General Aptitude

Q. No. 1 – 5 Carry One Mark Each

1. The chairman requested the aggrieved shareholders to ___________him.

(A) bare with (B) bore with (C) bear with (D) bare

Key: (C)

2. Identify the correct spelling out of the given options:

(A) Managable (B) Manageable (C) Manageble (D) Managible

Key: (B)

3. Pick the odd one out in the following

13, 23, 33, 43, 53

(A) 23 (B) 33 (C) 43 (D) 53

Key: (B)

Exp: Given numbers are 13, 23, 33, 43, 53.

All the numbers have second digits as 3.

If We sum of the digits of each number we get 4, 5, 6, 7, 8.

All given numbers are irrational numbers except 33 which is rotation.

So odd one out is 33.

4. R2D2 is a robot. R2D2 can repair aeroplanes. No other robot can repair aeroplanes.

Which of the following can be logically inferred from the above statements?

(A) R2D2 is a robot which can only repair aeroplanes.

(B) R2D2is the only robot which can repair aeroplanes.

(C) R2D2 is a robot which can repair only aeroplanes.

(D) Only R2D2 is a robot.

Key: (B)

5. If $|9y-6|=3$, then $y^2-4y/3$ is __________.

(A) 0 (B) $+1/3$ (C) $-1/3$ (D) undefined

Key: (C)

Exp: $|9Y-6|=3$

Possibility (A): $9y=9\Rightarrow \boxed{y=1}$

Possibility (B): $9y=3\Rightarrow \boxed{y=\frac{1}{3}}$

When y=1

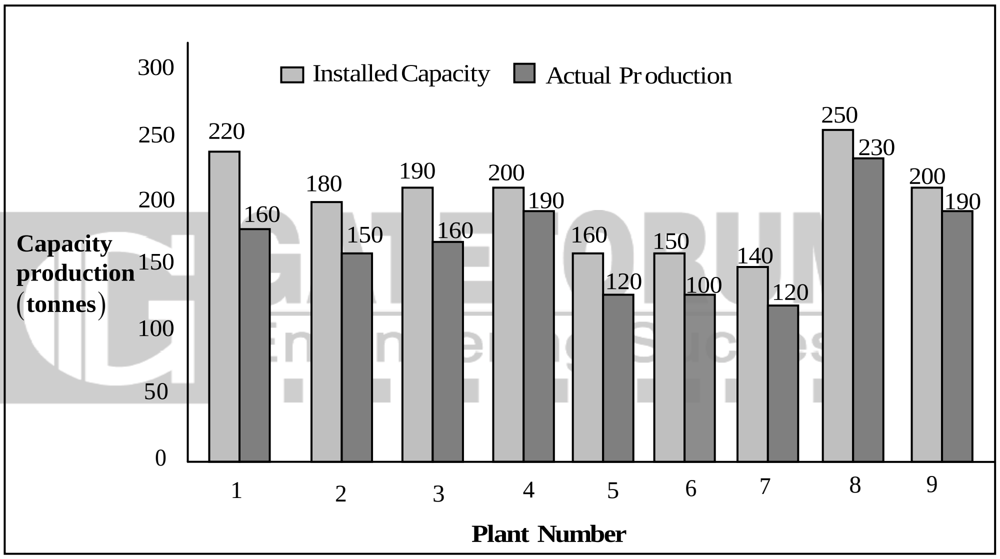
$$y^2-\frac{4y}{3}=1^2-\frac{4(1)}{3}=\frac{3-4}{3}=-\frac{1}{3}$$

When $y = \frac{1}{3}$

$$\left(\frac{1}{3}\right)^2 - \frac{4\left(\frac{1}{3}\right)}{3} = \frac{1}{9} - \frac{4}{9} = \frac{-3}{9} = -\frac{1}{3}$$

Q. No. 6 – 10 Carry Two Mark Each

6. The following graph represents the installed capacity for cement production (in tones) and the actual production (in tones) of nine cement plants of a cement company Capacity utilization of a plant is defined as ratio of actual production of cement to installed capacity. A plant with installed capacity of at least 200 tonnes is called a large plant and a plant with lesser capacity is called a small plant. The difference between total production of large plants and small plants, in tones is



Key: **120**

Exp: Largent plant

Installed Capacity	220	200	250	200
Actual production	160	190	230	190
Plant number	1	4	8	9

Total production of larger plants = 160+190+230+190=770 tonnes

Smaller Plants

Installed Capacity	180	190	160	150	140
Actual production	150	160	120	100	120
Plant number					

Total production of smallest plants = 150+160+120+100+120= 650tonnes

Difference = 770-650 = 120 tonnes

7. A poll of students appearing for masters in engineering indicated that 60% of the students believed that mechanical engineering is a profession unsuitable for women. A research study on women with master or higher degrees in mechanical engineering found that 99% of such women were successful in their professions.

Which of the following can be logically inferred from the above paragraph?

(A) Many students have isconceptions regarding various engineering disciplines

(B) Men with advanced degrees in mechanical engineering believe women are well suited to be mechanical engineers.

(C) Mechanical engineering is a profession well suited for women with masters or higher degrees in mechanical engineering.

(D) The number of women pursuing high degrees in mechanical engineering is small.

Key: (C)

8. Sourya committee had proposed the establishment of Sourya Institutes of Technology (SITs) in line with Indian Institutes of Technology (IITs) to cater to the technological and industrial needs of a developing country.

Which of the following can be logically inferred from the above sentence?

Based on the proposal,

(i) In the initial years, SIT students will get degrees from IIT.

(ii) SITs will have a distinct national objective

(iii) SIT like institutions can only be established in consultation with IIT.

(iv) SITs will serve technological needs of a developing country.

(A) (iii) and (iv) only
(B) (i) and (iv) only
(C) (ii) and (iv) only
(D) (ii) and (iii) only

Key: (C)

9. Shaquille O' Neal is a 60% career free throw shooter, meaning that he successfully makes 60 free throws out of 100 attempts on average. What is the probability that he will successfully make exactly 6 free throws in 10 attempts?

(A) 0.2508 (B) 0.2816 (C) 0.2934 (D) 0.6000

Key: (A)

10. The numeral in the units position of $211^{870} + 146^{127} \times 3^{424}$ is _____.

Key: (7)

Electrical Engineering

Q. No. 1 –25 Carry One Mark Each

1. The output expression for the Karnaugh map shown below is

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

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

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

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

A \ BC	00	01	11	10
0	1	0	0	1
1	1	1	1	1

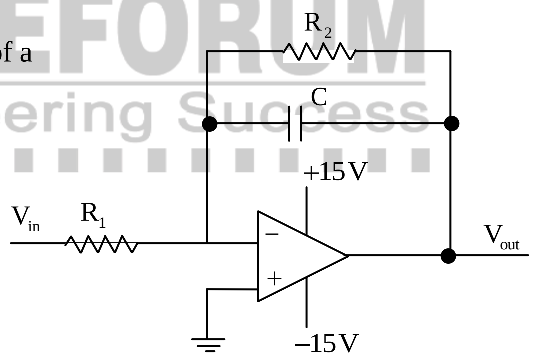
Key: (B)

Exp:

	$\overline{B}\,\overline{C}$	$\overline{B}\,C$	$B\,C$	$B\,\overline{C}$
$\overline{A}$	1	0	0	1
A	1	1	1	1

$$F(A,B,C) = A+\overline{C}$$

2. The circuit shown below is an example of a



(A) low pass filter

(B) band pass filter

(C) high pass filter

(D) notch filter

Key: (A)

Exp: $Z_1 + R_i,\ Z_2 = \dfrac{R_2 \times \frac{1}{cs}}{R_2 + \frac{1}{c_s}} = \dfrac{R_2}{1+R_2CS}$

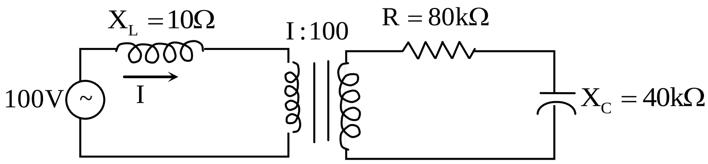
$$TF = -\frac{Z_2}{Z_1} = -\frac{R_2}{(1+R_2CS)R_1}$$

When $S=0$; $TF = -\dfrac{R_2}{R_1}$ (non zero value)

When $S=\infty$; $TF = 0$

Given circuit is an example of low pass filter

3. The following figure shows the connection of an ideal transformer with primary to secondary turns ratio of 1:100. The applied primary voltage is 100V (rms), 50Hz, AC. The rms value of the current I, in ampere, is ______.



