

General Aptitude

Q. No. 1 – 5 Carry One Mark Each

1. Which of the following combinations is incorrect?

(A) Acquiescence – Submission
(B) Wheedle – Roundabout
(C) Flippancy – Lightness
(D) Profligate – Extravagant

Answer: (B)

2. Given set A = {2, 3, 4, 5} and Set B = {11, 12, 13, 14, 15}, two numbers are randomly selected, one from each set. What is probability that the sum of the two numbers equals 16?

(A) 0.20 (B) 0.25 (C) 0.30 (D) 0.33

Answer: (A)

Exp: $4 \times 5 = 20$ Total mass

$\left. \begin{array}{l} 5,11 \\ 4,12 \\ 3,13 \\ 2,14 \end{array} \right\} 4 \text{ favorable}$

$$\therefore \frac{4}{20} = \frac{1}{5} = 0.2$$

3. Which of the following options is the closest in meaning to the sentence below?

She enjoyed herself immensely at the party.

(A) She had a terrible time at the party.
(B) She had a horrible time at the party.
(C) She had a terrific time at the party
(D) She had a terrifying time at the party

Answer: (C)

4. Based on the given statements, select the most appropriate option to solve the given question.

If two floors in a certain building are 9 feet apart, how many steps are there in a set of stairs that extends from the first floor to the second floor of the building?

Statements:

(I) Each step is $\frac{3}{4}$ foot high.
(II) Each step is 1 foot wide.

(A) Statement I alone is sufficient, but statement II alone is not sufficient.
(B) Statement II alone is sufficient, but statement I alone is not sufficient.
(C) Both statements together are sufficient, but neither statement alone is sufficient.
(D) Statement I and II together are not sufficient.

Answer: (A)

5. Didn't you buy _____ when you went shopping?
(A) any paper (B) much paper (C) no paper (D) a few paper

Answer: (A)

Q. No. 6 – 10 Carry Two Marks Each

6. The given statement is followed by some courses of action. Assuming the statement to be true, decide the correct option.

Statement:

There has been a significant drop in the water level in the lakes supplying water to the city.

Course of action:

- (I) The water supply authority should impose a partial cut in supply to tackle the situation.
(II) The government should appeal to all the residents through mass media for minimal use of water.
(III) The government should ban the water supply in lower areas.
(A) Statements I and II follow.
(B) Statements I and III follow
(C) Statements II and III follow.
(D) All statements follow.

Answer: (A)

7. The number of students in a class who have answered correctly, wrongly, or not attempted each question in an exam, are listed in the table below. The marks for each question are also listed. There is no negative or partial marking.

Q No	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	1	11	29	4
4	2	23	18	3
5	5	31	12	1

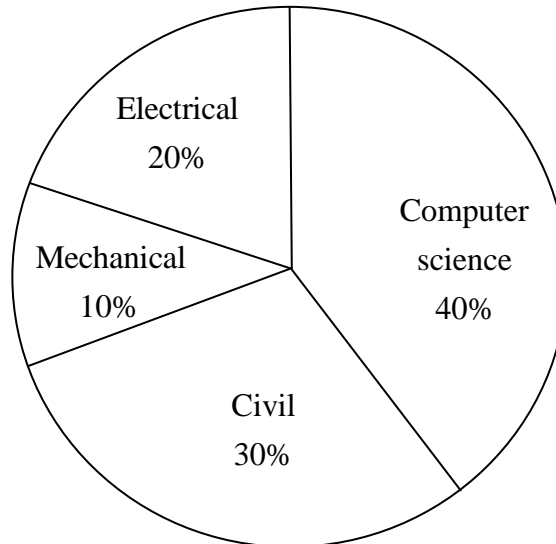
What is the average of the marks obtained by the class in the examination?

- (A) 2.290 (B) 2.970 (C) 6.795 (D) 8.795

Answer: (C)

Exp:
$$\frac{21 \times 2 + 15 \times 3 + 11 \times 1 + 23 \times 2 + 31 \times 5}{44} = 6.795$$

8. The pie chart below has the breakup of the number of students from different departments in an engineering college for the year 2012. The proportion of male to female students in each department is 5:4. There are 40 males in Electrical Engineering. What is the difference between numbers of female students in the Civil department and the female students in the Mechanical department?



Answer: 32

Exp: Electrical male students = 40

$$\therefore \text{Electrical Female students} = \frac{4}{5} \times 40 = 32$$

$$\therefore \text{Total no. of Student} = 40 + 32 = 72$$

$$\text{Mechanical Strength is } 10\% = 20 + 16 = 36$$

$$\text{Civil Strength is } 30\% = 50 + 48 = 98$$

$$\text{Difference of civil female to mechanical female} = 48 - 16 = 32$$

9. Select the alternative meaning of the underlined part of the sentence.

The chain snatchers took to their heels when the police party arrived.

- (A) took shelter in a thick jungle
- (B) open indiscriminate fire
- (C) took to flight
- (D) unconditionally surrendered

Answer: (C)

10. The probabilities that a student passes in Mathematics, Physics and Chemistry are m, p , and c respectively. Of these subjects, the student has 75% chance of passing in at least one, a 50% chance of passing in at least two and a 40% chance of passing in exactly two. Following relations are drawn in m, p, c :

- (I) $p + m + c = 27/20$
 (II) $p + m + c = 13/20$
 (III) $(p) \times (m) \times (c) = 1/10$
 (A) Only relation I is true
 (B) Only relation II is true
 (C) Relations II and III are true.
 (D) Relations I and III are true.

Answer: (A)

Exp: $P(\text{atleast two}) - p(\text{exat 2})$
 $= 0.5 - 0.4 = 0.1$
 $0.75 = p + m + c + 0.1 - (0.5 + 0.11 \times 2)$
 $\therefore p + mc = 0.65 + 0.7$
 $= 1.35$
 $= \frac{27}{20}$

Electrical Engineering

Q. No. 1 – 25 Carry One Mark Each

1. A moving average function is given by $y(t) = \frac{1}{T} \int_{t-T}^t u(\tau) d\tau$. If the input u is a sinusoidal signal of frequency $\frac{1}{2T}$ Hz, then in steady state, the output y will lag u (in degree) by _____.

Answer: 90

Exp: $u(\tau) = \sin(\omega\tau)$

$$\omega = 2\pi f = 2\pi \cdot \frac{1}{2T} = \frac{\pi}{T}$$

$$\omega T = \pi$$

$$y(t) = \frac{1}{T} \int_{t-T}^t \sin(\omega\tau) d\tau = \frac{\cos(\omega\tau)}{\omega T} \Big|_{t-T}^t = \frac{1}{\pi} [\cos \omega(t-T) - \cos \omega t]$$

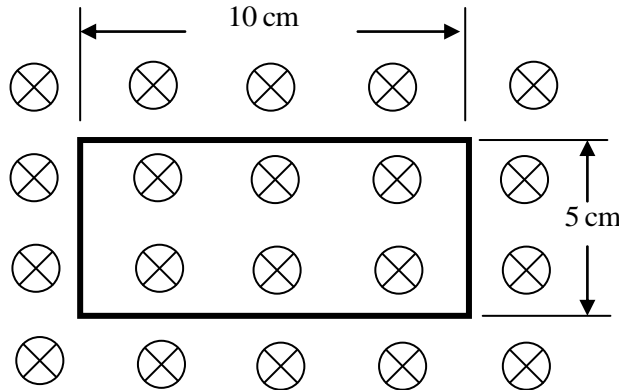
$$= \frac{1}{\pi} [\cos \omega t \cos \omega T + \sin \omega t \sin \omega T - \cos \omega t]$$

$$y(t) = -\frac{2}{\pi} \cos \omega t = \frac{2}{\pi} \sin(90 + \omega t)$$

$$x(t) = \sin \omega t$$

$$\phi = 90^\circ$$

2. Consider a one-turn rectangular loop of wire placed in a uniform magnetic field as shown in the figure. The plane of the loop is perpendicular to the field lines. The resistance of the loop is 0.4Ω , and its inductance is negligible. The magnetic flux density (in Tesla) is a function of time, and is given by $B(t) = 0.25\sin\omega t$, where $\omega = 2\pi \times 50$ radian/second. The power absorbed (in Watt) by the loop from the magnetic field is _____.



Answer: 0.192

Exp: $P = \frac{V_{emf}^2}{R}$

$$V_{emf} = \frac{-d\psi}{dt}$$

$$\psi = \int_S \mathbf{B} \cdot d\mathbf{S} = \mathbf{B} \cdot \mathbf{S} = \frac{1}{800} \sin\omega t$$

$$V_{emf} = \frac{-d\psi}{dt} = \frac{-1}{8} \pi \cos\omega t$$

$$p = \frac{\pi^2}{64} \cos^2\omega t \times \frac{1}{R}$$

$$p = \frac{\pi^2}{0.4 \times 64} \left[\frac{1 + \cos 2\omega t}{2} \right]$$

$$p_{avg} = \frac{\pi^2}{20 \times 0.4 \times 64} + \frac{\pi^2}{0.4 \times 64 \times 2} \cos 2\omega t$$

$$p_{avg} = \frac{\pi^2}{20 \times 0.4 \times 64} = 0.192W$$

3. If the sum of the diagonal elements of a 2×2 matrix is -6 , then the maximum possible value of determinant of the matrix is _____.

Answer: 9

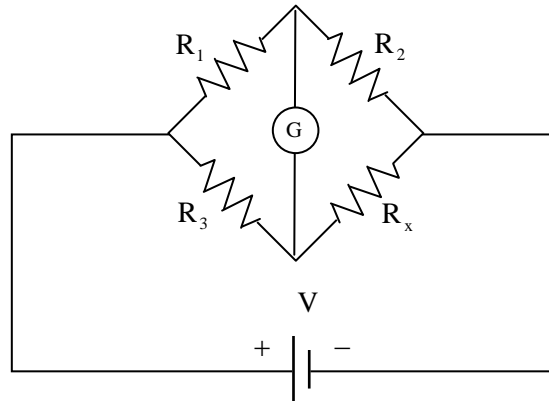
Exp: Sum of the diagonals elements is -6 for 2×2 matrix

The possible eigen value are

$$\begin{aligned} \rightarrow & -1, -5 \quad -5, -1, \quad -8, 2 \\ & -2, -3 \quad -4, -2 \quad -9, 3 \quad \text{-----} \\ & -3, -1 \quad -3, -3 \quad -10, 4 \end{aligned}$$

Maximum possible value of determinant is $-3 \times -3 = 9$.

