Solutions of

of

Electrical Engineering

GATE-2016

Session 8 | Set-2

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Section - I (General Aptitude)

One Mark Questions

Q.1 The chairman requested the aggrieved shareholders to ________ him.

(a) bare with (b) bore with
(c) bear with (d) bare

Ans. **(c)**

End of Solution

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

(a) Managable (b) Manageable
(c) Mangaeble (d) Managible

Ans. **(b)**

End of Solution

Q.3 Pick the odd one out in the following:
13, 23, 33, 43, 53

(a) 23 (b) 33
(c) 43 (d) 53

Ans. **(b)**

13, 23, 43, 53 are all prime numbers.
only 33 is composite 33, (11 × 3)
odd one out is 33.

End of Solution

Q.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) R2D2 is the only robot which can repair aeroplanes.
(c) R2D2 is a robot which can repair only aeroplanes.
(d) Only R2D2 is a robot.

Ans. **(b)**

End of Solution

Q.5 If $|9y-6| = 3$, then $y^2 - \frac{4y}{3}$ is________.

(a) 0
(b) $+\frac{1}{3}$
(c) $-\frac{1}{3}$
(d) undefined

Ans. **(c)**

$$|9y - 6| = 3$$

$\Rightarrow$ Either $(9y - 6 = 3)$ or $(9y - 6 = -3)$

$\Rightarrow [y = 1]$ or $\left[y = \frac{1}{3}\right]$

$\left[y^2 - \frac{4y}{3}\right]$

put $y = \frac{1}{3}$, $\left(\frac{1}{3}\right)^2 - \frac{4}{3} \times \frac{1}{3} = -\frac{1}{3}$

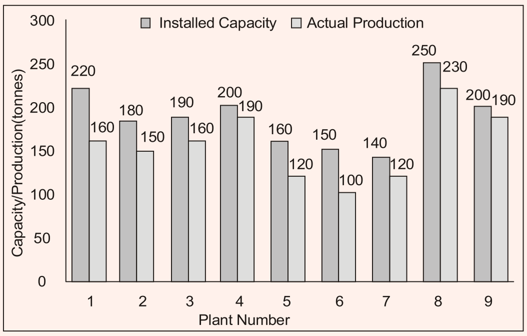
or $y^2 - \frac{4y}{3}$

put $y = 1$, $1^2 - \frac{4}{3} = -\frac{1}{3}$

End of Solution

Two Mark Questions

Q.6 The following graph represents the installed capacity for cement production (in tonnes) and the actual production (in tonnes) 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 tonnes is ____.



Ans. **(120)**

According to information in Question

Large plants are 1, 4, 8, 9 which are having installed capacity of at least 200 tonnes.

Total production of large plant [160 + 190 + 230 + 190] = 770

Remaining plant number 2, 3, 5, 6, 7 all are small plants with capacity less than 200 tonnes.

Total production of small plants = 150 + 160 + 120 + 100 + 120 = 650

Difference = 750 – 650 = z120

End of Solution

Q.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 masters 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 misconceptions 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 higher degrees in mechanical engineering is small.

Ans. **(a)**

End of Solution

Q.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

Ans. **(c)**

End of Solution

Q.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

Ans. **(a)**

$$\text{Probability of free throw} = \frac{60}{100} = .6$$

$$\text{Probability of NOT free throw} = 1 - .6 = .4$$

So required probability of exactly 6 throws in 10 attempts will be given by

$$^{10}C_6(.6)^6 \times (.4)^4 = .2508$$

End of Solution

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

Ans. **(7)**

Unit digit of $211^{870} + 146^{127} \times 3^{424}$ is $1 + 6 \times 1 = 7$

End of Solution

Section - II (Electrical Engineering)

One Mark Questions

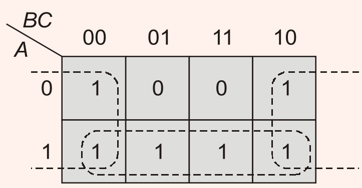
Q.1 The output expression for the Karnaugh map shown below is

