLUTION: (a)

The AC model of the circuit given in the question is shown below:



(1) $v_1 = 0 - I_x R_{ds}$

$v_1 = -I_x R_{ds}$

(2) $V_x = (I_x - g_m v_1)R_{ds} + I_x R_{ds}$

$V_x = (I_x + I_x R_{ds} g_m)R_{ds} + I_x R_{ds}$

$V_x/I_x = ((1 + g_m R_{ds})R_{ds} + R_{ds})$

On calculating above equation we'll get:

$$\frac{V_x}{I_x} = \left(2R_{ds} + g_m R_{ds}^2\right).$$

❐❐❐

THANK YOU