General Aptitude

Q. No. 1 – 5 Carry One Mark Each

1. The man who is now Municipal Commissioner worked as _____________.
(A) the security guard at a university
(B) a security guard at the university
(C) a security guard at university
(D) the security guard at the university

Key: (B)

2. Nobody knows how the Indian cricket team is going to cope with the difficult and seamer-friendly wickets in Australia.
Choose the option which is closest in meaning to the underlined phase in the above sentence.
(A) put up with (B) put in with (C) put down to (D) put up against

Key: (D)

3. Find the odd one in the following group of words.
Mock, deride, praise, jeer
(A) mock (B) deride (C) praise (D) jeer

Key: (C)

4. Pick the odd one from the following options.
(A) CADBE (B) JHKIL (C) XVYWZ (D) ONPMQ

Key: (D)

5. In a quadratic function, the value of the product of the roots (α, β) is 4. Find the value of

$$\frac{\alpha^n + \beta^n}{\alpha^{-n} + \beta^{-n}}$$

(A) n^4 (B) 4^n (C) 2^{2n-1} (D) 4^{n-1}

Key: (B)

Exp: Given $\alpha\beta = 4$

$$\frac{\alpha^n + \beta^n}{\alpha^{-n} + \beta^{-n}} = \frac{\alpha^n + \beta^n}{\frac{1}{\alpha^n} + \frac{1}{\beta^n}}$$

$$= \frac{\left(\alpha^n + \beta^n\right)\alpha^n\beta^n}{\left(\alpha^n + \beta^n\right)}$$

$$= (\alpha\beta)^n = 4^n$$

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Q. No. 6 – 10 Carry Two Mark Each

6. Among 150 faculty members in an institute, 55 are connected with each other through Facebook and 85 are connected through WhatsApp. 30 faculty members do not have Facebook or WhatsApp accounts. The number of faculty members connected only through Facebook accounts is ______.

(A) 35 (B) 45 (C) 65 (D) 90

Key: (A)

Exp: $F \rightarrow$ Facebook, $W \rightarrow$ WhatsApp, $E \rightarrow$ Total faculties

given

$$n(E) = 150,\ n\left(\overline{F \cup W}\right) = 30$$

$$n\left(F \cup W\right) = n(E) - N\left(\overline{F \cup W}\right) = 150 - 30$$

$$n\left(F \cup W\right) = 120$$

$$n\left(f \cup w\right) = n\left(f\right) + \left[n(w) - n(F \cap w\right]$$

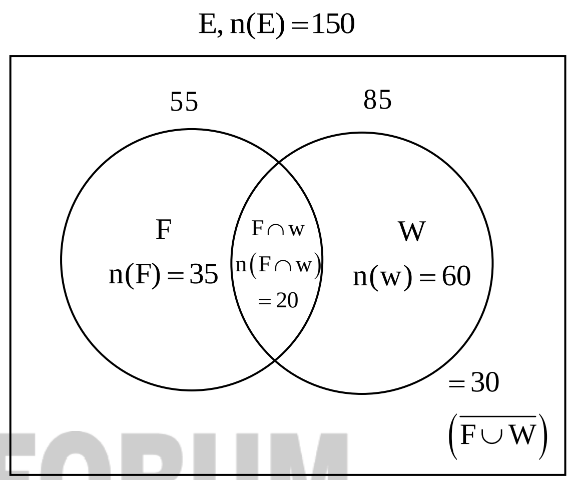
$$120 = n(F) + 85$$

$$n(F) = 120 - 85 = 35$$

$$55 = n(F) + n\left(F \cap W\right)$$

$$n\left(F \cap w\right) = 55 - n(F) = 55 - 35 = 20$$

$$n\left(w\right) = 85 - 20 = 65$$



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7. Computers were invented for performing only high-end useful computations. However, it is no understatement that they have taken over our world today. The internet, for example, is ubiquitous. Many believe that the internet itself is an unintended consequence of the original invention with the advent of mobile computing on our phones, a whole new dimension is now enabled. One is left wondering if all these developments are good or more importantly, required.

Which of the statement(s) below is/are logically valid and can be inferred from the above paragraph?

(i) The author believes that computers are not good for us

(ii) Mobile computers and the internet are both intended inventions

(A) (i) (B) (ii) only

(C) both (i) and (ii) (D) neither (i) nor (ii)

Key: (D)

8. All hill-stations have a lake. Ooty has two lakes.

Which of the statement(s) below is/are logically valid and can be inferred from the above sentences?

(i) Ooty is not a hill-station

(ii) No hill-station can have more than one lake.

(A) (i) Only (B) (ii) Only (C) both (i) and (ii) (D) neither (i) nor (ii)

Key: (D)

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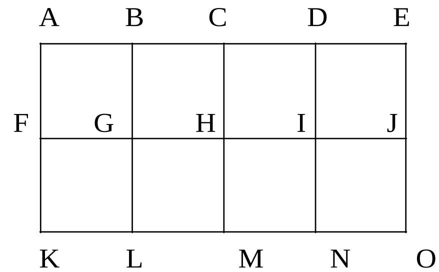
9. In a 2×4 rectangle grid shown below, each cell is a rectangle. How many rectangles can be observed in the grid?

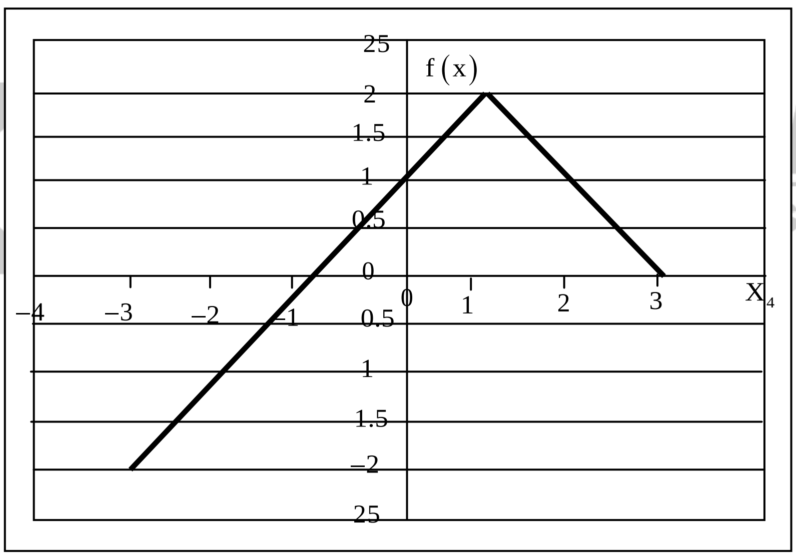
(A) 21 (B) 27
(C) 30 (D) 36

Key: **(C)**

Exp: 1: (AEOK)
2: (AEJF), (FJOK)
4: (ABLK), (BCML), (CDNM), (DEON)
2: ACMK, ADNK$|2:$ECMD, EBLO$|2:$ACHF, ADIF
2: ECHJ, EBGJ$|2:$FHMK, FINK$|2:$JHMD, JGLO
1: BDNL$|2:$BDIG, GINL
8: ABGF, BCHJ, CDIH, EDI, FGLK, GHML, HINM
Total = 1+2+4+2+2+2+2+2+2+1+2+8=30



10.



Chose the correct expression for f(x) given in the graph.

(A) $f(x) = 1 - |x - 1|$ (B) $f(x) = 1 + |x - 1|$

(C) $f(x) = 2 - |x - 1|$ (D) $f(x) = 2 + |x - 1|$

Key: **(C)**

Exp: Substituting the coordinates of the straight lines and checking all the four options given, we get the correct option as C which is f(x)= $2 - |x - 1|$

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Electrical Engineering

Q. No. 1 –25 Carry One Mark Each

1. The maximum value attained by the function $f(x) = x(x-1)(x-2)$ in the interval $[1, 2]$ is ____.

Key: **0**

Exp: $f(x) = x(x-1)(x-2) \quad \Rightarrow f(x) = x^3 - 3x^2 + 2x \Rightarrow f^1(x) = 0 \Rightarrow 3x^2 - 6x + 2 = 0$

$\Rightarrow x = 1 \pm \frac{1}{\sqrt{3}}$

But $x = 1 + \frac{1}{\sqrt{3}}$ only lies on the interval [1,2]

At $x = 1 + \frac{1}{\sqrt{3}}; f^{11}(x) = 6x - 6 = 6\left(1 + \frac{1}{\sqrt{3}}\right) - 6 > 0$

$\therefore \; x = 1 + \frac{1}{\sqrt{3}}$ is a point of minimum

$\therefore$ f(x) = x(x-1)(x-2) = 0 at either ends x =1 & x =2

$\therefore$ Max value = 0

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2. Consider a 3×3 matrix with every element being equal to 1. Its only non-zero eigenvalue is ____.

