Q.No. 1 – 5 Carry One Mark Each

1. While trying to collect an envelope from under the table, Mr. X fell down and

          I   II   III

   was losing consciousness.

         IV

   Which one of the above underlined parts of the sentence is NOT appropriate?

   (A) I   (B) II   (C) III   (D) IV

   Answer: (D)

2. If she _____ how to calibrate the instrument, she _____ done the experiment.

   (A) knows, will have   (B) knew, had

   (C) had known, could have   (D) should have known, would have

   Answer: (C)

3. Choose the word that is opposite in meaning to the word "coherent".

   (A) sticky   (B) well-connected   (C) rambling   (D) friendly

   Answer: (C)

4. Which number does not belong in the series below?

   2, 5, 10, 17, 26, 37, 50, 64

   (A) 17   (B) 37   (C) 64   (D) 26

   Answer: (C)

5. The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

No	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	2	23	18	3

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

   (A) 1.34   (B) 1.74   (C) 3.02   (D) 3.91

Answer: (C)

Exp: Total question

$44 \times 2 = 88$

$44 \times 3 = 132$

$\dfrac{144}{132} = \dfrac{88}{308}$

Total marks obtained= $(21 \times 2) + (15 \times 3) + (23 \times 2) = 133$

Total Number of students=44

Average $= \dfrac{133}{44} = 3.02$

Q.No. 6 – 10 Carry One Mark Each

6.   A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is

(A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.

(B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.

(C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.

(D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

Answer: (B)

7.   By the beginning of the 20th century, several hypotheses were being proposed, suggesting a paradigm shift in our understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

 Which of the following inference(s) may be drawn from the above passage?

(i) Our understanding of the universe changes based on the positions of stars

(ii) Paradigm shifts usually occur at the beginning of centuries

(iii) Stars are important objects in the universe

(iv) Experimental evidence was important in confirming this paradigm shift

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

Answer: (D)

8.   The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013

(A) increased by 5 %   (B) decreased by 13%

(C) decreased by 20%   (D) decreased by 11%

Answer: (D)

Exp: Per 100 Rs final value 107 Rs

$\Rightarrow$ Per $\dfrac{100}{50}$ Dollars final value $\dfrac{107}{60}$

for 100 dollars____?

$= \dfrac{100 \times 50}{100} \times \dfrac{107}{60} = 89.16$

Discrased by 11%.

9.   The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?
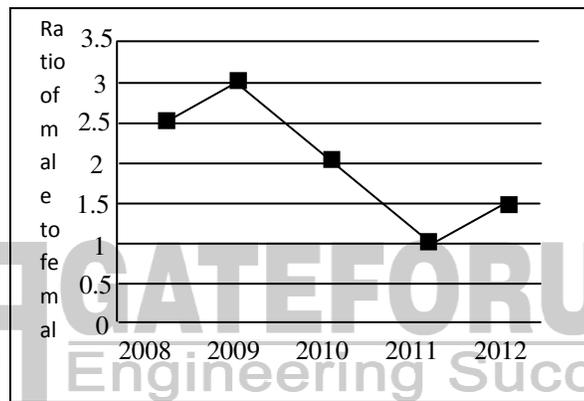
(A) 1:1   (B) 2:1   (C) 1.5:1   (D) 2.5:1

Answer: (C)

Exp: Take number of female students in 2011=100

$\therefore$ Number of male in 2011=100

No. of female in 2012=100

No. of male in 2012=150

$\text{ratio} = \dfrac{150}{100}$

10.   Consider the equation: $(7526)_8$ - $(Y)_8$ = $(4364)_8$, where $(X)_N$ stands for X to the base N. Find Y.

(A) 1634   (B) 1737   (C) 3142   (D) 3162

Answer: (C)

Exp: $(7526)_8 - (y)_8 = (4364)_8$

$\Rightarrow y_8 = (7526)_8 - (4364)_8$

$$\begin{array}{ccccc} & 7 & {}^4\cancel{5} & {}^{(8+2=10)}2 & 6 \\ & 4 & 3 & 6 & 4 \\ \hline & 3 & 1 & 4 & 2 \end{array}$$

When we have base 8, we borrow 8 instead of 10 as done in normal subtraction

Q.No. 1 – 25 Carry One Mark Each

1. Two matrices A and B are given below:

$$A = \begin{bmatrix} p & q \\ r & s \end{bmatrix}; \qquad B = \begin{bmatrix} p^2+q^2 & pr+qs \\ pr+qs & r^2+s^2 \end{bmatrix}$$

If the rank of matrix A is N, then the rank of matrix B is

(A) N /2   (B) N-1   (C) N   (D) 2 N

Answer: (C)

Exp: Rank of a matrix is unaltered by the elementary transformations i.e., Row/column operations

(Here B is obtained from A by applying row/column operations on A)

Since rank of A is N

∴ rank of B is also N

2. A particle, starting from origin at t = 0 s, is traveling along x-axis with velocity

$$v = \frac{\pi}{2}\cos\left(\frac{\pi}{2}t\right) m/s$$

At *t* = 3 s, the difference between the distance covered by the particle and the magnitude of displacement from the origin is _____.

Answer: 2

Exp: At $t = 3s$, the distance covered by the particle is $1+1+1 = 3m$ and displacement from the origin is -1

∴ difference between the distance covered by the particle and the magnitude of displacement from the origin is $3 - \left|-1\right| = 2$

3. Let, $\nabla(f \ v) = x^2y + y^2z + z^2x;$ where *f* and *v* are scalar and vector fields respectively. If $v = yi + zj + xk,$ then $v = \nabla f$ is

(A) $x^2y + y^2z + z^2x$ (B) $2xy + 2yz + 2zx$ (C) $x + y + z$ (D) 0

Answer: (A)

Exp: $\nabla.(f \ \vec{v}) = f(\nabla.\vec{v}) + \nabla f.\vec{v}$ .....(1)

Now $\nabla.\vec{v} = 0 + 0 + 0 = 0$

∴ (1) becomes $x^2y + y^2z + z^2x = f(0) + \vec{v}.\nabla f$

∴ $\vec{v}.\nabla f = x^2y + y^2z + z^2x$

4. Lifetime of an electric bulb is a random variable with density $f(x) = kx^2$, where x is measured in years. If the minimum and maximum lifetimes of bulb are 1 and 2 years respectively, then the value of k is _____.

Answer: 0.43

Exp: $f(x) = kx^2, 1 < x < 2$ and $f(x) = 0$, otherwise $since\ f(x)$ is a p.d.f

$$\therefore \int_1^2 f(x)dx = 1 \Rightarrow k\left[\frac{x^3}{3}\right]_1^2 = 1$$

$$\Rightarrow k = \frac{3}{7} = 0.428 \simeq 0.43$$

5.   A function f(t) is shown in the figure.
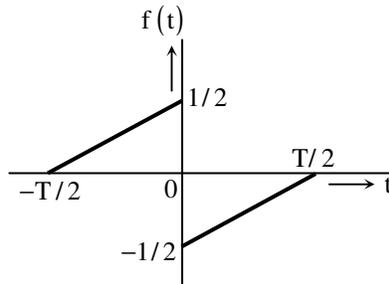
The Fourier transform $F(\omega)$ of f(t) is

(A) real and even function of ω (B) real and odd function of ω

(C) imaginary and odd function of ω (D) imaginary and even function of ω

Answer: (C)

Exp;   Since f(t) is odd and real

$f(t) = -f(-t)$

$\oint F(\omega)$ is imaginary and odd [symmetry property of fourier Transform]

6.   The line A to neutral voltage is $10\angle 15^O\,V$ for a balanced three phase star-connected load with phase sequence ABC. The voltage of line B with respect to line C is given by

(A) $10\sqrt{3}\angle 105^0\,V$ (B) $10\angle 105^0\,V$

(C) $10\sqrt{3}\angle -75^O\,V$ (D) $-10\sqrt{3}\angle -90^O\,V$

Answer: (C)

Exp: $V_L = \sqrt{3}\,V_{ph}$

$= \sqrt{3} \times 10 = 10\sqrt{3}$

If $V_A = 10\lfloor 0$

then $V_{BC} = 10\sqrt{3}\lfloor -90$

given $V_A = 10\lfloor 15^o$

$\therefore \quad V_{BC} = 10\sqrt{3}\lfloor -90 + 15 = 10\sqrt{3}\lfloor -75$
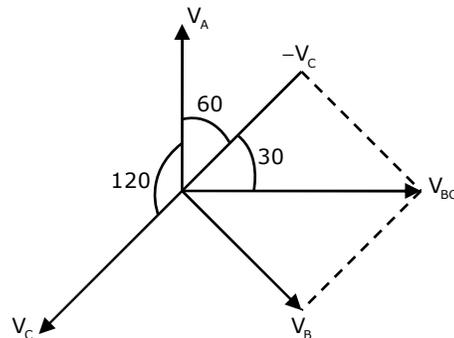
7.   A hollow metallic sphere of radius r is kept at potential of 1 Volt. The total electric flux coming out of the concentric spherical surface of radius R (> r) is

(A) $4\pi\varepsilon_0 r$ (B) $4\pi\varepsilon_0 r^2$ (C) $4\pi\varepsilon_0 R$ (D) $4\pi\varepsilon_0 R^2$

Answer: (A)