4. When the Wheatstone bridge shown is used to find value of resistance R_x , the Galvanometer G indicates zero current when $R_1 = 50\Omega$, $R_2 = 65\Omega$ & $R_3 = 100\Omega$. If R_3 is known with $\pm 5\%$ tolerance on its nominal value of 100Ω , what is range of R_x in ohms?



- (A) [123.5, 136.5] (B) [125.898, 134.12]
(C) [117, 143] (D) [120.25, 139.75]

Answer: (A)

Exp: Weinbridge is balanced, $R_1, R_x = R_2 R_3$

$$50 \times R_x = 65 \times 100$$

$$R_x = 130\Omega$$

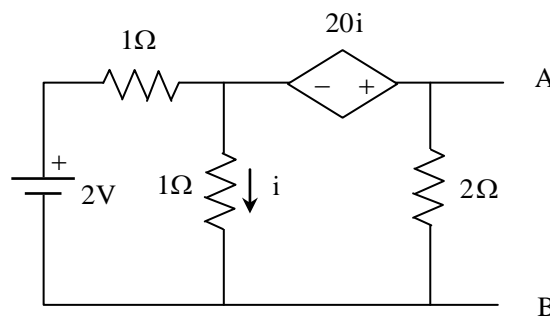
$$\text{Now } R_3 = 100 \pm 100 \times 0.05 = 100 \pm 5 = 95/105\Omega$$

$$R_x = \frac{R_2 R_3}{R_1} = \frac{65 \times 105}{50} = 136.5\Omega$$

$$R_x = \frac{65 \times 95}{50} = 123.5\Omega$$

Range of R_x is 123.5Ω to 136.5Ω

5. For the given circuit the Thevenin equivalent is to be determined. The Thevenin voltage, V_{Th} (in volt), seen from terminal AB is _____.



Answer: 3.36

Exp: $V_{th} = 2i_1$

$$2 = 1[i + i_1] + i = 2i + i_1$$

$$i(1) = -20i + 2i_1$$

$$\therefore 21i = 2i_1$$

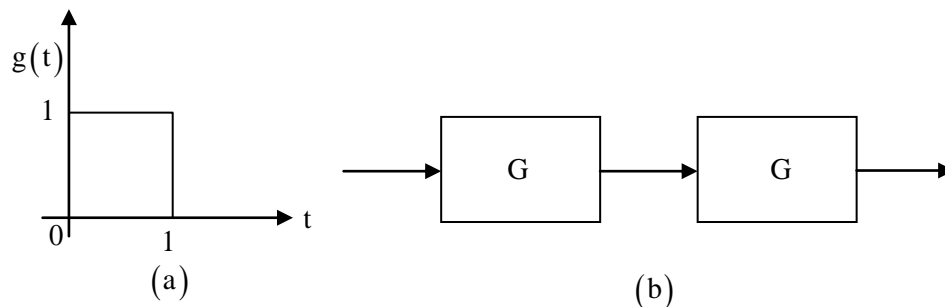
$$i = \left(\frac{2}{21} \right) i_1$$

$$2 = 2i + i_1 = 2 \left(\frac{2}{21} \right) i_1 + i_1 = \left(\frac{4}{21} + 1 \right) i_1 = \frac{25}{21} i_1$$

$$i_1 = \frac{42}{25} = 1.68$$

$$V_{th} = 2i_1 = 3.36V$$

6. The impulse response $g(t)$ of a system, G , is as shown in Figure (a). What is the maximum value attained by the impulse response of two cascaded blocks of G as shown in Figure (b)?



(A) $\frac{2}{3}$

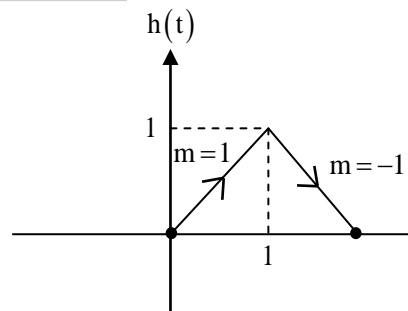
(B) $\frac{3}{4}$

(C) $\frac{4}{5}$

(D) 1

Answer: (D)

Exp: Overall impulse response = $g(f)*g(t)$
 $h(f) = g(f)*g(f)$



7. Base load power plants are

P: wind farms.

Q: run-of-river plants.

R: nuclear power plants.

S: diesel power plants.

- (A) P, Q and S only (B) P, R and S only (C) P, Q and R only (D) Q and R only

Answer: (C)

Exp: Wind farms along with combine cycle gas turbine supplies the base load.

Considering economic criteria, environmental issues and requirements, it is favorable to use wind generated electricity to meet the base load.

8. Of the four characteristics given below, which are the major requirements for an instrumentation amplifier?

P: High common mode rejection ratio

Q: High input impedance

R: High linearity

S: High output impedance

(A) P, Q and R only (B) P and R only (C) P, Q and S only (D) Q, R and S only

Answer: (A)

Exp: Additional characteristics include very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances. Instrumentation amplifiers are used where great accuracy and stability of the circuit both short and long-term are required.

9. A random variable X has probability density function $f(x)$ as given below:

$$f(x) = \begin{cases} a + bx & \text{for } 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

If the expected value $E[X] = 2/3$, then $\Pr[X < 0.5]$ is _____.

Answer: 0.25

Exp: $\int_{-\infty}^{\infty} f(x) dx = 1$

$$\text{so } \int_0^1 (a + bx) dx = 1$$

$$a + \frac{b}{2} = 1$$

$$2a + b = 2 \quad (1)$$

$$\text{given } E[X] = 2/3 = \int_0^1 x[a + bx] dx$$

$$\frac{2}{3} = \frac{a}{2} + \frac{b}{3}$$

$$3a + 2b = 4 \quad (2)$$

from (1) and (2)

$$a = 0$$

$$b = 2$$

$$p_r[X < 0.5] = \int_0^{0.5} f(x) dx = 2 \int_0^{0.5} x dx = 0.25$$

10. Consider a function $\vec{f} = \frac{1}{r^2} \hat{r}$, where r is the distance from the origin and \hat{r} is the unit vector in the radial direction. The divergence of the function over a sphere of radius R , which includes the origin, is

(A) 0 (B) 2π (C) 4π (D) $R\pi$

Answer: (A)

Exp: $F = \frac{1}{r^2} a_r$

$$\nabla \cdot F = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 F_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta F_\theta) + \frac{1}{r \sin \theta} \frac{\partial F_\phi}{\partial \phi}$$

$$\nabla \cdot F = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 + \frac{1}{r^2} \right) + 0 + 0$$

$$\nabla \cdot F = 0$$

11. A separately excited DC generator has an armature resistance of 0.1Ω and negligible armature inductance. At rated field current and rated rotor speed, its open-circuit voltage is 200 V. When this generator is operated at half the rated speed, with half the rated field current, an un-charged $1000 \mu\text{F}$ capacitor is suddenly connected across the armature terminals. Assume that the speed remains unchanged during the transient. At what time (in microsecond) after the capacitor is connected will the voltage across it reach 25V?

(A) 62.25 (B) 69.3 (C) 73.25 (D) 77.3

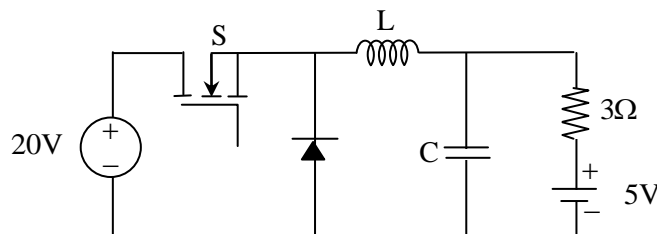
Answer: (B)

Exp: $\frac{E_{b2}}{E_{b1}} = \frac{N_2 \phi_2}{N_1 \phi_1} = \frac{0.5 N_1 \times 0.5 \phi_1}{N_1 \times \phi_{s1}} \Rightarrow E_{b2} = 0.25 \times E_{b1} = 0.25 \times 200 = 50$

$$\tau = R \times C = 0.1 \times 1000 \mu$$

$$50 = 2000 e^{-t/100 \times 10^{-6}} \Rightarrow t = 69.3 \mu\text{sec}$$

12. In the following chopper, the duty ratio of switch S is 0.4. If the inductor and capacitor are sufficiently large to ensure continuous inductor current and ripple free capacitor voltage, the charging current (in Ampere) of the 5 V battery, under steady-state, is _____.



Answer: 1

Exp: $V_0 = DV_s = 0.4 \times 20 = 8\text{V}$

$$I_0 = \frac{V_0 - E}{R} = \frac{8 - 5}{3} = \frac{3}{3} = 1\text{A}$$

13. If a continuous function $f(x)$ does not have a root in the interval $[a, b]$, then which one of the following statements is TRUE?

- (A) $f(a)f(b) = 0$
(B) $f(a)f(b) < 0$
(C) $f(a)f(b) > 0$
(D) $f(a)/f(b) \leq 0$

Answer: (C)

Exp: We know that, (Intermediate value theorem)

If $f(a)f(b) < 0$ then $f(x)$ has at least one root in (a, b)

$f(x)$ does not have root in (a, b) means $f(a)f(b) > 0$

14. The primary mmf is least affected by the secondary terminal conditions in a

- (A) power transformer (B) potential transformer
(C) current transformer (D) distribution transformer

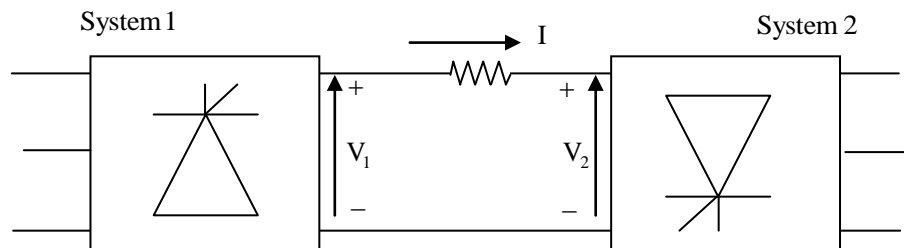
Answer: (C)

Exp: Primary winding of CT is connected in series with the circuit whose current is to be sensed & across the secondary of CT's the operating coil of the relay is connected.

