Q. No. 1 – 5 Carry One Mark Each

1. Choose the most appropriate phrase from the options given below to complete the following sentence.

India is a post-colonial country because

(A) it was a former British colony

(B) Indian Information Technology professionals have colonized the world

(C) India does not follow any colonial practices

(D) India has helped other countries gain freedom

Answer: (A)

2. Who ___________ was coming to see us this evening?

(A) you said (B) did you say (C) did you say that (D) had you said

Answer: (B)

3. Match the columns.

Column 1	Column 2
(1) eradicate	(P) misrepresent
(2) distort	(Q) soak completely
(3) saturate	(R) use
(4) utilize	(S) destroy utterly

(A) 1:S, 2:P, 3:Q, 4:R (B) 1:P, 2:Q, 3:R, 4:S

(C) 1:Q, 2:R, 3:S, 4:P (D) 1:S, 2:P, 3:R, 4:Q

Answer: (A)

4. What is the average of all multiples of 10 from 2 to 198?

(A) 90 (B) 100 (C) 110 (D) 120

Answer: (B)

Exp:

$$\left.\begin{array}{l} 10+190 \rightarrow \\ 20-180 \rightarrow \\ : \\ : \\ 90-110 \\ 100 \end{array}\right\} \begin{array}{l} 200 \\ 9 \end{array} \Rightarrow \frac{[(200)\times 9+100]}{19}=\frac{1900}{19}=100$$

5. The value of $\sqrt{12+\sqrt{12+\sqrt{12+....}}}$ is

(A) 3.464 (B) 3.932 (C) 4.000 (D) 4.444

Answer: (C)

Exp: let $= \sqrt{12+\sqrt{12+\sqrt{12+....}}} = y$

$\Rightarrow \sqrt{12+y} = y$

$\Rightarrow 12 + y = y^2$

$\Rightarrow (y-4)(y+3) = 0$

$\Rightarrow y = 4,\ y = -3$

Q.No. 6 – 10 Carry Two Marks Each

6. The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?

(A) Kaliningrad was historically Russian in its ethnic make up

(B) Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia

(C) Koenigsberg was renamed Kaliningrad, as that was its original Russian name

(D) Poland and Lithuania are on the route from Kaliningrad to the rest of Russia

Answer: (B)

7. The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.

Which one of the following statements, if true, does not contradict this conclusion?

(A) A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent

(B) More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency

(C) Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test

(D) The number of people with malarial fever (also contracted from mosquito bites) has increased this year

Answer: (D)

8. If x is real and $\left|x^2 - 2x + 3\right| = 11$, then possible values of $\left|-x^3 + x^2 - x\right|$ include

(A) 2, 4 (B) 2, 14 (C) 4, 52 (D) 14, 52

Answer: (D)

Exp: $x^2 - 2x + 3 = 11$

$\Rightarrow (x-4)(x+2) = 0 \Rightarrow x = 4, x = -2$

Values of $\left|-x^3 + x^2 - x\right|$

For $x = 4$

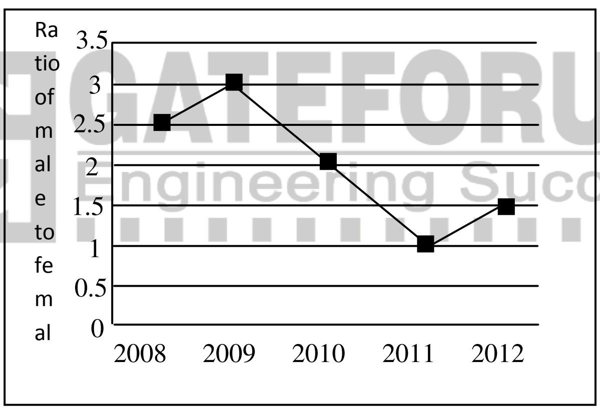
Value $= 52$

for $x = -2$

Value $= 14$

$\therefore \boxed{\text{Option D} = 14, 52}$

9. The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students doubled in 2009, by what percent did the number of male students increase in 2009?



Answer: 140%

Exp: $\dfrac{m}{f} = 3$ $\qquad$ $\dfrac{m}{f} = 2.5 \ \ m=2.5f$

$\dfrac{m'}{2f} = 3$

$m' = 6f$

$= \dfrac{m' - m}{m}$

$\% \uparrow = \dfrac{3.5f}{2.5f} \times 100$

$= \dfrac{7}{8} = 1.4$

$\boxed{\% \uparrow = 140\%}$

10. At what time between 6 a.m. and 7 a.m will the minute hand and hour hand of a clock make an angle closest to 60°?

(A) 6: 22 a. m. (B) 6:27 a.m. (C) 6: 38 a.m. (D) 6:45 a.m.

Answer: (A)

Exp: Angle by minute's hand

$60 \text{ min} \rightarrow 360^{o}$

$1 \text{min} \rightarrow \frac{360}{60} = 6^{o}$

$8 \text{min} \rightarrow 48^{o}$

$\text{Angle} \rightarrow 48^{o}$ with number '6'

Angle by hours hand

$60 \text{ min} = 30^{o}$

$22 \text{ min} \rightarrow \frac{30}{60} \times 22$

$= 11$

Total Angle=48+11=59°.

$\boxed{6.22\text{am}}$

Q.No. 1 – 25 Carry One Mark Each

1. Which one of the following statements is true for all real symmetric matrices?

(A) All the eigenvalues are real.
(B) All the eigenvalues are positive
(C) All the eigenvalues are distinct
(D) Sum of all the eigenvalues is zero.

Answer: (A)

Exp: Eigen values of a real symmetric matrix are all real

2. Consider a dice with the property that the probability of a face with *n* dots showing up is proportional to *n*. The probability of the face with three dots showing up is__________.

Answer: 1/7

Exp: $P(n) = k.n \text{ where } n = 1 \text{ to } 6$

$$\text{we know } \sum_x P(x) = 1 \Rightarrow K[1+2+3+4+5+6] = 1$$

$$\Rightarrow K = \frac{1}{21}$$

$$\therefore \text{required probability is } P(3) = 3K = \frac{1}{7}$$

3. Maximum of the real valued function $f(x) = (x-1)^{2/3}$ occurs at *x* equal to

(A) $-\infty$ (B) 0 (C) 1 (D) ∞

Answer: (C)

Exp: $$f^1(x) = \frac{2}{3(x-1)^{1/3}} \begin{array}{l}\text{is negative, } \forall x < 1 \text{ or } \forall x \text{ in } (1-h, 1) \\ \text{is positive, } \forall x > 1 \text{ or } \forall x \text{ in } (1, 1+h)\end{array}$$

h is positive & small

$\therefore$ f has local minima at $x = 1$ and the minimum value is '0'

4. All the values of the multi-valued complex function 1^i, where $i = \sqrt{-1}$, are

(A) purely imaginary
(B) real and non-negative
(C) on the unit circle.
(D) equal in real and imaginary parts

Answer: (B)

Exp: $1 = \cos(2k\pi) + i\sin(2k\pi)$ where k is integer

$$= e^{i(2k\pi)}$$

$$\therefore 1^i = e^{-(2k\pi)}$$

$\therefore$ All values are real and non negative

5. Consider the differential equation $x^2 \frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$. Which of the following is a solution to this differential equation for $x > 0$?

(A) e^x (B) x^2 (C) $1/x$ (D) $\ln x$

Answer: (C)

Exp:

$$x^2 \frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0 \text{ is cauchy} - \text{Euler equation}$$

$$\Rightarrow (\theta^2 - 1).y = 0 \text{ where } \theta = \frac{d}{dz} \text{ and } z = \log x,\ x = e^z$$

$$A.E: m^2 - 1 = 0 \Rightarrow m = -1, 1$$

$$\therefore \text{Solution is } y = C_1e^{-Z} + C_2e^{Z} = \frac{C_1}{x} + C_2x$$

$$\therefore \frac{1}{x} \text{is a solution}$$

6. Two identical coupled inductors are connected in series. The measured inductances for the two possible series connections are $380\mu H$ and $240\mu H$. Their mutual inductance in μH is ________

Answer: $35\mu H$

Exp: Two possible series connections are

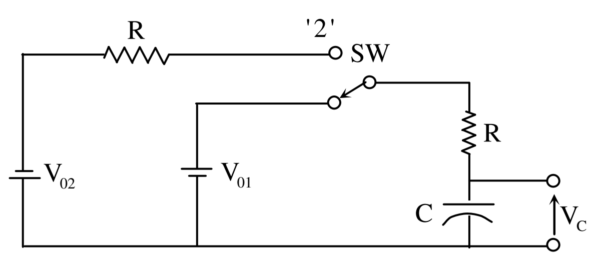
1. Aiding then L equation = $L_1 + L_2 + 2M$.
2. Opposing then L equation = $L_1 + L_2 - 2M$