Key: **(10)**

Exp: Where $Z_L = \frac{Z_{secondary}}{n^2} = \left[\frac{80 - j40}{(100/1)^2}\right](10)^3 = (8 - 4i)\Omega$

$$I = \frac{100}{j10 + Z_L} = \frac{100}{J10 + 8 - j4} = \frac{100}{8 + j6} = 10\underline{|-36.86}$$

Since all the calculation done with respect to RMS, I also in RMS

4. Consider a causal LTI system characterized by differential equation $\frac{dy(t)}{dt} + \frac{1}{6}y(t) = 3x(t)$. The response of the system to input $x(t) = 3e^{-\frac{1}{3}}u(t)$, where u(t) denotes the unit step function, is

(A) $9e^{-\frac{t}{3}}u(t)$ (B) $9e^{-\frac{t}{6}}u(t)$

(C) $9e^{-\frac{t}{3}}u(t) - 6e^{-\frac{t}{6}}u(t)$ (D) $54e^{-\frac{t}{6}}u(t) - 54e^{-\frac{t}{3}}u(t)$

Key: **(D)**

Exp: $\left(S + \frac{1}{6}\right)y(s) = 3 \times (s)$

$$\therefore H(s) = \frac{3}{\left(s + \frac{1}{6}\right)}$$

Similarly $X(s) = \frac{3}{\left(s + \frac{1}{3}\right)}$

$$\therefore y(s) = \frac{9}{\left(s + \frac{1}{3}\right)\left(s + \frac{1}{6}\right)} = \frac{54}{\left(s + \frac{1}{6}\right)} - \frac{54}{\left(s + \frac{1}{3}\right)}$$

Thus $y(t) = 54\, e^{-t/6}\, u(t) - 54e^{-t/3}\, u(t) = 0$

5. Suppose the maximum frequency in a band-limited signal x(t) is 5kHz. Then, the maximum frequency in $x(t)\cos(2000\pi t)$, in kHz, is ______.

Key: **6**

Exp: Maximum frequency of $x(t) = 5\text{kHz}$

Maximum frequency of $\cos(2000\pi t) = 1\text{kHz}$

$x(t)\cos(2000\pi t)$ Gives convolution between their respective spectrums in frequency domain

$\therefore$ max frequency of $x(t)\cos(2000\pi t) = 6\text{kHz}$

6. Consider the function $f(z) = z + z^*$ where z is a complex variable and z* denotes its complex conjugate. Which one of the following is TRUE?

(A) f(z) is both continuous and analytic

(B) f(z) is both continuous but not analytic

(C) f(z) is not continuous but is analytic

(D) f(z) is neither continuous not analytic

Key: **(B)**

Exp: $f(z) = z + z^*$

$= x + iy + x - iy \left[\because z^* \text{ is conjugate of } z\right]$

$= 2x + i(0)$

$\therefore f(z) = 2x$ is continues but not analytic, since

C – R equations will not satisfy

7. A 3×3 matrix P is such that, $P^3 = P$. Then the eigenvalues of P are

(A) 1, 1, - 1

(B) $1, 0.5 + j0.866, 0.5 - j0.866$

(C) $1, -0.5 + j0.866, 0.5 - j0.866$

(D) 0, 1, - 1

Key: **(D)**

Exp: If λ is an Eigen value of p then λ^3 is an Eigen value of p^3.

$\therefore p^3 = p$

$\Rightarrow \lambda^3 = \lambda$

$\Rightarrow \lambda^3 - \lambda = 0 \Rightarrow \lambda\left[\lambda^2 - 1\right] = 0 \Rightarrow \lambda = 0;\ \lambda^2 = 1$

$\Rightarrow \lambda = 0;\ \lambda = \pm 1$

8. The solution of the differential equation, for $t>0,\ y''(t)+2y'(t)+(y)(t)=0$ with initial conditions $y(0)=0$ and $y'(0)=1$, is $u(t)$ denotes the unit step function),

(A) $te^{-t}u(t)$ (B) $e^{-t}-te^{-t}u(t)$

(C) $\left(-e^{-t}+te^{-t}\right)u(t)$ (D) $e^{-t}u(t)$

Key: (A)

Exp: The operator form of the of given D.E is

$\left[D^2+2D+1\right]y=0$

The A.E is $D^2+2D+1=0$

$\Rightarrow(D+1)^2=0 \quad \Rightarrow D=-1,-1.$

$\therefore y(t)=e^{-t}\left[C_1+C_2t\right]$

Given $y(0)=0$ & $y'(0)=1$ i.e, $t=0;\ y=0$

from (s); $0=C_1 \ \Rightarrow C_1=0 \Rightarrow y'(0)=1$

From (1), $\dfrac{dy}{dt}=-e^{-t}\left[C_1+C_2t\right]+e^{-t}\left[C_2\right]$

At $t=0;\ \dfrac{dy}{dt}=y'=1$

$1=-\left[0+C_2(0)\right]+1\left[C_2\right]\Rightarrow\boxed{1+C_2}\Rightarrow\boxed{C_2=1}$

From (1) $y(t)=e^{-t}(t)\Rightarrow te^{-t}u(t)$

9. The value of the line integral $\int_c\left(2xy^2dx+2x^2ydy+dz\right)$ along a path joining the origin (0,0,0) and the point (1,1,1) is

(A) 0 (B) 2 (C) 4 (D) 6

Key: (B)

Exp: Let $\bar{f}=2xy^2\bar{i}+2x^2y\bar{j}+\bar{k}$

$$\therefore \text{curl } \bar{f}+\nabla\times\bar{f}=\begin{vmatrix}\bar{i} & \bar{j} & \bar{k}\\ \dfrac{\partial}{\partial x} & \partial/\partial y & \dfrac{\partial}{\partial z}\\ 2xy^2 & 2x^2y & 1\end{vmatrix}=\bar{0}$$

$\therefore \bar{f}$ is irrotational

$\therefore$ Consider a straight line passing through $(0,0,0)$ & $(1,1,1)$

i.e, $\dfrac{x}{1}=\dfrac{y}{1}=\dfrac{z}{1}=t \Rightarrow x=y=z=t\Rightarrow dx=dy=dz=dt$

$$\int_C 2xy^2dx+2x^2ydy+dz=\int_{t=0}^{1}2t^3dt+2t^3dt+dt=\int_{t=0}^{1}\left(4t^3+1\right)dt=\left(t^4+t\right)_0^1=2$$

10. Let f(x) be a real, periodic function satisfying $f(-x) = -f(x)$. The general form of its Fourier series representation would be

(A) $f(x) = a_0 + \sum_{k=1}^{\infty} a_k \cos(kx)$ (B) $f(x) = \sum_{k=1}^{\infty} b_k \sin(kx)$

(C) $f(x) = a_0 + \sum_{k=1}^{\infty} a_{2k} \cos(kx)$ (D) $f(x) = \sum_{k=1}^{\infty} a_{2k+1} \sin(2k+1)x$

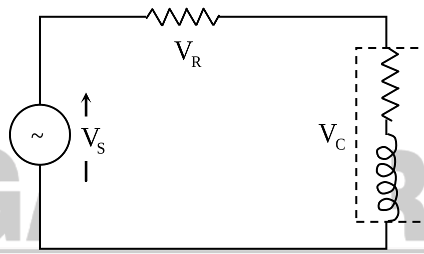
Key: (B)

Exp: We know that a periodic function f(x) defined in (-c, c) can be represented by the poisoins series

$$f(x) = \frac{a_o}{2} + \sum_{n=1}^{\infty} a_n \cos\frac{n\pi x}{c} + \sum_{n=1}^{\infty} b_n \sin\frac{n\pi x}{c}$$

If a periodic function f(x) is odd, its Fourier expression contains only sine terms

11. A resistance and a coil are connected in series and supplied from a single phase, 100V, 50Hz ac source as shown in the figure below. The rms values of plausible voltage across the resistance (V_R) and coil (V_C) respectively, in volts, are



(A) 65, 35 (B) 50, 50 (C) 60, 90 (D) 60, 80

Key: (C)

12. The voltage (v) and current (A) across a load are as follows.

$v(t) = 100 \sin\omega(t),\ i(t) = 10\sin(\omega t - 60^{o}) + 2\sin(3\omega t) + \sin(5\omega t)$

The average power consumed by the load, in W, is ________.

Key: 250

Exp: The instantaneous power of load is

$p(t) = V(\in)i(t)$

$$\left[(100\sin\omega t)(10\sin(\omega t - 60)\right] + \left[(100\sin\omega t)(2\sin 3\omega t)\right]$$
$$+ \left[(100\sin\omega t)(5\sin 5\omega t)\right]$$

$\rightarrow$ since $P_{avg} = \int_0^T P(t)dt$, in the above expression

Only 1st term will result non zero answer

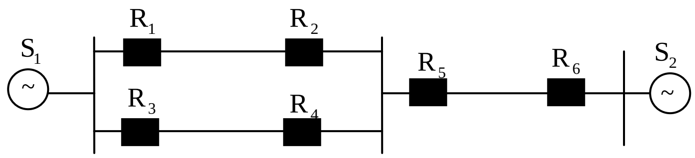
Remaining 2 terms will be 0.