In protection CT, one tube of primary winding i.e., the conductor of the circuit itself forms the primary of the CT.

\therefore The primary is connected in series with the power circuit, the voltage drop across its terminals is very small and the primary current is independent of the secondary current contrary to power transformer where the primary current depends upon the secondary current.

- Q15. Consider a HVDC link which uses thyristor based line-commutated converters as shown in the figure. For a power flow of 750 MW from System 1 to System 2, the voltages at the two ends, and the current, are given by: $V_1 = 500$ kV, $V_2 = 485$ kV and $I = 1.5$ kA. If the direction of power flow is to be reversed (that is, from System 2 to System 1) without changing the electrical connections, then which one of the following combinations is feasible?



If power is to be reversed

- (A) $V_1 = -500$ kV, $V_2 = -485$ kV and $I = 1.5$ kA
(B) $V_1 = -485$ kV, $V_2 = -500$ kV and $I = 1.5$ kA
(C) $V_1 = 500$ kV, $V_2 = 485$ kV and $I = -1.5$ kA
(D) $V_1 = -500$ kV, $V_2 = -485$ kV, $I = -1.5$ kA

Answer: (B)

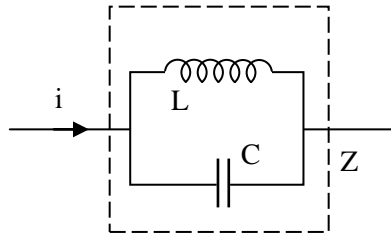
Exp: Initially, $I = \frac{V_1 - V_2}{R} [\because V_1 > V_2]$

For power flow to be reversed, polarity of voltage is changed keeping the direction of current unchanged.

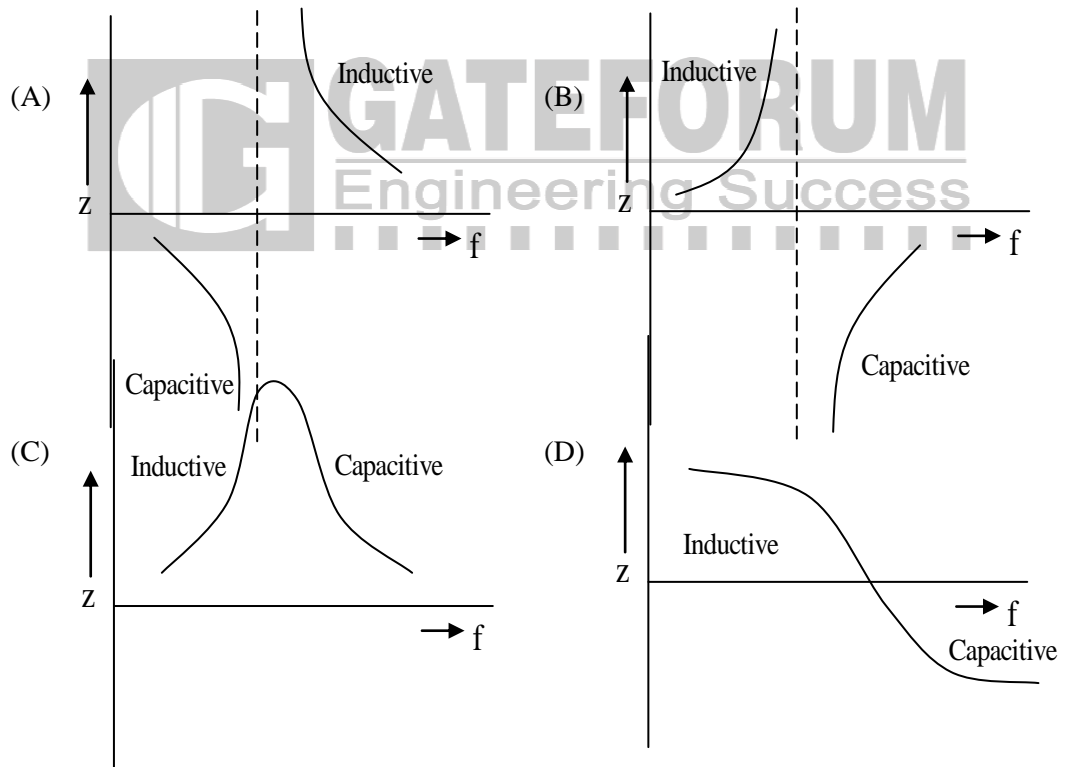
$$\therefore I(+ve) = \frac{V_1 - V_2}{R}$$

$$\text{Here } V_1 > V_2 \Rightarrow -485 > -500 \Rightarrow I(+ve)$$

16. An inductor is connected in parallel with a capacitor as shown in the figure.



As the frequency of current i is increased, the impedance (Z) of the network varies as



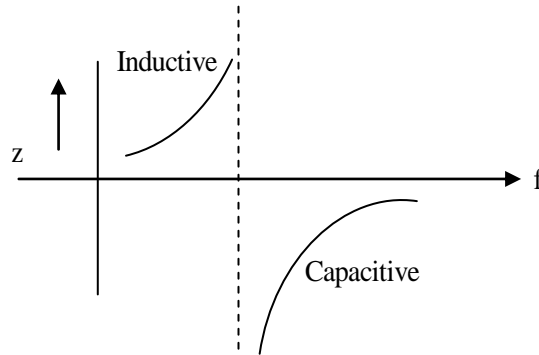
Answer: (B)

Exp: $Z = Z_L // Z_C$

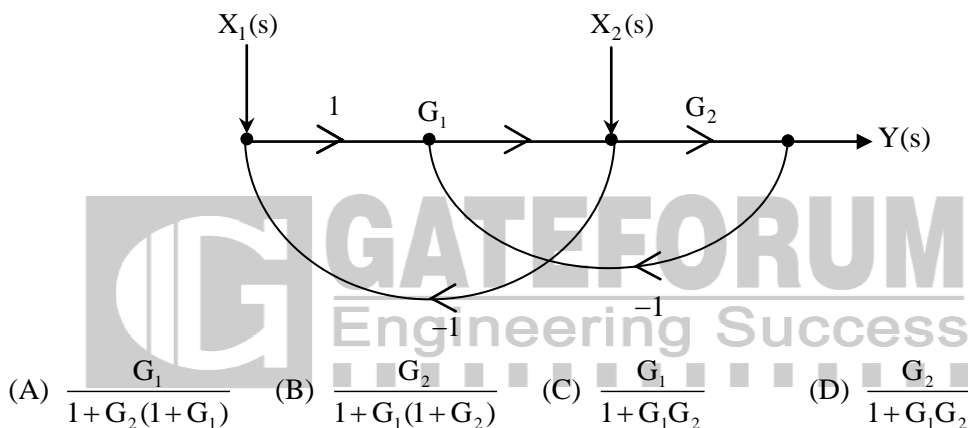
$$Z = \frac{j\omega L \times \frac{1}{j\omega C}}{\left(j\omega L + \frac{1}{j\omega C} \right)}$$

$$Z = \frac{j\omega L}{(1 + (-1)\omega^2 LC)}$$

$$Z = j \left[\frac{\omega L}{1 - \omega^2 LC} \right]$$



17. For the signal-flow graph shown in the figure, which one of the following expressions is equal to the transfer function $\left. \frac{Y(s)}{X_2(s)} \right|_{X_1(s)=0}$?



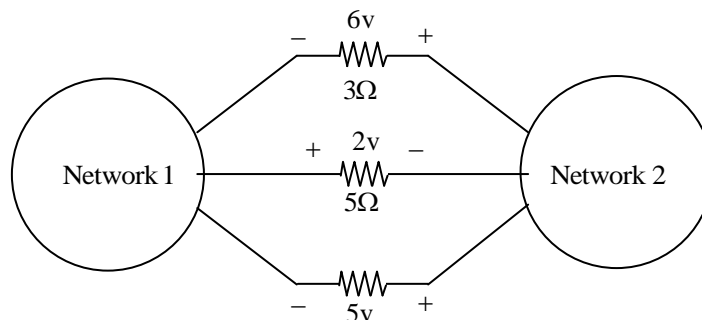
Answer: (B)

Exp: $P_1 = G_2$

$$\Delta = 1 - [-G_1 G_2 - G_1] = 1 + G_1(1 + G_2)$$

$$TF = \frac{P_1 \Delta_1}{\Delta} = \frac{G_2}{1 + G_1[1 + G_2]}$$

18. The voltages developed across the 3Ω and 2Ω resistors shown in the figure are 6V and 2V respectively, with the polarity as marked. What is the power (in Watt) delivered by the 5V voltage source?



(A) 5

(B) 7

(C) 10

(D) 14

Answer: A

Exp: $I = \frac{6V}{3\Omega} = 2A$

$$I = \frac{2V}{2\Omega} = 1A$$

$$I + I = 2$$

$$I = 1A$$

$$P = 5 \times 1 = 5W$$

- 19 The self inductance of the primary winding of a single phase, 50 Hz, transformer is 800 mH, and that of the secondary winding is 600 mH. The mutual inductance between these two windings is 480 mH. The secondary winding of this transformer is short circuited and the primary winding is connected to a 50 Hz, single phase, sinusoidal voltage source. The current flowing in both the winding is less than their respective rated currents. The resistance of both windings can be neglected. In this connection, what is the effective inductance (in mH) seen by the source?