Key: **3**

Exp: Consider $A_{3\times3} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

It's only non-zero Eigen value $\lambda = 1 \times \text{order of the matrix} = 1 \times 3 = 3$

3. The Laplace Transform of $f(t) = e^{2t}\sin(5t)u(t)$ is

(A) $\frac{5}{s^2 - 4s + 29}$ (B) $\frac{5}{s^2 + 5}$ (C) $\frac{s-2}{s^2 - 4s + 29}$ (D) $\frac{5}{s+5}$

Key: **(A)**

Exp: Consider

$x(t) = \sin 5t \, u(t) \xrightarrow{\ell} \frac{5}{s^2 + 25} = X(S)$

By frequency shifting property, $\ell^{-1}\{X(S - S_0)\} = x(t)e^{S_0 t}$

thus at $S_0 = 2$

$f(t) = e^{2t}\sin 5t u(t) \xrightarrow{\ell} \frac{5}{(s-2)^2 + 25} = F(s)$

$\therefore F(s) = \frac{5}{s^2 - 4s + 29}$

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4. A function $y(t)$, such that $y(0)=1$ and $y(1)=3e^{-1}$, is a solution of the differential equation $\frac{d^2y}{dt^2}+2\frac{dy}{dt}+y=0$. Then $y(2)$ is

(A) $5e^{-1}$ (B) $5e^{-2}$ (C) $7e^{-1}$ (D) $7e^{-2}$

Key: (B)

Exp: The operator function of given D.E is $(D^2+2D+1)y=0$

$\therefore$ A.E is $D^2+2D+1=0 \Rightarrow D=-1,-1$

$\therefore y=e^{-x}\left[C_1+C_2\right] \rightarrow (1)$

$\therefore$ Given $y(0)=1$ & $y(1)=3e^{-1}$

From ; $y(0)=1$ i.e , $y=1$ at $x=0$ $\boxed{1=C_1}$

$y(1)=3e^{-1}$ i.e, $y=3/e$ at $x=1$

$\frac{3}{e}=e^{-1}\left[1+C_2(1)\right]\Rightarrow 3=1+C_2\Rightarrow \boxed{C_2=2}$

$\therefore y=e^{-x}[1+2x]\Rightarrow y(2)=e^{-2}[1+4]=5e^{-2}$

5. The value of the integral $\oint_C \frac{2z+5}{\left(z-\frac{1}{2}\right)\left(z^2-4z+5\right)}dz$ over the contour $|z|=1$. taken in the anti-clockwise direction, would be

(A) $\frac{24\pi i}{13}$ (B) $\frac{48\pi i}{13}$ (C) $\frac{24}{13}$ (D) $\frac{12}{13}$

Key: (B)

Exp: Singular points are obtained by

$\left(z-\frac{1}{2}\right)\left(z^2-4z+5\right)=0\Rightarrow z=\frac{1}{2}$ & $z=2\pm i$

Out of these $z=\frac{1}{2}$ only lies inside C. $|z|=1$

$\therefore$ By Cauchy's integrated formula,

$$\oint_C \frac{2z+5}{\left(z-\frac{1}{2}\right)\left(z^2-4z+5\right)=0}dz=\oint_C \frac{\frac{2z+5}{z^2-4z+5}}{z-\frac{1}{2}}dz=2\pi i\left[\frac{2\left(\frac{1}{2}\right)+5}{\left(\frac{1}{2}\right)^2-4\left(\frac{1}{2}\right)+5}\right]=\frac{48\pi i}{13}$$

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6. The transfer function of a system is $\frac{Y(s)}{R(s)} = \frac{s}{s+2}$, The steady state output x(t) is A $\cos(2t+\varphi)$ for the input $\cos(2t)$. The value of A and φ, respectively are

(A) $\frac{1}{\sqrt{2}}, -45^{O}$ (B) $\frac{1}{\sqrt{2}}, +45^{O}$ (C) $\sqrt{2}, -45^{O}$ (D) $\sqrt{2}, +45^{O}$

Key: (B)

Exp: $H(s) = \frac{S}{S+2}$

$$H(\omega) = \frac{\omega}{\sqrt{\omega^2+4}} \underline{\left|90^0 - \tan^{-1}\left(\frac{\omega}{2}\right)\right.}$$

If input is COS 2t i.e., $\omega = 2$

$$H(\omega) = \frac{1}{\sqrt{2}} \underline{|45^0}$$

$$\rightarrow y(t) = \frac{1}{\sqrt{2}} \cos(2t + 45^0)$$

by comparision $A = \frac{1}{\sqrt{2}}$ & $\phi = 45_0$

7. The phase cross-over frequency of the transfer function $G(s) = \frac{100}{(s+1)^3}$ in rad/s is

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

Key: (A)

Exp: Phase Crossover frequency $\omega_{PC} : \underline{|GH}_{\omega=\omega_{PC}} = -180^0$

$$\underline{|GH} = -3\tan^{-1}\omega \Rightarrow -180^0 = -3\tan^{-1} w_{PC} \Rightarrow W_{PC} = \tan 60^0 = \sqrt{3}$$

8. Consider a continuous-time system with input x(t) and output y(t) given by $y(t) = x(t) \cos(t)$. This system is

(A) linear and time-invariant
(B) Non-linear and time-invariant
(C) linear and time-varying
(D) Non-linear and time-varying

Key: (C)

Exp: Linearity

$y_1(t) = x_1(t)\cos t; \quad y_2(t) = x_2(t)\cos t$

$\therefore y_1(t) + y_2(t) = x_1(t)\cos t + x_2(t)\cos t$

$y_1(t) + y_2(t) = [x_1(t) + x_2(t)]\cos t$

If $x_1(t) + x_2(t) = x(t)$ then $y_1(t) + y_2(t) = y(t)$

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Thus the system is linear

Time-invariance

consider $y_1(t) = x_1(t)\cos t$; If $x_1(t) = x(t-\tau)$

$\therefore y_1(t) = x(t-\tau)\cos t$

Define $y(t-\tau) = x(t-\tau)\cos(t-\tau)$

$\therefore y_1(t) \neq y(t-\tau)$ system is time-varient

9. The value of $\int_{-\infty}^{+\infty} e^{-t}\,\delta(2t-2)\,dt$. where $\delta(t)$ is the Dirac delta function, is

(A) $\frac{1}{2e}$ (B) $\frac{2}{e}$ (C) $\frac{1}{e^2}$ (D) $\frac{1}{2e^2}$

Key: (A)

10. A temperature in the range of $-40^{O}C$ to $55^{O}C$ is to be measured with a resolution of $0.1^{O}C$. The minimum number of ADC bits required to get a matching dynamic range of the temperature sensor is

(A) 8 (B) 10 (C) 12 (D) 14

Key: (B)

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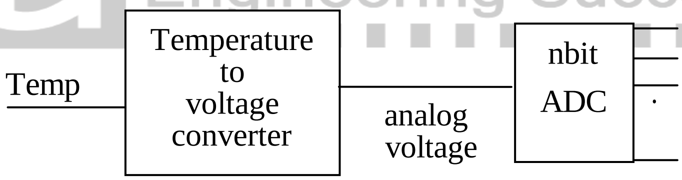
Exp: Usually when voltage information is given we use the formula $R = \frac{V_{max} - V_{min}}{2^n}$

Here based on the given information we can think the systems as following block diagram



$\rightarrow$ Here the V_{max} and V_{min} will be the equivalent of T_{max} and T_{min} respectively

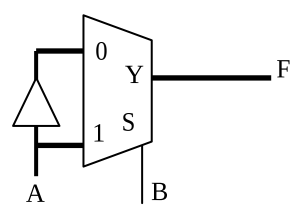
So we can still use the above relation

$\rightarrow$ Resolution $= \frac{T_{max} - T_{min}}{2^n} \Rightarrow 2^n = \frac{5-(-40)}{0.1} \Rightarrow 2^n = 950$

$\Rightarrow n = \log_2(950) = 9.89 \simeq 10$

So minimum requirement is 10 bits

11. Consider the following circuit which uses a 2-to-1 multiplexer as shown in the figure below. The Boolean expression for output F in terms of A and B is



(A) $A \oplus B$ (B) $\overline{A + B}$

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

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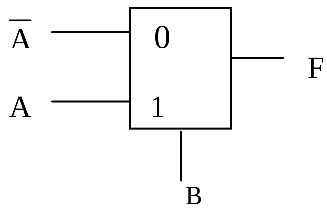
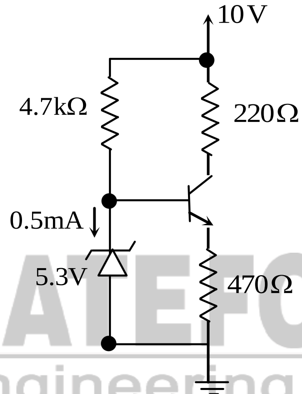
Key: **(D)**

Exp: We can redraw the max circuit as follows



So the Boolean expression of $F(A, B)=\bar{B}\bar{A}+BA=A\odot B=\overline{A\oplus B}$

12. A transistor circuit is given below. The Zener diode breakdown voltage is 53 V as shown The base to emitter voltage droop to be 0.6V. The value of the current gain β is ________.



Key: **19**

Exp: $5.3 = 0.6 + 470\, I_E$

$I_E = 0.01A$

$I_X = \dfrac{10 - 5.3}{4.7\times10^3} = 1mA$

$I_B = 1 - 0.5 = 0.5mA$

$I_E = (1+\beta)I_B$

$\Rightarrow 0.01 = (1+\beta)\times0.5\times10^{-3} \;\; \Rightarrow (1+\beta) = \dfrac{0.01}{0.5\times10^{-3}} = 20 \Rightarrow \beta = 19$

13. In cylindrical coordinate system, the potential produced by a uniform ring charge is given $\varphi = f(r, z)$, where f is a continuous function of r and z. Let $\vec{E}$ be the resulting electric field. Then the magnitude of $\nabla\times\vec{E}$

(A) increases with r (B) is 0

(C) is 3 (D) decreases with z

Key: **(B)**

Exp: Since the charge is not varying with time the field $\left(\bar{E}\right)$ is static So $\nabla\times\bar{E} = 0$

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14. A soft-iron toroid is concentric with a long straight conductor carrying a direct current I. If the relative permeability μ_r of soft-iron is 100, the ratio of the magnetic flux densities at two adjacent points located just inside and just outside the toroid, is ________.