8.   The driving point impedance Z(s) for the circuit shown below is
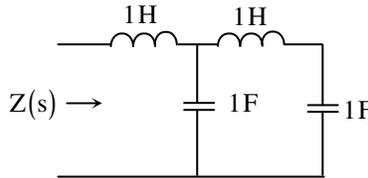
(A) $\dfrac{s^4 + 3s^2 + 1}{s^3 + 2s}$ (B) $\dfrac{s^4 + 2s^2 + 4}{s^2 + 2}$ (C) $\dfrac{s^2 + 1}{s^4 + s^2 + 1}$ (D) $\dfrac{s^3 + 1}{s^4 + s^2 + 1}$

Answer: (A)

Exp: S-Domain representation of the given circuit.

$$Z(s) = s + \frac{\dfrac{1}{s}\left[s + \dfrac{1}{s}\right]}{\dfrac{1}{s} + \left(s + \dfrac{1}{s}\right)}$$

$$Z(s) = \frac{s^4 + 3s^2 + 1}{s^3 + 2s}$$
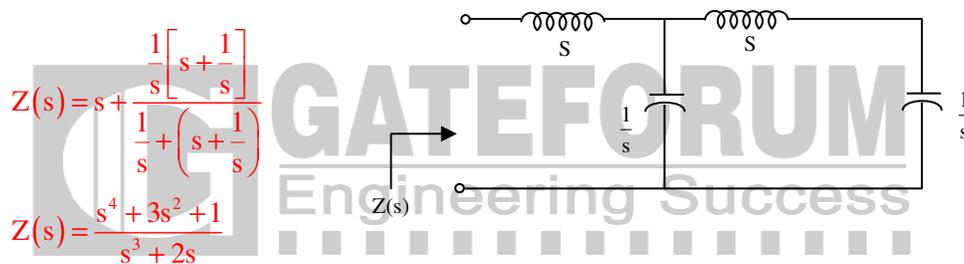
9.   A signal is represented by

$$x(t) = \begin{cases} 1 & |t| < 1 \\ 1 & |t| < 1 \end{cases}$$

The Fourier transform of the convolved signal y(t)=x(2t)*x(t/2) is

(A) $\dfrac{4}{\omega^2}\sin\left(\dfrac{\omega}{2}\right)\sin(2\omega)$ (B) $\dfrac{4}{\omega^2}\sin\left(\dfrac{\omega}{2}\right)$

(C) $\dfrac{4}{\omega^2}\sin(2\omega)$ (D) $\dfrac{4}{\omega^2}\sin^2\omega$

Answer: (A)

Exp:

$$x(t) = \text{rect}\left(\frac{t}{\tau}\right) = \text{rect}\left(\frac{t}{2}\right)$$

$$\because \text{rect}\left(\frac{t}{\tau}\right) \xrightarrow{F} \tau\,\text{sa}\left(\frac{\omega\tau}{2}\right)$$

$$x(f) = \text{rect}\left(\frac{t}{2}\right) \xrightarrow{F} 2\,\text{sa}(\omega) = \frac{2\sin\omega}{\omega}$$
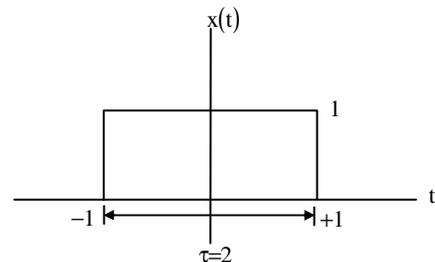
By using the scaling property of Fourier transforms,

$$F\{x(2t)\} = F[rect(t)] = 2 \times \frac{1}{2}sa\left(\frac{\omega}{2}\right) = \frac{sin\left(\frac{\omega}{2}\right)}{\left(\frac{\omega}{2}\right)}$$

$$Similarly, F\left\{x\left(\frac{t}{2}\right)\right\} = F\left[rect\left(\frac{t}{4}\right)\right] = 2 \times 2sa(2\omega) = \frac{4sin2\omega}{2\omega}$$

The convolved signal $y(f) = x(2t) \times x\left(\frac{t}{2}\right)$

$$\therefore F[y(t)] = Fx(2t) F\left[x\left(\frac{t}{2}\right)\right] = \left[\frac{sin\left(\frac{\omega}{2}\right)}{\left(\frac{\omega}{2}\right)}\right]\left[\frac{4sin2\omega}{2\omega}\right] = \frac{4}{\omega^2}sin\left(\frac{\omega}{2}\right)sin(2\omega)$$

10. For the signal $f(t) = 3\sin 8\pi t + 6\sin 12\pi t + \sin 14\pi t,$ the minimum sampling frequency (in Hz) satisfying the Nyquist criterion is _____.

Answer: 14 sample / sec

Exp: Maximum frequency content in 7Hz
$\Rightarrow$ Nyquist rate $= 2 \times 7 = 14$ sample / sec

11. In a synchronous machine, hunting is predominantly damped by
(A) mechanical losses in the rotor   (B) iron losses in the rotor
(C) copper losses in the stator   (D) copper losses in the rotor

Answer: (D)

Exp: In a synchronous machine the hunting will be damped by the copper losses in the rotor

12. A single phase induction motor is provided with capacitor and centrifugal switch in series with auxiliary winding. The switch is expected to operate at a speed of 0.7 Ns, but due to malfunctioning the switch fails to operate. The torque-speed characteristic of the motor is represented by
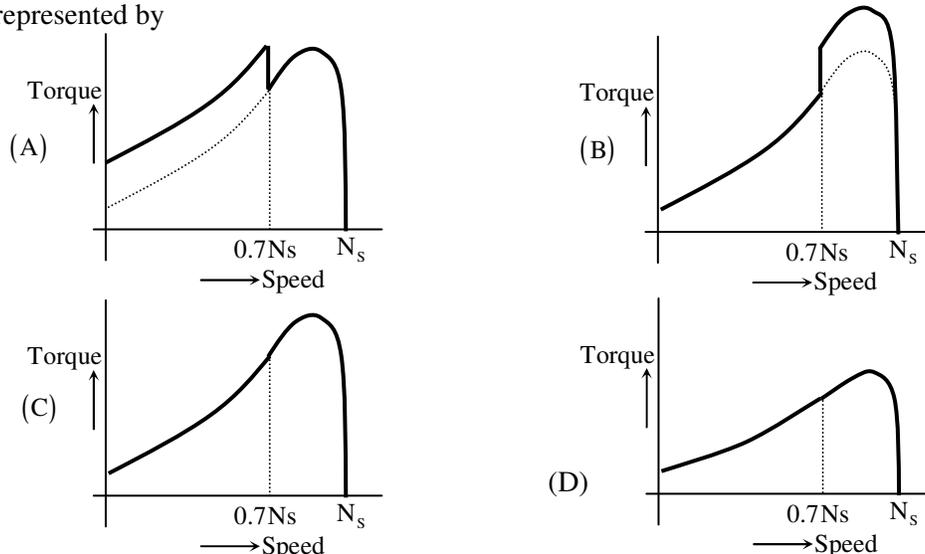
Answer: (C)

Exp: In $1-\phi$ induction motor the centrifugal switch is expected to operate at $0.7\,N_S$ but it fails to operate.

Then there is no increase in the torque after $0.7\,N_S$ Hence (C) is correct

13. The no-load speed of a 230 V separately excited dc motor is 1400 rpm. The armature resistance drop and the brush drop are neglected. The field current is kept constant at rated value. The torque of the motor in Nm for an armature current of 8 A is _____.

Answer: 12.5Nm

Exp: Given, $V = 230\,V, \quad N = 1400\,rpm$

$$R_a = 0 \qquad I_a = 8A$$

$$\therefore Torque,\ T = \frac{V.I_a}{W} = \frac{230 \times 8}{\dfrac{2\pi \times 1400}{60}} = 12.5\,Nm$$

14. In a long transmission line with r,l,g and c are the resistance, inductance, shunt conductance and capacitance per unit length, respectively, the condition for distortionless transmission is

(A) $rc = lg$ (B) $rc = \sqrt{l/c}$ (C) $rg = lc$ (D) $g = \sqrt{c/l}$

Answer: (A)

Exp For distortionless transmission line, $\dfrac{R}{L} = \dfrac{G}{C} \Rightarrow \boxed{RC = GL}$

15. For a fully transposed transmission line

(A) positive, negative and zero sequence impedances are equal

(B) positive and negative sequence impedances are equal

(C) zero and positive sequence impedances are equal

(D) negative and zero sequence impedances are equal

Answer: (B)

Exp: Where $Z_n \rightarrow$ neutral impedance

$Z_S \rightarrow$ Self impedance

$Z_m \rightarrow$ mutual impedance

Let $Z_0 \rightarrow$ zero sequence impedance

$Z_1 \rightarrow$ +ve sequence impedance

$Z_{2\rightarrow} -$ ve sequence impedance

$$Z_{012} = \begin{bmatrix} Z_0 & 0 & 0 \\ 0 & Z_1 & 0 \\ 0 & 0 & Z_2 \end{bmatrix} = \begin{bmatrix} Z_s + 2Z_m + 3Z_n & 0 & 0 \\ 0 & Z_s - Z_m & 0 \\ 0 & 0 & Z_s - Z_m \end{bmatrix}$$

$$\therefore Z_1 = Z_2 = Z_s - Z_m$$
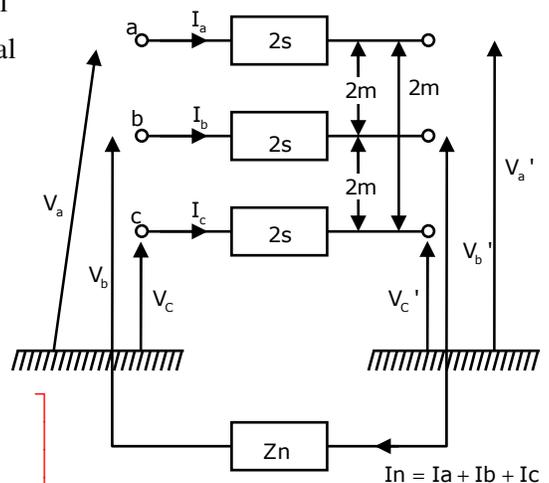
16.   A 183-bus power system has 150 PQ buses and 32 PV buses. In the general case, to obtain the load flow solution using Newton-Raphson method in polar coordinates, the minimum number of simultaneous equations to be solved is _____.s