$L_1 + L_2 + 2M = 380$ □H ...(1)

$L_2 + L_2 - 2M = 240$ □H ...(2)

From 1 & 2, $M = 35\mu H$

7. The switch SW shown in the circuit is kept at position '1' for a long duration. At t = 0+, the switch is moved to position '2' Assuming $|V_{02}| > |V_{01}|$, the voltage $V_C(t)$ across capacitor is



(A) $v_c(t) = -V_{02}(1 - e^{-t/RC}) - V_{01}$ (B) $v_c(t) = V_{02}(1 - e^{-t/RC}) + V_{01}$

(C) $v_c(t) = (-V_{02} + V_{01})(1 - e^{-t/RC}) - V_{01}$ (D) $v_c(t) = (V_{02} + V_{01})(1 - e^{-t/RC}) + V_{01}$

Answer: (D)

Exp: When switching is in position 1

$$V_C(t) = (\text{Initial} - \text{final})_e^{-t/z} + \text{final value}$$

$$V_C(t) = V_{01}\left[1 - e^{-t/RC}\right]$$

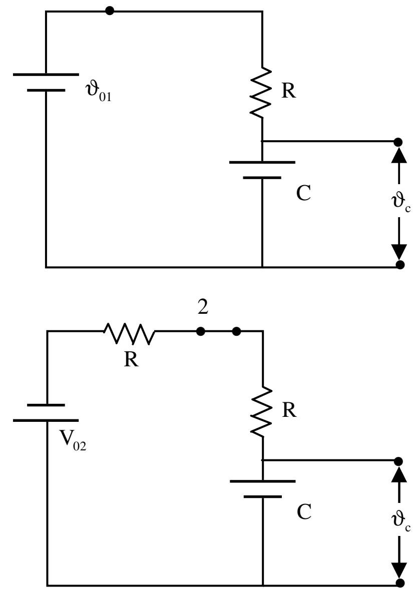
When switch is in position 2

Initial value is

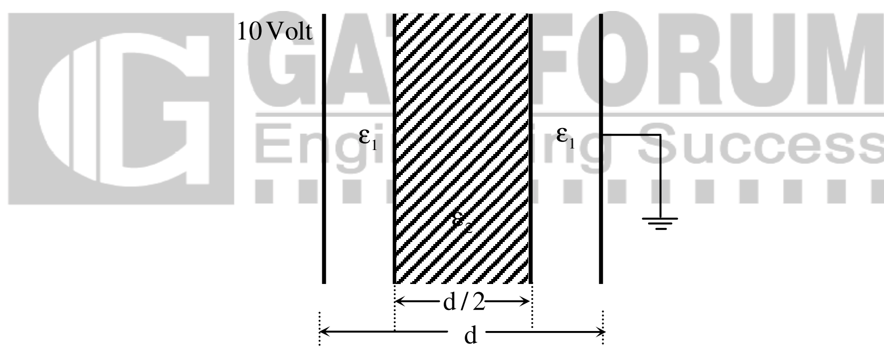
$$V_C(t) = V_{01}\left[1 - e^{-t/RC}\right]$$

Final value is $-V_{02}$

$$V_C(t) = V_{01}\left[V_{02} - V_{01}\right]\left[1 - e^{-t/2RC}\right]$$



8. A parallel plate capacitor consisting two dielectric materials is shown in the figure. The middle dielectric slab is place symmetrically with respect to the plates.



If the potential difference between one of the plates and the nearest surface of dielectric interface is 2Volts, then the ratio $\varepsilon_1 : \varepsilon_2$ is

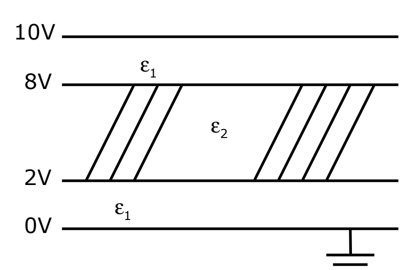
(A) 1 : 4 (B) 2 : 3 (C) 3: 2 (D) 4 : 1

Answer: (C)

Exp:

$$\underset{\text{constant}}{\underset{\downarrow}{Q}} = CV \left| \frac{C_1}{C_2} = \frac{V_2}{V_1} \right.$$

$$C = \frac{A\varepsilon}{d} \left| \frac{\varepsilon_1}{\varepsilon_2} = \frac{V_2}{V_1} \right.$$



$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{V_2}{V_1} \Rightarrow V_2 = \frac{\varepsilon_1}{\varepsilon_1 + \varepsilon_2}(V) \Rightarrow 6 = \frac{\varepsilon_1}{\varepsilon_1 + \varepsilon_2}(10)$$

$$\Rightarrow 3\varepsilon_1 + 3\varepsilon_2 = 5\varepsilon_1 \Rightarrow \frac{\varepsilon_1}{\varepsilon_1} = \frac{3}{2}$$

$$\varepsilon_1 : \varepsilon_2 = 3 : 2$$

9. Consider an LTI system with transfer function

$$H`(s) = \frac{1}{s(s+4)}$$

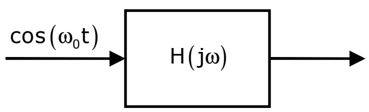
If the input to the system is cos(3t) and the steady state output is $A\sin(3t+\alpha)$, then the value of A is

(A) 1/30 (B) 1/15 (C) 3/4 (D) 4/3

Answer: (B)

Exp: Given $H(s) = \frac{1}{s(s+4)}$

$$|H(j\omega)| = \frac{1}{\omega\sqrt{\omega^2+16}}$$



$$y(t) = |H(j\omega)|_{\omega=\omega_0}\cos(\omega_0 t+\theta)$$

$$\text{where } \theta = \underline{|H(j\omega)}|_{\omega=0}$$

$$\Rightarrow A = |H(j\omega)|_{\omega=\omega_0}$$

$$\omega_0 = 3$$

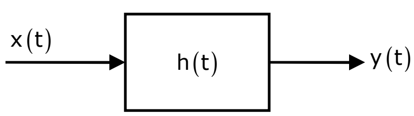
$$\Rightarrow A = \frac{1}{3\sqrt{9+16}} = \frac{1}{{}^{15}\!/_{1}}$$

10. Consider an LTI system with impulse response h(t) = $e^{-5t}u(t)$. If the output of the system is $y(t) = e^{-2t}\,u(t) - e^{-5t}u(t)$ then the input, x(t), is given by

(A) $e^{-3t}u(t)$ (B) $2e^{-3t}u(t)$ (C) $e^{-5t}u(t)$ (D) $2e^{-5t}u(t)$

Answer: (B)

Exp:



$$h(t) = e^{-5t}u(t) \leftrightarrow H(s) = \frac{1}{s+5}$$

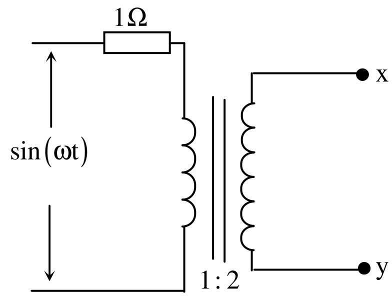
$$y(t) = e^{-3t} - e^{-5t}u(t) \leftrightarrow Y(s) = \frac{1}{s+3} - \frac{1}{s+5}$$

$$\Rightarrow H(s) = \frac{Y(s)}{X(s)}$$

$$\Rightarrow X(s) = \frac{Y(s)}{H(s)} = \frac{\dfrac{(5+5)-(s+3)}{(5+3)(s+5)}}{\dfrac{1}{s+5}} = \frac{2}{s+3}$$

$$x(t) = 2e^{-3t}u(t)$$

11. Assuming an ideal transformer,. The Thevenin's equivalent voltage and impedance as seen from the terminals x and y for the circuit in figure are



(A) $2\sin(\omega t),\ 4\Omega$ (B) $1\sin(\omega t),\ 1\Omega$

(C) $1\sin(\omega t),\ 2\Omega$ (D) $2\sin(\omega t),\ 0.5\Omega$

Answer: A

Exp: $\vartheta_{xy} = V_{oc}$

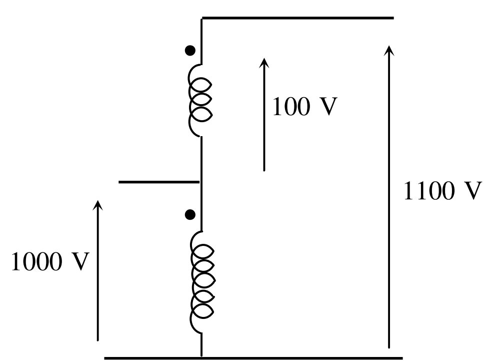
$$\frac{\vartheta_{in}}{1} = \frac{\vartheta_{xy}}{2} \Rightarrow \vartheta_{xy} = \vartheta_{oc} = 2\sin\omega t$$

$$R_{xy} = 100 \times \left(\frac{2}{1}\right)^2 \Rightarrow 4$$

$$\vartheta_{th} = 2\sin\omega t$$

$$R_{th} = 4\Omega$$

12. A single phase, 50kVA, 1000V/100V two winding transformer is connected as an autotransformer as shown in the figure.



The kVA rating of the autotransformer is ______________.