$\rightarrow$ so directly consider

$\left[P(t) = 100\sin\omega t\right]\left[10(\sin\omega t - 60)\right]$

$$P_{avg} = V_{rms}\ I_{rms}\ \cos\left(\theta_V - \theta_I\right) = \frac{100}{\sqrt{2}}\ \frac{10}{\sqrt{2}}\cos\left(60\right) = \frac{1000}{2}\ \frac{1}{2} = 250 \text{ watt}$$

13. A power system with two generators is shown in the figure below. The system (generators, buses and transmission lines) is protected by six overcurrent relays R_1 to R_6. Assuming a mix of directional and nondirectional relays at appropriate locations, the remote backup relays for R_4 are



(A) R_1, R_2 (B) R_2, R_6 (C) R_2, R_5 (D) R_1, R_6

Key: (D)

14. A power system has 100 buses including 10 generator buses. For the load flow analysis using Newton-Raphson method in polar coordinates, the size of the Jacobian is

(A) 189×189 (B) 100×100 (C) 90×90 (D) 180×180

Key: (A)

Exp: Total no of Buses = 100

generator buses = 10 – 1 = 9 (n)

load buses = 100 -10 = 90(m)

Jacobeam matrix size = $(2m+n)\times(2m+n) = (2\times90\times9)\times(2\times90+9) = 189\times189$

15. The inductance and capacitance of a 400kV. Three-phase. 50Hz lossless transmission line are 1.6 mH/km/phase and 10nF/km/phase respectively. The sending end voltage is maintained at 400kV. To maintain a voltage of 400kV at the receiving end, when the line is delivering 300MW load, the shunt compensation required is

(A) Capacitive (B) Inductive (C) Resistive (D) Zero

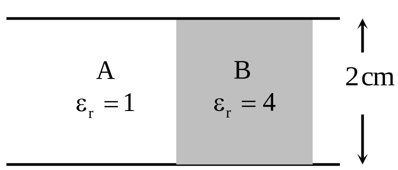
Key: (B)

Exp: $X_L = j\omega L = j314\times1.6\times10^{-3} = j0.5024$

$$X_C = \frac{-j}{\omega C} = \frac{-j}{314\times10\times10^{-9}} = -j31847.3376$$

Since $X_C > X_L$, the shunt compensation is inductive

16. A parallel plate capacitor field with two dielectrics is shown in the figure below. If the electric field in the region A is 4kV/cm, the electric field in the region B, in kV/cm, is



(A) 1 (B) 2 (C) 4 (D) 16

Key: (C)

Exp: Since the voltage & distance b/w the two plates are same for both the regions. The electric field is same for both the regions $\boxed{E = \frac{V}{d}}$

Electric field in region B = 4kV/cm

17. A 50MVA, 10kV, 50Hz, star-connected, unloaded three-phase alternator has a synchronous reactance of 1 p.u. and a sub-transient reactance of 0.2 p.u. If a 3-phase short circuit occurs close to the generator terminals, the ratio of initial and final values of the sinusoidal component of the short circuit current is _________.

Key: 5

Exp: $I_{SC} = \frac{V_{prefault}}{X(P.U)}$

$$\frac{I_{SC}(\text{initial})}{I_S\text{cfinal}} = \frac{1}{0.2} = 5$$

18. Consider a liner time-invariant system transfer function $H(s) = \frac{1}{(s+1)}$. If the input is cos(t) and the steady state output is $A\cos(t+\alpha)$, then the value of A is _________.

Key: 0.707

Exp: $H(\omega) = \frac{1}{\sqrt{\omega^2+1}} \underline{|-\tan^{-1}\omega}$

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

So when input is cost then O/P

$$y(t) = \frac{1}{\sqrt{2}}\cos(t-45^O)$$

So $A = \frac{1}{\sqrt{2}} = 0.707$

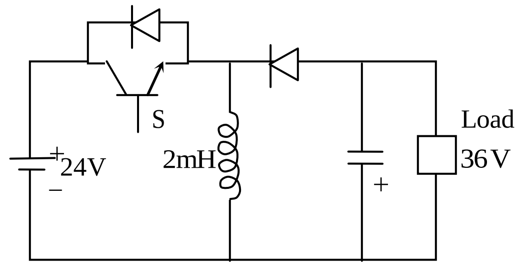
19. A three-phase diode bridge rectifier is feeding a constant DC current of 100A to a highly inductive load. If three-phase, 415V, 50Hz AC source is supplying to this bridge rectifier then the rms value of the current in each diode, in ampere, is _________.

Key: 57.73

Exp: $I_O = 100A$

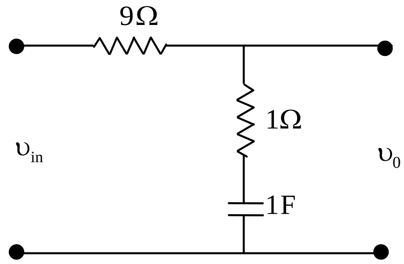
RMS, diode current $= \frac{100}{\sqrt{3}} = 57.73A$

20. A buck-bost DC-DC converter shown in the figure below, is used to convert 24 V battery voltage to 36 V DC voltage to feed a load of 72 W. It is operated at 20kHz with an inductor of 2 mH and output capacitor of 1000 μF. All devices are considered to be ideal. The peak voltage across the solid-state switch (S), in volt, is _________.



Key: 60

21. For the network shown in the figure below, the frequency (in rad/s) at which the maximum phase lag occurs is.______.



Key: 0.316

Exp: The given circuit is standard lag compensator

Whose Transfer function

$$G(s)\frac{1+\frac{1}{s}}{a+1+\frac{1}{s}}=\frac{s+1}{1+10s}=\frac{1+\tau s}{1+\alpha\tau s}$$

So $\tau=1, \alpha=10$ the frequency at which maximum phase lag happen

$$\omega_m=\frac{1}{\tau\sqrt{\alpha}}=\frac{1}{\sqrt{10}}=0.316 \text{ rad/sec}$$

22. The direction of rotation of a single-phase capacitor run induction motor is reversed by

(A) interchanging the terminals of the AC supply

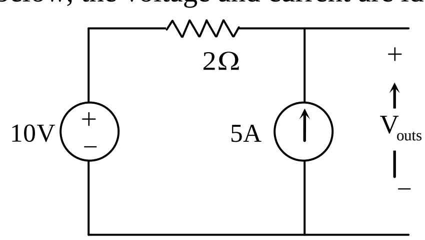
(B) interchanging the terminals of the capacitor

(C) interchanging the terminals of the auxiliary winding.

(D) interchanging the terminals of both the windings

Key: (C)

23. In the circuit shown below, the voltage and current are ideal. The voltage (V_{out}) across the current source, in volts, is



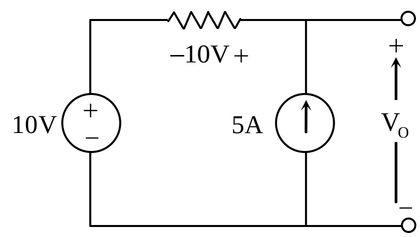
(A) 0 (B) 5 (C) 10 (D) 20

Key: **(D)**

Exp: Writing KVL

$V_O - 10 - 10 = 0$

$V_O = 20V$



24. The graph associated with an electrical network has 7 branches and 5 nodes. The number of independent KCL equations and the number of independent KVL equations, respectively, are

(A) 2 and 5 (B) 5 and 2 (C) 3 and 4 (D) 4 and 3

Key: **(D)**

Exp: No of branches = 7

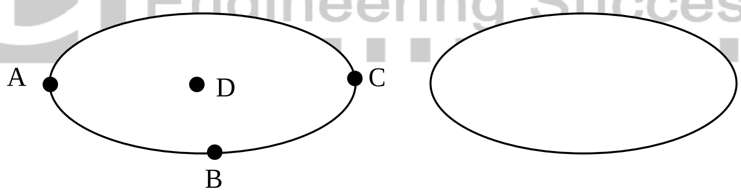
Nodes = 5

No of KCL equations = No of Modal equations = n – 1 = 5 – 1 = 4

No of KVL equations = No of Mesh equations = b-(n – 1) = 7-4 = 3

Since no information given regarding how many simple & principal node, if we assume all principal nodes then the answer for nodal is 5 – 1 = 4

25. The electrodes, whose cross-sectional view is shown in the figure below, are at the same potential The maximum electric field will be at the point