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

(a) $A + \bar{B}$ (b) $A + \bar{C}$

(c) $\bar{A} + \bar{C}$ (d) $\bar{A} + C$

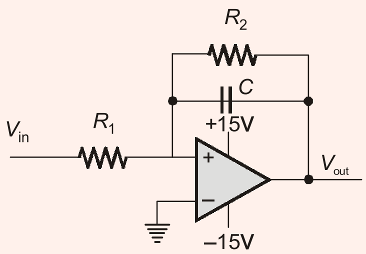
Ans. **(b)**



$$F = A + \bar{C}$$

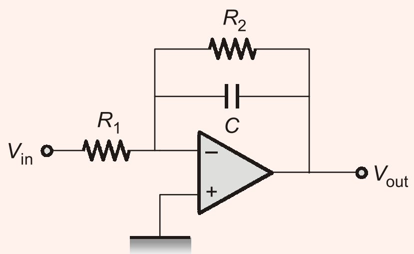
End of Solution

Q.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.

Ans. **(a)**



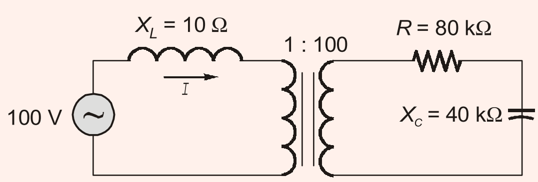
$$\frac{V_{out}}{V_{in}} = -\left[\frac{R_2 \cdot \frac{1}{j\omega C} \Big/ R_2 + \frac{1}{j\omega C}}{R_1}\right]$$

$$\frac{V_{out}}{V_{in}} = -\left[\frac{R_2}{R_1(R_2 j\omega C + 1)}\right]$$

So the system is a low pass filter.

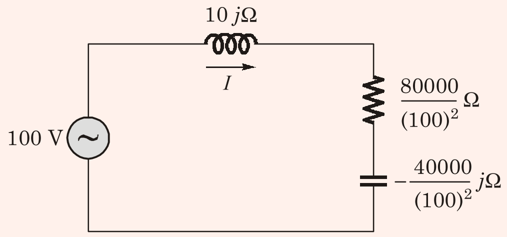
End of Solution

Q.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 100 V (rms), 50 Hz, AC. The rms value of the current I, in ampere, is______.



Ans. (10)

The above circuit can be drown by transferring secondary circuit to primary side.



$$I = \frac{100v}{(8+10j-4j)\Omega}$$

$$= \frac{100V}{(8+6j)\Omega}$$

So the rms value of I will be 10 A.

End of Solution

Q.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 the input $x(t) = 3e^{-\frac{t}{3}}u(t)$, 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) $54e^{-\frac{t}{6}}u(t)-54e^{-\frac{t}{3}}u(t).$

Ans. (d)

The differential equation

$$\frac{dy(t)}{dt}+\frac{1}{6}y(t) = 3x(t)$$

So,
$$sY(s)+\frac{1}{6}Y(s) = 3X(s)$$

$$Y(s) = \frac{3X(s)}{\left(s+\frac{1}{6}\right)}$$

$$X(s) = \frac{9}{\left(s+\frac{1}{3}\right)}$$

So, $$Y(s) = \frac{9}{\left(s+\frac{1}{3}\right)\left(s+\frac{1}{6}\right)} = \frac{54}{\left(s+\frac{1}{6}\right)} - \frac{54}{\left(s+\frac{1}{3}\right)}$$

So, $$y(t) = (54e^{-1/6t} - 54e^{-1/3t})\, u(t)$$

End of Solution

Q.5 Suppose the maximum frequency in a band-limited signal $x(t)$ is 5 kHz. Then, the maximum frequency in $x(t)$ cos(2000 πt), in kHz, is______.

Ans. **(6)**

Since $x(t)$ is band limited to 5 kHz then maximum frequency in $x(t)$cos $(2000\pi t)$ is 6 kHz.