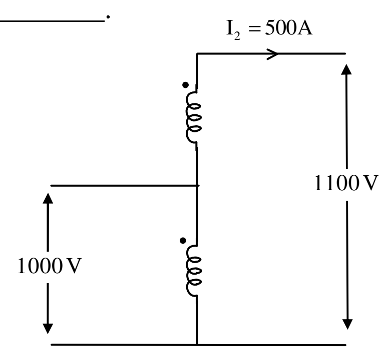
Answer: 550kVA

Exp: Given,

$$50\text{kVA},\ \frac{1000\text{V}}{100\text{V}}$$

$$I_2 = \frac{50 \times 10^3}{100} = 500$$

$$\therefore (\text{kVA})_{A.TFr} = 1100 \times 500 = 550\text{kVA}$$



13. A three-phase, 4pole, self excited induction generator is feeding power to a load at a frequency f_1. If the load is partially removed, the frequency becomes f_2. If the speed of the generator is maintained at 1500 rpm in both the cases, then

(A) $f_1\ f_2 > 50\text{Hz}$ and $f_1 > f_2$
(B) $f_1 < 50\text{Hz}$ and $f_2 > 50\text{Hz}$
(C) $f_1\ f_2 < 50\text{Hz}$ and $f_2 > f_2$
(D) $f_1 > 50\text{Hz}$ and $f_2 < 50\text{Hz}$

Answer: (C)

Exp: Initially self excited generator supply power to a load at f_1. If load is partially removed then slightly speed increase, also frequency f_2

$\therefore f_2 > f_1$

But both cases $f_1 f_2 < 50\text{Hz}$

14. A single phase induction motor draws 12 MW power at 0.6 lagging power. A capacitor is connected in parallel to the motor to improve the power factor of the combination of motor and capacitor to 0.8 lagging. Assuming that the real and reactive power drawn by the motor remains same as before, the reactive power delivered by the capacitor in MVAR is ____________.

Answer: 7MVAR

Exp: Given, $1-\phi$ Induction motor draws 12mW at 0.6pf, lag

Let $P_1 = 12\text{mW}$

$\cos\phi_1 = 0.6\text{pf}$

To improve pf, $\cos\phi_2 = 0.8$

$(Q_c)_{\text{del by capacitor}} = ?$

$$\cos\phi_1 = \frac{P_1}{S_1} \Rightarrow S_1 = \frac{12\times10^6}{0.6}$$

$\Rightarrow S_1 = 20\text{MVA}$

4 Reactive power, $Q_1 = \sqrt{S_1^2 - P_1^2} = 16\text{MVAR}$

When capacitor is connected then

$$\cos\phi_2 = \frac{P_1}{S_2}\ (\because \text{Real power drawn is same})$$

$$0.8 = \frac{12\times10^6}{S_2}$$

$S_2 = 15\text{MVA}$

$\therefore$ Reactive power, $Q_2 = \sqrt{S_2^2 - P_1^2} = 9\text{MVAR}$

But motor should draw the same reactive power.

$\therefore (Q_c)_{\text{del by capacitor}} = 16 - 9 = 7\text{MVAR}$

15. A three phase star-connected load is drawing power at a voltage of 0.9 pu and 0.8 power factor lagging. The three phase base power and base current are 100MVA and 437.38A respectively. The line-to line load voltage in kV is ___________.

Answer: 117-120

Exp: Given, 100 mVA, 437.38 A

$$V_{L-L}(kV) = ?$$

We know that, $S = \sqrt{3}\, V_L . I_L$

$$100\times10^6 = \sqrt{3}.V_L.I_L$$

$$V_L = \frac{100\times10^6}{\sqrt{3}\times437.38}$$

$$V_L = 132.001kV$$

But it is drawing power at a voltage of 0.9 pu

$$\therefore V_{pu} = \frac{V_{actual}}{V_{Base}}$$

$$\Rightarrow V_{actual} = V_{L-L} = V_{pu}\times V_B$$
$$= 0.9\times132 = 118.8kV$$

16. Shunt reactors are sometimes used in high voltage transmission system to

(A) limit the short circuit current through the line.

(B) compensate for the series reactance of the line under heavily loaded condition.

(C) limit over-voltages at the load side under lightly loaded condition.

(D) compensate for the voltage drop in the line under heavily loaded condition.

Answer: (C)

17. The closed-loop transfer function of a system is $T(s) = \frac{4}{(s^2+0.4s+4)}$. The steady state error due to unit step input is ________.

Answer: 0

Exp: Steady state error for Type-1 for unit step input is 0.

18. The state transition matrix for the system

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}u \text{ is}$$

(A) $\begin{bmatrix}e^t & 0\\ e^t & e^t\end{bmatrix}$ (B) $\begin{bmatrix}e^t & 0\\ t^2e^t & e^t\end{bmatrix}$ (C) $\begin{bmatrix}e^t & 0\\ -te^t & e^t\end{bmatrix}$ (D) $\begin{bmatrix}e^t & te^t\\ 0 & e^t\end{bmatrix}$

Answer: (C)

Exp: Given $A=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix} B=\begin{bmatrix}1\\ 1\end{bmatrix}$

$$[SI-A]^{-1}=\left[\begin{pmatrix}s & 0\\ 0 & s\end{pmatrix}-\begin{pmatrix}1 & 0\\ 1 & 1\end{pmatrix}\right]^{-1}$$

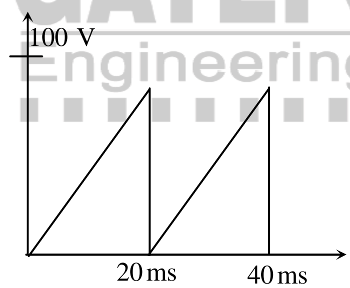
$$[SI-A]^{-1}=\begin{bmatrix}\frac{1}{(s-1)} & 0\\ \frac{1}{(s-1)^2} & \frac{1}{(s-1)}\end{bmatrix}$$

The state transition matrix

$$e^{At}=L^{-1}\left[(SI-A)^{-1}\right]$$

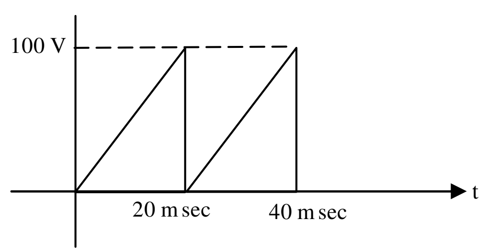
$$e^{At}=\begin{bmatrix}e^t & 0\\ te^t & e^t\end{bmatrix}$$

19. The saw-tooth voltage wave form shown in the figure is fed to a moving iron voltmeter. Its reading would be close to ___________



Answer: 57.73

Exp:



Moving iron meter reads RMS value only RMS value of saw-tooth waveform is $\frac{\vartheta_{max}}{\sqrt{3}}$

Meter reads $=\frac{100}{\sqrt{3}}$

$= 57.73$ volts

20. While measuring power of a three-phase balanced load by the two-wattmeter method, the readings are 100W and 250 W. The power factor of the load is _____________.

Answer: 0.802

Exp: In two-wattmeter method,

The readings are 100 W & 250 W

Power factor $= \cos\phi$

$$= \cos\left[\tan^{-1}\left[\frac{\sqrt{3}\left|\omega_1 - \omega_2\right|}{\omega_1 + \omega_2}\right]\right]$$

$$= \cos\left[\tan^{-1}\left[\frac{\sqrt{3}(150)}{350}\right]\right]$$

$$= 0.8029$$

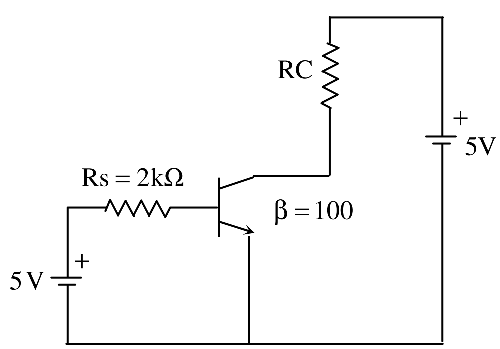
21. Which of the following is an invalid state in an 8-4-2-1. Binary Coded Decimal counter

(A) 1 0 0 0 (B) 1 0 0 1 (C) 0 0 1 1 (D) 1 1 0 0

Answer: (D)

Exp: In binary coded decimal (BCD) counter the valid states are from 0 to 9 only in binary system 0000 to 1001 only. So, 1100 in decimal it is 12 which is invalid state in BCD counter.