(A) 416

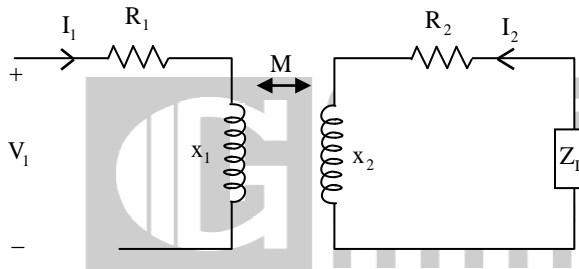
(B) 440

(C) 200

(D) 920

Answer: (A)

Exp:



$$Z_{in} = \frac{V_1}{I_1} = (R_1 + jX_1) + \frac{\omega^2 M^2}{R_2 + jX_2 + Z_L}$$

Given, $L_1 = 800 \text{ mH}$
 $L_2 = 600 \text{ mH}$
 $M = 480 \text{ mH}$
 $\omega = 314 \text{ rad/sec}$
 $Z_L = 0$
 R_1, R_2 neglected

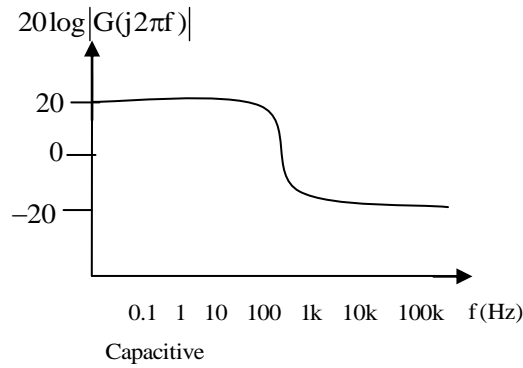
$$\therefore Z_{in} = jX_1 + \frac{\omega^2 M^2}{jX_2} = j \left[X_1 - \frac{\omega^2 M^2}{X_2} \right]$$

$$= j \left[314 \times 0.8 - \frac{314^2 \times 0.48^2}{0.6 \times 314} \right] = j[251.32 - 120.576]$$

$$= j130.744 = j\omega L_{eff} = j314 \cdot L_{eff}$$

$$\therefore L_{eff} = 0.416 = 416 \text{ mH}$$

20. A Bode magnitude plot for the transfer function $G(s)$ of a plant is shown in the figure. Which one of the following transfer functions best describes the plant?



- (A) $\frac{1000(s+10)}{s+1000}$ (B) $\frac{10(s+10)}{s(s+1000)}$ (C) $\frac{s+1000}{10s(s+10)}$ (D) $\frac{s+1000}{10(s+10)}$

Answer: (D)

Exp:

$$\therefore G(S) = \frac{K \cdot \left(1 + \frac{1}{1000}S\right)}{\left(1 + \frac{1}{10}S\right)}$$

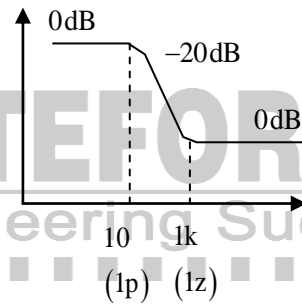
$M_{dB} = 20\text{dB}$ @ initial frequency

$$20 \log M = 20$$

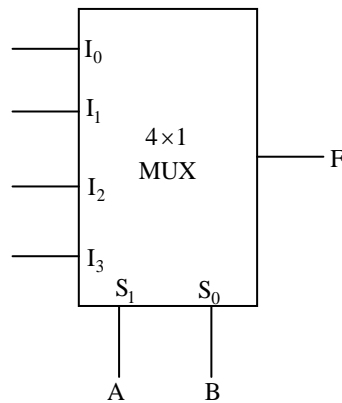
$$20 \log K = 20$$

$$K = 10$$

$$G(S) = \frac{10(S+1000) \times 10}{1000(S+10) \times 1} = \frac{(S+1000)}{10(S+10)}$$



21. In the 4×1 multiplexer, the output F is given by $F = A \oplus B$. Find the required input ' $I_3 I_2 I_1 I_0$ '.



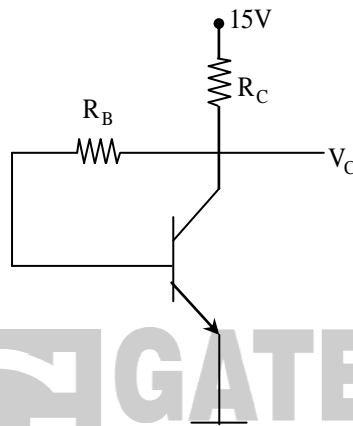
- (A) 1010 (B) 0110 (C) 1000 (D) 1110

Answer: (B)

Exp: $F = A \oplus B = AB' + A'B$

	AB		
$S_1 S_0$			
00	$A'B'$	$I_0 = 0$	$I_1 = 1$
01	$A'B$	$I_1 = 1$	$I_2 = 1$
10	AB'	$I_2 = 1$	$I_3 = 0$
11	AB	$I_3 = 0$	

22. In the given circuit, the silicon transistor has $\beta = 75$ and collector voltage $V_c = 9V$. Then the ratio of R_B and R_C is _____.



Answer: 105.1

Exp: $I_C + I_B = \frac{6}{R_C}$

$$I_B = \frac{8.3}{R_B},$$

$$\Rightarrow \beta = 75, I_C = \beta I_B$$

$$(76)I_B = \frac{6}{R_C}, I_B = \frac{8.3}{R_B}$$

$$76 \times \frac{8.3}{R_B} = \frac{6}{R_C}$$

$$\frac{R_B}{R_C} = \frac{76 \times 8.3}{6} = 105.1$$

23. A (0-50A) moving coil ammeter has a voltage drop of 0.1 V across its terminals at full scale deflection. The external shunt resistance (in milliohms) needed to extend its range to (0-500A) is _____.

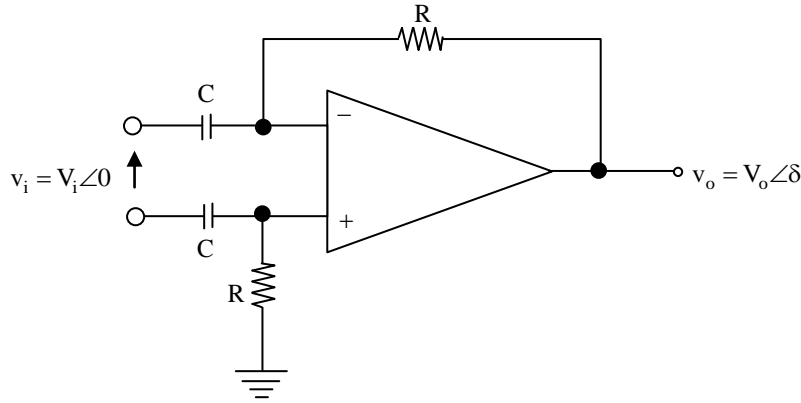
Answer: 0.22

Exp: $I_2 = 500, I_1 = 500$

$I_2 - I_1 = 450$

$450 \times R_{sh} = 0.1 \Rightarrow R_{sh} = 0.1 / 450 = 0.22 \text{ m}\Omega$

24. Consider the circuit shown in the figure,. In this circuit $R = 1\text{k}\Omega$, and $C = 1\mu\text{F}$. The input voltage is sinusoidal with a frequency of 50 Hz, represented as phasor with magnitude V_i and phase angle 0 radian as shown in the figure. The output voltage is represented as a phasor with magnitude V_o and phase angle δ radian. What is the value of output phase angle δ (in radian) relative to the phase angle of the input voltage?



- (A) 0 (B) π (C) $\frac{\pi}{2}$ (D) $-\frac{\pi}{2}$

Answer: D

Exp: It acts as differential amplifier

$V_1 = V_i, V_2 = -V_i, R_f = R$

$V_o = -2V_{in} R j \omega C$

$= -j2V_{in} R \times 2\pi f \times C$

$= -j2V_{in} \times 1\text{m} \times 2\pi \times 50$

$= KV_{in} \angle -90^\circ$

So $\delta = -90^\circ$ or $-\frac{\pi}{2}$

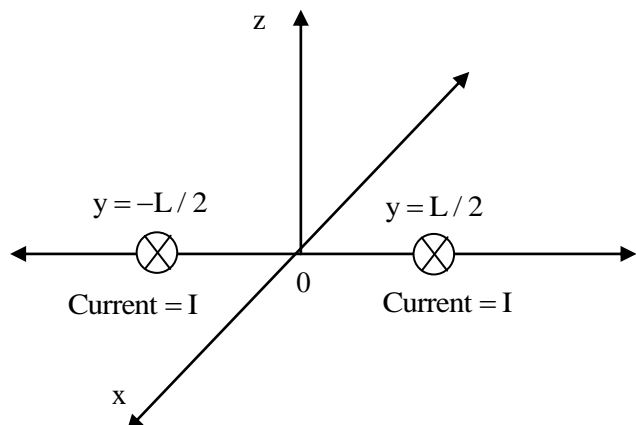
25. A steady current I is flowing in the $-x$ direction through each of two infinitely long wires at $y = \pm \frac{L}{2}$ as shown in the figure.

The permeability of the medium is μ_0 . The \vec{B} - field at $(0, L, 0)$ is

(A) $-\frac{4\mu_0 I}{3\pi L} \hat{z}$

(B) $+\frac{4\mu_0 I}{3\pi L} \hat{z}$

(C) 0

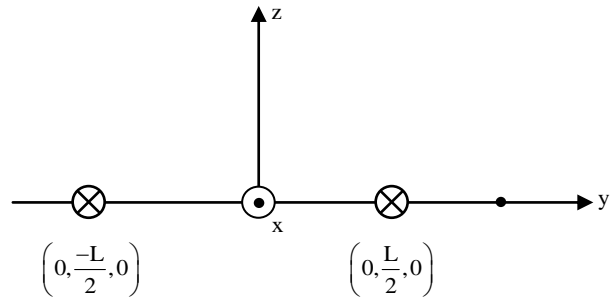


(D) $-\frac{3\mu_0 I}{4\pi L} \hat{z}$

Answer: (A)

Exp: $H = H_1 + H_2$

$$\begin{aligned} &= \frac{I}{2\pi(L/2)}(-a_z) + \frac{I}{2\pi\left(\frac{3L}{2}\right)}(-a_z) \\ &= \frac{I}{2\pi}(-a_z) \left[\frac{2}{L} + \frac{2}{3L} \right] \\ &= \frac{4I}{3\pi L}(-a_z) \end{aligned}$$



Q. No. 26 – 55 Carry Two Marks Each

26. Consider a discrete time signal given by

$$x[n] = (-0.25)^n u[n] + (0.5)^n u[-n-1]$$

The region of convergence of its Z-transform would be

- (A) the region inside the circle of radius 0.5 and centered at origin.
- (B) the region outside the circle of radius 0.25 and centered at origin.
- (C) the annular region between the two circles, both centered at origin and having radii 0.25 and 0.5.
- (D) the entire Z plane.