End of Solution

Q.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 continuous but not analytic

(c) $f(z)$ is not continuous but is analytic

(d) $f(z)$ is neither continuous nor analytic

Ans. **(b)**

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

$$f(z) = 2x \quad \text{is continuous (polynomial)}$$

$$u = 2x \qquad v = 0$$

$$u_x = 2 \qquad u_y = 0$$

$$v_x = 0 \qquad v_y = 0$$

C.R. equiation not satisfied.

∴ No where analytic.

End of Solution

Q.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

Ans. **(d)**

By Calyey Hamilton theorem

$$\lambda^3 = \lambda$$

$$\lambda = 0, 1, -1$$

End of Solution

Q.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) $(-e^{-t} + te^{-t})u(t)$
(d) $e^{-t}u(t)$

Ans. **(a)**

The differential equation is

$$y''(t) + 2y'(t) + y(t) = 0$$

So, $(s^2Y(s) - sy(0) - y'(0)) + 2[sY(s) - y(0)] + Y(s) = 0$

So,
$$Y(s) = \frac{sy(0) + y'(0) + 2y(0)}{(s^2 + 2s + 1)}$$

Given that $y'(0) = 1,\ y(0) = 0$

So,
$$Y(s) = \frac{1}{(s+1)^2}$$

So,
$$y(t) = te^{-t}\,u(t)$$

End of Solution

Q.9 The value of the line integral

$$\int_C (2xy^2dx + 2x^2ydy + dz)$$

along a path joining the origin (0, 0, 0) and the point (1, 1, 1) is

(a) 0
(b) 2
(c) 4
(d) 6

Ans. **(b)**

$$\int_C \bar{F}\cdot\bar{dr}$$

where
$$\bar{F} = xy^2\bar{i} + 2x^2y\bar{j} + \bar{k}$$

$$\nabla \times F = O$$

(F is irrotational $\Rightarrow$ F is conservative)

$$F = \nabla\phi \quad (\phi \text{ is scalar potational function})$$

$$\phi_x = 2xy^2$$
$$\phi_y = 2x^2y$$
$$\phi_z = 1$$

$\Rightarrow$
$$\phi = x^2y^2 + z + C$$

where, F is conservative

$$\int_C \bar{F}.\bar{d}r = \int_{(0,0,0)}^{(1,1,1)} d\phi = \left[x^2y^2 + z\right]_{(0,0,0)}^{(1,1,1)}$$

$$= 2$$

End of Solution

Q.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) $f(x) = \sum_{k=0}^{\infty} a_{2k+1} \sin(2k+1)x$

Ans. **(b)**

Given that $f(-x) = -f(x)$

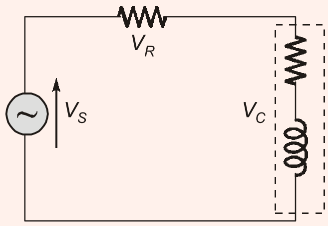
So function in an odd function.

So the Fourier series will have sine term only so

$$f(x) = \sum_{k=1}^{\infty} b_x \sin(kx)$$

End of Solution

Q.11 A resistance and a coil are connected in series and supplied from a single phase, 100 V, 50 Hz ac source as shown in the figure below. The rms values of plausible voltages 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

Ans. **(d)**

Since V_s = 100 V, and the vector sum of V_R and V_C should be equal to V_s i.e.

$$V_s = \sqrt{V_R^2 + V_C^2}$$

From the option we get

$$V_R = 60 \text{ V}$$
$$V_C = 80 \text{ V}$$

End of Solution

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

$V(t) = 100 \sin(\omega t)$

$i(t) = 10 \sin(\omega t - 60°) + 2\sin(3\omega t) + 5 \sin(5\omega t)$.

The average power consumed by the load, in W, is______.