22. The transistor in the given circuit should always be in active region. Take $V_{CE(sat)} = 0.2\,V$. $V_{EE} = 0.7\,V$. The maximum value of R_C in Ω which can be used is __________.



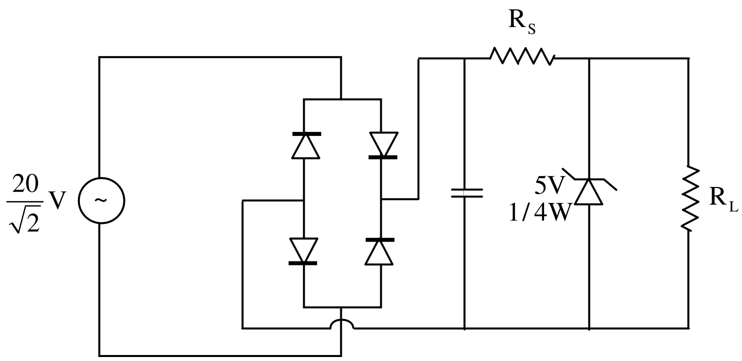
Answer: 22.32Ω

Exp: $I_B = \frac{5-0.7}{2k} = 2.15\,mA$

$I_C = 0.215A$

$\therefore R_C = \frac{5-0.2}{0.215} = 22.32\Omega$

23. A sinusoidal ac source in the figure has an rms value of $\frac{20}{\sqrt{2}}$V. Considering all possible values of R_L, the minimum value of R_S in Ω to avoid burnout of the Zener diode is ________.



Answer: 300Ω

Exp: $V_m = 20V$

$$P_z = V_z I_z \Rightarrow I_z = \frac{P_z}{V_z} = 50mA$$

$$R_S(\min) = \frac{20-5}{50mA} = 300\Omega$$

24. A step-up chopper is used to feed a load at 400 V dc from a 250 V dc source. The inductor current is continuous. If the 'off' time of the switch is $20\mu s$, the switching frequency of the chopper is kHz is __________.

Answer: 31.25 kHz

Exp: $V_0 = 400v, \quad V_s = 250v, \; T_{off} = 20\mu sec, \quad F = ?$

Given chopper in step up chopper

$$\therefore V_o = \frac{V_s}{1-D}$$

$$400 = \frac{250}{1-D} \Rightarrow 1-D = \frac{250}{400}$$

$$D = 3/8 = 0.375$$

$$\text{but } T_{off} = (1-D)T$$

$$20\times10^{-6} = \left(1-3/8\right)T$$

$$\therefore T = 32\mu sec$$

$$\text{Then } f = \frac{1}{T} = \frac{1}{32\times10^{-6}} = 31.25Hz$$

$$\therefore f = 31.25kHz$$

25. In a constant V/f control of induction motor, the ratio *V/f* is maintained constant from 0 to base frequency, where V is the voltage applied to the motor at fundamental frequency *f*. Which of the following statements relating to low frequency operation of the motor is TRUE?

(A) At low frequency, the stator flux increases from its rated value.

(B) At low frequency, the stator flux decreases from its rated value.

(C) At low frequency, the motor saturates.

(D) At low frequency, the stator flux remains unchanged at its rated value.

Answer: (B)

Exp: During constant $\frac{V}{f}$ control, at low frequency, the voltage also applied to the induction motor is low. Hence the stator flux also decreases from its rated value.

Q.No. 26 – 55 Carry Two Marks Each

26. To evaluate the double integral $\int_0^8 \left(\int_{y/2}^{(y/2)+1} \left(\frac{2x-y}{2} \right) dx \right) dy$, we make the substitution $u = \left(\frac{2x-y}{2} \right)$ and $v = \frac{y}{2}$. The integral will reduce to

(A) $\int_0^4 \left(\int_0^2 2\,u\,du \right) dv$ (B) $\int_0^4 \left(\int_0^1 2\,u\,du \right) dv$

(C) $\int_0^4 \left(\int_0^1 u\,du \right) dv$ (D) $\int_0^4 \left(\int_0^2 u\,du \right) dv$

Answer: (B)

Exp: $u = \frac{2x-y}{2}$ ....(1) and $V = \frac{y}{2}$ ....(2)

$x = \frac{y}{2} \Rightarrow u = 0\,;\; x = \frac{y}{2} + 1 \Rightarrow u = 1$

$y = 0 \Rightarrow v = 0\,;\; y = 8 \Rightarrow v = 4$

from (1) and (2), $x = u + v$ ...(3) and $y = 2v$ ...(4)

$$\text{Jacobian transformation; } J = \begin{vmatrix} \frac{\partial x}{\partial u} & \frac{\partial x}{\partial v} \\ \frac{\partial y}{\partial u} & \frac{\partial y}{\partial v} \end{vmatrix} = \begin{vmatrix} 1 & 1 \\ 0 & 2 \end{vmatrix} = 2$$

$$\therefore \int_0^8 \left(\int_{y/2}^{(y/2)+1} \left(\frac{2x-y}{2} \right) dx \right) dy = \int_{v=0}^{4} \left(\int_{u=0}^{1} (u)|J|\,du \right) dv$$

$$= \int_0^4 \left(\int_0^1 2u\,du \right) dv$$

27. Let X be a random variable with probability density function

$$f(x)=\begin{cases}0.2, & \text{for } |x|\le 1\\ 0.1, & \text{for } 1<|x|\le 4\\ 0, & \text{otherwise}\end{cases}$$

The probability $p(0.5<x<5)$ is __________

Answer: 0.4

Exp: $P(0.5<x<5)=\int_{0.5}^{5} f(x)dx$

$$=\int_{0.5}^{1} f(x)dx+\int_{1}^{4} f(x)dx+\int_{4}^{5} f(x)dx\,\frac{\text{Opposite}}{\text{Hypotenuse}}$$

$$=(0.2)(x)_{0.5}^{1}+(0.1)(x)_{1}^{4}+0$$

$$=0.1+0.3=0.4$$

28. The minimum value of the function $f(x)=x^3-3x^2-24x+100$ in the interval [-3. 3] is

(A) 20 (B) 28 (C) 16 (D) 32

Answer: (B)

Exp: $f^1(x)=0\Rightarrow x^2-2x-8=0$

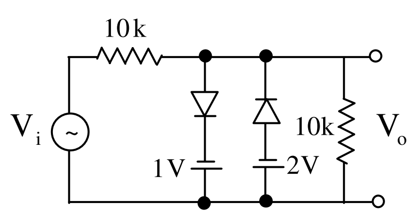
$\Rightarrow x=-2,4\in[-3,3]$

Now $f(-3)=118$; $f(3)=28$

and $f(-2)=128$; $f(4)=44$

$\therefore f(x)$ is minimum at $x=3$ and the minimum value is $f(3)=28$

29. Assuming the diodes to be ideal in the figure, for the output to be clipped, the input voltage v_i must be outside the range



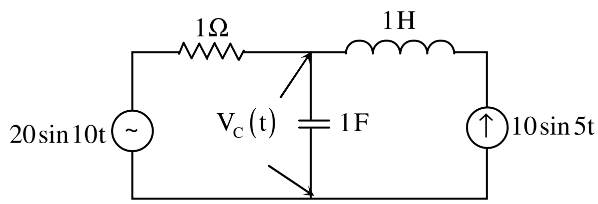
(A) $-1V$ to $-2V$ (B) $-2V$ to $-4V$ (C) $+1V$ to $-2V$ (D) $+2V$ to $-4V$

Answer: (B)

Exp: When both diodes are 0FF, $v_o=\frac{v_i}{2}$ (Not clipped).