Answer: 332

Exp: No of load | PQ buses $= 150$

No of generator |PV buses $=32$

Minimum no of simultaneous equations $= 2 \times 150 + 32 = 332$

17.   The signal flow graph of a system is shown below. $U(s)$ is the input and $C(s)$ is the output
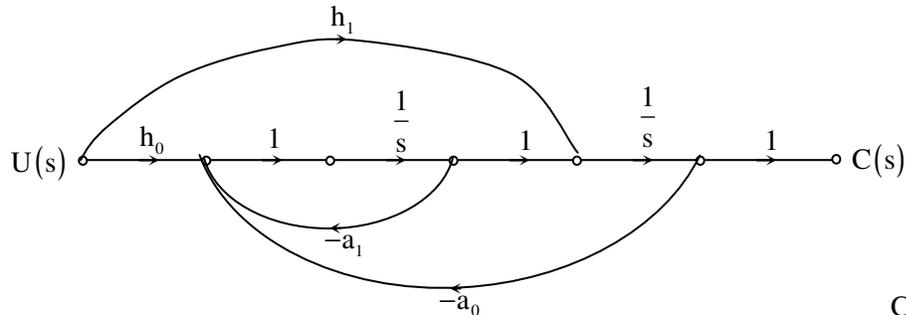
Assuming, $h_1 = b_1$ and $h_0 = b_0 - b_1 a_1$, the input-output transfer function, $G(s) = \dfrac{C(s)}{U(s)}$ of the system is given by

(A) $G(s) = \dfrac{b_0 s + b_1}{s^2 + a_0 s + a_1}$

(B) $G(s) = \dfrac{a_1 s + a_0}{a^2 + b_1 s + b_0}$

(C) $G(s) = \dfrac{b_1 s + b_0}{a^2 + a_1 s + a_0}$

(D) $G(s) = \dfrac{a_0 s + a_1}{a^2 + b_0 s + b_1}$

Answer: (C)

Exp: From the signal flow graph, $G(s) = \dfrac{C(s)}{U(s)}$

By mason's gain relation,

Transfer function $= \dfrac{P_1 \Delta_1 + P_2 \Delta_2 + ...}{\Delta}$

$P_1 = \dfrac{h_1}{S}; P_2 = \dfrac{h_o}{s_2}$

$\Delta_1 = \left[1 + \dfrac{a_1}{s}\right]; \Delta_2 = 1 \; ; \qquad \Delta = 1 + \dfrac{a_1}{s} + \dfrac{a_0}{s^2}$

Transfer function $= \dfrac{\dfrac{h_1}{s}\left[1 + \dfrac{a_1}{s}\right] + \dfrac{b_0}{s^2}}{1 + \dfrac{a_1}{s} + \dfrac{a_0}{s^2}} = \dfrac{b_1 s + b_0}{s^2 + a_1 s + a_0}$

18.   A single-input single-output feedback system has forward transfer function $G(s)$ and feedback transfer function $H(s)$ It is given that $| G(s).H(s)|<1$. Which of the following is true about the stability of the system?

(A) The system is always stable

(B) The system is stable if all zeros of $G(s).H(s)$ are in left half of the s-plane

(C) The system is stable if all poles of $G(s).H(s)$ are in left half of the s-plane

(D) It is not possible to say whether or not the system is stable from the information given

Answer: (A)

19.   An LPF wattmeter of power factor 0.2 is having three voltage settings 300 V, 150 V and 75 V, and two current settings 5 A and 10 A. The full scale reading is 150. If the wattmeter is used with 150 V voltage setting and 10 A current setting, the multiplying factor of the wattmeter is _____.

Answer: 2

Exp: In LPF wattmeter, T_d on the moving system is small owing to low power factor even when the current and potential coils are fully excited. Also the errors introduced due to inductance of pressure coil tend to be large at low power factors. So for calculating multiplying factor for a low p.f. wattmeter, p.f. mentioned on the wattmeter should be taken into account. Therefore,

Multiplying Factor = (Current range used*Voltage range used*p.f)/Power at FSD

Given, Power at Full scale reading = 150

Current Range used   = 10 A

Voltage Range used   = 150 V

Power Factor   = 0.2

Therefore, m = $\dfrac{10 \times 150 \times 0.2}{150} = 2$

20.   The two signals S1 and S2, shown in figure, are applied to Y and X deflection plates of an oscilloscope.
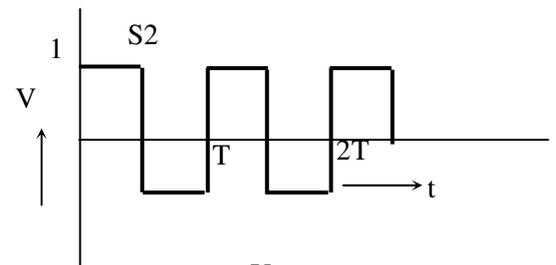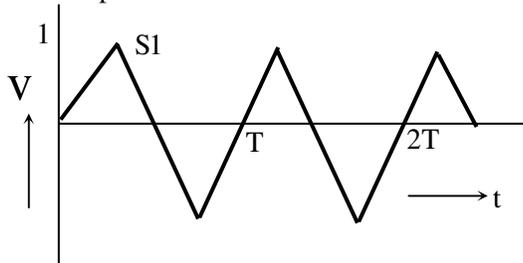

The waveform displayed on the screen is

(C)

(D)

Answer: (A)

Exp:

X Y mode

Vector sum (in X-Y mode)

| Points	$Y_{(s_1)}$	$X_{(s_2)}$	$\sqrt{x^2 + y^2}$	$\phi = 100^{-1}$
A	0	1	1	0
B	1	1	$\sqrt{2}$	45º
C	0	0	0	0
D	−1	−1	$\sqrt{2}$	225º
E				
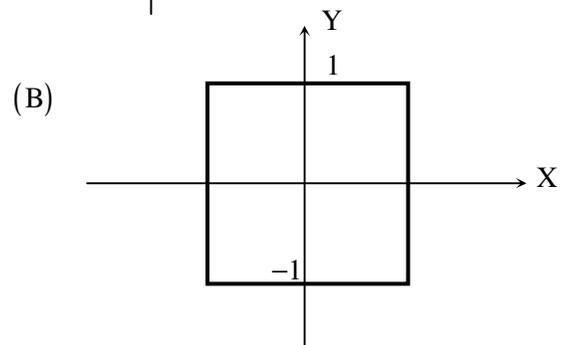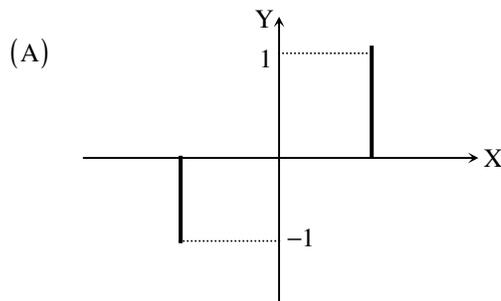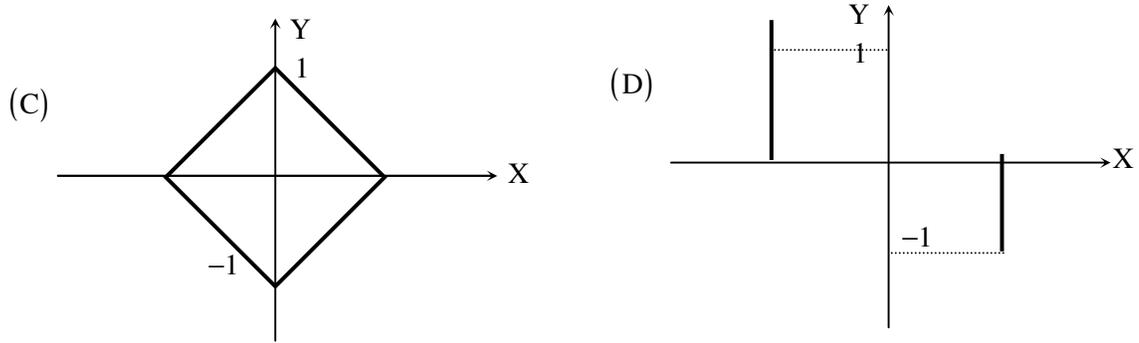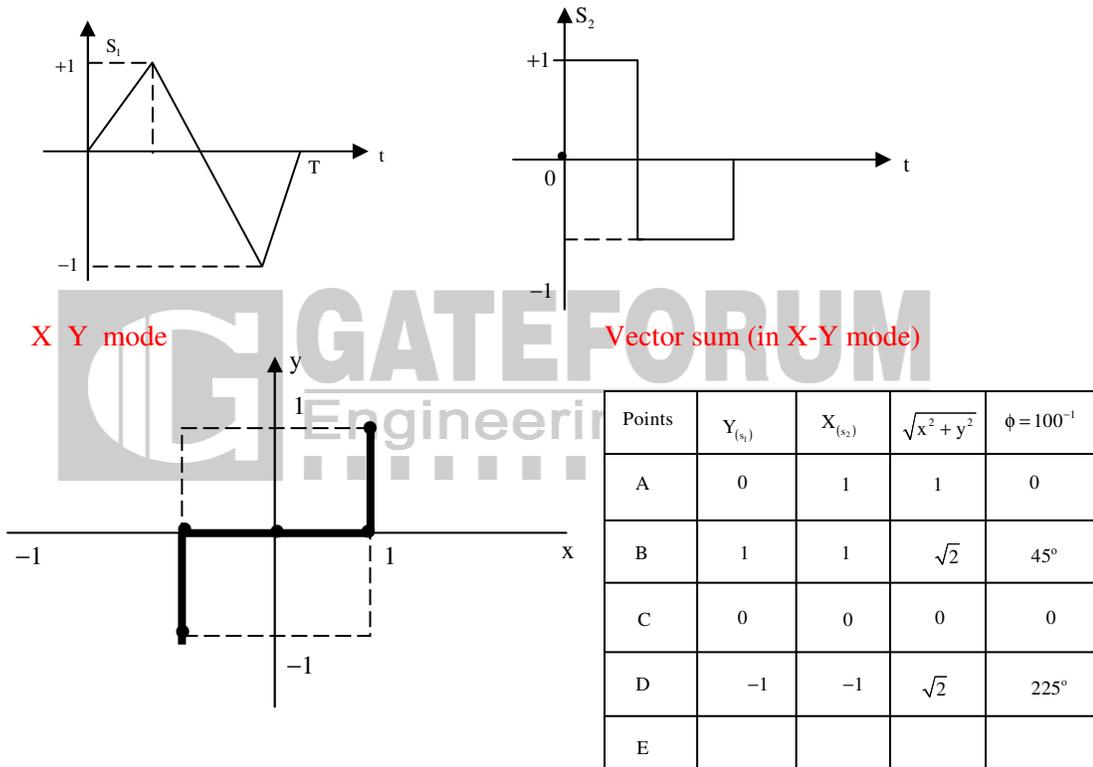
21. A state diagram of a logic gate which exhibits a delay in the output is shown in the figure, where X is the don't care condition, and Q is the output representing the state.