Ans. **(250)**

Method 1:

The average power conusmed by the load $= P = V_I \, I_1 \cos\phi_1$

$$= \frac{100}{\sqrt{2}} \cdot \frac{10}{\sqrt{2}} \cos 60° = 250 \text{ W}$$

Method 2:

$$V(t) = 100 \sin(\omega t)$$

$$i(t) = 10 \sin(\omega t - 60°) + 2 \sin(3\omega t) + 5 \sin(5\omega t)$$

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

$= 1000 \sin \omega t \,.\, \sin(\omega t - 60°) + 200 \sin \omega t \,.\, \sin 3\omega t + 500 \sin \omega t \sin 5\omega t$

$= 500 [\cos(\omega t - \omega t + 60°) - \cos(\omega t + \omega t - 60°)] + 100 [\cos(\omega t - 3\omega t) - \cos(\omega t + 3\omega t)]$

$+ 250 [\cos(\omega t - 5\omega t) - \cos(\omega t + 500 \omega t]$

$= 500 [\cos 60° - \cos(2\omega t - 60°)] + 100 (\cos(-2\omega t) - \cos 4\omega t]$

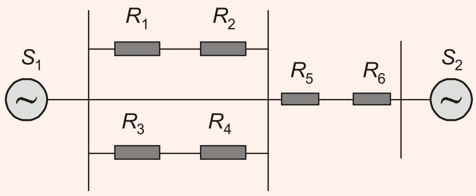
$+ 250 [\cos(-4\omega t) - \cos(6\omega t)]$

$= 500 \cos 60° = 250$ W

average value of $\cos(2\omega t - 60°)$, $\cos(2\omega t)$, $\cos(4\omega t)$, $\cos(6\omega t)$ will be zero.

End of Solution

Q.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

Ans. **(d)**

End of Solution

Q.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

Ans. **(a)**

Size of the Jacobian matrix is, 2m – m – 1 × 2n – m –1

Given that 10 generator buses, we need to assume with in the 10 buses one bus as slack bus

then (2 × 100 – 10 – 1) × (2 × 100 – 10 – 1)

189 × 189

End of Solution

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

(a) capacitive (b) inductive
(c) resistive (d) zero

Ans. **(b)**

$$Z_n = \sqrt{\frac{L}{C}} = \sqrt{\frac{1.6 \times 10^{-3}}{10 \times 10^{-9}}} = 400\ \Omega$$

$$\text{SIL} = \frac{400 \times 400}{400} = 400\ \text{MW}$$

In the second case SIL decreases means Z_n increases.

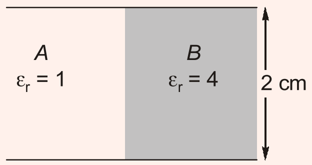
Z_n increases with increase in inductance 'L'.

So, it is inductive

Load < SIL means, line behaves capacitive to compensate it inductor to be placed.

End of Solution

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



(a) 1
(b) 2
(c) 4
(d) 16

Ans. **(c)**

As voltage is same across both the regions and distance between two plates is also same, then electric field remains same throughout the both region.

As we know $$E = \frac{V}{d} = \text{constant for both regions.}$$

End of Solution

Q.17 A 50 MVA, 10 kV, 50 Hz, 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 ________.

Ans. **(5.0)**

$$I'' = \frac{E_g}{X_d''} \quad ; \quad I = \frac{E_g}{X}$$

$$\frac{I''}{I} = \frac{X}{X_d''} = \frac{1.0}{0.2} = 5.0 \text{ p.u.}$$

End of Solution

Q.18 Consider a linear time-invariant system with 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_______.