Key: 100

Exp: The field inside and outside the toroid is due to long straight conductor only

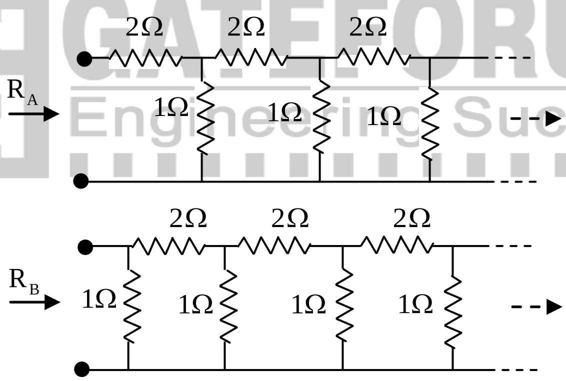
Let the two points almost at same distance

The flux density inside toroid $= \dfrac{\mu_0 \mu_r I}{2\pi r}$

The flux density outside toroid $= \dfrac{\mu_0 I}{2\pi r} T$

$$\text{Ratio} = \frac{\dfrac{\mu_0 \mu_r I}{2\pi r}}{\dfrac{\mu_0 I}{2\pi r}} = \mu_r = \boxed{100}$$

15. R_A and R_B are the input resistances of circuits as shown below. The circuits extend infinitely in the direction shown. Which one of the following statements is TRUE?



(A) $R_A = R_B$ (B) $R_A = R_B = 0$ (C) $R_A < R_B$ (D) $R_B = R_A/(1+R_A)$

Key: (D)

Exp: By comparing 2 network on the input side

we can say that $R_B = 1//R_A \Rightarrow R_B = \dfrac{R_A}{1+R_A}$

16. In a constant V/f induction motor drive, the slip at the maximum torque

(A) is directly proportional to the synchronous speed

(B) remains constant with respect to the synchronous speed

(C) has an inverse relation with the synchronous speed

(D) has no relation with the synchronous speed

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Key: (C)

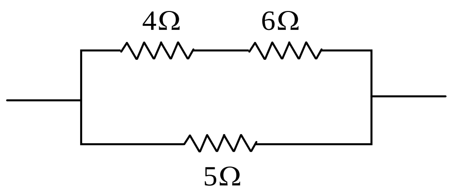
Exp: $$\text{SmT} = \frac{r_2}{x_2} = \frac{r_2}{j\omega L_2} = \frac{r_2}{j2\pi L_2.f}$$

$$\text{SmT}\ \alpha \frac{1}{f}$$

$$N_S = \frac{120f}{P}$$

$$\therefore\ \text{SMT}\ \alpha\ \frac{1}{NS}$$

17. In the portion of a circuit shown, if the heat generated in 5Ω resistance is 10 calories per second then heat generated by the 4Ω resistance, the calories per second, is ______.



Key: 2

Exp: Here the power information regarding the resistor is given because

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$$P = \frac{E}{t} = \frac{\text{Calorie}}{\text{sec}} = \text{watt}$$

$$\rightarrow P_{5\Omega} = 10$$

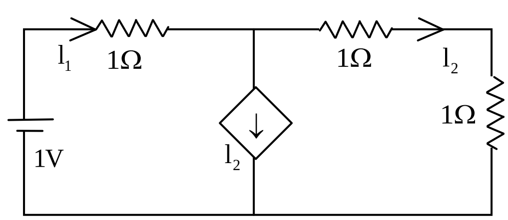
$$\Rightarrow \frac{V_{5\Omega}}{5\Omega} = 10 \quad \Rightarrow V_{5\Omega} = 50$$

$$\rightarrow P_{4\Omega} \text{ is asked}$$

$$P_{4\Omega} = \frac{(V_{4\Omega})^2}{4} = \frac{1}{4}\left[\frac{4}{4+6}\sqrt{50}\right]^2$$

$$= \frac{1}{4} \times \frac{16}{100} \times 50 = 2\frac{\text{calorie}}{\text{sec}}$$

18. In the given circuit, the current supplied by the battery, in ampere, is ________.



Key: 0.5

Exp: If we write KCL at node × then

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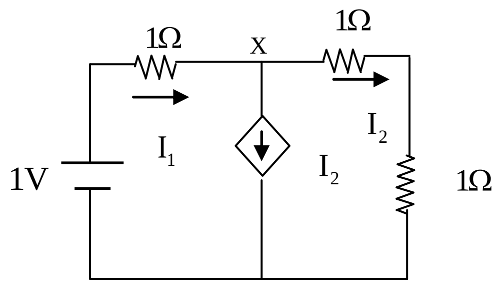
$I_1 = 2\,I_2 \Rightarrow I_2 = \frac{I_1}{2}$

Write KVL in the outer boundary of network

$$1-(1\times I_1)-(2\times I_2)=0 \Rightarrow 1 = I_1 + 2I_2$$

$$1 = I_1 + 2\left(\frac{I_1}{2}\right) \Rightarrow 1 = 2J_1 \Rightarrow I_1 = \frac{1}{2} = 0.5A$$



19. In a 100bus power system, there are 10 generators. In a particular iteration of Newton Raphson load flow technique (in polar coordinates). Two of the PV buses are converted to PQ type. In this iteration.
    (A) The number of unknown voltage angles increases by two and the number of unknown voltage magnitudes increases by two.
    (B) The number of unknown voltage angles remain unchanged and the number of unknown voltage magnitudes increases by two
    (C) The number of unknown voltage angles increases by two and the number of unknown voltage magnitudes decreases by two
    (D) The number of unknown voltage angles remains unchanged and the number of unknown voltage magnitudes decreases by two

Key: (B)

Exp: Total no of Buses = 100

Generator Buses = 10

$\therefore$ Load Buses = 100-10=90

Slack Bus = 1

If 2 of the PV buses are converted to PQ type the no of on voltage magnitudes increases by 2 with constant unknown voltage angles

20. The magnitude of three-phase fault current at buses A and B of a power system are 10 pu and 8 pu, respectively. Neglect all resistance in the system and consider the pre-fault system to be unloaded. The pre-fault voltage at all buses in the system is 1.0 pu. The voltage magnitude at bus B during a three-phase fault as but. A is 0.8pu. The voltage magnitude at bus A during a three-phase fault at bus B, in pu, is _____.

Key: 0.84

Exp: Voltage at ith bus when fault is at kth bus is

$$V_i = E\left(1-\frac{Z_{ik}}{Z_{kk}+Z_f}\right) \qquad I_f = \frac{V_{product}}{X_{(p.u)}}$$

$$10 = \xrightarrow[x_n]{1} X_A = 0.1P.U$$

$$8 = \xrightarrow[x_B]{1} \times B = 0.125P.U$$

$$V_B = E\left(1-\frac{Z_{AB}}{Z_{AA}}\right)$$

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$$0.8 = 1\left(1 - \frac{Z_{AB}}{0.1}\right) \Rightarrow Z_{AB} = 0.02$$

$$V_A = \left[1 - \frac{2AB}{2_{BB}}\right] = 1 - \left(1 - \frac{0.02}{0.125}\right) = 0.84 \text{ P.U}$$

21. Consider a system consisting of a synchronous generator working at a lagging power factor, a synchronous motor working at an overexcited condition and a directly grid-connected induction generator. Consider capacitive VAr to be a source and inductive VAr to be a sink of reactive power. Which one of the following statements is TRUE?

(A) Synchronous motor and synchronous generator are sources and induction generator is a sink of reactive power.

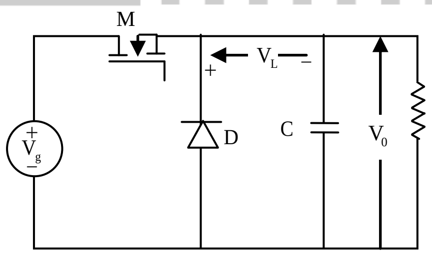
(B) Synchronous motor and induction generator are sources and synchronous generator is a sink of reactive power.