Answer: (C)

Exp: $x[n] = \underbrace{(-0.25)^n u[n]}_{ROC_1} + \underbrace{(0.5)^n u[-n-1]}_{ROC_2}$

$$ROC_1 : |Z| > 0.25 \quad ROC_2 : |Z| < 0.5$$

$$ROC = ROC_1 \cap ROC_2$$

$$\therefore 0.25 < |Z| < 0.5$$

27. Two players, A and B, alternately keep rolling a fair dice. The person to get a six first wins the game. Given that player A starts the game, the probability that A wins the game is

- (A) 5/11
- (B) 1/2
- (C) 7/13
- (D) 6/11

Answer: (D)

Exp: Probability of getting 6 is $= \frac{6}{36} = \frac{1}{6}$

i.e., Probability of A wins the game $= \frac{1}{6}$

Probability of A not wins the game $= 1 - \frac{1}{6} = \frac{5}{6}$

$$\text{Probability of B wins the game} = \frac{1}{6}$$

$$\text{Probability of B not win the game} = \frac{5}{6}$$

If a starts the game, Probability A win the game

$$= P(A) + P(\bar{A})P(\bar{B})P(A) + P(\bar{A})P(\bar{B})P(\bar{A})P(\bar{B})P(A) + \dots$$

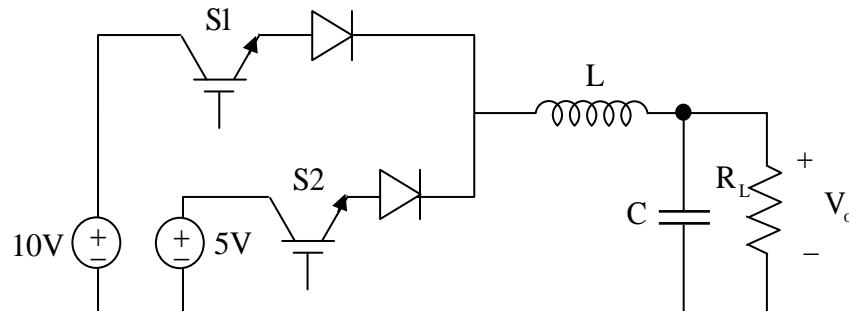
$$= \frac{1}{6} + \frac{5}{6} \frac{5}{6} \frac{1}{6} + \frac{5}{6} \frac{5}{6} \frac{5}{6} \frac{1}{6} + \dots$$

$$= \frac{1}{6} \left[1 + \frac{5}{6} + \frac{5}{6} \frac{5}{6} + \dots \right]$$

$$= \frac{1}{6} \left[1 + \left(\frac{5}{6}\right)^2 + \left(\frac{5}{6}\right)^4 + \dots \right]$$

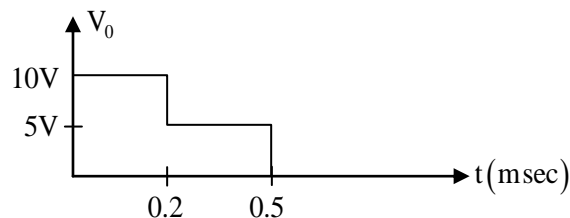
$$= \frac{1}{6} \left[\frac{1}{1 - \left(\frac{5}{6}\right)^2} \right] = \frac{1}{6} \times \frac{3}{6} = \frac{6}{11}$$

28. The circuit shown is meant to supply a resistive load R_L from two separate DC voltage sources. The switches S_1 and S_2 are controlled so that only one of them is ON at any instant. S_1 is turned on for 0.2 ms and S_2 is turned on for 0.3 ms in a 0.5 ms switching cycle time period. Assuming continuous conduction of the inductor current and negligible ripple on the capacitor voltage, the output voltage V_0 (in Volt) across R_L is _____.



Answer: (7)

Exp:



$$V_0 = \frac{10 \times 0.2 + 5 \times 0.3}{0.5} = 7V$$

29. Determine the correctness or otherwise of the following Assertion [a] and the Reason p[r].
Assertion: Fast decoupled load flow method gives approximate load flow solution because it uses several assumptions.

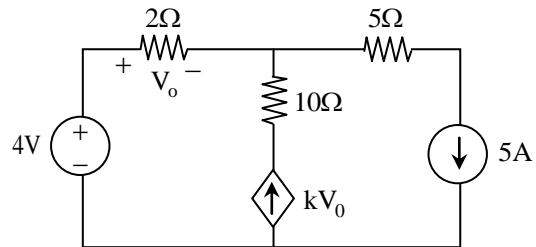
Reason: Accuracy depends on the power mismatch vector tolerance.

- (A) Both [a] and [r] are true and [r] is the correct reason for [a].
(B) Both [a] and [r] are true and [r] is not the correct reason for [a].
(C) Both [a] and [r] are false.
(D) [a] is false and [r] is true.

Answer: (D)

Exp: Fast decoupled load flow method gives moderate solution considering two approximations. It doesn't use several assumptions.

30. In the given circuit, the parameter k is positive, and the power dissipated in the 2Ω resistor is 12.5 W. The value of k is _____.



Answer: 0.5

Exp: $P_{2\Omega} = 12.5 \text{ W}$

$$i_{2\Omega} = \sqrt{\frac{12.5}{2}} = 2.5$$

$$V_0 = 2 \times 2.5 = 5 \text{ V}$$

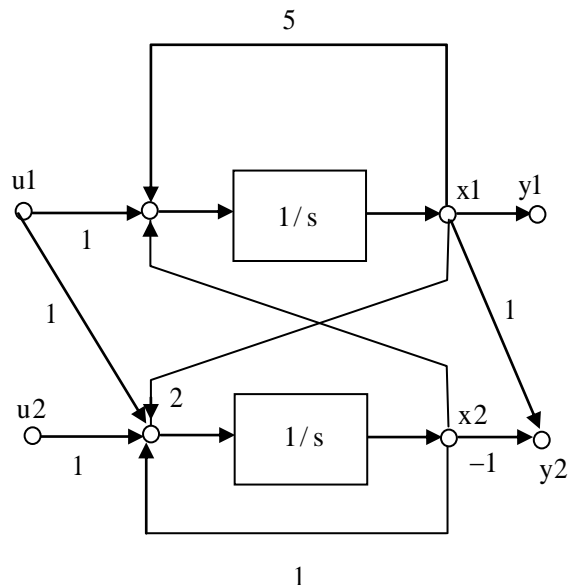
$$2.5 + kV_0 = 5$$

$$kV_0 = 2.5$$

$$K = \frac{2.5}{5} = \frac{1}{2} = 0.5$$

31. In the signal flow diagram given in the figure, u_1 and u_2 are possible inputs whereas y_1 and y_2 are possible outputs. When would the SISO system derived from this diagram be controllable and observable?

- (A) When u_1 is the only input and y_1 is the only output.
(B) When u_2 is the only input and y_1 is the only output.
(C) When u_1 is the only input and y_2 is the only output.
(D) When u_2 is the only input and y_2 is the only output.



Answer: (B)

32. In a linear two-port network, when 10 V is applied to Port 1, a current of 4 A flows through Port 2 when it is short-circuited. When 5V is applied to Port1, a current of 1.25 A flows through a 1Ω resistance connected across Port 2. When 3V is applied to Port 1, then current (in Ampere) through a 2Ω resistance connected across Port 2 is _____.

Answer: 0.545

Exp: $I_1 = y_{11}V_1 + y_{12}V_2$ $I_2 = 0.4 \times 3 - 0.6[2I_2]$

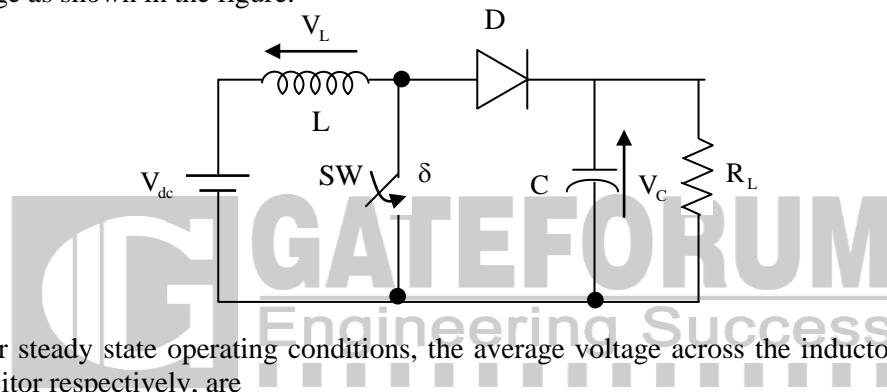
$I_2 = y_{21}V_1 + y_{22}V_2$ $= 1.2 - 1.2I_2$

$4 = 10y_{21} \rightarrow y_{21} = 0.4$ $I_2 = 0.545A.$

$1.25 = 0.4V_1 + 1.25y_{22} = 0.4$

$y_{22} = -0.6$

33. A self commutating switch SW, operated at duty cycle δ is used to control the load voltage as shown in the figure.



Under steady state operating conditions, the average voltage across the inductor and the capacitor respectively, are

(A) $V_L = 0$ and $V_C = \frac{1}{1-\delta} V_{dc}$

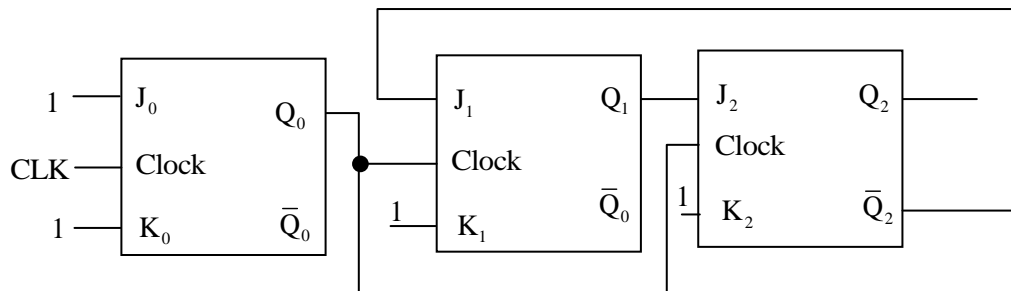
(B) $V_L = \frac{\delta}{2} V_{dc}$ and $V_C = \frac{1}{1-\delta} V_{dc}$

(C) $V_L = 0$ and $V_C = \frac{\delta}{1-\delta} V_{dc}$

(D) $V_L = \frac{\delta}{2} V_{dc}$ and $V_C = \frac{\delta}{1-\delta} V_{dc}$

Answer: (A)

34. The figure shown a digital circuit constructed using negative edge triggered J-K flip flops. Assume a starting state of $Q_2Q_1Q_0 = 000$. This state $Q_2Q_1Q_0 = 000$ will repeat after _____ number of cycles of the clock CLK.