0x / 1. 10 / 1

11 / 0   Q = 0   Q = 1   0x / 1.10 / 1

11 / 0
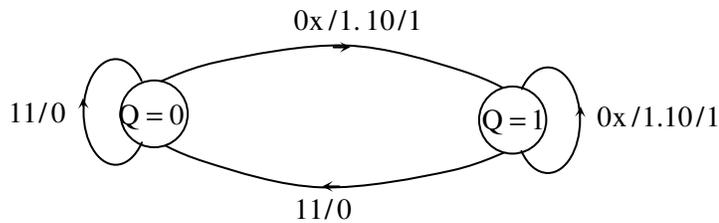
The logic gate represented by the state diagram is

(A) XOR   (B) OR   (C) AND   (D) NAND

Answer: (D)

Exp: True Table

A	B	Y	Q
1	1	0	0
0	0	1	1
0	1	1	1
1	0	1	1
1	1	0	0

If you will observe this true table corresponding to state diagram, then if any input is 0 output is 1 and if all the inputs are one output is zero it means it corresponds to NAND gate.

22.   An operational-amplifier circuit is shown in the figure.
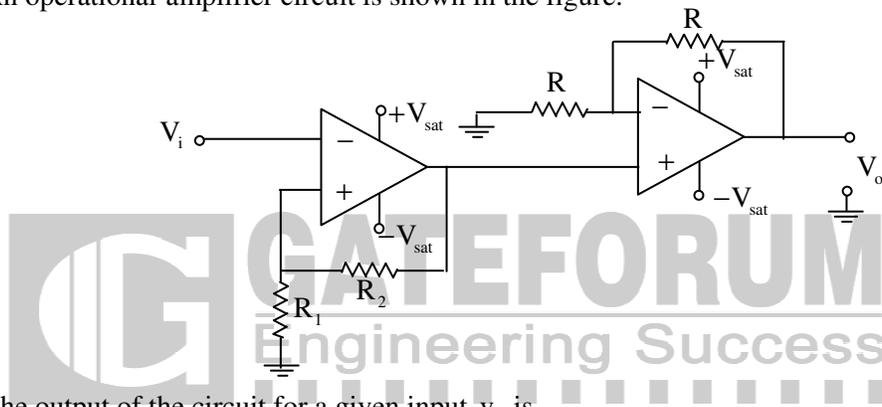
The output of the circuit for a given input v_i is

(A) $-\left(\dfrac{R_2}{R_1}\right)v_t$ (B) $-\left(1+\dfrac{R_2}{R_1}\right)v_t$ (C) $\left(1+\dfrac{R_2}{R_1}\right)v_t$ (D) $+V_{sat}$ or $-V_{sat}$

Answer: (D)

Exp: Output of first Op-Amp is $+V_{sat}$

2nd Op-Amp circuit is non-inverting amplifier

$\therefore V_0 = \left(1+\dfrac{R}{R}\right)V_{sat} > V_{sat}$

$\therefore V_0 = \pm V_{sat}$

23.   In 8085A microprocessor, the operation performed by the instruction LHLD 2100_H is

(A) $(H) \leftarrow 2I_H, (L) \leftarrow 00_H$

(B) $(H) \leftarrow M(2I00_H), (L) \leftarrow M(2101_H)$

(C) $(H) \leftarrow M(2I01_H), (L) \leftarrow M(2100_H)$

(D) $(H) \leftarrow 00_H, (L) \leftarrow 21_H$

Answer: (C)

Exp: Instruction given is:

LHLD   2100H

The operation performed by this instruction is load HL register pair from the specified address in the instruction, directly. HL register pair is required 2-Byte data, but in 8085 at one address it contains only one-byte data, so this instruction will access two memory locations.

So, first byte address (i.e., 2100H) is mentioned in instruction itself and by default second byte data is accessed from the next location (i.e., 2101H). Lower address data will be copied to lower byte $(i.e., (L) \leftarrow M(2100H))$ and higher address data will be copied to higher byte $(i.e, (H) \leftarrow M(2101H))$

24. A non-ideal voltage source V_S has an internal impedance of Z_S If a purely resistive load is to be chosen that maximizes the power transferred to the load, its value must be

(A) 0   (B) real part of Z_s

(C) magnitude of Z_s (D) complex conjugate of Z_s

Answer: (C)

Exp: For minimum power transferred to the load,

Its value must be $R_L = |Z_s|$

$$\boxed{R_L = \sqrt{R_s^2 + X_s^2}}$$
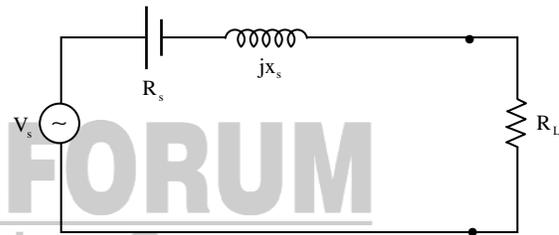
25. The torque-speed characteristics of motor (T_M) and load (T_L) for two cases are shown in the figures (a) and (b). The load torque is equal to motor torque at points P, Q, R and S
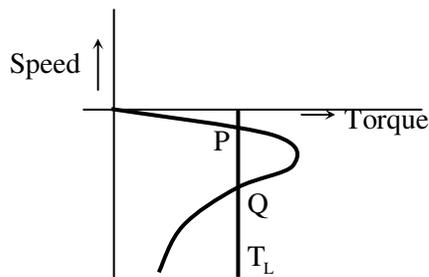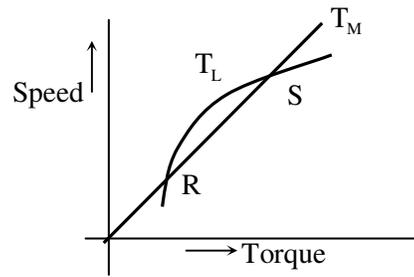
(a)   (b)

The stable operating points are

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

Answer: (B)

Exp: From the given torque speed characteristics of motor (T_m) and load (T_L) at the points 'P' and 'S' the motor stable. Since at low value of slip the motor is stable.