(C) Synchronous motor is a source and induction generator and synchronous generator are sinks of reactive power

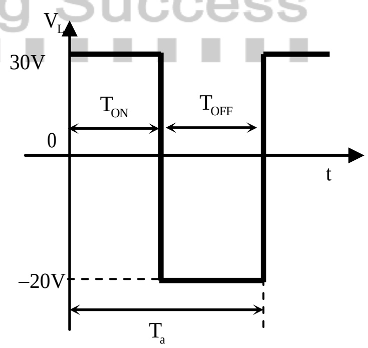
(D) All are sources of reactive power

Key: (A)

22. A buck converter, as shown in figure (a) below, is working in steady state. The output voltage and the inductor current can be assumed to be ripple free. Figure (b) shows the inductor voltage V_L during a complete switching interval. Assuming all devices are ideal, the duty cycle of the buck converter is _______



(a)



(b)

Key: 0.4

Exp: When M is ON, $V_S = V_L + V_0$

$\therefore V_L = 30 = V_S - V_0$

When M is OFF, $V_L = -V_0 \Rightarrow -20 = -V_0 \Rightarrow V_0 = 20$

$\therefore 30 + V_S - 20 \Rightarrow V_s = 50V$

$$D = \frac{V_0}{V_S} = \frac{2}{5} = 0.4$$

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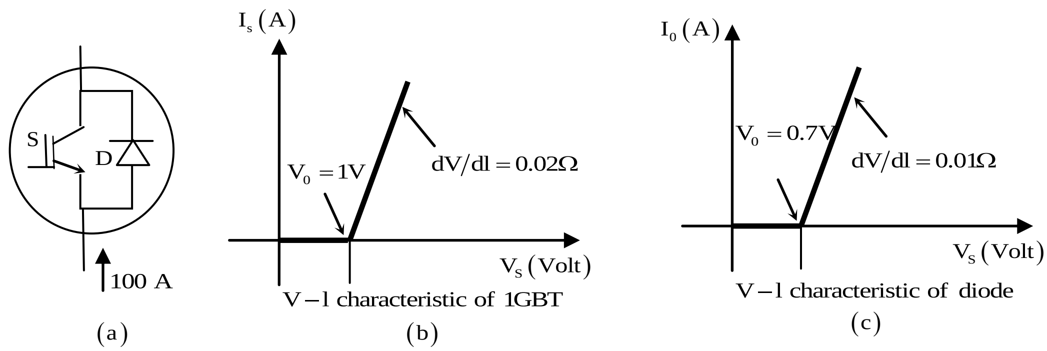
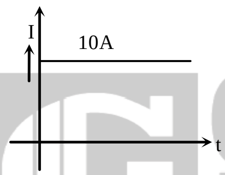
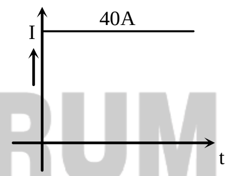
23. A steady dc current of 100A is flowing through a power module (S.D) as shown in Figure (a). The V-I characteristics of the IGBT (S) and the diode (D) are shown in Figures (b) and (c), respectively. The conduction power loss in the power module (S, D), in watts, is _____

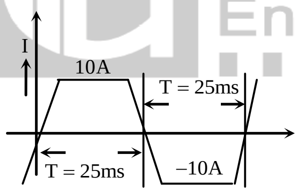


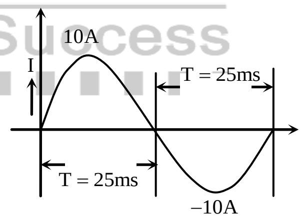
Key: 169 to 171

24. A 4pole, lap-connected, separately excited dc motor is drawing a steady current of 40 A while running at 600 rpm. A good approximation for the waveshape of the current in armature conductor of the motor is given by

(A)


(B)


(C)


(D)


Key: (C)

Exp: no of parallel paths = 4

Armature current/conductor = $\frac{40}{4}$ =10A

For linear commutation, the change from $+10A$ to $-10A$ is straight line

N = 600rpm

Time for 1 revolution =- 0.1 sec.

For 1 pole-pitch, $t = \frac{0.1}{4\,\text{poles}} = 25\,\text{m sec}$

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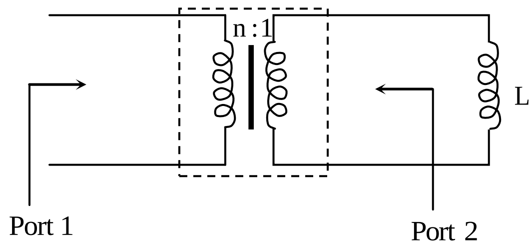
25. If an ideal transformer has an inductive load element at port 2 as shown in the figure below, the equivalent inductance at port 1 is

`



(A) nL (B) n^2L (C) $\frac{n}{L}$ (D) $\frac{n^2}{L}$

Key: (B)

Exp: The property of an ideal transformer is of port2 is terminated by an impedance Z_L then the impedance seen from port is $\frac{Z_L}{(N_Z/N_L)^2}$

In the given problem $Z_{in} = \frac{L}{(1/n)^2} = n^2L$

Q. No. 26 – 50 Carry Two Mark Each

26. Candidates were asked to come to an interview with 3 pens each. Black, blue, green and red were the permitted pen colours that the candidate could bring. The probability that a candidate comes with all 3 pens having the same colour is ______.

Key: 0.06

Exp: Total possible options = 4^3

Favorable choices {BBB, BlBlBl, GGG, RRR} = 4

Probability $= \frac{4}{4^3} = \frac{1}{16} = 0.06$

27. Let $S = \sum_{n=0}^{\infty} n\alpha^n$ where $|\alpha| < 1$. The value of α in the range $0 < \alpha < 1$. Such that $S = 2\alpha$ is ______.

Key: 0.293

Exp: $S = \sum_{n=0}^{\infty} n\,\alpha^n$

$\Rightarrow 2\alpha = \alpha + 2\alpha^2 + 3\alpha^3 + ---]\backslash$

$\Rightarrow 2\alpha = \alpha[1 + 2\alpha + 3\alpha^2 + ---]$

$\Rightarrow 2\alpha = \alpha[1-\alpha]^{-2}\text{if}\,|\alpha| < 1$

$\Rightarrow (1-\alpha)^{-2} = 2 \Rightarrow \alpha = 1 - \frac{1}{\sqrt{2}} \Rightarrow \alpha \simeq 0.293$

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28. Let the eigenvalues of a 2 x 2 matrix A be 1, -2 with eigenvectors x_1 and x_2 respectively. Then the eigenvalues and eigenvectors of the matrix $A^2 - 3A + 4I$ would, respectively, be

(A) $2, 14;\ x_1, x_2$ (B) $2, 14;\ x_1 + x_2, x_1 - x_2$

(C) $2, 0;\ x_1, x_2$ (D) $2, 0;\ x_1 + x_2,\ x_1 - x_2$

Key: **(A)**

Exp: Matrix A

Eigen values 1 , -2

Matrix A^2-3A+4I

$1^2 - 3(1) + 4, (-2)^2 - 3(-2) + 4$

Eigen values 2 , 14 respectively

$\therefore$ A & $P(A) = a_0I + a_1A + a_2A_2$ have same eigen vectors

29. Let A be a 4×3 real matrix with rank 2. Which one of the following statement is TRUE?

(A) Rank of A^TA is less than 2

(B) Rank of A^TA is equal 2

(C) Rank of A^TA is greater than 2

(D) Rank of A^TA can be any number between 1 and 3

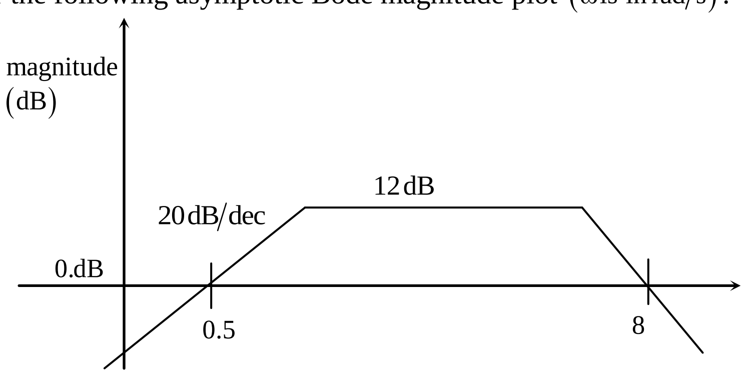
Key: **(B)**

Exp: Given that $\rho(A_{4\times3}) = 2$

From the properties of Rank; we have $\rho(AA^T) = \rho(A)$

$\Rightarrow$ Rank of AA^T = Rank of A^TA = Rank of A = 2

30. Consider the following asymptotic Bode magnitude plot $(\omega \text{ is in rad/s})$.



Which one of the following transfer function is best represented by the above Bode magnitude plot?

(A) $\dfrac{2s}{(1+0.5s)(1+0.25s)^2}$ (B) $\dfrac{4(1+0.5s)}{s(1+0.25s)}$

(C) $\dfrac{2s}{(1+2s)(1+4s)}$ (D) $\dfrac{4s}{(1+2s)(1+4s)^2}$

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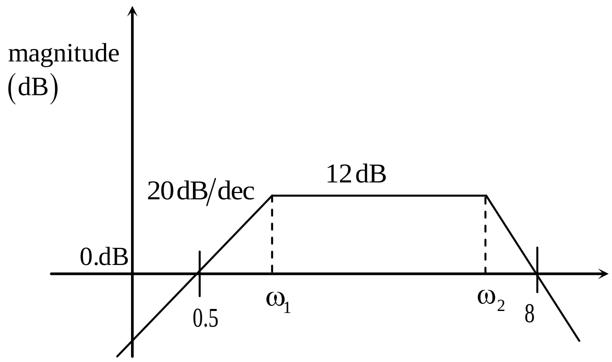
Key: **(A)**

Exp: By looking to the plot we can say that since the initial slope is +20 there must be a zero on the origin

If we find ω_2 we can get the answer by eliminating options



$$\text{Slope} = \frac{M_2 - M_1}{\log\omega_2 - \log\omega_1}$$

$$\Rightarrow -40 = \frac{0-12}{\log 8 - \log\omega_2}$$

$$\Rightarrow \log 8 - \log\omega_2 = \frac{12}{40}$$

$$\Rightarrow \log\omega_2 = \log 8 - \frac{12}{40} \quad \Rightarrow \omega_2 = 4$$

So one of the corner frequency is $\omega_2 = 4s$ at this frequency 2 poles should exist because the change in slope is -40db

From this we can say option A satisfies the condition

(i) A zero at origin

(ii) one of corner frequency 4H term will be $\left(1+\frac{s}{4}\right)$ having 2 poles

31. Consider the following state-space representation of a linear time-invariant system

$$\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} x(t),\ y(t) = c^T x(t),\ c = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

The value of y(t) for $t = \log_e 2$ is __________.