Ans. **(0.707)**

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

Put $s = j\omega$, $$H(j\omega) = \frac{1}{j\omega + 1}$$

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

$\because$ input $x(t) = \cos(t)$

Here $\omega = 1$ rad/sec

and $|x(t)| = 1$

Hence, steady state output

$$y(t) = |x(t)| \times |H(j\omega)|_{\omega=1} \cos[t + \angle H(j\omega)]$$

$$A = |x(t)| \times |H(j\omega)]_{\omega=1}$$

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

End of Solution

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

Ans. **(57.7)**

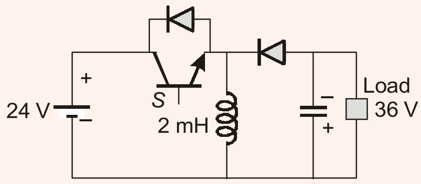
In the 3-ϕ diode bridge rectifier each diode conducts for 120° for one complete cycle.

$$I_{D\,\text{rms}} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi/3} I_0^2\, d\omega t} = I_o\sqrt{\frac{2\pi}{2\pi \times 3}}$$

$$= \frac{I_o}{\sqrt{3}} = \frac{100}{\sqrt{3}} = 57.7 \text{ A}$$

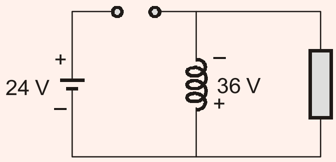
End of Solution

Q.20 A buck-boost 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 20 kHz 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 ________.



Ans. **(60)**

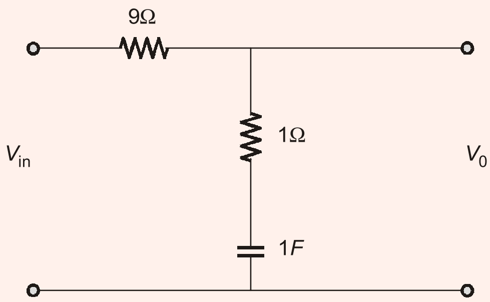
When switch '*S*' is off, diode *D* is on then



∴ Peak voltage across switch = 24 + 36 = 60 V

End of Solution

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



Ans. **(0.316)**

∵ Assuming Fig.

$R_1 = 9\ \Omega$

$R_2 = 1\ \Omega$

We can write,

$$\frac{V_o(s)}{V_{in}(s)} = \frac{R_2 + \frac{1}{sC}}{R_1 + R_2 + \frac{1}{sC}}$$

$$= \frac{1 + R_2.Cs}{1 + (R_1 + R_2)Cs}$$

$$= \frac{1 + R_2.Cs}{1 + \left(\frac{R_1 + R_2}{R_2}\right) R_2 Cs}$$

Let $R_2C = T$

$$\frac{R_1 + R_2}{R_2} = \beta$$

Hence $$\frac{V_o(s)}{V_{in}(s)} = \frac{1 + Ts}{(1 + \beta Ts)}$$

which represent a lag compensator

$\because$ here $T = R_2C = 1.1 = 1$ sec

$$\beta = \frac{1+9}{1} = 10$$

Maximum phase lag occurs at frequency

$$\omega_n = \frac{1}{T\sqrt{\beta}} = \frac{1}{1\sqrt{10}}$$

$$= 0.316 \text{ rad/sec}$$

End of Solution

Q.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.

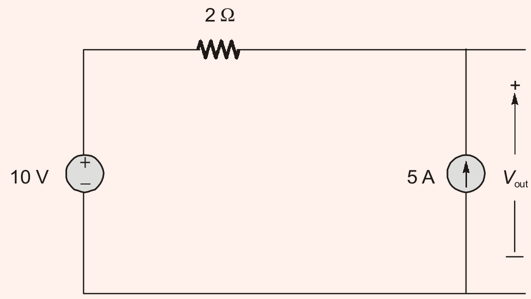
(d) interchanging the terminals of both the windings.

Ans. **(c)**

Inter changing the terminals of the auxiliary winding.