Q.No. 26 – 55 Carry Two Marks Each

26. Integration of the complex function $f(z) = \dfrac{z^2}{z^2-1}$,,, in the counterclockwise direction, around $|z-1| = 1$, is

    (A) $-\pi i$ (B) 0   (C) πi (D) $2\pi i$

Answer: (C)

Exp:

$Z = -1, 1$ are the simple poles of $f(z)$ and $z = 1$ lies inside $C : |z-1| = 1$

$$\therefore \oint_C f(z)\,dz = 2\pi i \times \left[\operatorname*{Res}_{z=1} f(z) \right]$$

$$= 2\pi i \times \left[\operatorname*{Lt}_{z \to 1} (z-1).f(z) \right]$$

$$= 2\pi i \times \left[\operatorname*{Lt}_{z \to 1} \frac{z^2}{z+1} \right] = \pi i$$

27. The mean thickness and variance of silicon steel laminations are 0.2 mm and 0.02 respectively. The varnish insulation is applied on both the sides of the laminations. The mean thickness of one side insulation and its variance are 0.1 mm and 0.01 respectively. If the transformer core is made using 100 such varnish coated laminations, the mean thickness and variance of the core respectively are

    (A) 30 mm and 0.22   (B) 30 mm and 2.44

    (C) 40 mm and 2.44   (D) 40 mm and 0.24

Answer: (D) [Key form IIT website]

Exp: mean thickness of silicon steel laminations = 0.2 mm

variance of silicon steel lamination = 0.02

Vanish insulation applied both sides of laminations

Mean thickness of one side insulation = 0.1 mm

variance of one side insulation = 0.01

Transformer core made with 100 vanish coated laminations

Mean thickness of two side insulation applied to core

= 2×0.1 = 0.2mm

$\therefore$ mean thickness of one lamination

    = mean thickness of silicon steel + mean thickness of two side insulation

    = 0.2+0.2 = 0.4 mm

100 laminations are using so

Mean thickness of core = 0.4×100 = 40 mm

To find thickness of each lamination

From variance

$$\frac{(d_1 - 0.2)^2 + (d_2 - 0.2)^2 + \ldots (d_{100} - 0.2)^2}{100} = 0.02 \qquad \left[\because \text{Varience} = \frac{\sum (x - \hat{x})^2}{n} \right]$$

All have same thickness

$$\therefore \frac{100 \times (d - 0.2)^2}{100} = 0.02$$

(d-0.2)=0.1414

Each lamination d=0.3414mm

Thickness

Similarly

$$\frac{(x_1 - 0.1)^2 + \ldots + (x_{100} \, 0.1)^2}{100} = 0.01$$

Each side lamination is equal (Assume)

$$\frac{100 \times (x - 0.1)^2}{100} = 0.01$$

$$x - 0.1 = 0.1$$

Each side x=0.2 mm

Insulation thickness

Two side insulation thickness =0.4 mm

$$\left.\begin{array}{l} \text{Each lamination (insulation)} \\ + \text{si steel) thickness} \end{array}\right\} \begin{array}{l} = 0.3414 + 0.4 \\ = 0.7414 \text{ mm} \end{array}$$

Variance of overall core

$$= \frac{100 \times (0.7414 - 0.4)^2}{100} = 0.1166$$

$\therefore$ mean thickness & variance of the core=40mm and 0.1166

[No option is matching]

28. The function $f(x) = e^x - 1$ is to be solved using Newton-Raphson method. If the initial value of x0 is taken as 1.0, then the absolute error observed at 2nd iteration is _____.

Answer: 0.06

Exp: Clearly, $x = 0$ is a root of the equation $f(x) = e^x - 1 = 0$

$f'(x) = e^x$ and $x_0 = 1.0$

Using Newton raphson method, $x_1 = x_0 - \dfrac{f(x_0)}{f'(x_0)} = 1 - \dfrac{(e-1)}{e} = \dfrac{1}{e}$

and $x_2 = x_1 - \dfrac{f(x_1)}{f^1(x_1)} = \dfrac{1}{e} - \dfrac{\left(e^{1/e} - 1\right)}{e^{1/e}} = \dfrac{1}{e} + \dfrac{1}{e^{1/e}} - 1 = 0.37 + 0.69 - 1 = 0.06$

$\therefore$ absolute error at 2nd iteration is $|0 - 0.06| = 0.06$

29.   The Norton's equivalent source in amperes as seen into the terminals X and Y is _____.
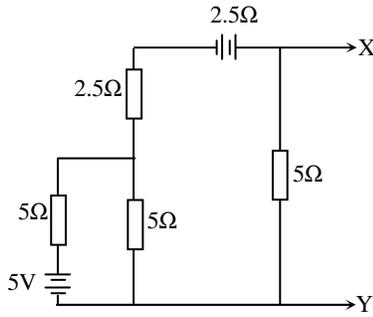
Answer: 2   [Key form IIT website]

Exp:
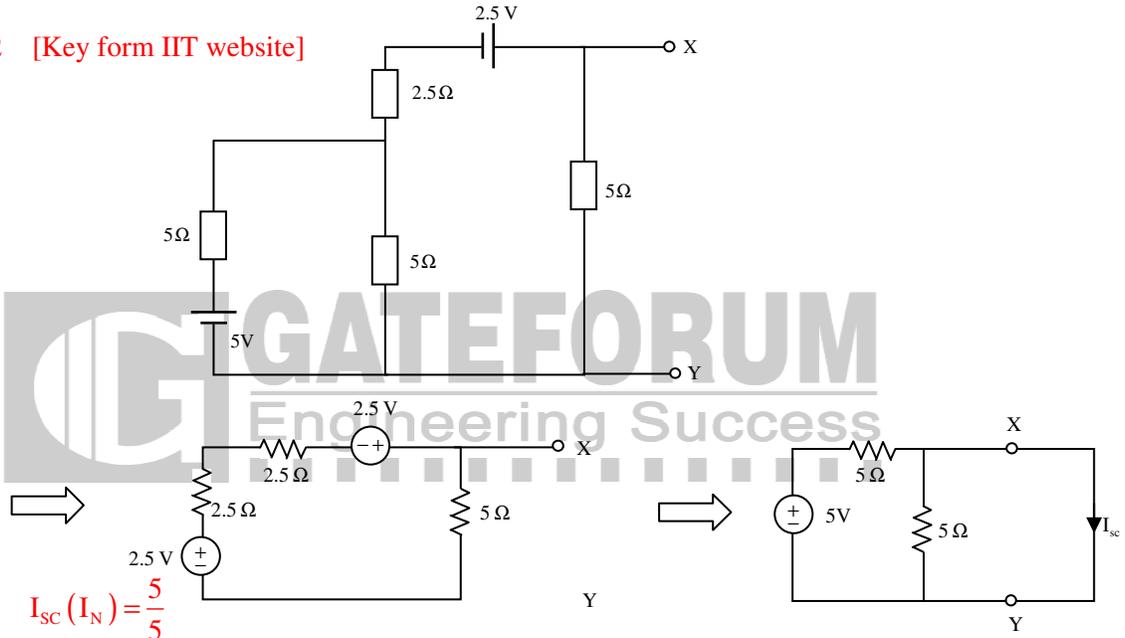
$$I_{SC}(I_N) = \frac{5}{5}$$

$$I_{SC} = 1A$$

[Answer is not matching]

30.   The power delivered by the current source, in the figure, is _____.
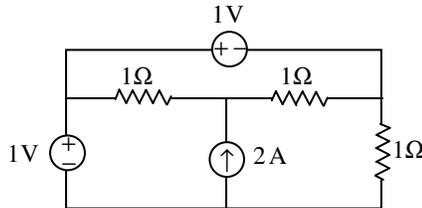
Answer: 3 Watts

Exp: KCL at node V_x:

$$\frac{1 - V_x}{1} + 2 = \frac{V_x}{1}$$

$$\boxed{V_x = 1.5V}$$

Power delivered by current source is = 2× 1.5 = 3 watts
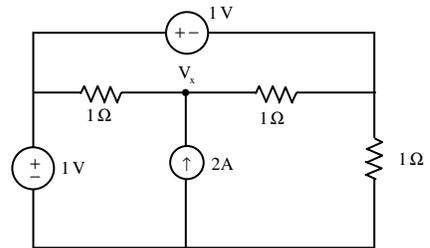
31. A perfectly conducting metal plate is placed in x-y plane in a right handed coordinate system. A charge of $+32\pi\varepsilon_0\sqrt{2}$ columbs is placed at coordinate (0, 0, 2). $\in_0$ is the permittivity of free space. Assume $\hat{I}, \hat{j}, \hat{k}$ to be unit vectors along x, y and z axes respectively. At the coordinate . $\left(\sqrt{2},\sqrt{2},0\right)$, the electric field vector $\vec{E}$ (Newtons/Columb) will be

(A) $2\sqrt{2}\,\hat{k}$

(B) $-2\,\hat{k}$

(C) $2\,\hat{k}$

(D) $-2\sqrt{2}\,\hat{k}$

Answer: (B)

Exp:
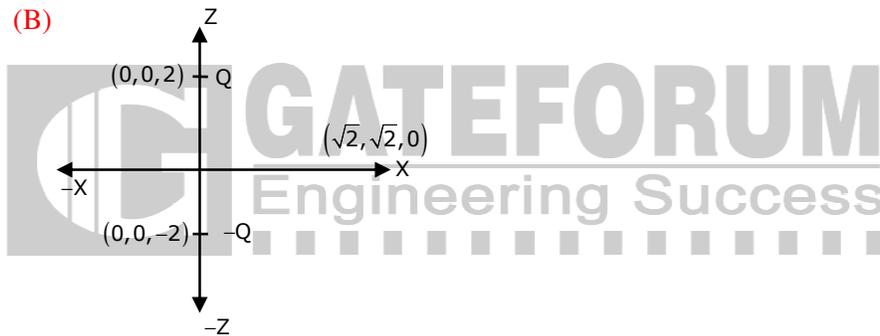
$$E = E_1 + E_2 = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1 R_1}{R_1{}^3} + \frac{Q_2 R_2}{R_2{}^3}\right]$$

$$Q_2 = -Q_1 \begin{vmatrix} R_1 = \left(\sqrt{2},\sqrt{2},0\right) - (0,0,2) \\ R_1 = \sqrt{2}\ a_x + \sqrt{2}\ a_y - 2a_z \\ R_2 = \left(\sqrt{2},\sqrt{2},0\right) - (0,0,-2) \\ \quad = \sqrt{2}\ a_x + \sqrt{2}\ a_y + 2a_z \end{vmatrix}$$

$$E = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{16\sqrt{2}}\left(\sqrt{2}\ a_x + \sqrt{2}\ a_y - 2a_z\right) - \frac{Q_1}{16\sqrt{2}}\left(\sqrt{2}\ a_x + \sqrt{2}\ a_y + 2a_z\right)\right]$$

$$= \frac{Q}{16\sqrt{2}\times 4\pi\varepsilon_0}\left[-4a_z\right] = \frac{32\sqrt{2}\pi\varepsilon_0}{16\sqrt{2}\pi\varepsilon_0}\left(-a_z\right)$$

$$E = -2a_z$$

32. A series RLC circuit is observed at two frequencies. At $\omega_1 = 1\,k\,rad/s,$ we note that source voltage $V_1 = 100\angle 0^0\,V$ results in current $I_1 = 0.03\angle 31^O$ A. At $\omega_2 = 2$ krad/s, the source voltage $V_2 = 100\angle 0^o\,V$ results in a current $I_2 = 2\angle 0^o\,V$ A. The closest values for R,L,C out of the following options are