Key: **6**

32. Loop transfer function of a feedback system is $G(s)H(s) = \frac{s+3}{s^2(s-3)}$.Take the Nyquist contour in the clockwise direction. Then the Nyquist plot of G(s) H(s) encircles – 1 + j0

(A) Once in clockwise direction
(B) Twice in clockwise direction
(C) Once in anticlockwise direction
(D) Twice in anticlockwise direction

Key: **(A)**

Exp: $GH = \frac{S+3}{S(S-3)}$

$$|GH| = \frac{(\omega^2+a)^{1/2}}{\omega^2(\omega^2+a)^{1/2}} = \frac{1}{\omega^2}$$

$$\underline{|GH} = \left[\tan^{-1}\frac{\omega}{3}\right] - \left[180^0 + 180^0 - \tan^{-1}\frac{\omega}{3}\right] = 2\tan^{-1}\frac{\omega}{3}$$

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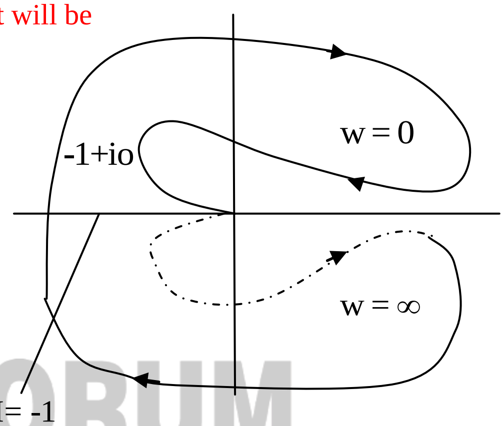
$\rightarrow GH = \frac{1}{\omega^2}\left|\underline{2\tan^{-1}\frac{\omega}{3}}\right.$

at $\omega = 0$, $GH = \infty\lfloor 0$

at $\omega = \infty$, $GH = 0\lfloor 180^0$

at $\omega = 3$, $GH = \frac{1}{9}\lfloor 90^0$

So the plot start at 0^0 and goes to 180^0 through 90^0 Since there are 2 poles on origin we will get $2\ \infty$ radius semicircle those will start where the mirror image ends and will terminate where the actual plot started in clockwise direction. So the plot will be



So the Nyquist plot of G(s) H(s) encircles – 1 + j0 once in clockwise direction

33. Given the following polynomial equation $s^3+5.5s^2+8.5s+3=0$, the number of roots of the polynomial, which have real parts strictly less than – 1, is _______

Key: 2

Exp: The polynomial is $S^3+5.5S^2+8.5S+3=0$, since we are interested to see the roots wrt S = -1 so in the above equation replace S by z-1 then the equation is

$(Z\text{-}1)^3+5.5(Z\text{-}1)^2+8.5(Z\text{-}1)+3=0$

$\Rightarrow Z^3\text{-}3Z^2+3Z\text{-}1+5.5(Z^2+1\text{-}2Z)+8.5Z\text{-}8.5+3=0$

$\Rightarrow Z^3+Z^2(-3+5.5)+Z(3+8.5\text{-}11)+(\text{-}1+5.5\text{-}8.5+3)=0$

$\Rightarrow Z^3+2.5Z^2+0.52-1=0$

Using RH table

Z^3	1	0.5
Z^2	2.5	–1
Z^1	0.9	
Z^0	–1	

The single sign change in 1st column indicate that out of 3 roots 1 root lie on the right half of S = -1 plane if memory remaining 2 lies on left half of S = -1 plane.

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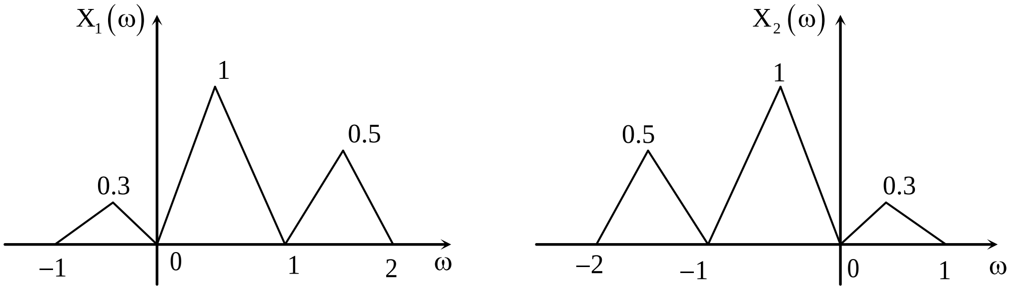
34. Suppose $x_1(t)$ and $x_2(t)$ have the Fourier transforms as shown below.



Which one of the following statements is TRUE?

(A) $x_1(t)$ and $x_2(t)$ are complex and $x_1(t)x_2(t)$ is also complex with nonzero imaginary part

(B) $x_1(t)$ and $x_2(t)$ are real and $x_1(t)x_2(t)$ is also real

(C) $x_1(t)$ and $x_2(t)$ are complex but $x_1(t)x_2(t)$ is real

(D) $x_1(t)$ and $x_2(t)$ are imaginary but $x_1(t)x_2(t)$ is real

Key: (C)

Exp: $x_1(t)$ & $x_2(t)$ are complex functions

$x_2(\omega) = x_1(-\omega)$, $x_2(t) = x_1(-t)$

$\therefore x_1(t)\ x_2(t)$ will be real

35. The output of a continuous-time, linear time-invariant system is denoted by $T\{x(t)\}$ where $x(t)$ is the input signal. A signal z(t) is called eigen-signal of the system T, when $T\{z(t) = \gamma z(t),\}$, where γ is a complex number, in general, and is called an eigen value of T. suppose the impulse response of the system T is real and even. Which of the following statements is TRUE?

(A) cos(t) is and eigen-signal but sin(t) is not

(B) cos(t) is and sin(t) are both eigen-signal but with different eigenvalues

(C) sin(t) is an eigen-signal but cos(t) is not

(D) cos(t) and sin(t) are both eigen-signal with identical eigenvalues

Key: (D)

Exp: Consider the Eigen signal Z(t) = Cos t

For Cost, $y(t) = \int_{-\infty}^{\infty} \cos(t-\tau)h(\tau)d\tau \;\; = \int_{-\infty}^{\infty} (\cos t\cos\tau + \sin t\sin\tau)h(\tau)d\tau$

$$= \cos t\int_{-\infty}^{\infty} \cos\tau h(\tau)d\tau + \sin t\int_{-\infty}^{\infty} \sin\tau h(\tau)d\tau$$

$\therefore h(\tau)$ is an even signal $\int_{-\infty}^{\infty} \sin\tau h(\tau)d\tau = 0$

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$$\therefore y(t) = \cos t \int_{-\infty}^{\infty} \cos \tau h(\tau) d\tau$$

Thus the integration value will be an Eigen value γ.

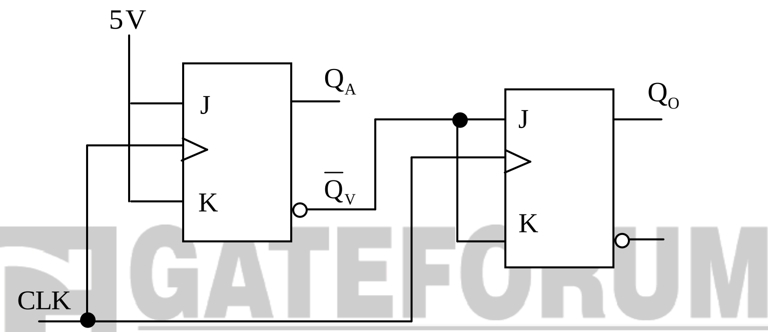
Similarly consider the Eigen signal Z(t) = sin t

For sint, $y(t) = \int_{-\infty}^{\infty} \sin(t-\tau)h(\tau)d\tau = \sin t \int_{-\infty}^{\infty} \cos \tau h(\tau)d\tau + \cos t \int_{-\infty}^{\infty} \sin \tau h(\tau)d\tau$