$\therefore$ For the clipped, v_i must bt ouside the range $-2V$ to $-4V$

30. The voltage across the capacitor, as sown in the figure, is expressed as $v_t(t) = A_1 \sin(\omega_1 t - \theta_1) + A_2 \sin(\omega_2 t - \theta_2)$



The value of A_1 and A_2 respectively, are

(A) 2.0 and 1.98 (B) 2.0 and 4.20 (C) 2.5 and 3.50 (D) 5.0 and 6.40

Answer: (A)

Exp: By using super position theorem,

1. $\vartheta_{C_1}(t)-$ When 20 sin 10t voltage source is acting,

$$\text{Network function } H(j\omega) = \frac{\frac{1}{j\omega c}}{R + \frac{1}{j\omega c}} \Rightarrow \frac{1}{(10j+1)}$$

$$\vartheta_{c_1}(t) = \frac{1}{\sqrt{101}} 20\sin\left(10t - \tan^{-1}(10)\right)$$

2. $\vartheta_{c_2}(t)-$ When 10 sin 5t current source is acting

$$\vartheta_{c_2} = \frac{10\angle 0 \times 1}{1-0.2j} \times -0.2j$$

$$\vartheta_{c_2} = \frac{-2j}{1-0.2j}$$

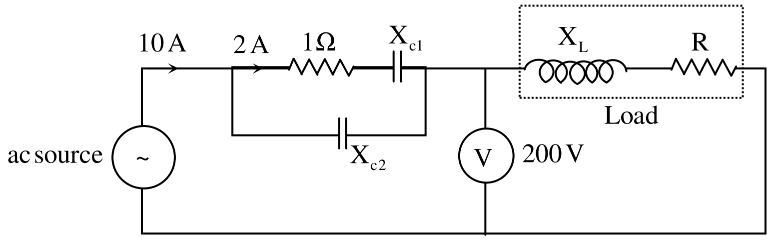
$$\vartheta_{c_2}(t) = \frac{2}{\sqrt{1+(0.2)^2}}.\sin(5t-\theta_2)$$

$$\vartheta_{c_2}(t) = 1.98\sin(5t-\theta_2)$$

$$V_C(t) = 2\sin(10t-\theta_1) + 1.98(5t-\theta_2)$$

By comparing with given expression, $A_1 = 2.0$, $A_2 = 1.98$

31. The total power dissipated in the circuit, show in the figure, is 1kW.



The voltmeter, across the load, reads 200 V. The value of X_L is __________.

Answer: 17.34 Ω

Exp: Total power dissipated in the circuit is 1kW.

$$P = 1kW$$

$$1000 = I^2.1 + I^2.R.$$

$$1000 = (2)^2.1 + (10)^2.R.$$

$$\Rightarrow \boxed{R = 9.96\,\Omega}$$

$$|Z| = \frac{V}{I} \Rightarrow \frac{200}{10} = 20$$

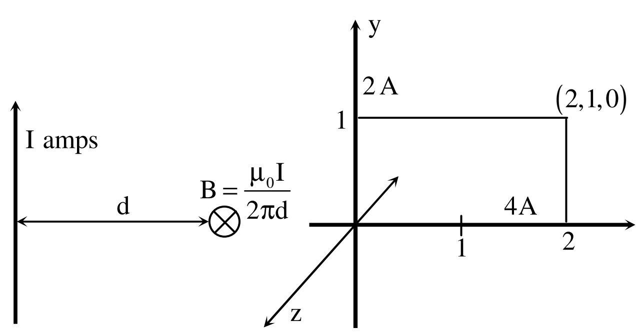
$$|Z| = \sqrt{R^2 + X_L^2}$$

$$\Rightarrow X_L^2 = (Z)^2 - R^2$$

$$X_L^2 = (20)^2 - (9.96)^2$$

$$\Rightarrow \boxed{X_L = 17.34\,\Omega}$$

32. The magnitude of magnetic flux density $(\vec{B})$ at a point having normal distance d meters from an infinitely extended wire carrying current of 1 A is $\frac{\mu_0 I}{2\pi d}$ (in SI units). An infinitely extended wire is laid along the x-axis and is carrying current of 4 A in the +ve x direction. Another infinitely extended wire is laid along the y-axis and is carrying 2 A current in the +ve y direction μ_0 is permeability of free space Assume $\hat{I}, \hat{J}, \hat{K}$ to be unit vectors along x, y and z axes respectively.



Assuming right handed coordinate system, magnetic field intensity, $\vec{H}$ at coordinate (2,1,0) will be

(A) $\frac{3}{2\pi}\hat{k}$ weber / m^2

(B) $\frac{4}{3\pi}\hat{i}$ A / m

(C) $\frac{3}{2\pi}\hat{k}$ A / m

(D) 0 A / m

Answer: (C)

Exp: $H = H_x + H_y$

$$H_x = \frac{I}{2\pi\rho}a\phi = \frac{4}{2\pi(1)}(a_x \times a_y) = \frac{2}{\pi}a_z$$

$$H_y = \frac{I}{2\pi\rho}a\phi = \frac{2}{2\pi(2)}(a_y \times a_x) = \frac{-1}{2\pi}a_z$$

$$H = \frac{1}{\pi}\left(2 - \frac{1}{2}\right) = \frac{3}{2\pi}a_z$$

33. A discrete system is represented by the difference equation

$$\begin{bmatrix} X_1(k+1) \\ X_2(k+1) \end{bmatrix} = \begin{bmatrix} a & a-1 \\ a+1 & a \end{bmatrix} \begin{bmatrix} X_1(k) \\ X_2(k) \end{bmatrix}$$

It has initial condition $X_1(0) = 1; X_2(0) = 0$. The pole location of the system for a = 1, are

(A) $1 \pm j0$ (B) $-1 \pm j0$ (C) $\pm 1 + j0$ (D) $0 \pm j1$

Answer: (A)

Exp: from the given difference equation,

$$A = \begin{bmatrix} a & a-1 \\ a+1 & a \end{bmatrix}$$

The pole locations of the system for a = 1.

Then $A = \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}$

$|SI - A|. \Rightarrow (s-1)^2 = 0$

$S = 1 \pm j0$

34. An input signal $x(t) = 2 + 5\sin(100\pi t)$ is sampled with a sampling frequency of 400 Hz and applied to the system whose transfer function is represented by

$$\frac{Y(z)}{X(z)} = \frac{1}{N}\left(\frac{1 - z^{-N}}{1 - z^{-1}}\right)$$

where, N represents the number of samples per cycle. The output y(n) of the system under steady state is

(A) 0 (B) 1 (C) 2 (D) 5

Answer: (C)

Exp: $x(t) = 2 + 5\sin(100\pi t)$

$$x(nT_s) = 2 + 5\sin\left(100\pi\, n . \frac{1}{400}\right)$$

$$= 2 + 5\sin\left(\frac{\pi}{4} n\right), \quad N = 8$$

$$\frac{Y(e^{j\Omega})}{X(e^{j\Omega})} = \frac{1}{N}\left[\frac{1 - e^{-j\Omega N}}{1 - e^{-j\Omega}}\right] = H(e^{j\Omega})$$

$$x[n] = x_1[n] + x_2[n]$$

due to $x_1[n]$

$$y_1[n] = \left|H(e^{j\Omega})\right|_{r=0} = x_1[n]$$

$$y_1[n] = 2$$

$$y_2[n] = \left|H(e^{j\Omega})_{\Omega=\frac{\pi}{4}} \sin\left(\frac{\pi}{4} n + \underline{|H(e^{j\Omega})}_{\Omega=\frac{\pi}{4}}\right)\right|$$

$$\left|H(e^{j\Omega})\right|_{\Omega=\frac{\pi}{4}} = 0$$

$$y[n] = y_1[n] + y_2[n]$$

$$y[n] = 2$$

Thus at steady state $y[n] = 2$

35. A 10 kHz even-symmetric square wave is passed through a bandpass filter with centre frequency at 30 kHz and 3 dB passband of 6 kHz. The filter output is

(A) a highly attenuated square wave at 10kHz

(B) nearly zero.

(C) a nearly perfect cosine wave at 30kHz.

(D) a nearly perfect sine wave at 30kHz.

Answer: (C)

Exp: 10 KHz even symmetric square wave have frequency component present

10KHz, 30KHz, 50KHz, 70KHz

[only odd harmonics due to half wave symmetry]

Since bandpass filter is contered at 30KHz, 30KHz component will pass through

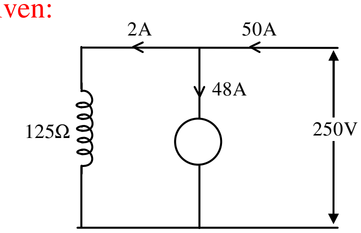
$\Rightarrow$ filter output is nearly perfect cosine wave at 10 KHz

Cosine in due to reason that signal in even signal.

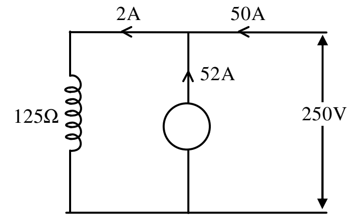
36. A 250 V dc shunt machine has armature circuit resistance of 0.6Ω and field circuit resistance of $125\ \Omega$. The machine is connected to 250 V supply mains. The motor is operated as a generator and then as a motor separately. The line current of the machine in both the cases is 50 A. The ratio of the speed as a generator to the speed as a motor is ____________.