(A) A (B) B (C) C (D) D

Key: **(A)**

Exp: At A

Fields are additive $|F_1 + F_2|$

At C

Fields are subtractive $|F_1 - F_2|$

At D field is due to one electrode $|F_2|$

At B field make an angle

$$\sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

So maximum electric field is at 'A'

Q. No. 26 – 50 Carry Two Mark Each

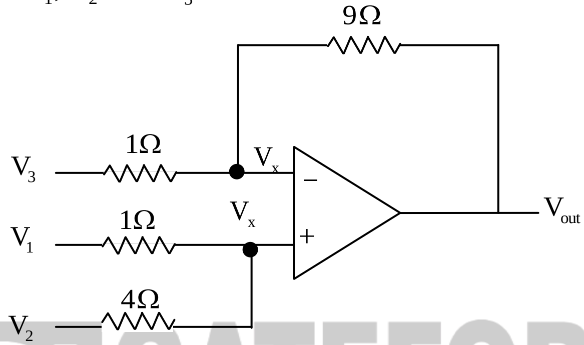
26. The Boolean expression $\overline{\left(a+\bar{b}+c+\bar{d}\right)+\left(b+\bar{c}\right)}$ simplifies to

(A) 1 (B) $\overline{a.b}$ (C) a.b (D) 0

Key: (D)

Exp: $F = \overline{\left(a+\bar{b}+c+\bar{d}\right)+\left(b+\bar{c}\right)} = \overline{a+\bar{d}+\left(b+\bar{b}\right)+\left(c+\bar{c}\right)} = \overline{a+\bar{d}+1+1} = \bar{1} = 0$

27. For the circuit shown below, taking the opamp is ideal, the output voltage V_{out} in terms of the input voltages V_1, V_2 and V_3 is



(A) $1.8V_1 + 7.2V_2 - V_3$ (B) $2V_1 + 8V_2 - 9V_3$

(C) $7.2V_1 + 1.8V_2 - V_3$ (D) $8V_1 + 2V_2 - 9V_3$

Key: (D)

Exp: $\dfrac{V_x - V_1}{1} + \dfrac{V_x - V_2}{4} = 0; \quad V_x = \dfrac{4V_1 + V_2}{5}$

$$\frac{\left(V_x - V_3\right)}{1} + \frac{V_x - V_{out}}{9} = 0$$

$$\frac{\left(4V_1 + V_2\right)}{5} - V_3 + \frac{\frac{\left(4V_1 + V_2\right)}{5} - V_{out}}{9} = 0$$

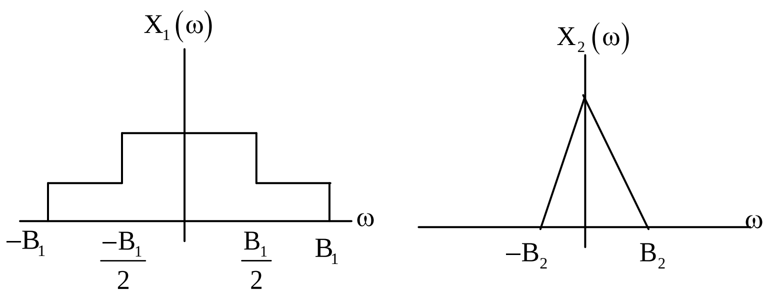
$$\left(4V_1 + V_2 - 5V_3\right) + \frac{\left(4V_1 + V_2 - 5V_{out}\right)}{9} = 0$$

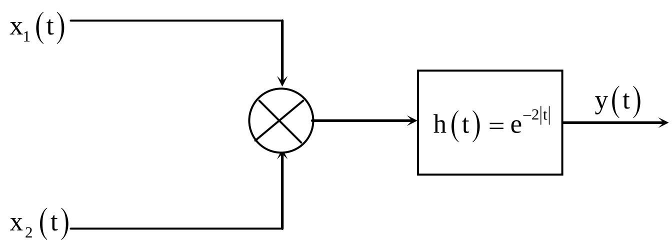
$$36V_1 + 9V_2 - 45V_3 + 4V_1 + V_2 - 5V_{out} = 0$$

$$V_{out} = \frac{40V_1 + 10V_2 - 45V_3}{5}$$

$$V_{out} = 8V_1 + 2V_2 - 9V_3$$

28. Let $x_1(t) \leftrightarrow X_1(\omega)$ and $x_2(t) \leftrightarrow X_2(\omega)$ be two signals whose Fourier Transforms are as shown in the figure below. In the figure h(t) = $e^{-2|t|}$ denotes the impulse response.





For the system shown above, the minimum sampling rate required to sample y(t), so that y(t) can be uniquely reconstructed from its samples, is

(A) $2B_1$ (B) $2(B_1 + B_2)$ (C) $4(B_1 + B_2)$ (D) ∞

Key: **(B)**

Exp: $y(t) = [x_1(t)x_2(t)] * h(t)$

In frequency duration

$y(\omega) = [X_1(\omega) * X_2(\omega)] H(\omega)$

Max. Frequency of $X_1(\omega) = B_1$

Max, frequency of $X_2(\omega) = B_2$

Max frequency of $X_1(\omega) * X_2(\omega) = (B_1 + B_2)$

Max frequency of $H(\omega) = \infty$

Thus max, freq of $y(\omega) = (B_1 + B_2)$

Max frequency

$\therefore$ Nyquist frequency = $2(B_1 + B_2)$

29. The value of the integral $2\int_{-\infty}^{\infty}\left(\frac{\sin 2\pi t}{\pi t}\right)dt$ is equal to

(A) 0 (B) 0.5 (C) 1 (D) 2

Key: **(D)**

Exp: $2\int_{-\infty}^{\infty}\left(\frac{\sin 2\pi t}{\pi t}\right)dt = 2\times 2\int_{0}^{\infty}\frac{\sin 2\pi t}{\pi t}dt \qquad \left[\frac{\sin 2\pi t}{\pi t}\text{ is an even function}\right]$

$= 4\int_{0}^{\infty} e^{-0.t}\ \frac{\sin 2\pi t}{\pi t}.dt$

By the defining of L.T; we have

$= 4L\left\{\frac{\sin 2\pi t}{\pi t}\right\}$; where $S = 0$

$= \frac{4}{\pi}L\left\{\frac{\sin 2\pi t}{t}\right\}$; where $s = 0$ $= \frac{4}{\pi}\tan^{-1}\left(\frac{2\pi}{s}\right)$; where $s = 0$ $\left[\because L\left\{\frac{\sin at}{t}\right\} = \tan^{-1}\left(\frac{a}{s}\right)\right]$

Putting s = 0; than

$= \frac{4}{\pi}\tan^{-1}(\infty) = \frac{4}{\pi}\times \pi/2 = 2$

$\therefore 2\int_{-\infty}^{\infty}\left(\frac{\sin 2\pi t}{\pi t}\right)dt = 2$

30. Let y(x) be the solution of the differential equation $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$ with initial conditions $y(0) = 0$ and $\left.\frac{dy}{dx}\right|_{x=0} = 1$. Then the value of y (1) is ________.

Key: **7.398**

Exp: The operate form of given D.E is

$\left[D^2 - 4D + 4\right]y = 0$

The A.E is $D^2 - 4D + 4 = 0$

$\Rightarrow (D-2)^2 = 0 \Rightarrow D = 2, 2$

$\Rightarrow (D-2)^2 = 0 \Rightarrow D = 2, 2$

$\therefore$ The solution is $y = e^{2x}\left[C_1 + C_2 x\right] \rightarrow (1)$

Given that $y(0) = 0$ & $y'(0) = 1$

i.e $x = 0 \Rightarrow y = 0$; i.e at $x = 0,\ y' = 1$

$\therefore$ from (1); $0 = 1\left[C_1 + 0\right]$; from $(1) \Rightarrow y^1 = e^{2x}\left[C_2\right] + (C_1 + C_2x)2c^{2x}$

$\Rightarrow C_1 = 0$; $\Rightarrow 1 = C_2 + 0 \Rightarrow C_2 = 1$

$\therefore$ from $(1)\ y = e^{2x}\ (0 + 1.x) \Rightarrow y = xe^{2x}$

$\therefore y(1) = 1e^{2(1)} = e^2 \Rightarrow \boxed{y(1) = e^2}$ (or) $\boxed{y(1) = 7.389}$

31. The line integral of the vector field F = $5xz\hat{i} + \left(3x^2 + 2y\right)\hat{j} + x^2 z\hat{k}$ along a path from (0,0,0) to (1,1,1) parametrized by $\left(t, t^2, t\right)$ is ________.