(A) $R = 50\Omega; L = 25\,mH; C = 10\mu F;$

(B) $R = 50\Omega; L = 10\,mH; C = 25\mu F;$

(C) $R = 50\Omega; L = 50\,mH; C = 5\mu F; a$

(D) $R = 50\Omega; L = 5\,mH; C = 50\mu F;$

Answer: B

Exp: Given $V_1 = 100\underline{|0^o}V; I_1 = 0.03\underline{|31^o}$ at $\omega_1 = 1000$ r/sec

$V_2 = 100\underline{|0^o}V; I_2 = 2\underline{|0^o}$ at $\omega_2 = 2000$ r/sec

i.e. $R = \dfrac{\vartheta_2}{I_2} = \dfrac{100}{2} \Rightarrow 50\Omega$

$Z = \dfrac{v_1}{I_1} \Rightarrow \dfrac{100\underline{|0^o}}{0.03\underline{|31^o}} \Rightarrow R + j(X_L - X_C)$

$\phi = 31^o \Rightarrow \tan^{-1}\left(\dfrac{X_L - X_C}{R}\right)$

$\Rightarrow \tan 31^o = \left(\dfrac{X_L - X_C}{R}\right)$

$\tan 31^o = \dfrac{\left(\omega_1 L - \dfrac{1}{\omega_1 c}\right)}{R}$

$\Rightarrow \left[\omega_1 L - \dfrac{1}{\omega_1 C}\right] = 0.600 \times 50 \Rightarrow \left[\omega_1 L - \dfrac{1}{\omega_1 C}\right] = 30.04$ q   ....(1)

$\omega_2 L - \dfrac{1}{\omega_2 C} = 0$ ....(2)

$\omega_1 = 1000\,r/sec$; $\omega_2 = 2000\,r/sec$

from 1 and 2, $C = 25\mu F$

$L = 10mH$

33. A continuous-time LTI system with system function $H(\omega)$ has the following pole-zero plot. For this system, which of the alternatives is TRUE?

(A) $|H(0)| > |H(\omega)|; |(\omega)| > 0$

(B) $|H(\omega)|$ has multiple maxima, at ω_1 and ω_2

(C) $|H(\omega)| < |H(\omega)|; |(\omega)| > 0$
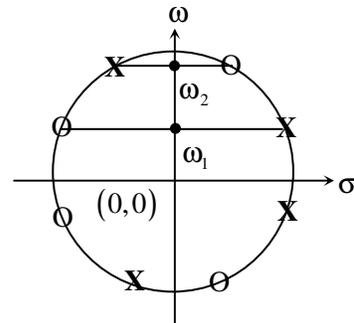
(D) $|H(\omega)| = \text{constant}; -\infty < \omega < \infty$

Answer: (D)

Exp: The transfer function can be written as

$$H(s) = K \frac{(s - z_1)(s - z_1{}^*)(s - z_2)(s - z_2{}^*)}{(s - p_1)(s - p_1{}^*)(s - p_2)(s - p_2{}^*)}$$

$$\left| H(j\omega) \right|$$

$$= K \frac{\sqrt{\omega^2 + |z_1|^2} \sqrt{\omega^2 + |z_1|^2} \sqrt{\omega^2 + |z_2|^2} \sqrt{\omega^2 + |z_2|^2}}{\sqrt{s^2 + |p_1|^2} \sqrt{\omega^2 + |p_1|^2} \sqrt{\omega^2 + |p_2|^2} \sqrt{\omega^2 + |p_2|^2}}$$

from figure $|z_1| = |p_2|$

$|z_2| = |p_1|$

$\Rightarrow (H(j\omega)) = K[\text{cons tan t}]$
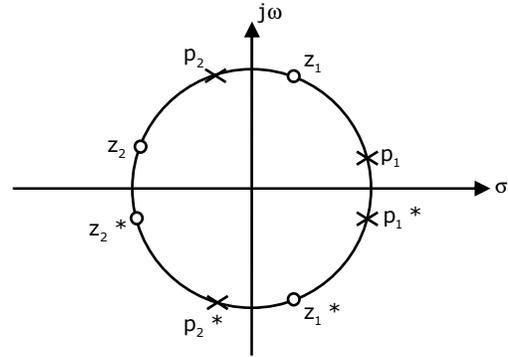
34. A sinusoid $x(t)$ of unknown frequency is sampled by an impulse train of period 20 ms. The resulting sample train is next applied to an ideal lowpass filter with a cutoff at 25 Hz. The filter output is seen to be a sinusoid of frequency 20 Hz. This means that $x(t)$ has a frequency of

(A) 10 Hz   (B) 60 Hz   (C) 30 Hz   (D) 90 Hz

Answer: (C)

Exp: Sampling rate 50Hz

Let x(t) has a frequency of f_x Hz,

After sampling with 50Hz

Spectrurm will be

LPF of cut off $= 25\,Hz$

output $= 20Hz$

$\Rightarrow 50 - f_x = 20$

$\Rightarrow f_x = 30Hz$
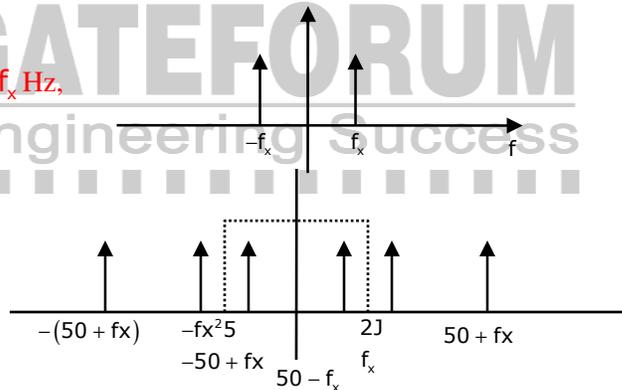
35. A differentiable non constant even function $x(t)$ has a derivative $y(t)$, and their respective Fourier Transforms are $X(\omega)$ and $Y(\omega)$. Which of the following statements is TRUE?

(A) $X(\omega)$ and $Y(\omega)$ are both real.   (B) $X(\omega)$ is real and $Y(\omega)$ is imaginary.

(C) $X(\omega)$ and $Y(\omega)$ are both imaginary.   (D) $X(\omega)$ is imaginary and $Y(\omega)$ is real.

Answer: (B)

Exp: $y(t) = \dfrac{d}{dt} x(t)$

$\downarrow$

$Y(\omega) = j\omega \times (\omega)$

$\Rightarrow$ if $X(\omega)$ is real, $Y(\omega)$ is imaginary

36. An open circuit test is performed on 50 Hz transformer, using variable frequency source and keeping V/f ratio constant, to separate its eddy current and hysteresis losses. The variation of core loss/frequency as function of frequency is shown in the figure

The hysteresis and eddy current losses of the transformer at 25 Hz respectively are

(A) 250 W and 2.5 W   (B) 250 W and 62.5W

(C) 312.5 W and 62.5 W   (D) 312.5 W and 250 W

Answer: (B)

Exp: Given 50Hz transformer

Here $\dfrac{-v}{f}$ ratio maintains constant

$\therefore W_n = Af; \quad W_e = B - f^2$

where, $A = 10 \quad \& \quad B = \tan\theta = \dfrac{5}{50} = 0.1$

$\therefore W_n$ at 25Hz $= 10 \times 25 = 250\,W$

W_e at 25Hz $= 0.1 \times (25)^2 = 62.5\,W$

37. A non-salient pole synchronous generator having synchronous reactance of 0.8 pu is supplying 1 pu power to a unity power factor load at a terminal voltage of 1.1 pu. Neglecting the armature resistance, the angle of the voltage behind the synchronous reactance with respect to the angle of the terminal voltage in degrees is _____.