Thus $y(t) = \sin t \int_{-\infty}^{\infty} \cos \tau h(\tau)d\tau$

$\therefore$ Eigen value 'γ 'is same for both the Eigen functions sint & cost

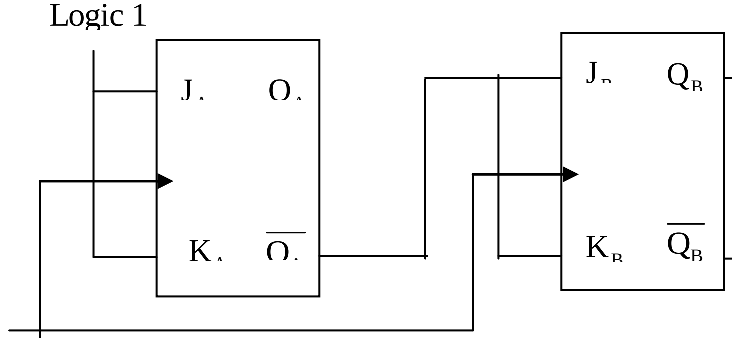
36. The current state Q_A Q_B of a two JK flip-flop system is 00. Assume that the clock rise-time is much smaller than the delay of the JK flip-flop. The next state of the system is



(A) 00 (B) 01 (C) 11 (D) 10

Key: **(C)**

Exp:



$J_A = K_A = 1$

$J_B = K_B = \overline{Q_A}$

It is given initially $Q_A\ Q_B = 0$

Since it is a synchronous counter, when clock is applied both flipflop will change there state simultaneously based on JK FF state table

$\rightarrow [J_A = 1, K_A = 1], [Q_A = 0] \rightarrow Q_A^+ = 1$

$[J_B = 1, K_B = 1], [Q_B = 0] \rightarrow Q_B^+ = 1$

So next state $Q_A^+ Q_B^+$ is 11

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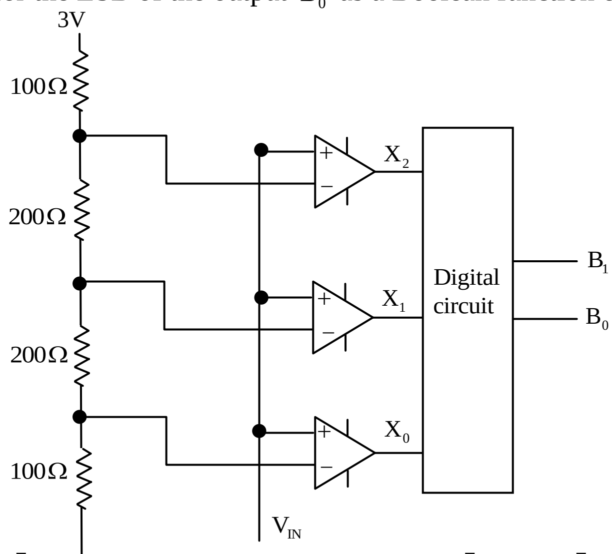
37. A 2-bit flash Analog to Digital Converter (ADC) is given below. The input is $0 \le V_{IN} \le 3$ Volts. The expression for the LSB of the output B_0 as a Boolean function of X_2, X_1, and X_0 is



(A) $X_0\left[\overline{X_2 \oplus X_1}\right]$ (B) $\overline{X}_0\left[\overline{X_2 \oplus X_1}\right]$

(C) $X_0\left[X_2 \oplus X_1\right]$ (D) $\overline{X}_0\left[X_2 \oplus X_1\right]$

Key: (A)

38. Two electric charges q and -2q are placed at (0,0) and (6,0) on the x-y plane. The equation of the zero equipotential curve in the x-y plane is

(A) $x = -2$ (B) $y = 2$ (C) $x^2 + y^2 = 2$ (D) $(x+2)^2 + y^2 = 16$

Key: (D)

Exp: The potential due to Q 4-2Q at (x, y) is $= \dfrac{q}{k\sqrt{x^2+y^2}} - \dfrac{2q}{k\sqrt{(x\text{-}6)^2+y^2}}$

If potential at (x, y) = 0 where $k = \dfrac{1}{4\pi\varepsilon}$

$$\frac{q}{k\sqrt{x^2+y^2}} - \frac{2q}{k\sqrt{(x\text{-}6)^2+y^2}} = 0 \Rightarrow \sqrt{(x\text{-}6)^2+y^2} - 2\sqrt{x^2+y^2} = 0$$

$$\Rightarrow (x\text{-}6)^2 + y^2 = 4(x^2+y^2) \Rightarrow x^2 + 36 - 12x + y^2 = 4x^2 + 4y^2$$

$$\Rightarrow x^2 + y^2 - 4x - 12 = 0$$

Option:D $(x+2)^2 + y^2 = 16 \Rightarrow x^2 + 4x + 4 + y^2 = 16 \Rightarrow x^2 + y^2 + 4x - 12 = 0$

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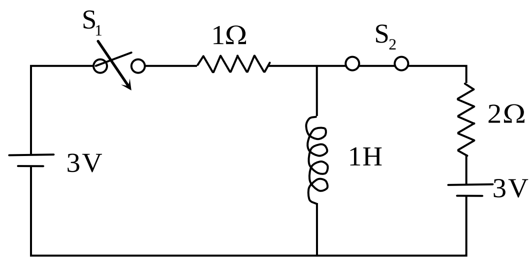
39. In the circuit shown, switch S_2 has been closed for a long time. A time t = 0 switch S_1 is closed At $t = 0^+$, the rate of change of current through the inductor, in amperes per second, is _______.



Key: 2

Exp: At $t = 0^-$ Network is in steady state with S_1 opens S_2 (closed) So we can say $i_L(0^-)=\frac{3}{2}=1.5A$

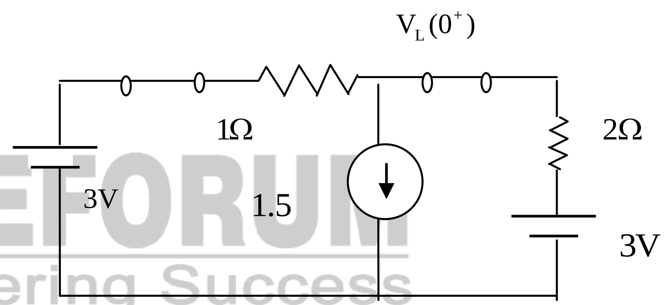
At $t = 0^+$ indicator behaves as ideal current source of 1.5A if we draw the network at $t = 0^+$, both switch closed

Writing Nodes equation at $V_L(0^+)$ node

$$V_L(0^+)=\left(\frac{1}{1}+\frac{1}{2}\right)=\frac{3}{1}+\frac{3}{2}-1.5$$

$$\Rightarrow V_L(0^+) = 2$$

$$\Rightarrow L\frac{di(0^+)}{dt}=2 \Rightarrow \frac{di_L(0^+)}{dt}=2A/sec$$



at $t = 0^+$

GATEFORUM Engineering Success

40. A three-phase cable is supplying 800kW and 600kVAr to an inductive load, It is intended to supply an additional resistive load of 100kW through the same cable without increasing the heat dissipation in the cable, by providing a three-phase bank of capacitors connected in star across the load. Given the line voltage is 3.3kV, 50Hz, the capacitance per phase of the bank, expressed in microfarads, is _________.

Key: 47 to 49

41. A 30MVA, 3-phase, 50Hz 13.8kV, star-connected synchronous generator has positive, negative and zero sequence reactance, 15%,15% and 5% respectively. A reactance (X_n) is connected between the neutral of the generator and ground. A double line to ground fault takes place involving phases 'b' and 'c', with a fault impedance of j0.1 p.u. The value of X_n (in p.u.) that will limit the positive sequence generator current to 4270 A is ________.

Key: 1.108

Exp: $X_1 = 0.15$ P.U

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$$I_{base} = \frac{30\times10^6}{\sqrt{3}\times 13.8\times10^3} = 1255.109$$

$$X_2 = 0.15\text{P.U}$$

$$X_0 = 0.05\text{P.U}$$

$$X_f = 0.1\text{P.U}$$

$$I(\text{P.U}) = \frac{I_{actual}}{I_{base}} = \frac{4270}{1255.109}\ 3.4(\text{P.U})$$

$$I_{a1} = \frac{Ea}{Z_1 + (Z_2 \parallel Z_O + 3z_f + 3z_n)}$$

$$3.4 = \frac{1}{0.15 + [Z_2 \parallel Z_0 + 3z_f + 3z_n]}$$

$$Z_2 \parallel (20 + 3z_f + 3z_n) = 0.144$$

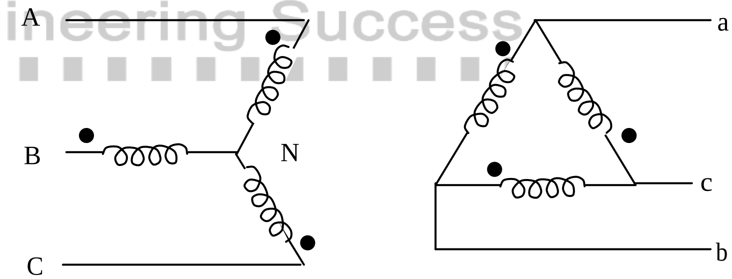
$$\frac{1}{Z_2} + \frac{1}{20 + 3z_f + 3z\ln} = \frac{1}{0.144}$$

$$20 + 3z_f + 3z_n = 3.675$$

$$3z_n = 3.675 - 0.05 - 3\times0.1$$

$$Z_n = 1.108\text{P.U}$$

42. If the star side of the star-delta transformer shown in the figure is excited by a negative sequence voltage, then



(A) V_{AB} leads V_{ab} by 60^O

(B) V_{AB} lags V_{ab} by 60^O

(C) V_{AB} leads V_{ab} by 30^O

(D) V_{AB} lags V_{ab} by 30^O

Key: (D)