Key: **4.4167**

Exp: $F = 5xz\bar{i} + \left(3x^2 + 2y\right)\bar{j} + x^2 z = \bar{k}$

$x = t;\ y = t^2\ ;\ z = t$

$\Rightarrow dx = dt \Rightarrow d = 2t\,dt; \Rightarrow dz = dt$

$\therefore$ The line integral of the vector field is

$$\int_C \bar{F}.d\bar{r} = \int 5xzdx + \left(3x^2 + 2y\right)dy + \left(x^2 z\right)dz$$

$$= \int_{t=0}^{1} 5t^2\ dt + 10t^3 dt + t^3 dt$$

$$= \int_{t=0}^{1} 5t^2\ dt + 11t^3 dt$$

$$= 5\left[\frac{t^3}{3}\right]_0^1 + 11\left[\frac{t^4}{4}\right]_0^1$$

$$= \frac{5}{3} + \frac{11}{4} = \frac{20+23}{12} = \frac{53}{12} = 4.4167$$

32. Let P = $\begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$. Consider the set S of all vector $\begin{pmatrix} x \\ y \end{pmatrix}$ such than $a^2 + b^2 = 1$ where $\begin{pmatrix} a \\ b \end{pmatrix} = p\begin{pmatrix} x \\ y \end{pmatrix}$. Then S is

(A) A circle of radius $\sqrt{10}$

(B) a circle of radius = $\frac{1}{\sqrt{10}}$

(C) an ellipse with major axis along $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$

(D) an ellipse with minor axis along $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$

Key: **(D)**

Exp: $P = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$

$$\begin{bmatrix} a \\ b \end{bmatrix} = P\begin{pmatrix} x \\ y \end{pmatrix} \Rightarrow \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} \Rightarrow 3x + y = a \quad \Rightarrow x + 3y = b$$

$a^2 + b^2 = 1$

$$\Rightarrow (3x + y)^2 + (x + 3y)^2 = 1$$

$$\Rightarrow 10x^2 + 10y^2 + 12xy = 1$$

$a = 10;\ b = 10;\ h = 6$

$\therefore$ It represents ellipse

The length of semi-axes is $\left(ab-h^2\right)r^4-\left(a+b\right)r^2+1=0$

$$\Rightarrow 64r^4-20r^2+1=0 \Rightarrow r^2=\frac{1}{4}\left(\text{or}\right)r^2=\frac{1}{16}$$

Both r^2 values are positive, so it represents ellipse

$$\Rightarrow r=\frac{1}{2}\left(\text{or}\right)r=\frac{1}{4}$$

Length of major axis = $2r=1$

Length of minor axis = $2r=2\left(\frac{1}{4}\right)=1/2$

$\therefore$ Equation of the major axis is $\left(a-\frac{1}{r_1^2}\right)x+hy=0$

$$\Rightarrow\left(10-4\right)x+6y=0 \Rightarrow x+y=0$$

Equation of the minor axis is $\left(a-\frac{1}{r_2^2}\right)x+hy=0$

$$\Rightarrow\left(10-16\right)x+6y=0\Rightarrow y-x=0$$

Major axis exists along y = -x and minor axis exists along y = x.

$\therefore$ The vector $\begin{bmatrix}1\\1\end{bmatrix}$ Lies on the line y = x

33. Let the probability density function of random variable, X, be given as:

$$f_x\left(x\right)=\frac{3}{2}e^{-3x}u\left(x\right)+ae^{4x}u\left(-x\right)$$

where u(x) is the unit step function. Then the value of 'a' and Prob$\left\{X\leq 0\right\}$, respectively, are

(A) $2,\frac{1}{2}$ (B) $4,\frac{1}{2}$ (C) $2,\frac{1}{4}$ (D) $4,\frac{1}{4}$

Key: (A)

Exp: we have $\int_{-\infty}^{\infty}f_x\left(x\right)dx=1$

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

$$\Rightarrow\int_{-\infty}^{0}ae^{4x}dx+\int_{0}^{\infty}\frac{3}{2}e^{-3x}dx=1$$

$\because u\left(x\right)=1$ for $x\geq 0$

$= 0$, other wise

$$u(-x) = 1 \text{ for } x \le 0$$
$$\qquad 0, \text{otherwise}$$

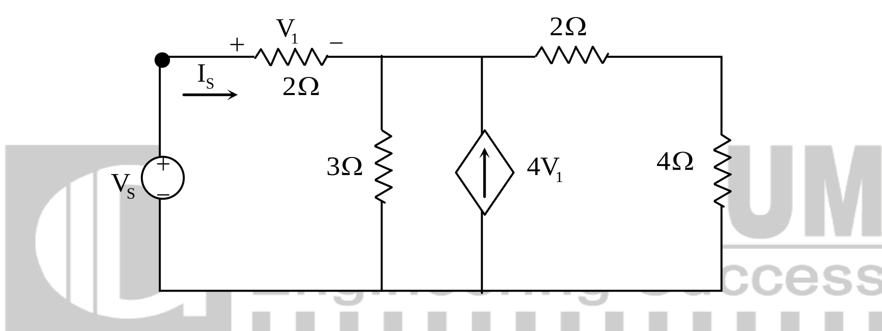
$$\Rightarrow \int_{-\infty}^{0} a\,e^{4x}\,dx + \int_{0}^{\infty} \frac{3}{2} e^{-3x}\,dx = 1 \quad \Rightarrow a\left[\frac{e^{4x}}{4}\right]_{-\infty}^{0} + \frac{3}{2}\left[\frac{e^{-3x}}{-3}\right]_{0}^{\infty} = 1$$

$$\Rightarrow a\left[\frac{1}{4} - 0\right] - \frac{1}{2}[0-1] = 1 \Rightarrow \frac{a}{4} + \frac{1}{2} = 1 \Rightarrow \frac{a}{4} = \frac{1}{2} \Rightarrow a = 2$$

$$\text{Prob } (x \le 0) = \int_{-\infty}^{0} f_x(x)dx = \int_{-\infty}^{0} a.e^{4x}\,dx = a\int_{-\infty}^{0} e^{4x}dx$$

$$= 2\left[\frac{e^{4x}}{y}\right]_{-\infty}^{0} = \frac{2}{4}[1-0] = \frac{1}{2}$$

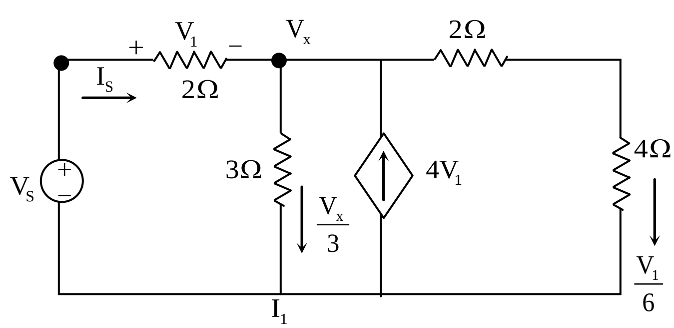
34. The driving point input impedance seen from the source V_S of the circuit shown below, in Ω, is __________.



Key: **20**

Exp: The Driving point impedance is nothing but the ratio of voltage to current from the defined port.

In this case it is $\frac{V_S}{I_S}$



$\rightarrow$ Writing KCL at node x

$$-I_S + \frac{V_x}{3} - 4V_1 + \frac{V_x}{6} = 0$$

Substituting these in Eq(1)

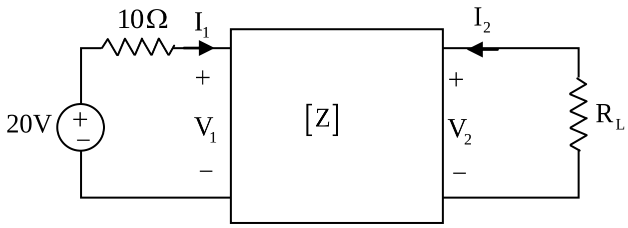
$$-I_S + \frac{V_S - 2I_s}{3} - 8I_s \rightarrow \frac{V_S - 2I_s}{6} = 0$$

$$\Rightarrow V_S\left(\frac{1}{3} + \frac{1}{6}\right) = I_S\left(1 + \frac{2}{3} + 8 + \frac{2}{6}\right)$$

$$\Rightarrow V_S(2+1) = I_S(6 + 4 + 48 + 2)$$

$$\Rightarrow \frac{V_S}{I_S} = \frac{60}{3} = 20\Omega$$

35. The z-parameters of the two port network shown in the figure are $Z_{11}=40\Omega, Z_{12}=60\Omega$, $Z_{21}=80\Omega, Z_{22}=100\Omega$. The average power delivered to $R_L=20\Omega,$ in watts, is ____.



Key: 35.55

Exp: In the given terminated 2 port network the Z matrix is known and for load of 20Ω we want to find power on the load.