Answer: 1.27

Exp: Given:



Motor



Generator

$$E_b = V - I_a R_a$$
$$= 250 - 48 \times 0.6$$
$$= 221.2V$$

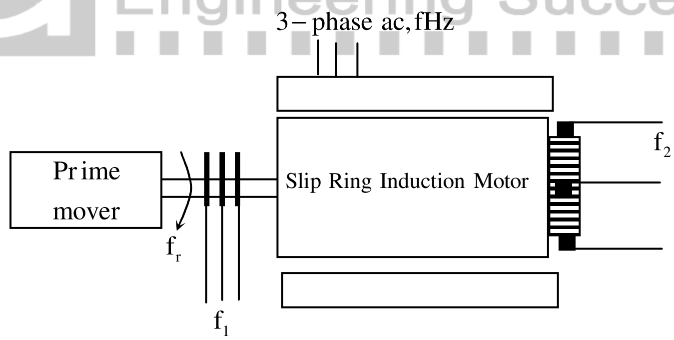
$$E_b = V + I_a R_a$$
$$= 250 + 52 \times 0.6$$
$$= 281.2V$$

$$\therefore \frac{N_g}{N_m} = ?$$

We know that $\frac{N_g}{N_m} = \frac{E_g}{E_b}$ $(\because$ flux is constant$)$

$$= \frac{281.2}{221.2} \Rightarrow \frac{N_g}{N_m} = 1.27$$

37. A three-phase slip-ring induction motor, provided with a commutator winding, is shown in the figure. The motor rotates in clockwise direction when the rotor windings are closed.



If the rotor winding is open circuited and the system is made to run at rotational speed f_r with the help of prime-mover in anti-clockwise direction, then the frequency of voltage across slip rings is f_1 and frequency of voltage across commutator brushes is f2. The values of f1 and f2 respectively are

(A) $f + f_r$ and f (B) $f - f_r$ and f (A) $f - f_r$ and $f + f_r$ (D) $f - f_r$ and f

Answer: (A)

Exp: Whenever the Rotor winding is open circuited and rotating in anti-clockwise direction then the frequency of voltage across slip rings is $f_1 = \frac{(N_s + N_r)P}{120}$

$$f_1 = f + f_r$$

At the same time frequency of voltage across commutator brushes if

$$f_2 = \frac{N_s P}{120} = f$$

38. A 20-pole alternator is having 180 identical stator slots with 6 conductors in each slot. All the coils of a phase are in series. If the coils are connected to realize single-phase winding, the generated voltage is V_1. If the coils are reconnected to realize three-phase star-connected winding, the generated phase voltage is V_2. Assuming full pitch, single-layer winding, the ratio V_1/V_2 is

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$ (C) $\sqrt{3}$ (D) 2

Answer: (D)

Exp: Given poles, P=20

Total slots = 180

4 Total no. of conductor = $180 \times 6 = 1080$

4 the ratio of voltage generated when the coils are connected in $1-\phi$ to when the coils are connected in $3-\phi$, Y-connection.

i.e., $\frac{(V_1)_{1-\phi}}{(V_2)_{3-\phi}} = 2$

39. For a single phase, two winding transformer, the supply frequency and voltage are both increased by 10%. The percentage changes in the hysteresis loss and eddy current loss, respectively, are

(A) 10 and 21 (B) -10 and 21 (C) 21 and 10 (D) -21 and 10

Answer: (A)

Exp: Given $1-\phi$ Transformer

V and f are increased by 10%

$\therefore \%\Delta W_n = ?$

$\%\Delta W_e = ?$

Here $\frac{V}{f}$ is constant $\therefore W_n \propto f$

$W_e \propto f^2$

$W_{n_n} \propto f$

as 'f' increased by 10%

$\Rightarrow W_n$ also $\uparrow$ 10%

$W_e \propto f^2$

$W_e \propto 1.21 f^2$

$\Rightarrow W_e \uparrow$ by 21%

40. A synchronous generator is connected to an infinite bus with excitation voltage Ef = 1.3 pu. The generator has a synchronous reactance of 1.1 pu and is delivering real power (P) of 0.6 pu to the bus. Assume the infinite bus voltage to be 1.0 pu. Neglect stator resistance. The reactive power (Q) in pu supplied by the generator to the bus under this condition is _________.

Answer: 0.109

Exp: Given, $E_f = 1.3$ P.u

$X_s = 1.1$ P.u

$P = 0.6$ pu

$V = 1.0$ pu

$Q = ?$

We know that, $P = \frac{EV}{X_s}\sin\delta$

$\Rightarrow 0.6 = \frac{1.3\times 1}{1.1}\times\sin\delta$

$\Rightarrow \delta = 30.5°$

$\therefore Q = \frac{V}{X_s}\left[E\cos\delta - V\right] = 0.109$

41. There are two generators in a power system. No-load frequencies of the generators are 51.5 Hz and 51Hz, respectively, and both are having droop constant of 1 Hz/MW. Total load in the system is 2.5 MW. Assuming that the generators are operating under their respective droop characteristics, the frequency of the power system in Hz in the steady state is __________.

Answer: 50

Exp: Given, two generators in a power system has no load frequency of 51.5 & 51 Hz.

$\therefore$ drop constant=1Hz/mW

Total load=2.5 mW

for generator '1', $f = -x_1 + 51.5$

generator '2' $f = -x_2 + 51$

$\therefore -x_1 + 51.5 = -x_2 + 51$

$\Rightarrow x_1 - x_2 = 0.5$ ...(1)

Total load $\Rightarrow x_1 + x_2 = 2.5$ ...(2)

By solving (1) & (2) $\Rightarrow x_1 = \frac{3}{2} = 1.5$

$\therefore f = -1.5 + 51.5 = 50$ Hz

42. The horizontally placed conductors of a single phase line operating at 50 Hz are having outside diameter of 1.6 cm, and the spacing between centers of the conductors is 6 m. The permittivity of free space is 8.854×10^{-12}. The capacitance to ground per kilometer of each line is

(A) 4.2×10^{-9}F (B) 8.4×10^{-9}F (C) 4.2×10^{-12}F (D) 8.4×10^{-12}F

Answer: (B)

Exp: Given, diameters of conductor =1.61m

$\therefore$ radius, r = 0.8 cm

Spacing between conductors, d=6m

Permitivity $\in_0 = 8.85\times10\text{-}12$

$\therefore$ capacitance to ground per km = ?

$$\therefore C = \frac{2\pi\in_o}{\ln\left(\frac{d}{r}\right)} = \frac{2\pi\times8.85\times10^{-12}}{\ln\left[\frac{6}{0.8\times10^{-2}}\right]} = 8.4\times10^{-12}$$

$C/km = 8.4\times10^{-19}F$

43. A three phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive, negative, and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu, and 0.05 pu, respectively, at the machine base quantities. If a bolted single phase to ground fault occurs at the terminal of the unloaded generator, the fault current in amperes immediately after the fault is _________.

Answer: 15500

Exp: Single line to ground fault,

Fault current in $I_f = 3I_{a1}$

positive sub transient circuit,

$$\therefore I_{a1} = \frac{E_a}{z_1+z_2+z_0}$$

$$= \frac{1+j_o}{j0.2+j0.2+j0.05}$$

$$= \frac{1}{j0.45} = -j2.2223\,pu$$

Fault current $(I_f) = 3\times I_{a1}$

$= (3\times -j2.222) = -j6.666\,pu$

Base current $= \frac{100\times10^6}{\sqrt{3}\times25\times10^3} = 2309.4$ pu

Fault circuit = pu fault circuit in pu x Base circuit in Amp

$I_f = 15396A$

44. A system with the open loop transfer function:

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

is connected in a negative feedback configuration with a feedback gain of unity. For the closed loop system to be marginally stable, the value of K is ______

Answer: 5

Exp: The characteristic equation 1 + G(s) = 0

$$1+\frac{k}{s(s+2)(s^2+2s+2)}=0$$

$$\Rightarrow s^4+4s^3+6s^2+4s+k=0$$

R–H Arry:

$$\begin{array}{c|ccc} S^4 & 1 & 6 & k \\ S^3 & 4 & 4 & 0 \\ S^2 & 5 & k & 0 \\ S^1 & \frac{20-4k}{5} & 0 & \\ S^0 & k & & \end{array}$$

For marginally stable, 20–4k = 0

$$20 = 4\,k \Rightarrow k=5$$

45. For the transfer function

$$G(s)=\frac{5(S+4)}{s(s+0.25)(s^2+4s+25)}$$

The values of the constant gain term and the highest corner frequency of the Bode plot respectively are

(A) 3.2, 5.0 (B) 16.0, 4.0 (C) 3.2, 4.0 (D) 16.0, 5.0

Answer: (A)