Answer: 33.61°

Exp: Given, $P = 1$ P.u; $\qquad V_t = 1.1$ P.u; $\qquad X_s = 0.8$ P.u

$P_f = 1.$

$\therefore \quad I_a = \dfrac{P}{V \cos\phi} = \dfrac{1}{1.1 \times 1} = 0.91$

$\therefore \quad E = \sqrt{(V\cos\phi + I_a R_a)^2 + (V\sin\phi + I_a X_s)^2}$

$E = \sqrt{(1.1 \times 1 + 0)^2 + (0 + 0.91 \times 0.8)^2} = 1.314\,V$

$\therefore$ From power equation, $P = \dfrac{EV}{X_s}\sin\delta$

$\Rightarrow 1 = \dfrac{1.314 \times 1.1}{0.8}\sin\delta \Rightarrow \boxed{\delta = 33.61^\circ}$

38. A separately excited 300 V DC shunt motor under no load runs at 900 rpm drawing an armature current of 2 A. The armature resistance is 0.5Ω and leakage inductance is 0.01 H. When loaded, the armature current is 15 A. Then the speed in rpm is _____

Answer: 880 rpm

Exp: Given $300V_1$

$N_1 = 900\,rpm$

$R_a = 0.5\Omega$

$Ia_1 = 2A;\quad Ia_2 = 15A$

$\therefore Eb_1 = 300 - 2\times0.5 = 299V$

$Eb_2 = 300 - 15\times0.5 = 292.5V$

$\therefore \dfrac{N_2}{N_1} = \dfrac{Eb_2}{Eb_1} \Rightarrow N_2 = 900\times\dfrac{2925}{29} = 880\ rpm$

39. The load shown in the figure absorbs 4 kW at a power factor of 0.89 lagging.
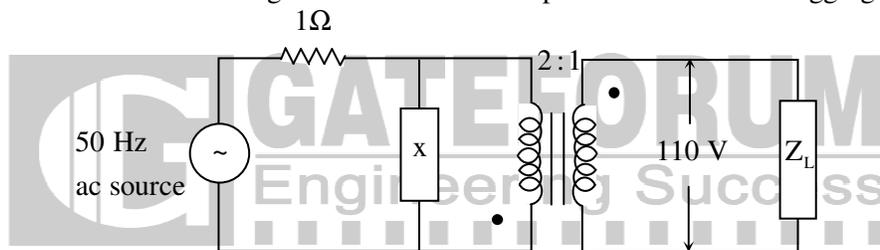
Assuming the transformer to be ideal, the value of the reactance X to improve the input power factor to unity is _____.

Answer: 24

Exp: Given, $V_2 = 110$

Load power, $P_2 = 4\ kW$

$pf = \cos\theta_2 = 0.89$

$I_2 = \dfrac{\text{load power}}{V_2\times\cos\theta_2} = \dfrac{4000}{110\times0.89} = 40.858\ A$

primary current, $I_1 = K\,I_2$

$= \left(\dfrac{N_2}{N_1}\right)I_2 = \dfrac{1}{2}\times40.858$

$= 20.429\ A$

to improve input power factor units,

Reactive power $= \phi = \dfrac{V_1^2}{X}$

$\therefore$ Reactance, $X = \dfrac{V_1^2}{\phi} = \dfrac{220^2}{220\times20.429\times\sin(27)} = 23.6\Omega.$

40. The parameters measured for a 220V/110V, 50 Hz, single-phase transformer are:

Self inductance of primary winding = 45 mH

Self inductance of secondary winding = 30 mH

Mutual inductance between primary and secondary windings = 20 mH

Using the above parameters, the leakage (L_{l1} , L_{l2}) and magnetizing (L_m) inductances as referred to primary side in the equivalent circuit respectively, are

(A) 5mH, 20mH and 40mH   (B) 5mH, 80mH and 40mH

(C) 25mH, 10mH and 20mH   (D) 45mH, 30mH and 20mH

Answer: (B)

Exp: Given, 220/110v, 50Hz.

$L_1 = 45mH, L_2 = 30mH$

M=20 mH.

Leakage inductancy are,

$Ll_1 = L_1 - 2(m) = 45 - 2(20)$
$$= 5\,mH$$
$Ll_2 = L_2 - 2(m)$
$$= 30 - 2(20) = 10\,mH$$
But refered to primary,

$$Ll_2' = \frac{30}{\left(\dfrac{1}{2}\right)^2} - 2(20)$$

$$= 120 - 40 = 80\,mH$$

41. For a 400 km long transmission line, the series impedance is $(0.0 + j0.5)\,\Omega/km$ and the shunt admittance is $(0.0 + j5.0)\,\mu mho/km$. The magnitude of the series impedance (in O) of the equivalent p circuit of the transmission line is _____.

Answer: 186.66

Exp: For a long transmission line,

$$\begin{bmatrix} AB \\ CD \end{bmatrix} = \begin{bmatrix} 1+\dfrac{yz}{2} & z\left[1+\dfrac{yz}{6}\right] \\ y\left[1+\dfrac{yz}{6}\right] & 1+\dfrac{yz}{2} \end{bmatrix}$$

Where z= total series impedance $= j0.5\,\Omega/km \times 400\,km = j200\,\Omega$

$y = j5s\ 10^{-6}/km = j5 \times 10^{-6} \times 400s = j2 \times 10^{-3} simen$

ABCD parameters of a π circuit is
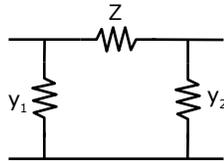
$$\begin{bmatrix} AB \\ CD \end{bmatrix} = \begin{bmatrix} 1 + y_2 z & z \\ y_1 + y_2 + y_1 y_2 z & 1 + y_1 z \end{bmatrix}$$

$$\therefore Z = B = Z\left(\frac{1 + yz}{6}\right)$$

$$= j200\left[1 + \frac{(j200)(j2 \times 10^{-3})}{6}\right]$$

$$= j200\left[\frac{1 - 0.4}{6}\right] = j186.66$$

42. The complex power consumed by a constant-voltage load is given by $(P_l + jQ_l)$ where, $1kW \le P_l \le 1.5kW$ and $0.5kVAR \le Q_l \le 1kVAR$

A compensating shunt capacitor is chosen such that $|Q| \le 0.25kVAR$ where Q is the net reactive power consumed by the capacitor-load combination. The reactive power (in kVAR) supplied by the capacitor is _____.

Answer: 0.75

Exp: Net reactive power consumed by capacitor-load combination is 0.25 KVAR.
        Reactive power required for load is 1KVAR
        Reactive power supplied by capacitor is 0.75 KVAR.

43. The figure shows the single line diagram of a single machine infinite bus system.

Infinite
bus
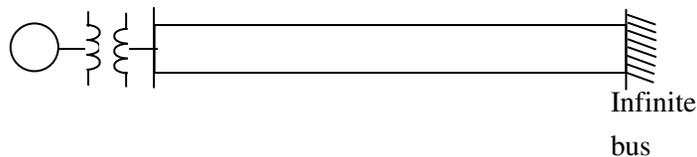
The inertia constant of the synchronous generator H =5 MW-s/MVA. Frequency is 50 Hz.

Mechanical power is 1 pu. The system is operating at the stable equilibrium point with rotor angle δ equal to 30°. A three phase short circuit fault occurs at a certain location on one of the circuits of the double circuit transmission line. During fault, electrical power in pu is P_{max} sin δ If the values of δ and $d\delta/dt$ at the instant of fault clearing are 45° and 3.762 radian/s respectively, then P_{max} (in pu) is _____.

Answer: 0.24

Exp: Given, $H = 5MW - S/MVA$

                  $f = 50Hz$

                  $P_m = 1pu$

                  $\delta_0 = 30°$

        At the instant of fault clearing,

$$\delta = 45°\,;\, \frac{d\delta}{dt} = 3.762\,\text{rad}/\text{s}$$

$$\therefore \frac{d^2\delta}{dt^2} = \frac{1}{M}\left[p_m - p_3\right]$$

$$\frac{d\delta}{dt} = \left[\frac{2}{M}\int_{\delta_0}^{\delta}\left(p_m - p_e\right)ds\right]^{\frac{1}{2}}\left[\frac{d}{dt}\left(\frac{ds}{dt}\right)^2 = 2\left(\frac{d\delta}{dt}\right)\left(\frac{d^2\delta}{dt^2}\right)\right]$$

$$= \left[\frac{2}{H/\pi f}\int_{30}^{45}\left(1 - p_{max}\sin\delta\right)ds\right]^{\frac{1}{2}}$$

$$3.762 = \left[\frac{2\times\pi\times50}{5}\left(\delta + p_{max}\cos\delta\right)_{30}^{45}\right]^{\frac{1}{2}}$$

$$\Rightarrow 14.152 = 20\pi\left\{\left(45° - 30°\right) + p_{max}\left(\cos45° - \cos30°\right)\right\}$$

$$\Rightarrow p_{max} = 0.24\,\text{p.u}$$

44.   The block diagram of a system is shown in the figure
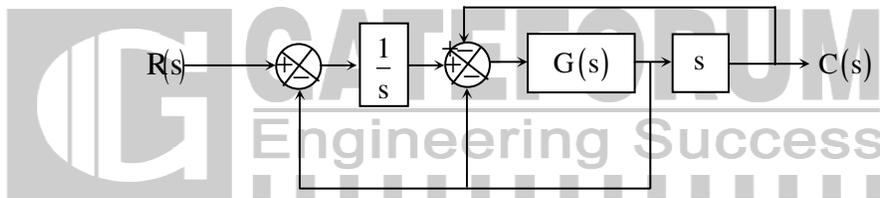
If the desired transfer function of the system is

$$\frac{C(s)}{R(s)} = \frac{s}{s^2 + s + 1}$$

then G(s) is

(A) 1   (B) s   (C) 1/s   (D) $\dfrac{-s}{s^3 + s^2 - s - 2}$

Answer: (B)