→ The get it assuming R_L as load let first obtain the thevenin equivalent of 2 port

→ Thevenin equivalent means V_{th} & R_{th}

$V_{th}=V_2\big|_{I_2=0}$ i.e., O.C voltage of port 2

$I_{SC}=-I_2/V_2=0$ i.e., s.c current of port 2,

$R_{in}=\frac{V_{th}}{I_{sc.}}$

→ Evaluation of V_{th}.

The Z matrix equation is

$V_1=40I_1+60I_2$

$V_2=80I_1+100I_2$

In the above two equations if $I_2=0$ then

$V_1=40I_1$ (1)

$V_2=80I_1$ (2)

From the input side we can say $(V_1=20-10I_1)$

$\Rightarrow 20-10I_1=40I_1$

$\Rightarrow I_1=2/5\,A$ Then equation 2 becomes $\frac{2}{3}$

$\Rightarrow V_2=80\,I_1=80\times\frac{2}{5}=32\,V$

so $V_{th}=V_2=32$

Evaluation of I_{SC}

In the Z matrix equation if we put $V_2=0$ then

$V_1=40I_1+60I_2$ ...(5)

$0=80I_1+100I_2$ ...(4)

$$I_1 = -\frac{10}{8} I_2 \ \& \ V_1 = 20 - 10I_1 = 20 + \frac{100}{8} I_2$$

Using these V_1 & I_1 in equation 3

$$20 + \frac{100}{8} I_2 = -\frac{400}{8} I_2 + 60I_2$$

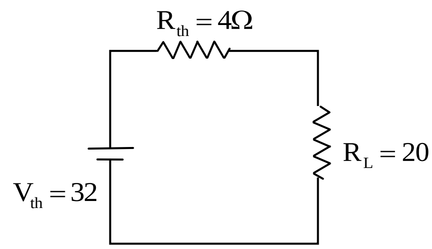
$$\Rightarrow 160 + 100I_2 = -400I_2 + 480I_2$$

$$\Rightarrow 160 = -20I_2 \Rightarrow I_2 = -8A$$

$$I_{SC} = -I_2 = 8A$$

$$\rightarrow R_{in} = \frac{V_{in}}{I_{sc}} = \frac{32}{8} = 4\Omega$$

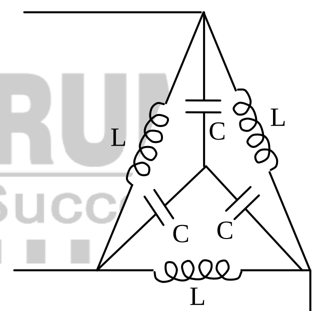
$\rightarrow$ Now the ckt is from port 2is



$$P_{20\Omega} = (I_{20\Omega})^2 \, 20$$

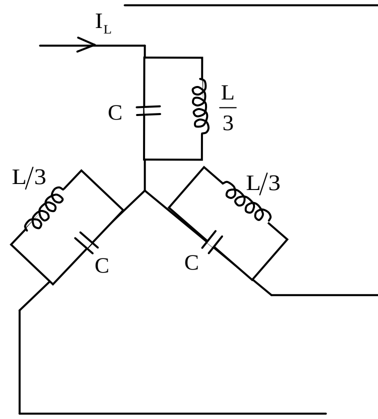
$$= \left(\frac{32}{4+20}\right) 20 \quad = 35.55\text{watt}$$

36. In the balanced 3-phase, 50Hz, circuit shown below, the value of inductance (L) is 10mH. The value of the capacitance (C) for which all the line current are zero, in millifarads, is _____.



Key: 3.04

Exp: $I_L = 0 \Rightarrow 2ph = \infty$



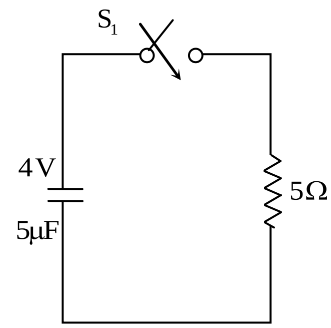
$$Z_{ph} = \frac{X_L . X_C}{X_L + X_C} = \frac{\left(\frac{j\omega L}{3}\right)\left(\frac{-j}{\omega c}\right)}{\frac{j\omega L}{3} - \frac{j}{\omega c}}$$

$$\frac{\omega L}{b} = \frac{1}{\omega c}$$

$$314 = \frac{3}{\sqrt{10 \times 10^{-3} \times C}}$$

$$C = 3.04 \text{ mF}$$

37. In the circuit shown below, the initial capacitor voltage is 4V. Switch S_1 is closed at t = 0. The charge $(\text{in } \mu C)$ lost by the capacitor from $t = 25\mu s$ to $t = 100\mu s$ is _______.



Key: **6.99**

Exp: It is given $V_C(0^-) = 4$

$$R = 5\Omega,\ C + 54f \text{ so } \frac{1}{RC} = 40000$$

→ Since it is a source free network we can say

$V_C(t) = V_C(0^-)\, e^{-t/\tau}\ ; t > 0 \quad = 4e^{-40000\, t}$

→ We are asked to find the charge last by capacitor

From $t = 25\mu s$ to $100\mu s$

We know in a capacitor $Q = CV$

or $\Delta Q = C(\Delta V)$

$$\Delta Q = C\left[V_C(25\mu sec) - V_C(100\mu sec)\right]$$

→ $V_C = 4e^{-40000t}$

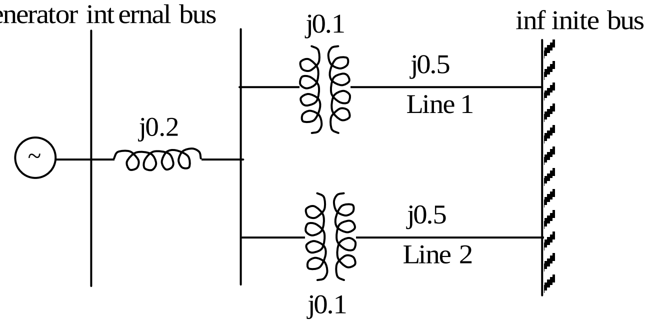
→ $V_C\big|_{t=25\mu sec} = 4e^{-40000\times 25\times 10^{-6}} = 1.47$

→ $V_C\big|_{t=100\mu sec} = 4e^{-40000\times 100\times 10^{-6}} = 0.073$

→ $\Delta Q = 5\left[1.47 - 0.073\right] = 6.99\mu s$

38. The single line diagram of a balanced power system is shown in the figure. The voltage magnitude at the generator internal bus is constant and 1.0 p.u. the p.u. reactances of different components in the system are also shown in the figure. The infinite bus voltage magnitude is 1.0p.u. A three phase fault occurs at the middle of line 2.

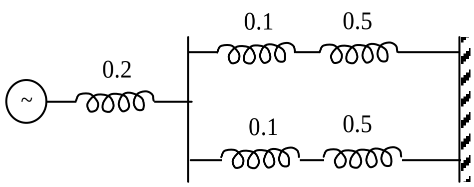
The ratio of the maximum real power that can be transferred during the pre-fault condition to the maximum real power that can be transferred under the faulted condition is ______



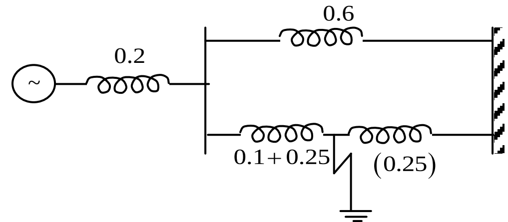
Key: **2.286**

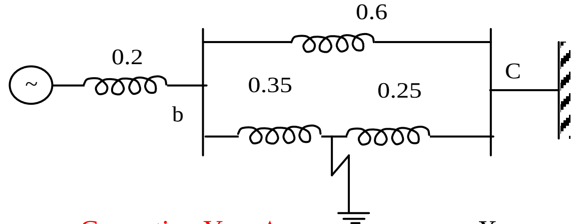
Exp:

Before fault



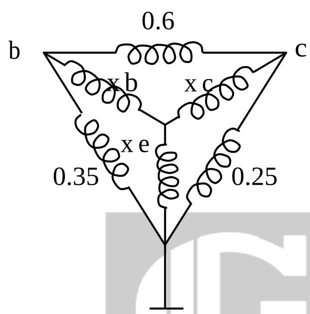
During fault

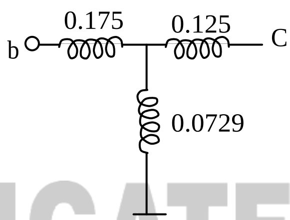




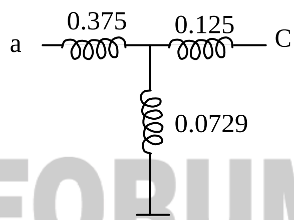
$$Xeq = 0.2 + \frac{0.1+0.5}{2} = 0.5 \text{ P.U}$$

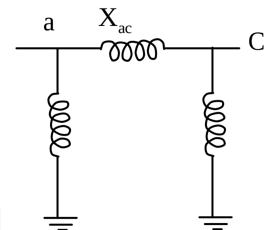
$$P_e(\max) = \frac{EV}{X_{eq}} = 2EV$$





Converting $Y \to \Delta$





$$X_{ac} = \frac{0.375\times0.125 + 0.125\times0.0729 + 0.0729\times0.375}{0.0729} = 1.143$$

$$Pe(\max) = \frac{EV}{1.143} \Rightarrow \frac{Pe(\text{Prefault})}{Pe(\text{during fault})} = \frac{1.143}{20.5} = 2.286$$

39. The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K(s+1)}{s(1+Ts)(1+2s)}, \quad K>0,\ T>0.$$

The closed loop system will be stable if

(A) $0 < T < \frac{4(K+1)}{K-1}$

(B) $0 < K < \frac{4(T+2)}{T-2}$

(C) $0 < K < \frac{T+2}{T-1}$

(D) $0 < T < \frac{8(K+1)}{K-1}$

Key: **(C)**

Exp: To comment closed 100b system stability we need the characteristic equation. Here it is given that it is a unity feedback system.