Exp: $G(s)=\dfrac{5(s+4)}{s(s+0.25)(s^2+4s+25)}$

If we convert it into time constants,

$$G(s)=\frac{5\times 4\left[1+\frac{s}{4}\right]}{s[0.25]\left[1+\frac{s}{0.25}\right]25\left[1+\frac{4}{25}.s+\left[\frac{s}{5}\right]^2\right]}$$

$$G(s)=\frac{3.2\left[1+\frac{s}{4}\right]}{s\left[1+\frac{s}{0.25}\right]\left[1+\frac{4}{25}.s+\frac{s^2}{25}\right]}$$

Constant gain term is 3.2

$\omega_n=5\rightarrow$ highest corner frequency

46. The second order dynamic system

$$\frac{dX}{dt} = PX + Qu$$
$$y = RX$$

has the matrices P, Q and R as follows:

$$P = \begin{pmatrix} -1 & 1 \\ 0 & -3 \end{pmatrix} \quad Q = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad R = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

The system has the following controllability and observability properties:

(A) Controllable and observable
(B) Not controllable but observable
(C) Controllable but not observable
(D) Not controllable and not observable

Answer: (C)

Exp: Given $P = \begin{bmatrix} -1 & 1 \\ 0 & -3 \end{bmatrix} Q = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

For controllability:

$$Q_C = \begin{bmatrix} Q & PQ \end{bmatrix} \Rightarrow \begin{bmatrix} 0 & 1 \\ 1 & -3 \end{bmatrix}$$

$|Q_C| \neq 0 \therefore$ controllable

For observability:

$$Q_0 = \begin{bmatrix} R^T & P^T.R^T \end{bmatrix} \Rightarrow \begin{bmatrix} 0 & 0 \\ 1 & -3 \end{bmatrix}$$

$|Q_0| = 0 \;\therefore$ Not observable.

47. Suppose that resistors R_1 and R_2 are connected in parallel to give an equivalent resistor R. If resistors R_1 and R_2 have tolerance of 1% each., the equivalent resistor R for resistors R1 = 300Ω and $R_2 = 200\Omega$ will have tolerance of

(A) 0.5% (B) 1% (C) 1.2% (D) 2%

Answer: (B)

Exp: $R_1 = 250 \pm 1\%$ $\qquad R_T = \dfrac{R_1 R_2}{R_1 + R_2}$

$R_2 = 300 \pm 1\%$ $\qquad R_T = 136.36\Omega$

$$\%\ E_{RT} = \frac{\Delta R_T}{R_T} \times 100$$

$$= \pm\left[\frac{R_T}{R_1}.\frac{\Delta R_1}{R_1} + \frac{R_T}{R_2}.\frac{\Delta R_2}{R_2}\right] \times 100$$

$$\Delta R_1 = \frac{R_1.\in R_1}{100} = 2.5; \Delta R_2 = \frac{R_2.\in R_2}{100}$$

$$= \pm\left[\frac{136.36}{250}.\frac{2.5}{250} + \frac{136.36}{300}.\frac{3}{300}\right] = \pm 1\%$$

48. Two ammeters X and Y have resistances of $1.2\,\Omega$ and $1.5\,\Omega$ respectively and they give full scale deflection with 150 mA and 250 mA respectively. The ranges have been extended by connecting shunts so as to give full scale deflection with 15 A. The ammeters along with shunts are connected in parallel and then placed in a circuit in which the total current flowing is 15A. The current in amperes indicated in ammeter X is __________.

Answer: 10.157

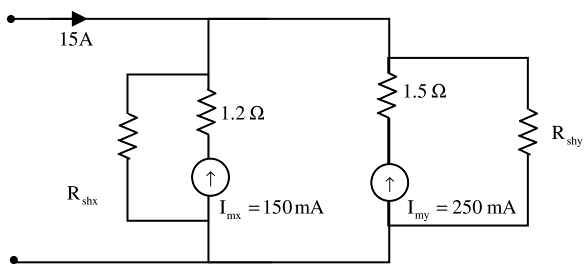
Exp: X and Y ammeters are connected in parallel

Shunt Registration of X and Y meters:

$$R_{shx} = \frac{1.2}{\left(\frac{15\times10^3}{150} - 1\right)}$$

$$R_{shx} = 0.01212\,\Omega$$

$$R_{shy} = \frac{1.5}{\left(\frac{15\times10^3}{250} - 1\right)}$$



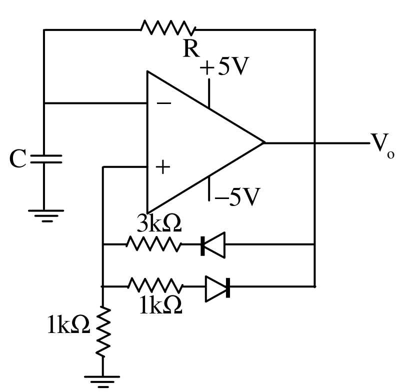
$$R_{shy} = 0.02542\Omega$$

Current through X ammeter is

$$= \frac{0.02542}{(0.01212 + 0.02542)} \times 15$$

$$= 10.157 \text{ ampers}$$

49. An oscillator circuit using ideal op-amp and diodes is shown in the figure



The time duration for +ve part of the cycle is Δt_1 and for-ve part is Δt_2.The value of $e^{\frac{\Delta t_1 - \Delta t_2}{RC}}$ will be___________.

Answer: 1.3

Exp:

$$V_C(t) = V_{max} + (V_{initial} - V_{max})e^{-t/\tau}$$

$$UTP = +V_{sat} + (LTP - V_{sat})e^{-t_1/\tau}$$

$$\frac{5}{4} = 5 + \left(\frac{-5}{2} - 5\right)e^{-t_1/\tau}$$

where

$$UTP = 5 \times \frac{1}{4} = \frac{5}{4}$$

$$LTP = 5 \times \frac{1}{2} = \frac{-5}{2}$$

$$\frac{5}{4} - 5 = \left(\frac{-15}{2}\right)e^{-t_1/\tau}$$

$$-3.75 = -7.5\,e^{-t/\tau}$$

$$0.5 = e^{-t_1/\tau}$$

$$t_1 = 0.69\,\tau$$

$$LTP = -V_{sat} + (LTP + V_{sat})e^{-t_2/\tau}$$

$$\frac{-5}{2} = -5 + \left(\frac{-5}{2} + 5\right)e^{-t_2/\tau}$$

$$5 - \frac{5}{2} \Rightarrow 2.5 = -5 + (2.5)e^{-t_2/\tau}$$

$$7.5 = 2.5e^{-t_2/\tau} \Rightarrow e^{-t_2/\tau} = 3$$

$$t_2 = -1.098\tau$$

$$e^{(0.69\tau + 1.098\tau)/\tau} = 5.98.$$

50. The SOP (sum of products) form of a Boolean function is $\Sigma(0,1,3,7,11)$, where inputs are A,B,C,D (A is MSB, and D is LSB). The equivalent minimized expression of the function is

(A) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{B})(\overline{C}+D)$

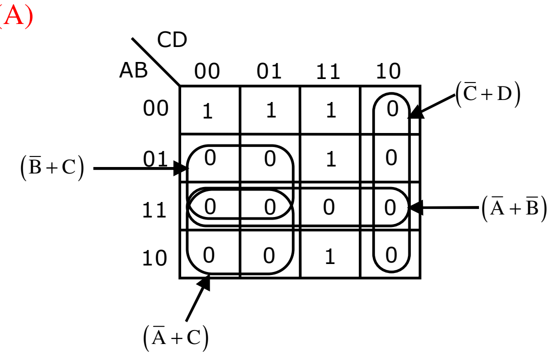
(B) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{C})(\overline{C}+D)$

(C) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{C})(\overline{C}+\overline{D})$

(D) $(\overline{B}+C)(A+\overline{B})(\overline{A}+B)(\overline{C}+D)$

Answer: (A)

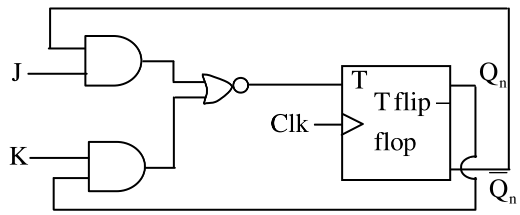
Exp:



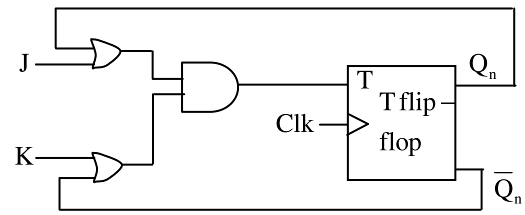
The equivalent minimized expression of this function is $= (\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{B})(\overline{C}+D)$