Answer: 6

Exp: First flip flop acts as mod-2 counter

Second 2 flip flops from mod $(2n-1)$ Johnson counter = mod counter

\therefore overall modulus = mod – 6 counter

35. The signum function is given by

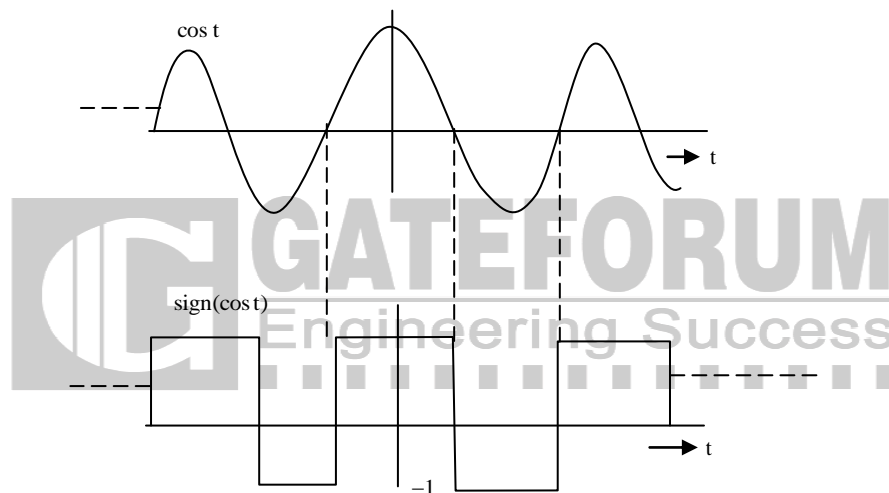
$$\text{sgn}(x) = \begin{cases} \frac{x}{|x|}; & x \neq 0 \\ 0; & x = 0 \end{cases}$$

The Fourier series expansion of $\text{sgn}(\cos(t))$ has

- (A) only sine terms with all harmonics.
- (B) only cosine terms with all harmonics
- (C) only sine terms with even numbered harmonics.
- (D) only cosine terms with odd numbered harmonics.

Answer: (D)

Exp: $\text{sgn}(\cos t) = 1; \cos t > 0$
 $= -1; \cos t < 0$



it represents square wave, which is even and half wave symmetry function, it contains cosine terms for all odd harmonics.

36. A DC motor has the following specifications: 10 hp, 37.5 A, 230V; flux/pole = 0.01 Wb, number of poles = 4, number of conductors = 666, number of parallel paths = 2. Armature resistance = 0.267Ω . The armature reaction is negligible and rotational losses are 600W. The motor operates from a 230V DC supply. If the motor runs at 1000 rpm, the output torque produced in (in Nm) is _____.

Answer: 14.14

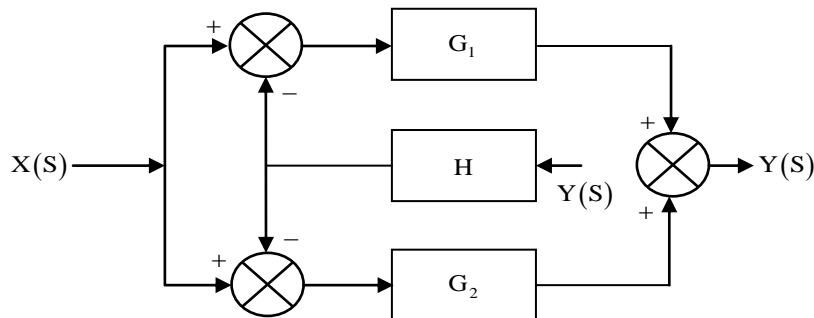
Exp: $E = \frac{\phi 2Np}{60A} = \frac{0.01 \times 666 \times 4 \times 1000}{60 \times 2} = 55.5$

Internal power = $E I = 55.5 \times 37.5 = 2081.25$

$P_{out} = 2081.25 - 600 = 1481.25$

$$T = \frac{P_{out}}{w} = \frac{1481.25}{2\pi \times \frac{1000}{60}} = 14.14 \text{ Nm}$$

37. Find the transfer function $\frac{Y(s)}{X(s)}$ of the system given below.



- (A) $\frac{G_1}{1-HG_1} + \frac{G_2}{1-HG_2}$ (B) $\frac{G_1}{1+HG_1} + \frac{G_2}{1+HG_2}$
(C) $\frac{G_1+G_2}{1+H(G_1+G_2)}$ (D) $\frac{G_1+G_2}{1-H(G_1+G_2)}$

Answer: (C)

Exp: From the block diagram

$$Y = G_1(X - HY) + G_2(X - HY)$$

$$Y = X(G_1 + G_2) - HY(G_1 + G_2)$$

$$Y[1 + H(G_1 + G_2)] = X(G_1 + G_2)$$

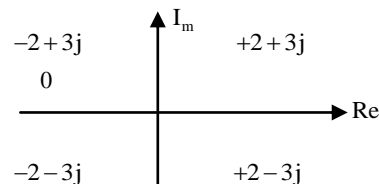
$$\Rightarrow \frac{Y}{X} = \frac{G_1 + G_2}{1 + H(G_1 + G_2)}$$

38. The transfer function of a second order real system with a perfectly flat magnitude response of unity has a pole at $(2-j3)$. List all the poles and zeroes.

- (A) Poles at $(2 \pm j3)$, no zeroes
(B) Poles at $(\pm 2-j3)$, one zero at origin
(C) Poles at $(2-j3)$, $(-2+j3)$, zeroes at $(-2-j3)$, $(2+j3)$
(D) Poles at $(2 \pm j3)$, zeroes at $(-2 \pm j3)$

Answer: (D)

Exp: This is an APF

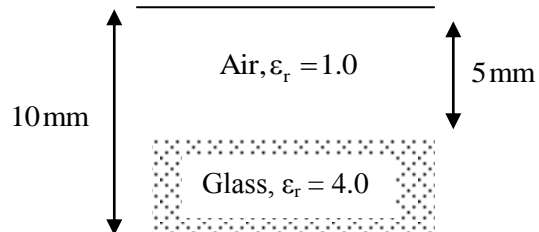


39. Two single-phase transformers T_1 and T_2 each rated at 500 kVA are operated in parallel. Percentage impedances of T_1 and T_2 are $(1+j6)$ and $(0.8+j4.8)$, respectively. To share a load of 1000 kVA at 0.8 lagging power factor, the contribution of T_2 (in kVA) is _____.

Answer: 555

Exp: $S_{T2} = S \times \frac{z_1}{z_1 + z_2} = 1000 \times \frac{6.08 \angle 80.53}{10.94 \angle 80.53} = 555 \text{ KVA}$

40. A parallel plate capacitor is partially filled with glass of dielectric constant 4.0 as shown below. The dielectric strengths of air and glass are 30 kV/cm and 300 kV/cm, respectively. The maximum voltage (in kilovolts), which can be applied across the capacitor without any breakdown, is _____.



Answer: 18.75

Exp: $C_1 = \frac{A \epsilon_0}{d}$

$C_2 = \frac{4A \epsilon_0}{d}$

$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{4A \epsilon_0}{5d}$

$D_n = \rho_s = \frac{Q}{A} = \frac{CV}{A} = \frac{C_{eq} V}{A}$

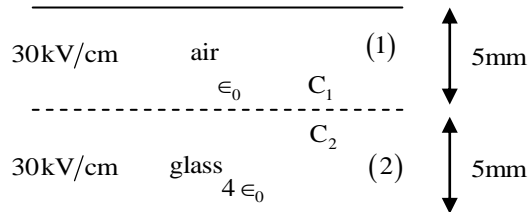
$D_n = \frac{4A \epsilon_0}{5dA} V$

$D_n = \left(\frac{4 \epsilon_0}{5d} \right) V$

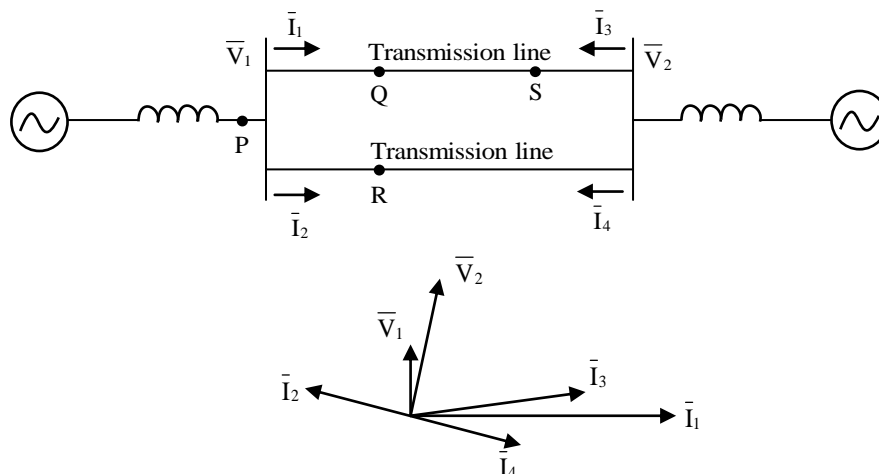
$E_1 = \frac{D_n}{\epsilon_0} = \frac{4}{5d} V$

$30 \times 10^5 = \frac{4V}{4d} \Rightarrow V = \frac{30 \times 5 \times 5 \times 10^{-3} \times 10^5}{4}$

$V = 18.75 \text{ kV}$



41. A sustained three-phase fault occurs in the power system shown in the figure. The current and voltage phasors during the fault (on a common reference), after the natural transients have died down, are also shown. Where is the fault located?