43. A single-phase thyristor-bridge rectifier is fed from a 230V, 50Hz, single-phase, AC mains. If it is delivering a constant DC current 10A, at firing angle of 30^O, then value of the power factor at AC mains is

(A) 0.87 (B) 0.9 (C) 0.78 (D) 0.45

Key: (C)

Exp: IPF = $0.9\cos\alpha = 0.9\cos30 = 0.78$

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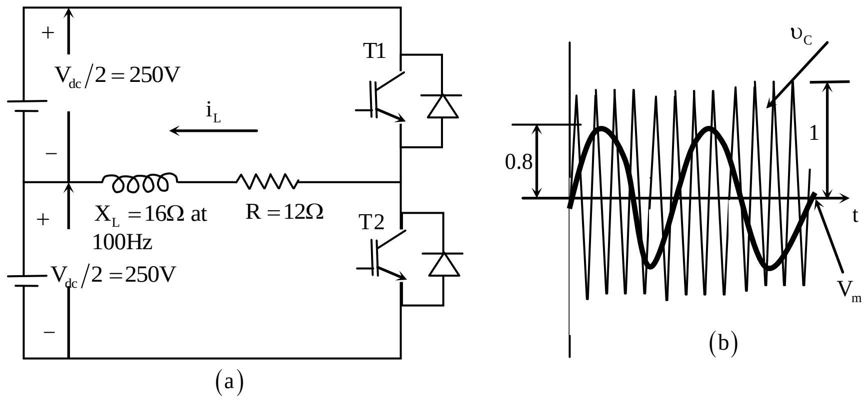
44. The switches T1 and T2 are shown in Figure (a).



They are switched in a complementary fashion with sinusoidal pulse width modulation technique. The modulating voltage $\upsilon_m(t) = 0.8\sin(200\pi t)$ V and the triangular carrier voltage (υ_c) are as shown in Figure (b). The carrier frequency is 5kHz. The peak value of the 100Hz component of the load current (i_L), in ampere, is ______.

Key: 10

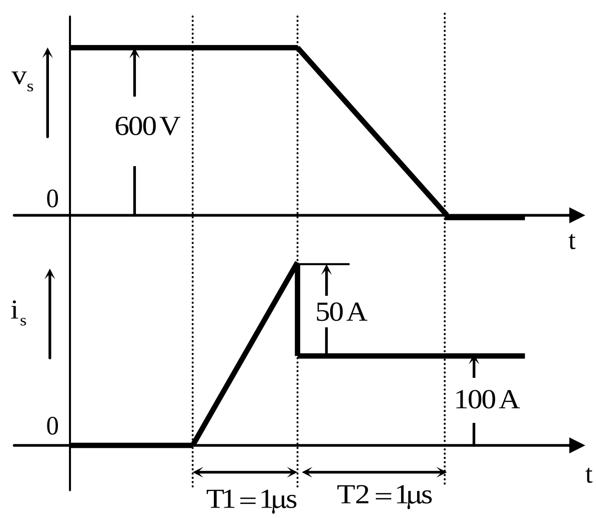
Exp: $m_a = \frac{V_m}{V carrier} = 0.8$

$V_{01}(max) = ma.\frac{Vds}{2} = 0.8 \times 250 = 200V$

$2L = \sqrt{16^2 + 12^2} = 20\Omega$

$I_L(max) = \frac{200}{20} = 10A$

45. The voltage (υ_s) across and the current (I_g) through a semiconductor switch during a turn-ON transition are shown in figure. The energy dissipated during the turn – ON transition, in mJ, is _________.



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Key: **75**

Exp: $E = \int Pdt = \int V(t)\ell tdt = 600\left[\frac{1}{2}\times 150\times 10^{-6}\right] + 100\left[\frac{1}{2}\times 600\times 10^{-6}\right] = 75mJ$

46. A single-phase 400V, 50Hz transformer has an iron loss of 5000W at the condition. When operated at 200V, 25Hz, the iron loss is 2000W. When operated at 416V, 52Hz, the value of the hysteresis loss divided by the eddy current loss is

Key: **1.4423**

Exp: Since $\frac{V}{f}\left(\frac{400}{50} = \frac{200}{2.5} = 8\right)$ is constant, Bm is constant

$P_{core} = P_h + P_e = k_1 f + k_2 f^2$

$P_h = k_1 f$ $\qquad$ $5000 = 50k_1 + 50^2 . k_2 = 50k_1 + 2500k_2$

$P_e = K_2 f^2$ $\qquad$ $2000 = 25k_1 + 25k_1 + 25^2\ k_2 = 25k_1 + 625k_2$

$$\left.\begin{matrix} k_1 + 50k_2 + 100 \\ k_1 + 25k_2 = 80 \end{matrix}\right\} \begin{matrix} k_2 = 0.8 \\ k_1 = 60 \end{matrix}$$

$\therefore\ P_{core} = 60f + (0.8)f^2$

$P_h = 60f$

$P_e = 0.8f^2$

When $f = 52Hz,\ P_h = 60\times 52 = 3120$

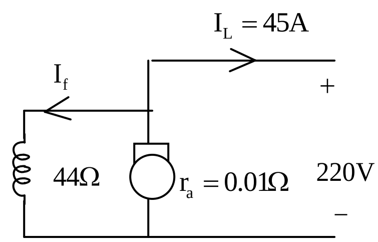
$P_e = 0.8\times 52^2 = 2163.2$

$\frac{P_h}{P_e} = \frac{3120}{2163.2} = 1.4423$

47. ADC shunt generator delivers 45 A at a terminal voltage of 220V. The armature and the shunt field resistance are 0.01Ω and 44Ω respectively. The stray losses are 375W. The percentage efficiency of the DC generator is ______.

Key: **86.84**

Exp: $P_{out} = 220\times 45 = 990W$



$I_f = \frac{220}{44} = 5A$

$I_a = I_L + I_f = 45 + 5 = 50A$

Armature losses = $I_a^2 r_a = 50^2\times 0.01 = 25W$

Field losses = $I_f^2 R_f = 5^2\times 44 = 1100W$

Stray losses = 375W

Total losses = 1500W

$losses = \left(\frac{1}{\eta} - 1\right) P_{out}$

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$$1500 = \left(\frac{1}{\eta} - 1\right) 9900 \Rightarrow \eta = 86.84\%$$

48. A three-phase, 50Hz salient-pole synchronous motor has a per-phase direct-axis reactance (X_d) of 0.8pu and a per-phase quadrature-axis reactance (X_q) of 0.6pu. Resistance of the machine is negligible. It is drawing full-load current at 0.8pf (leading)j. When the terminal voltage is 1pu, per-phase induced voltage, in pu, is ______.

Key: 1.608

Exp: $X_d = 0.8\text{P.U} \quad \text{P.f} = 0.8 \text{ leading } Ra = 0$

$X_q = 0.6\text{PU} \quad Vt = 1\text{P.U}$

$\cos\phi = 0.8 \Rightarrow \phi = 36..86$

$I_a = 1\underline{|36.86}$

$$\tan\delta = \frac{I_a \times q\cos\phi + I_a R_a \sin\phi}{V_t + I_a \times q \sin\phi - I_a R_a \cos\phi} = \frac{I_a \times q\cos\phi}{V_t + Ia \times q \sin\phi} = \frac{1\times 0.6\times 0.8}{1+1\times 0.6\times 0.6} = 0.3529$$

$\delta = 19.44^O$

$\varphi = \phi + \delta = 36.86 + 19.44 = 56.3$

$I_d = I_a \sin\varphi = 1\times\sin 56.4 = 0.832$

$I_q = I_a \cos\varphi = 1\times 0.5547 = 0.5547$

$Ef = V\cos\delta + Id\times d - I_q R_a 0 = V\cos\delta + I_d \times d = 1.\cos 19.44 + 0.832\times 0.8 = 1.608\text{pu}$

$E_F = 1.608\,\text{PU}$

49. A single-phase, 22kVA, 2200V/220, 50Hz, distribution transformer is to be connected as an auto-transformer to get an output voltage of 2420 V. Its maximum kVA rating as an auto-transformer is

(A) 22 (B) 24.2 (C) 242 (D) 2420

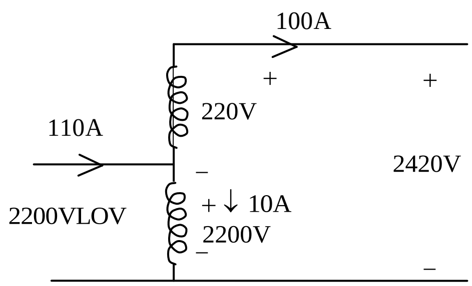
Key: (C)

Exp: Rated LV current $= \dfrac{22\text{kVA}}{220} = 100\text{A}$

$$KVA_{max} = \frac{2200\times 10}{1000} = 242\text{kVA}$$

Or

$$= \frac{2420\times 100}{1000} = 242\text{kVA}$$



50. A single-phase full-bridge voltage source inverter (VSI) is fed from a 300 V battery. A pulse of 120^O duration is used to trigger the appropriate devices in each half-cycle. The rms value of the fundamental component of the output voltage, in volts, is

(A) 234 (B) 245 (C) 300 (D) 331

Key: (A)

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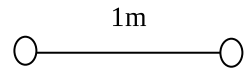
Exp: $V_O(t) = \sum_{n=1,3,s}^{\infty} \left(\frac{4Vs}{n\pi}\right) \cos\frac{n\pi}{6} \sin n(\omega t)$

$$V_{01} = \frac{1}{\sqrt{2}}\left[\frac{4V_S}{\pi}\right] \cos\pi/6 = 233.9 \approx 234V$$

51. A single-phase transmission line has two conductors each of 10mm radius. These are fixed a center-to-center distance of 1m in a horizontal plane. This is now converted to a three-phase transmission line by introducing a third conductor of the same radius. This conductor is fixed at an equal distance D from the two single-phase conductors. The three-phase line is fully transposed. The positive sequence inductance per phase of the three-phase system is to be 5% more than that of the inductance per conductor of the single-phase system. The distance D, in meters, is _______.