51. A JK flip flop can be implemented by T flip-flops. Identify the correct implementation.

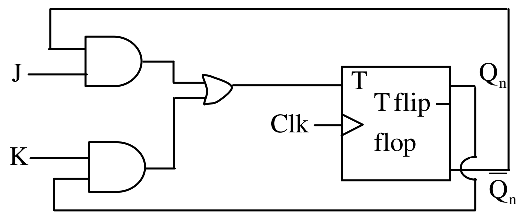
(A)



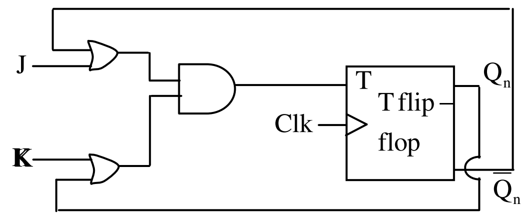
(B)



(C)



(D)



Answer: (B)

Exp:

Q_n	J	K	Q_{n+1}	T
0	0	0	0	0
0	0	1	0	0
0	1	0	1	1
0	1	1	1	1
1	0	0	1	0
1	0	1	0	1
1	1	0	1	0
1	1	1	0	1

Q_n \ JK	00	01	11	10
0	0	0	1	1
1	0	1	1	0

$T = \overline{Q}_n J + Q_n k$

Analysis:

If you will observe the combinational circuit output expression which is the input for T flip flop is not matching directly, so you should go through the option. If you will solve the combinational circuit of option (B) then

$$T = (J + Q_n).(K + \overline{Q}_n)$$

$$= J.K + J\overline{Q}_n + K.Q_n + Q_n\overline{Q}_n = J.K + J\overline{Q}_n + K.Q_n + 0 \left(\because Q_n.\overline{Q}_n = 0\right)$$

$$= J.K + J\overline{Q}_n + K.Q_n$$

Now, according to consensus theorem J-K will become redundant term, so it should be eliminated.

Hence, $T = J\overline{Q}_n + K.Q_n$, which in matching with our desired result and option-(B) is correct answer.

52. In an 8085 microprocessor, the following program is executed

Address location – Instruction	
2000H	XRA A
2001H	MVI B,04H
2003H	MVI A, 03H
2005H	RAR
2006H	DCR B
2007H	JNZ 2005
200AH	HLT

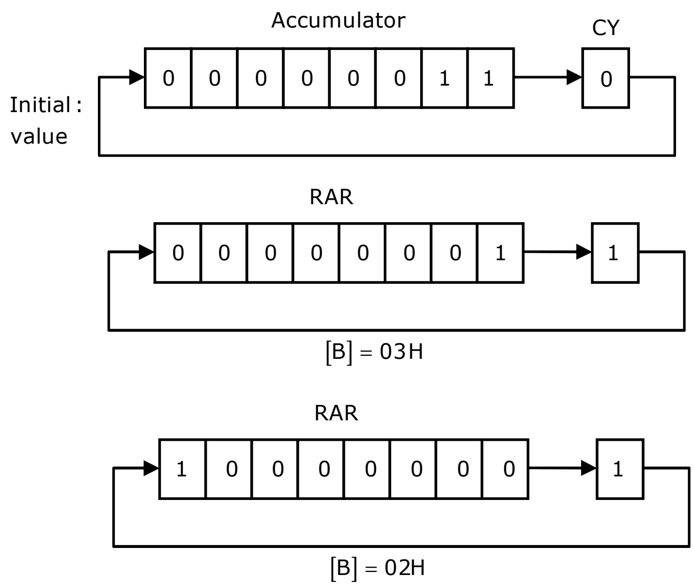
At the end of program, register A contains

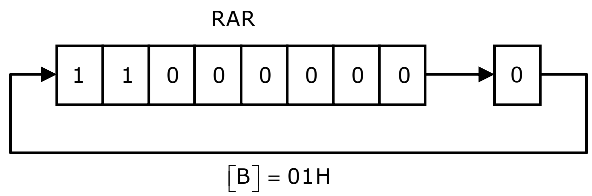
(A) 60H (B) 30H (C) 06H (D) 03H

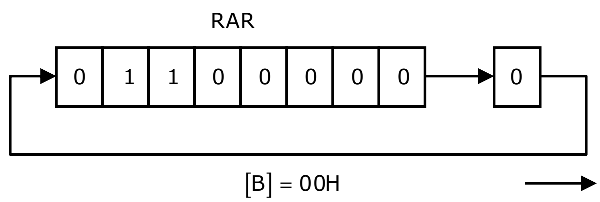
Answer: (A)

Exp:

Address location	**Instruction**	**Operation**
2000H	XRA A	$[A]=00H,\ CY=0, Z=1$
2001H	MVI B, 04H	$[B]=04H$
2003H	MVI A, 03H	$[A]=03H$
2005H	RAR	Rotate accumulator right with carry
2006H	DCR B	Decrement content of B register by one
2007H	JNZ 2005H	Jump on no zero to location 2005H
200AH	HLT	

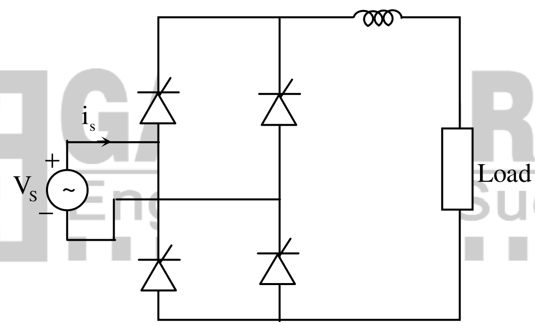






Now loop will be over and HLT will execute and program will be over

53. A fully controlled converter bridge feeds a highly inductive load with ripple free load current. The input supply (V_s) to the bridge is a sinusoidal source. Triggering angle of the bridge converter is $\alpha = 30^O$. The input power factor of the bridge is_________.



Answer: 0.78

Exp: For fully controlled converter bridge

The input power factor (PF) = $0.9\times\cos\alpha$

$$\therefore \text{IPF} = 0.9\times\cos 30$$

$$\Rightarrow \text{IPF} = 0.78$$

54. A single-phase SCR based ac regulator is feeding power to a load consisting of 5Ω resistance and 16 mH inductance. The input supply is 230 V, 50 Hz ac. The maximum firing angle at which the voltage across the device becomes zero all throughout and the rms value of current through SCR, under this operating condition, are

(A) 30^0 and 46 A (B) 30^0 and 23 A (C) 45^0 and 23 A (D) 45^0 and 32 A

Answer: (C)

Exp: $V_s = 230\text{V}, 50\,\text{Hz}$

$R = 5\Omega,\ L = 16\text{mH}$

The maximum firing angle at which the volt across device becomes zero is the angle at which device trigger i.e. minimum firing angle to converter.

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

$$\alpha = \phi = \tan^{-1}\left(\frac{2\pi\times 50\times 16\times 10^{-3}}{5}\right) = 45.1°$$

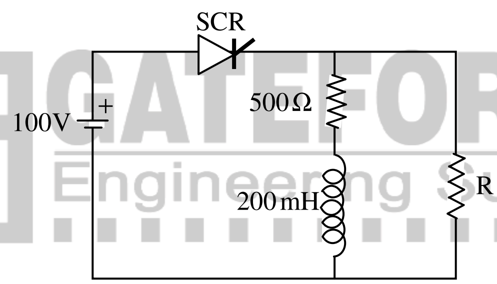
The current flowing SCR is max at their angle ie. when $\alpha=\phi,\ \gamma=\pi$

$$I_{Trms} = \left(\frac{1}{2\pi}\int_{\alpha}^{\pi+\alpha}\left\{\frac{V_m}{2}\sin(\omega t-\alpha)\right\}^2 .d\omega t\right)^{1/2}$$

$$I_{Trms} = \frac{V_m}{2z} = \frac{\sqrt{2}\times 230}{2\times\sqrt{5^2+5.042}}$$

$$\therefore I_{Trms} = 22.9 \approx 23A$$

55. The SCR in the circuit shown has a latching current of 40 mA. A gate pulse of 50 μs is applied to the SCR. The maximum value of R in Ω to ensure successful firing of the SCR is ________.



Answer: 6060Ω

Exp: $I_L = 40\,mt$

Width of gate pulse

$t=50\mu sec$

When SCR in ON with given pulse width of gate

$$I = I_1 + I_2$$

$$I = \frac{V}{R_1}\left(1-e^{-t/\tau}\right)+\frac{V}{R_2}$$

$$\tau = \frac{L}{R} = \frac{200\times 10^{-3}}{500}$$

Time constant of RL circuit, $\tau=0.4\times10^{-3}$

$$40\times10^{-3} = \frac{100}{500}\left(1-e^{\frac{-50\times10^{-6}}{0.4\times10^{-3}}}\right)+\frac{100}{R_2}$$

$$\therefore R = 6060\Omega$$