Unity feedback system

So the characteristic equation is

$$S(1+TS)(1+2S) + K(S+1) = 0$$

$$\Rightarrow \left(S+TS^2\right)\left(1+2S\right)+KS+K=0$$

$$\Rightarrow S+2S^2+TS^2+2TS^3+KS+K=0$$

$$\Rightarrow S^3\left(2T\right)+S^2\left(2+T\right)+S\left(1+k\right)+k=0$$

$$\Rightarrow s^3+\left(\frac{2+T}{2T}\right)s^2+\left(\frac{k+1}{2T}\right)s+\frac{k}{2T}=0$$

$\rightarrow$ for stability using $R(t)$ criterion

$$\left(\frac{2+T}{2T}\right)\left(\frac{K+1}{2T}\right)>\frac{K}{2T}$$

$$\Rightarrow (T+2)(K+1)>K \quad \Rightarrow \frac{K+1}{K}>\frac{1}{T+2}$$

$$\Rightarrow \frac{1}{K}>\frac{1}{T+2}-1 \Rightarrow \frac{1}{K}>-\left(\frac{T+1}{T+2}\right)\Rightarrow K<-\left[\frac{T+2}{T+1}\right]$$

40. At no load condition a 3-phase, 50Hz, lossless power transmission line has sending –end and receiving-end voltage of 400 kV and 420kV respectively. Assuming the velocity of traveling wave to be the velocity of light, the length of the line, in km, is _________.

Key: **294.84**

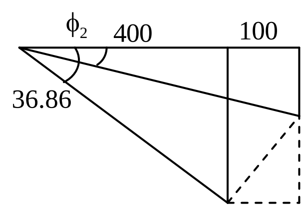
Exp: $V_S=V_r\left[1-\frac{\omega^2\ell^2\times10^{10}}{18}\right]$

$$400=420\left[1-\frac{314^2\times\ell^2\times10^{10}}{18}\right]\Rightarrow \ell=294.84\text{km}$$

41. The power consumption of industry is 500kVA, at 0.8 p.f. lagging. A synchronous motor is added to raise the power factor of the industry to unity. If the power intake of the motor is 100kW. The p.f. of the motor is _________.

Key: **0.3162**

Exp: $\cos\phi_2=1$



$\phi_2=0$

$\phi_1=36.86$

$\cos\phi_1=\frac{P}{S}$

$P_1=400;\quad P_2=100$

$Q_{motor}=P_1\tan\phi_1-\left(P_1+P_2\right)\tan\phi_2=400\tan 36.86-500\tan\theta=300\text{ kW}$

$S_{motor}=100-j300$

$\cos\phi_m=0.3162$

42. The flux linkage (λ) and current (i) relation for an electromagnetic system is $\lambda = \left(\sqrt{i}\right)/g$. When i = 2A and g $(\text{air} - \text{gap length}) = 10\text{cm}$, the magnitude of mechanical force on the moving part, in N, is ________.

Key: 186 to 190

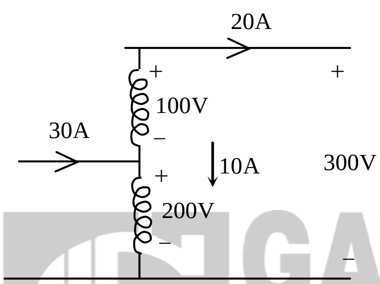
43. The starting line current of a 415V. 3-phase, delta connected induction motor is 120A, when the rated voltage is applied to its stator winding. The starting line current at a reduced voltage of 110V, in ampere is _________.

Key: 31 to 33

44. A single-phase, 2kVA, $100/200\text{V}$ transformer is reconnected as an auto-transformer such that its kVA rating is maximum. The new rating in kVA, is _______.

Key: 6

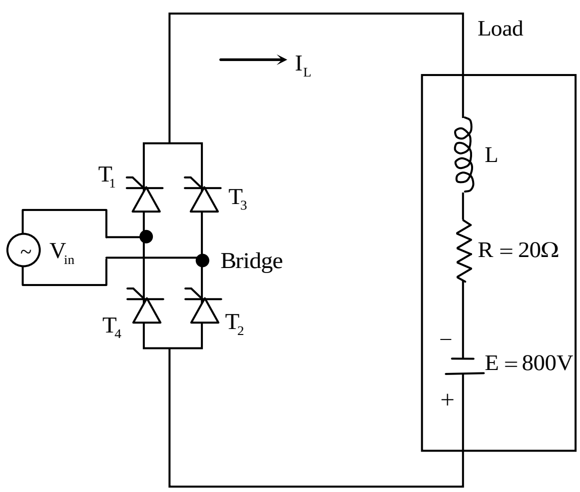
Exp:



max KVA rating $= 300 \times 200$

$= 6\text{kVA}$

45. A full-bridge converter supplying in RLE load is shown in figure. The firing angle of the bridge converter is 120^{O}. The supply voltage $\upsilon_m(t) = 200\pi \sin(100\pi t)\text{V}$, $R = 20\Omega$, $E = 800\text{V}$. The inductor L is large enough to make the output current I_L a smooth dc current. Switches are lossless. The real power fed back to the source. In kW is ________.



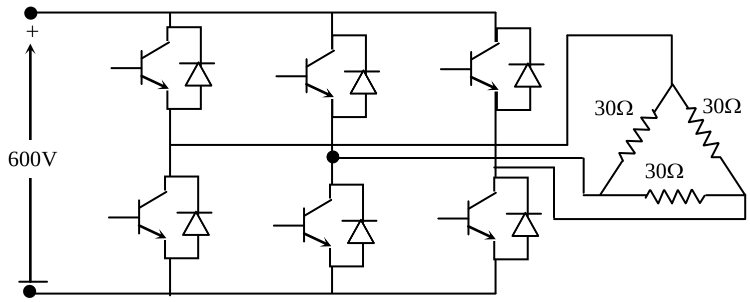
Key: 6

Exp: $V_0 = \dfrac{2Vm}{\pi}\cos\alpha = 2 \times \dfrac{200\pi}{\pi}\cos 120 = -200\text{V}$

$$I_0 = \frac{E - V_0}{R} = \frac{800 - 200}{20} = 30A$$

$$P_{fedback} = V_0 I_0 = +\,200 \times 30 = 6kW.$$

46. A three – phase Voltage Source Inverter (VSI) as shown in the figure is feeding a delta connected resistive load of $30\Omega/\text{phase}$. If it is fed from a 600V battery, with 180^O conduction of solid-state devices, the power consumed by the load, in kW, is _________.