- (A) Location P (B) Location Q (C) Location R (D) Location S

Answer: (B)

42. The maximum value of “a” such that the matrix $\begin{pmatrix} -3 & 0 & -2 \\ 1 & -1 & 0 \\ 0 & a & -2 \end{pmatrix}$ has three linearly independent real eigenvectors is

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

Answer: (B)

Exp: The characteristic equation of A is

$$|A - \lambda I| = 0$$

$$\Rightarrow f(x) = x^3 + 6x^2 + 11x + 6 + 2a$$

$$= (x+1)(x+2)(x+3) + 2a = 0$$

$f(x)$ cannot have all 3 real roots (if any) equal

for if $f(x) = (x-k)^3$, then comparing coefficients, we get

$$6 = -3k, \quad 3k^2 = 11$$

No such k exists

(a) Thus $f(x) = 0$ has repeated (2) roots (say) α, α, β

or

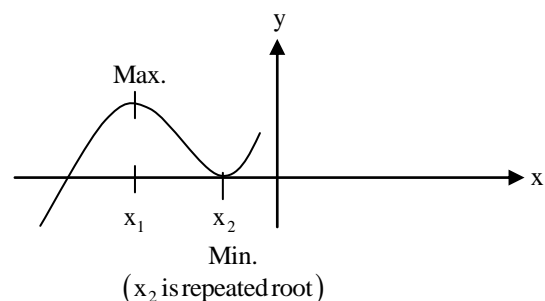
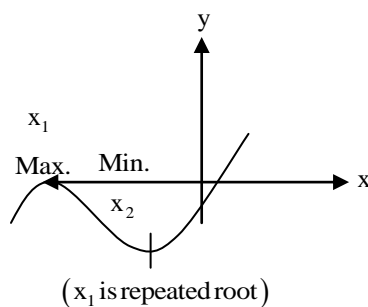
(b) $f(x) = 0$ has real roots (distance)(say) α, β, δ

$$\text{Now } f'(x) = 0 \Rightarrow x_1 = \frac{-6 - \sqrt{3}}{3} \approx -2.577a; \quad x_2 = \frac{-6 + \sqrt{3}}{3} \approx -1.422$$

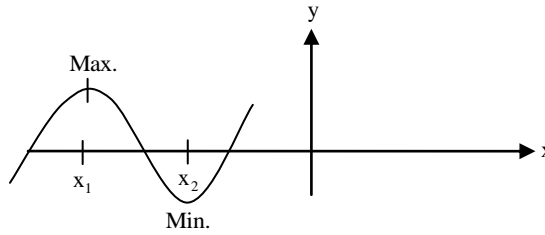
At x_1 , $f(x)$ has relative max.

At x_2 , $f(x)$ has relative min.

The graph of $f(x)$ will be as below

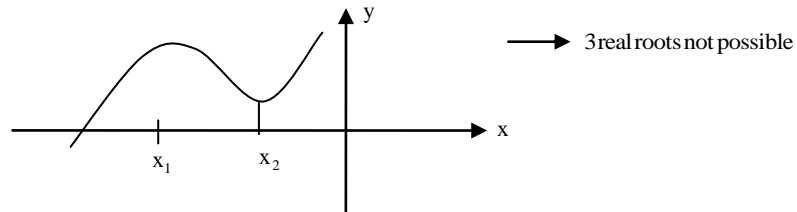


Case (a) repeated roots (α, α, β)



Case (b) distinct roots

Note that the graph of $f(x)$ cannot be like the one given below



Thus in all possible cases we have

$$f(x_2) \leq 0 \Rightarrow 2 \left(a - \frac{\sqrt{3}}{9} \right) \leq 0 \Rightarrow a \leq \frac{1}{3\sqrt{3}}$$

43. The open loop poles of a third order unity feedback system are at 0, -1, -2. Let the frequency corresponding to the point where the root locus of the system transits to unstable region be K . Now suppose we introduce a zero in the open loop transfer function at -3, while keeping all the earlier open loop poles intact. Which one of the following is TRUE about the point where the root locus of the modified system transits to unstable region?
- (A) It corresponds to a frequency greater than K
 - (B) It corresponds to a frequency less than K
 - (C) It corresponds to a frequency K
 - (D) Root locus of modified system never transits to unstable region

Answer: (D)

44. A 200/400V, 50 Hz, two-winding transformer is rated at 20 kVA. Its windings are connected as an auto-transformer of rating 200/600V. A resistive load of 12Ω is connected to the high voltage (600V) side of the auto-transformer. The value of equivalent load resistance (in Ohm) as seen from low voltage side is _____.

Answer: 1.33

Exp:

$$R_{eq(LV)} = \frac{R_{H.V}}{K^2} \left[\text{where } K = \frac{600}{200} \right]$$

$$= \frac{12}{9} = 1.33$$

45. Consider the economic dispatch problem for a power plant having two generating units. The fuel costs in Rs/MWh along with the generation limits for the two units are given below:

$$C_1(P_1) = 0.01P_1^2 + 30P_1 + 10; \quad 100\text{MW} \leq P_1 \leq 150\text{MW}$$

$$C_2(P_2) = 0.05P_2^2 + 10P_2 + 10; \quad 100\text{MW} \leq P_2 \leq 180\text{MW}$$

The incremental cost (in Rs/MWh) of the power plant when it supplies 200 MW is ____.

Answer: 20

Exp:

$$C_1(p_1) = (0.01)p_1^2 + 30p_1 + 10 \Rightarrow \frac{dc_1}{dp_1} = 0.02p_1 + 30 \quad ; 100 \leq p_1 \leq 150$$

$$C_2(p_2) = 0.05p_2^2 + 10p_2 + 10 \Rightarrow \frac{dc_2}{dp_2} = 0.1p_2 + 10 \quad ; 100 \leq p_2 \leq 180$$

$$\lambda_1^{\min} = 0.02(100) + 30 = 32; \lambda_1^{\max} = 0.02(150) + 30 = 33$$

$$\lambda_2^{\min} = 0.1(100) + 10 = 20; \lambda_2^{\max} = 0.1(180) + 10 = 28.$$

We always prefer low value of incremental cost.

$$\therefore \lambda = 20 \text{ Rs / hwhr.}$$

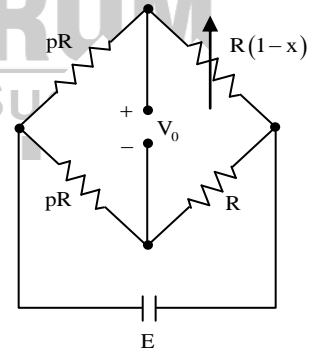
46. An unbalanced DC Wheatstone bridge is shown in the figure. At what value of p will the magnitude of V_0 be maximum?

(A) $\sqrt{1+x}$

(B) $(1+x)$

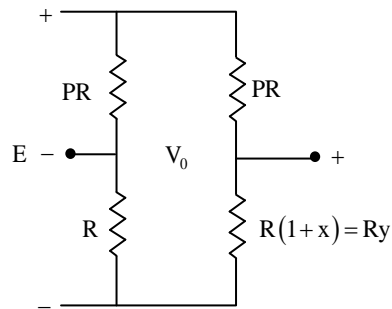
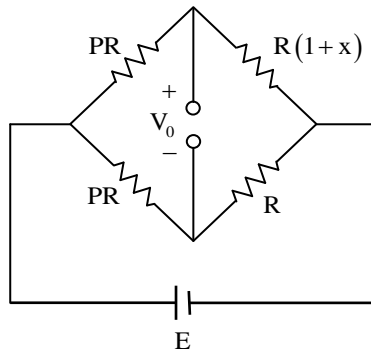
(C) $1/\sqrt{1+x}$

(D) $\sqrt{1-x}$



Answer: (A)

Exp:



$$\text{Let } 1+x = y$$

$$V_{0(-)} = \frac{RE}{R + PR} = \frac{E}{1 + P}$$

$$V_{0(+)} = \frac{R \cdot y}{Ry + PR} \cdot E = \left(\frac{y}{p + y} \right) E$$

$$V_0 = V_{0(+)} - V_{0(-)} = \left[\frac{y}{p + y} - \frac{1}{1 + p} \right] E$$

$$\frac{dV_0}{dp} = \left[\frac{-y}{(p + y)^2} + \frac{1}{(1 + p)^2} \right] E = 0$$

$$\frac{1}{(1 + P)^2} = \frac{y}{(p + y)^2}$$

$$\frac{1}{1 + p} = \frac{\sqrt{y}}{p + y} \Rightarrow p + y = \sqrt{y} + p\sqrt{y}$$

$$p(1 - \sqrt{y}) = \sqrt{y} - y = \sqrt{y}[1 - \sqrt{y}]$$

$$p = +\sqrt{y} = +\sqrt{1 + x}$$

47. A separately excited DC motor runs at 1000 rpm on no load when its armature terminals are connected to a 200V DC source and the rated voltage is applied to the field winding. The armature resistance of this motor is 1Ω. The no-load armature current is negligible. With the motor developing its full load torque, the armature voltage is set so that the rotor speed is 500 rpm. When the load torque is reduced to 50% of the full load value under the same armature voltage conditions, the speed rises to 520 rpm. Neglecting the rotational losses, the full load armature current (in Ampere) is _____.

Answer: (100)

Exp:

$$\left. \begin{array}{l} N_0 = 1000 \text{ rpm} \\ E_0 = 200 \text{ V} \\ N_{\text{full}} = 500 \text{ rpm} \end{array} \right\} \begin{array}{l} E \propto N\phi \\ \frac{200}{E_{\text{full}}} = \frac{1000}{500} \\ E_{\text{full}} = 100 \text{ V} = V - I_a r_a = 200 - I_a \\ I_a = 100 \text{ A} \end{array}$$

48. A solution of the ordinary differential equation $\frac{d^2 y}{dt^2} + 5 \frac{dy}{dt} + 6y = 0$ is such that $y(0) = 2$ and $y(1) = -\frac{1-3e}{e^3}$. The value of $\frac{dy}{dt}(0)$ is _____.