Key: **1.439**

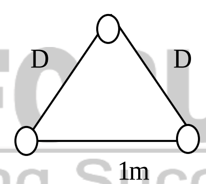
Exp: For single phase



$$L_{1-\phi} = 0.2\lambda n\left(\frac{D_m}{Ds}\right) = 0.2\ell n\left(\frac{1}{D_s}\right)$$

For three phase

$$L3-\phi = 0.2\ell n\frac{DM}{DS} = 0.2\ell n\left(\frac{D^{2/3}}{Ds}\right)$$



$$D_m = 3\sqrt{D.D.1} = D^{2/3}$$

$$L_3-\phi = 1.05L1-\phi$$

$$0.2\ \ell\left(\frac{D^{2/3}}{D_S}\right) = 1.05\ (0.2)\ell n\left(\frac{1}{DS}\right)$$

$\therefore D = 1.439$ mts

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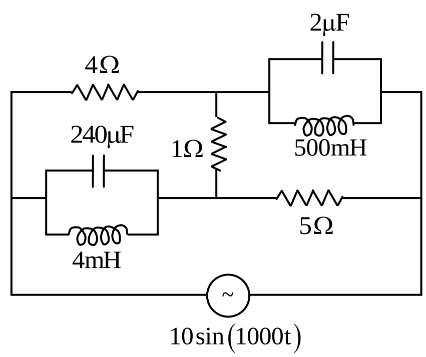
52. In the circuit shown below, the supply voltage is $10\sin(1000t)$ volts. The peak value of the steady state current through the 1Ω resistor, in amperes, is _________.



Key: 1

Exp: W =1000, the various impedance at this frequency are

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$\rightarrow Z_{250\mu f} \| Z_{4mH} = \left[\dfrac{-j}{1000 \times 250 \times 10^{-6}}\right] \| (j\,1000 \times 4 \times 10^{-3})$

$= (-j4) \| (j4) = \infty = \text{open circuit}$

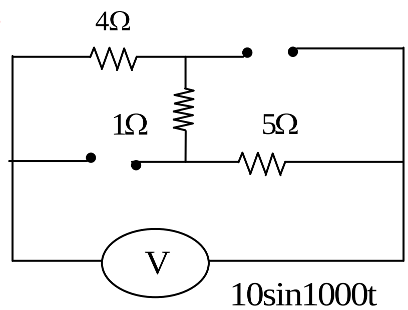
$\rightarrow Z_{24f} \| Z_{500mH} = \left[\dfrac{-j}{1000 \times 250 \times 10^{-6}}\right] \| (j\,1000 \times 500 \times 10^{-3})$

$= (-j500) \| (j500) = \infty = \text{open circuit}$

Since both LC pair parallel combination becomes open then the circuit can be redrawn as

$\rightarrow I_{1\Omega} = \dfrac{10\sin 1000t}{4+1+5} = \sin 1000t$

$\rightarrow$ So peak value of $I_{1\Omega} = 1A$



53. A dc voltage with ripple is given by $\upsilon(t) = [100 + \sin(\omega t) - 5\sin(3\omega t)]$ volts. Measurements of this voltage $\upsilon(t)$, made by moving-coil and moving-iron voltmeters, show readings of V_1 and V_2 respectively. The value of $V_2 - V_1$, in volts, is _______.

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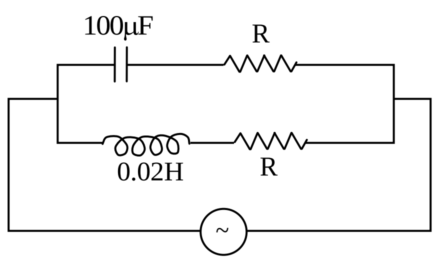
Key: 0.312

Exp: $V_1 = 100V$

$V_2 = \sqrt{100^2 + \left(\dfrac{10}{\sqrt{2}}\right)^2 + \left(\dfrac{5}{\sqrt{2}}\right)^2} = 100.312V$

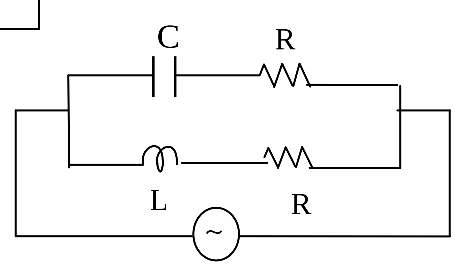
$V_2 - V_1 = 0.312\,V$

54. The circuit below is excited by a sinusoidal source. The value of R, in Ω, for which the admittance of the circuit becomes a pure conductance at all frequencies is ________.



Key: 14.14

Exp: Admittance becomes pure conductance means the imaginary part of Y must be zero which imply resonance condition.
Let first get Y expression interms of L,C then by equalising imaginary part we will



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get the answer.

$$Y=\frac{1}{R+j\omega L}+\frac{1}{R-\frac{1}{\omega C}}=\frac{R-j\omega L}{R^2+(\omega L)^2}+\frac{R+\frac{j}{\omega C}}{R^2+\left(\frac{1}{\omega C}\right)^2}\Rightarrow \text{Img}[Y_{eq}]=0$$

$$\Rightarrow\frac{\omega L}{R^2+(\omega L)^2}=\frac{\frac{1}{\omega C}}{R^2+\left(\frac{1}{\omega C}\right)^2}$$

$\Rightarrow$ Cross multiplying

$$(\omega L)R^2+\omega L\left(\frac{1}{\omega C}\right)^2=\left(\frac{1}{\omega C}\right)R^2+(\omega L)^2\frac{1}{\omega C}$$

$$\Rightarrow R^2\left[\omega L-\frac{1}{\omega C}\right]=\left(\frac{1}{\omega C}\right)\left(\omega L-\frac{1}{\omega C}\right)=0$$

$$\Rightarrow\left(R^2-\frac{L}{C}\right)\left[\omega L-\frac{1}{\omega C}\right]=0$$

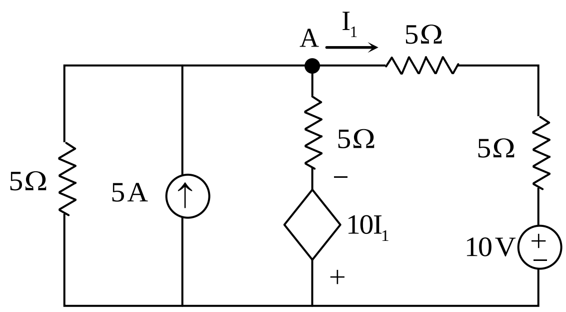
Now by looking into above equation we can say that if

$R^2=\frac{L}{C}$ then it will have no depending on frequency

for resonance $\Rightarrow R^2=\frac{L}{C}$

So $R=\sqrt{\frac{L}{C}}=\sqrt{\frac{0.02}{100\times10^{-6}}}=10\sqrt{2}=14.14\Omega$

55. In the circuit shown below, the node voltage V_A is _________V.



Key: **11.42**

Exp: All the branch currents are expressed interval of V_A now writing KCL at node A

$$\Rightarrow\frac{V_A}{5}-5+\frac{V_A+10I_1}{5}+\frac{V_A-10}{5}=0$$

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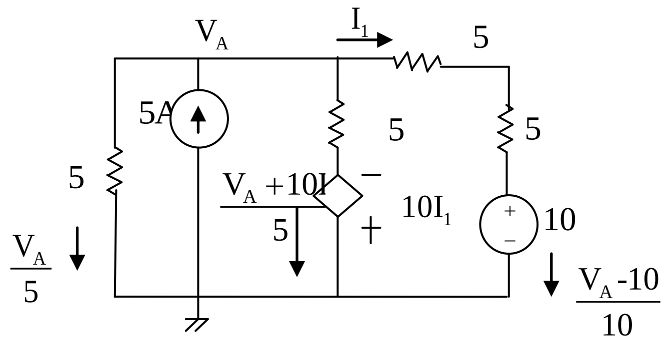
$$\Rightarrow V_A\left(\frac{1}{5}+\frac{1}{5}+\frac{1}{10}\right)+2I_1=5+1$$

$$\Rightarrow V_A\left(\frac{2}{5}+\frac{1}{10}\right)+2\left(\frac{V_A-10}{10}\right)=6$$

$$\Rightarrow V_A\left(\frac{2}{5}+\frac{1}{10}+\frac{2}{10}\right)=6+2$$

$$\Rightarrow V_A\left(\frac{7}{10}\right)=8\Rightarrow V_A=\frac{80}{7}=11.42V$$



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