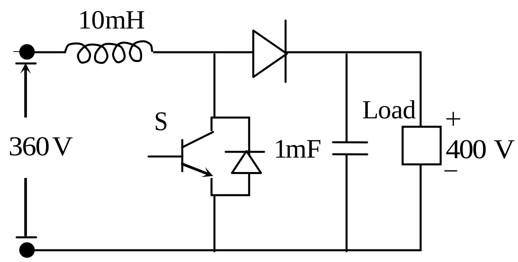


Key: **24**

Exp: $V_{ph} = \frac{\sqrt{2}}{3} Vdc = \frac{\sqrt{2}}{3} \times 600 = 200\sqrt{2}\,V$

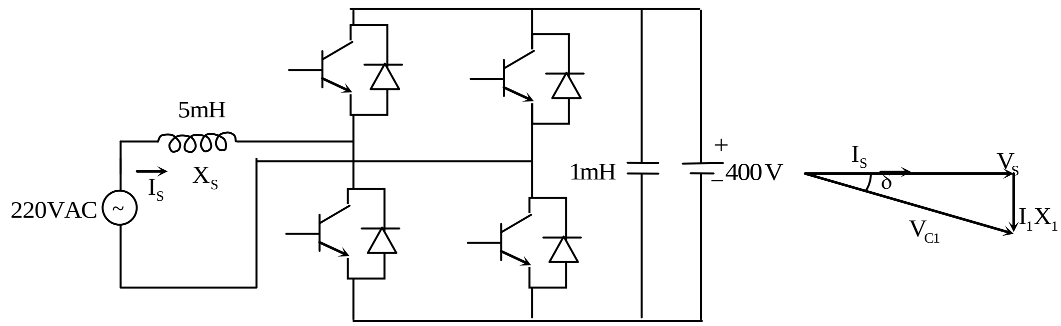
$$R_{ph} = \frac{R\Delta}{3} = \frac{30}{3} = 10\Omega \Rightarrow P_{Load} = \frac{3Vph^2}{R_{ph}} = 3 \times \frac{\left(200\sqrt{2}\right)^2}{10} = 24kW$$

47. A DC-DC boost converter, as shown in the figure below, is used to boost 360V to 400V, at a power of kW. All devices are ideal. Considering continuous inductor current, the rms current in the solid state switch (S), in ampere, is ______.



Key: **3 to 4**

48. A single-phase bi-directional voltage source converter (VSC) is shown in the figure below. All devices are ideal. It is used to charge a battery at 400V with power of 5kW from a source $V_s = 220V\,(\text{rms}), 50\,Hz$ sinusoidal AC mains at unity p.f. If its ac side interfacing inductor is 5mH and the switches are operated at 20kHz, then the phase shift (δ) between AC mains voltage (V_S) and fundamental AC rms VSC voltage (V_{C1}), in degree, is________.



Key: 9.1 to 9.3

49. Consider a linear time invariant system $\dot{x} = Ax$, with initial condition x(0) at t = 0. Suppose α and β are eigenvectors of (2×2) matrix A corresponding to distinct eigenvalues λ_1 and λ_2 respectively. Then the response $x(t)$ of the system due to initial condition x (0) = α is

(A) $e^{\lambda_1 t}\alpha$ (B) $e^{\lambda_1 t}\beta$ (C) $e^{\lambda_2 t}\alpha$ (D) $e^{\lambda_2 t}\alpha + e^{\lambda_2 t}\beta$

Key: (A)

Exp: Eigen values are nothing but pole location

Here with respect to α the pole is λ_1

wrt β Pole is λ_2

The section should be of form

$\alpha e^{\lambda_1 t} + \beta e^{\lambda_2 t}$ but we are asking w.r.t

Initial condition $x(0) = \alpha$ only so the response should be $\alpha e^{\lambda_1 t}$

50. A second-order real system has the following properties:

(a) the damping ratio $\zeta = 0.5$ and undamped natural frequency $\omega_n = 10$ rad/s,

(b) the steady state value of the output, to a unit step input, is 1.02.

The transfer function of the system is

(A) $\frac{1.02}{s^2+5s+100}$ (B) $\frac{102}{s^2+10s+100}$ (C) $\frac{100}{s^2+10s+100}$ (D) $\frac{102}{s^2+5s+100}$

Key: (B)

Exp: The standard 2nd order T/F is $\left[K\frac{\omega_n{}^2}{s^2+2\xi\omega_n s+\omega_n^2}\right]$

it is given that $\xi = 0.5$ & $\omega_n = 10$

$$G(s) = K\frac{100}{s^2+10s+100}$$

Now to satisfy the steady state O/P 1.02

$$y(\infty) = \underset{s\to 0}{\ell t}\ \frac{1}{s}\left(\frac{100}{s^2+10s+100}\right)K = 1.02 \Rightarrow K = 1.02$$

$$G(s) = \frac{1.02\times 100}{s^2+10s+100} = \frac{102}{s^2+10s+100}$$

51. Three single-phase transformers are connected to form a delta-star three-phase transformer of 110kV/11kV. The transformer supplies at 11kV a load of 8MW at 0.8 p.f. lagging to a nearby plant. Neglect the transformer losses. The ratio of phase current in delta side to star side is

(A) $1:10\sqrt{3}$ (B) $10\sqrt{3}:1$ (C) $1:10$ (D) $\sqrt{3}:10$

Key: **(A)**

Exp: $N_1 : N_2 = 110 : \dfrac{11}{\sqrt{3}} = 10\sqrt{3}:1$

$I_1 N_1 = I_2 N_2$

$I_i \left(10\sqrt{3}\right) = I_2.1$

$\dfrac{I_1}{I_2} = \dfrac{1}{10\sqrt{3}}$

52. The gain at the breakaway point of the root locus of a unity feedback system with open loop transfer function $G(s) = \dfrac{Ks}{(s-1)(s-4)}$ is

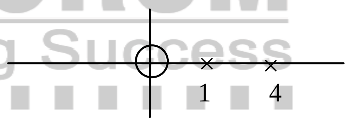
(A) 1 (B) 2 (C) 5 (D) 9

Key: **(A)**

Exp: $G(s)\dfrac{Ks}{(s-1)(s-4)}$

To find Break away point

We need to find the root of $\dfrac{dk}{ds} = 0$ where



$$K = -\frac{(s-1)(s-4)}{s} = -\left(\frac{s^2 - 5s + 4}{s}\right)$$

$$\frac{dk}{ds} = \left[\frac{s\dfrac{d}{ds}\left(s^2 - 5s + 4\right) - \left(s^2 - 5s + 4\right)\dfrac{d}{ds}(s)}{s^2}\right]$$

$\Rightarrow S(2S-5) - \left(S^2 - 5S + 4\right) = 0$

$\Rightarrow 2S^2 - 5S - S^2 + 5S - 4 = 0$

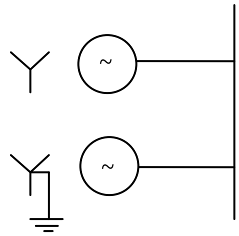
$\Rightarrow S^2 - 4 = 0 \Rightarrow S = \pm 2$

From the pole zero plot it is clean that Break away point must be $S = +2$ as it is in between 2 poles

Now to find gain at this point use magnitude condition

$$\Rightarrow \left|\frac{KS}{(s-1)(s-4)}\right|_{s=2} = 1 \quad \Rightarrow \left|\frac{KS}{(1)(-2)}\right| = 1 \Rightarrow K = 1$$

53. Two identical unloaded generators are connected in parallel as shown in the figure. Both the generators are having positive, negative and zero sequence impedance of $j0.4$p.u, $j0.3$p.u and terminals of the generators, the fault current, in p.u., is ________.



Key: 6

Exp: $Z_0 = 0.15\text{ P.U};\quad Z_1 = \dfrac{0.4}{2} = 0.2\text{ P.U};\qquad Z_2 = \dfrac{0.3}{2} = 0.15\text{P.U}$

$$I_f = \frac{3\text{Vprefault}}{Z_O + Z_1 + Z_2} = \frac{3}{0.15+0.2+0.15} = 6\text{p.u}$$

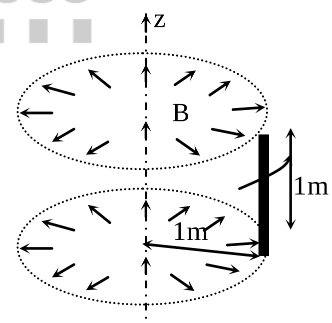
54. An energy meter, having meter constant of 1200 revolutions kWh, makes 20 revolutions in 30 seconds for a constant load. The load, in kW is ______

Key: 2

Exp: $K = 1200\text{rev/kwh} = \dfrac{20\text{revolutions}}{P(\text{kW})\times\left(\dfrac{30}{3600}\right)\text{hr}}$

$\therefore P = 2\text{kW}$

55. A rotating conductor of 1m length is placed in a radially outward (about the z-axis) magnetic flux density (B) of 1 Tesla as shown in figure below. Conductor is parallel to and at 1m distance from the z-axis. The speed of the conductor in r.p,m. required to induce a voltage of 1V across it, should be ______.



Key: 9.55

Exp: Voltage = $\upsilon B \ell$

Velocity $\upsilon = \dfrac{\text{Voltage}}{B\ell} = \dfrac{1}{1\times1} = 1\text{m/s}$

i.e, 1m takes

$\Rightarrow 2\pi\gamma = 2\pi\times1 = 2\pi\text{m}$ Takes $2\pi r$

$\Rightarrow 2\pi r$ for 1 rotation

$\Rightarrow$ in 1 minute $= \dfrac{60}{2\pi}$

Velocity $= \dfrac{60}{2\pi} = 9.55$ rpm