Answer: (-3)

Exp: Roots, -3, -2

$$y(t) = C_1 e^{-3t} + C_2 e^{-2t}$$

$$y(0) = C_1 + C_2 = 2$$

$$y(1) = -\left(\frac{1-3e}{e^3} \right) = -e^{-3} + 3e^{-2} = C_1 e^{-3} + C_2 e^{-2}$$

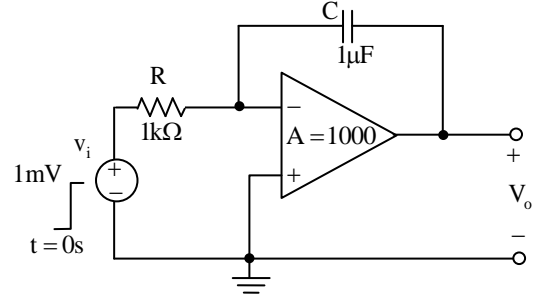
So, $C_1 = -1, C_2 = -3$

So,

$$y(t) = -e^{-3t} + 3e^{-2t}$$

$$\frac{dy(t)}{dt} = 3e^{-3t} - 6e^{-2t}, \quad \frac{dy(0)}{dt} = 3 - 6 = -3$$

49. The op-amp shown in the figure has a finite gain $A = 1000$ and an infinite input resistance. A step-voltage $V_i = 1 \text{ mV}$ is applied at the input at time $t = 0$ as shown. Assuming that the operational amplifier is not saturated, the time constant (in millisecond) of the output voltage V_o is



- (A) 1001 (B) 101
(C) 11 (D) 1

Answer: (A)

Exp: $V_o = -x.A = -1000x$

By nodal analysis

$$\frac{x - V_i}{1k} + C \frac{d(x - V_o)}{dt} = 0$$

$$\text{so, } x = -\frac{V_o}{1000}$$

$$-\frac{V_o}{1M} - \frac{V_i}{1k} - \frac{1\mu \times 1001}{1000} \frac{dV_o}{dt} = 0$$

$$\frac{dV_o}{dt} + \frac{1000}{1001} V_o = \frac{-1}{1\mu \times 1000} V_i$$

By LT on both sides

$$V_o \left(S + \frac{1000}{1001} \right) = \frac{-1}{S \cdot 1\mu \times 1001}$$

$$V_o = -\frac{10^6}{1001} \left[\frac{1}{S \left(S + \frac{1000}{1001} \right)} \right]$$

$$V_o = -\frac{10^3}{\left(S + \frac{1000}{1001} \right)} + \frac{10^3}{S} = 10^3 \left(1 - e^{\frac{-1000t}{1001}} \right) u(t)$$

$$\tau = \frac{1001}{1000} = 1001 \text{ ms}$$

50. A 3-phase 50 Hz square wave (6-step) VSI feeds a 3-phase, 4 pole induction motor. The VSI line voltage has a dominant 5th harmonic component. If the operating slip of the motor with respect to fundamental component voltage is 0.04, the slip of the motor with respect to 5th harmonic component of voltage is _____.

Answer: 1.16

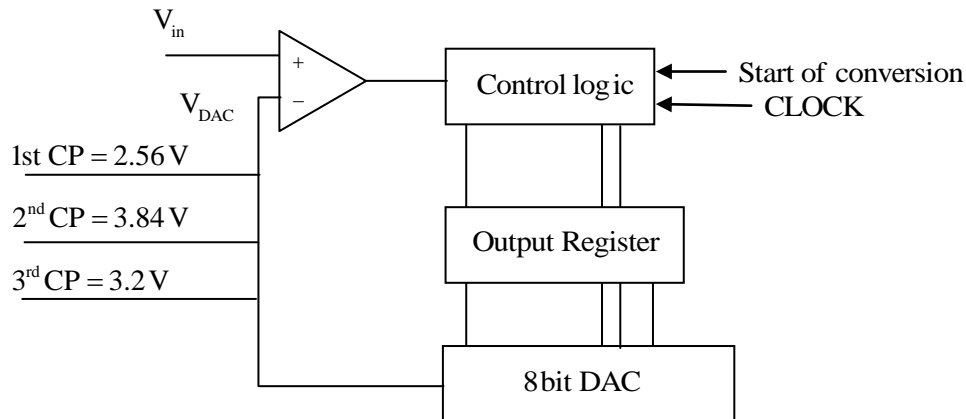
Exp: Slip of motor w.r.t 5th harmonics $= \frac{6-5s}{h} = \frac{6-5 \times 0.04}{5} = 1.16$

51. An 8 bit unipolar Successive Approximation Register type ADC is used to convert 3.5V to digital equal output. The reference voltage is +5V. The output of ADC at end of 3rd clock pulse after the start of conversion is _____.

- (A) 1010 0000 (B) 1000 0000 (C) 0000 0001 (D) 0000 0011

Answer: (A)

Exp: The block diagram of SAR type ADC is as follows



Unipolar means all the voltages will be +ve i.e. nothing is -ve.

The functionality of SAR type DAC is, it will load a value to output register with MSB=1 and remaining bit=0, and it will cross check a logic as follows.

if $V_{in} \geq V_{DAC} \Rightarrow$ maintain the loaded bit

$V_{in} < V_{DAC} \Rightarrow$ clear the loaded bit.

This process continues upto 8 number of clock pulses

The output of DAC = (Resolution) \times (Decimal equivalent of applied binary).

From the given information

$$\text{Resolution} = \frac{5}{2^8 - 1} \approx 20 \text{ mV.}$$

when SOC is applied

on 1st clock the value located to output register is $(10000000)_2 = (128)_{10}$

$$\text{then } V_{DAC} = 128 \times 20 \text{ mV} = 2.56 \text{ V}$$

So $3.5 > 2.56 \text{ V} \Rightarrow$ maintain the bit

So at the end of 1st clock pulse the output is 10000000.

On second clock pulse the value loaded to output register is $(10100000)_2 = (192)_{10}$

then $V_{DAC} = 195 \times 20\text{mv} = 3.84\text{V}$

So $3.5 < 3.84\text{V} \Rightarrow$ clear the loaded bit

So at the end of 2nd clock pulse output is $(10000000)_2$.

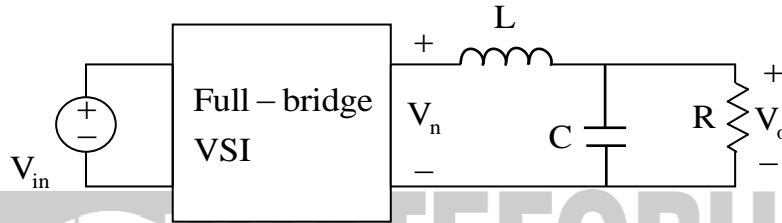
On third clock pulse the value loaded to output register is $(10100000)_2 = (160)_{10}$

then $V_{DAC} = 160 \times 20\text{mv} = 3.2\text{V}$

So $3.5 > 3.2\text{V} \Rightarrow$ maintain the loaded bit

So at the end of 3rd clock pulse output is $(10100000)_2$.

52. The single-phase full-bridge voltage source inverter (VSI), shown in figure, has an output frequency of 50 Hz. It uses unipolar pulse width modulation with switching frequency of 50 kHz and modulation index of 0.7. For $V_m = 100\text{ V DC}$, $L = 9.55\text{ mH}$, $C = 63.66\text{ }\mu\text{F}$, and $R = 5\Omega$, the amplitude of the fundamental component in the output voltage V_o (in volt) under steady-state is _____.



Answer: (56.72V)

Exp: $\mu = \frac{\delta}{\pi} \rightarrow$ pulse width

$$\delta = \mu\pi = 0.7 \times 180^\circ = 126^\circ$$

$$\begin{aligned} \text{The amplitude of fundamental component in } V_o &= \frac{2V_{dc}}{\pi} \sin \frac{\delta}{2} \\ &= \frac{2 \times 100}{\pi} \sin \frac{126}{2} = 56.72\text{V} \end{aligned}$$

53. $f(A,B,C,D) = \prod m(0,1,3,4,5,7,9,11,12,13,14,15)$ is a maxterm representation of a Boolean function $f(A,B,C,D)$ where A is the MSB and D is the LSB. The equivalent minimized representation of this function is

- (A) $(A + \bar{C} + D)(\bar{A} + B + D)$ (B) $A\bar{C}D + \bar{A}BD$
(C) $\bar{A}\bar{C}D + A\bar{B}C\bar{D} + A\bar{B}C\bar{D}$
(D) $(B + \bar{C} + D)(A + \bar{B} + \bar{C} + D)(\bar{A} + B + C + D)$

Answer: (C)

Exp: $f(A, B, C, D) = \overline{A}C\overline{D} + A\overline{B}\overline{D}$

In option (C)

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

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

$$= \overline{A}C\overline{D} + A\overline{B}\overline{D}.1$$

$$= \overline{A}C\overline{D} + A\overline{B}\overline{D}$$

CD \ AB	00	01	11	10
00	0	0	0	1
01	0	0	0	1
11	0	0	0	0
10	1	0	0	1

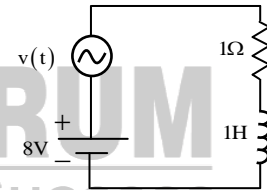
Annotations: $\overline{A}C\overline{D}$ points to the 1s in the 10 column (CD=00, 01). $A\overline{B}\overline{D}$ points to the 1s in the 00 row (AB=10, 11).

54. A 50Hz generating unit has H-constant of 2 MJ/MVA. The machine is initially operating in steady state at synchronous speed, and producing 1 pu of real power. The initial value of the rotor angle δ is 5° , when a bolted three phase to ground short circuit fault occurs at the terminal of the generator. Assuming the input mechanical power to remain at 1 pu, the value of δ in degrees, 0.02 second after the fault is _____.

Answer: 5.9

Exp: At end $\delta_1 = \delta_0 + \Delta\delta_1 = 5 + 0.9 = 5.9$

55. The circuit shown in the figure has two sources connected in series. The instantaneous voltage of the AC source (in volt) is given by $v(t) = 12 \sin t$. If the circuit is in steady-state, then the rms value of the current (in Ampere) flowing in the circuit is _____.



Answer: (10)

Exp: $Y(S) = \frac{1}{Z(S)} = \frac{1}{(1 + j\omega)}$

$$Y(S) = \frac{1}{\sqrt{1 + \omega^2}} \angle -\tan^{-1}(\omega)$$

$$v_{in}(t) = 8 + 12 \sin t$$

$$i(t) = 8 \cdot \frac{1}{\sqrt{1+0}} \angle -\tan^{-1}(0) + \frac{12}{\sqrt{1+1}} \sin(t - 45^\circ)$$

$$i(t) = 8 + \frac{12}{\sqrt{2}} \left(\sin t \cdot \frac{1}{\sqrt{2}} - \cos t \cdot \frac{1}{\sqrt{2}} \right)$$

$$i(t) = 8 + 6 \sin t - 6 \cos t$$

$$I_{rms} = \sqrt{8^2 + \left(\frac{6}{\sqrt{2}}\right)^2 + \left(\frac{6}{\sqrt{2}}\right)^2} = 10$$