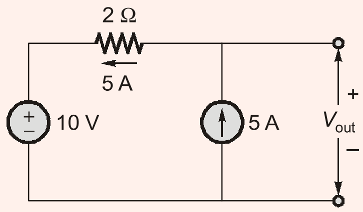
End of Solution

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



(a) 0
(b) 5
(c) 10
(d) 20

Ans. **(d)**



So
$$V_{out} = (5 \times 2) + 10$$
$$= 20 \text{ V}$$

End of Solution

Q.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

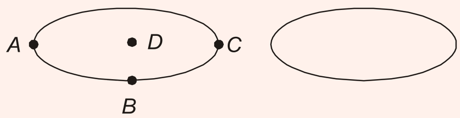
Ans. **(d)**

Number of KCL equation $= n - 1 = 5 - 1 = 4$

Number of KVL equation $= b - (n - 1) = 7 - (5 - 1) = 3$

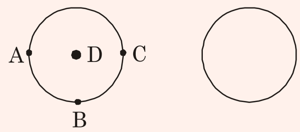
End of Solution

Q.25 Two 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*

Ans. **(c)**



At the point C, $\bar{E}$ (electric field intensity) is maximum being closest to the other plate.

End of Solution

Two Mark Questions

Q.26 The Boolean expression $\overline{(a+\bar{b}+c+\bar{d})+(b+\bar{c})}$ simplifies is

(a) 1
(b) $\overline{a.b}$
(c) a, b
(d) 0

Ans. **(d)**

$$F =$$

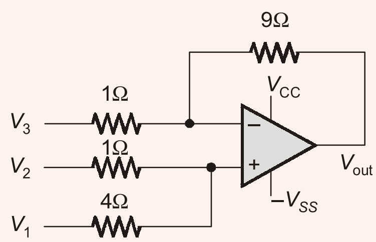
$$\overline{(a+\bar{b}+c+\bar{d})+(b+\bar{c})} = \overline{(a+\bar{b}+c+\bar{d})}\cdot\overline{(b+\bar{c})}$$

$$= \bar{a}\cdot b\cdot\bar{c}\cdot d\cdot\bar{b}\cdot c$$

$$F = 0$$

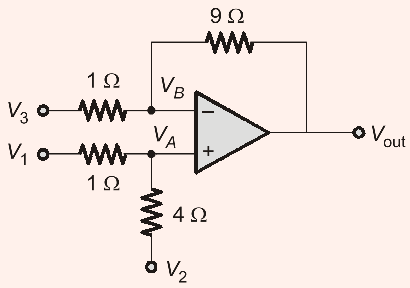
End of Solution

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



(a) $1.8V_1 + 7.2\,V_2 - V_3$
(b) $2V_1 + 8V_2 - 9V_3$
(c) $7.2\,V_1 + 1.8\,V_2 - V_3$
(d) $8V_1 + 2V_2 - 9V_3$

Ans. **(d)**

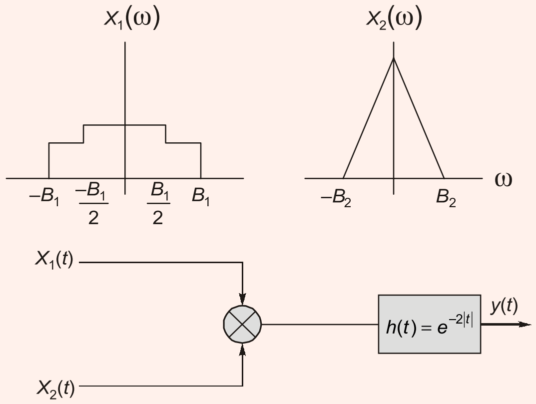


$$V_A = \left(\frac{4}{5}V_1 + \frac{1}{5}V_2\right)$$

$$V_{out} = -9\ V_3 + 10\ V_A = -9\ V_3 + 8\ V_1 + 2\ V_2$$

End of Solution

Q.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) ∞

Ans. **(b)**

Given that,

$$\text{Bandwidth of } X_1(\omega) = B_1$$
$$\text{Bandwidth of } X_2(\omega) = B_2$$

System has $h(t) = e^{-2|t|}$ and input to the system is $x_1(t) \cdot x_2(t)$

The bandwidth of $x_1(t) \cdot x_2(t)$ is $B_1 + B_2$.