Exp:
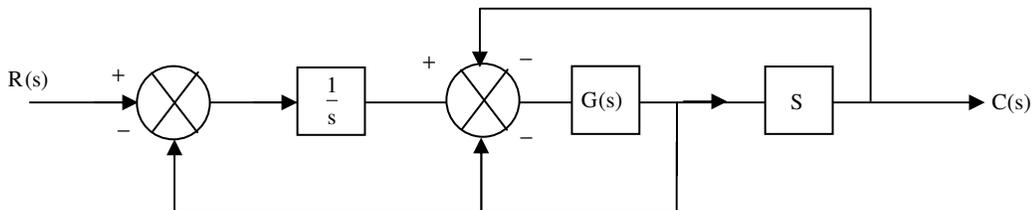
If $G(s) = S.$

$$\frac{C(s)}{R(s)} = \frac{S}{s^2 + s + 2}$$

45. Consider the system described by following state space equations

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \ y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

If *u* is unit step input, then the steady state error of the system is

(A) 0   (B) 1/2   (C) 2/3   (D) 1

Answer: (A)

Exp: Transfer function $\Rightarrow C[SI - A]^{-1}.B.$

$$= \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} S & -1 \\ 1 & (s+1) \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Transfer function $= \dfrac{1}{s^2 + s + 1}$

$\dfrac{G(s)}{1 + G(s)} = \dfrac{1}{s^2 + s + 1}$

$\Rightarrow G(s) = \dfrac{1}{s^2 + s}$

Steady state error for unit step

$e_{ss} = \dfrac{A}{1 + K_p}$

$e_{ss} = \dfrac{1}{1 + \lim\limits_{s \to 0} G(s)}$

$e_{ss} = \dfrac{1}{1 + \lim\limits_{s \to 0} \dfrac{1}{s^2 + s}}$

$e_{ss} = \dfrac{1}{1 + \infty}$

$\boxed{e_{ss} = 0}$

46.   The magnitude Bode plot of a network is shown in the figure
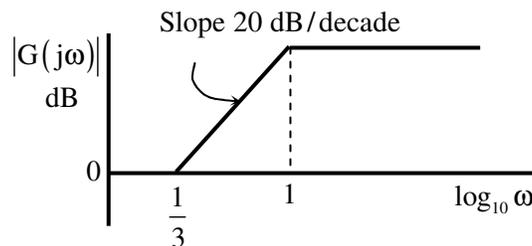
The maximum phase angle .m and the corresponding gain Gm respectively, are

(A) -30° and $1.73\,dB$ (B) -30° and $4.77\,dB$

(C) $+30^o$ and $4.77\,dB$ (D) $+30^o$ and $1.73\,dB$

Answer: C

Exp: $G(s) = k.\dfrac{(1+3s)}{(1+s)}$

$$G(s) = \dfrac{3k.\left(s + \dfrac{1}{3}\right)}{(s+1)}$$

Here k = 1

$$\dfrac{1}{T} = \dfrac{1}{3} \Rightarrow \dfrac{1}{\alpha T} = 1$$

$$\omega_m = \dfrac{1}{\sqrt{3}} ; \alpha = \dfrac{1}{3}$$

$$G(s)\Big|_{\omega = \frac{1}{\sqrt{3}}} = \dfrac{\sqrt{4}}{\sqrt{\dfrac{4}{3}}} \Rightarrow \sqrt{3}$$

$$G_m\Big|_{in\ dB} = 20\log\sqrt{3} = 4.77\ dB$$

$$\phi_m = \sin^{-1}\left[\dfrac{1-\alpha}{1+\alpha}\right]$$

$$\alpha = \dfrac{1}{3} = \sin^{-1}\left[\dfrac{1-\dfrac{1}{3}}{1+\dfrac{1}{3}}\right] = \sin^{-1}\left(\dfrac{1}{2}\right)$$

$$\boxed{\phi_m = 30^o}$$

47.   A periodic waveform observed across a load is represented by

$$V(t) = \begin{cases} 1+\sin\omega t & 0 \le \omega t < 6\pi \\ -1+\sin\omega t & 6\pi \le \omega t < 12\pi \end{cases}$$

The measured value, using moving iron voltmeter connected across the load, is

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

Answer: (A)

Exp: M.I instrument reads RMS value

$$= \sqrt{(1)^2 + \left(\dfrac{1}{\sqrt{2}}\right)^2} = \sqrt{1 + \dfrac{1}{2}} \Rightarrow \sqrt{\dfrac{3}{2}}$$

48.   In the bridge circuit shown, the capacitors are loss free. At balance, the value of capacitance C_1 in microfarad is _____.
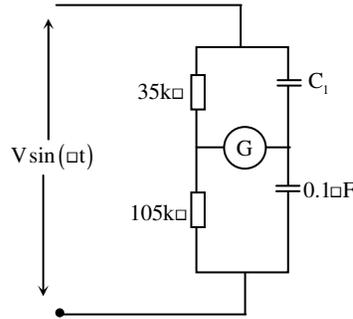

Answer: $0.3\,\mu F$

Exp: Bridge is balanced

$$z_1 z_4 = z_2 z_3$$

$$35k.\frac{1}{j\omega 0.1\mu F} = 105k.\frac{1}{j\omega c_1}$$

$$\boxed{C_1 = 0.3\,\mu F}$$

49.   Two monoshot multivibrators, one positive edge triggered (M_1) and another negative edge triggered (M_2), are connected as shown in figure
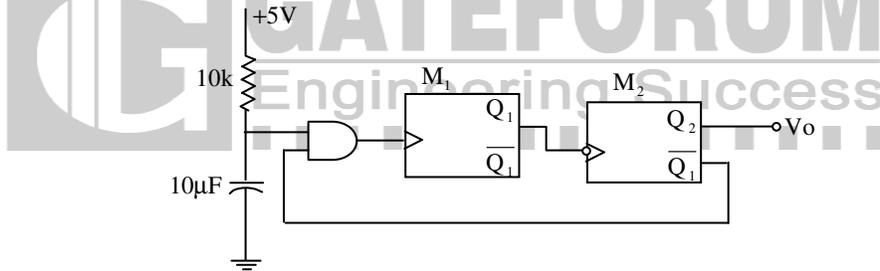

The monoshots M_1 and M_2 when triggered produce pulses of width T_1 and T_2 respectively, where $T_1 > T_2$. The steady state output voltage v_o of the circuit is

Answer: (C)

Exp:

$V_2(t) =$

$5\tau = 50 \sec$
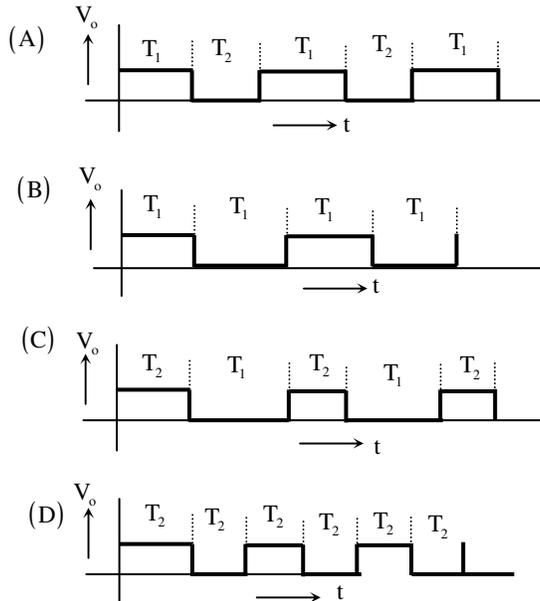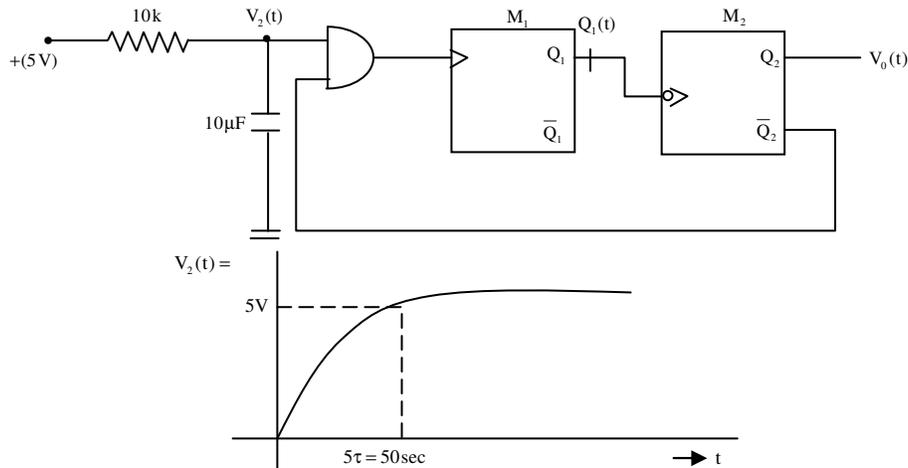
$\rightarrow$ given M_1 mono-stable multivibrator generates pulse width T_1.

T_1
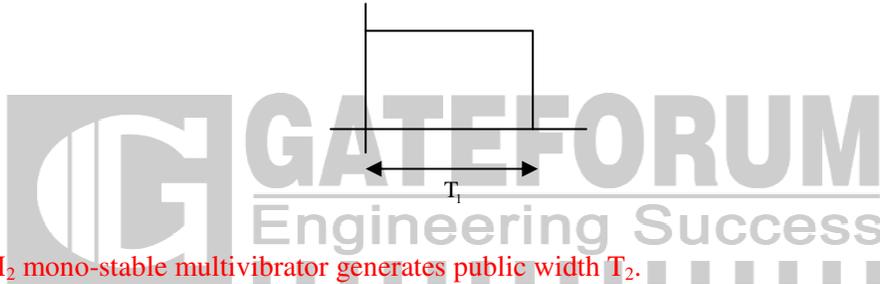
M_2 mono-stable multivibrator generates public width T_2.


(Because $T_1 > T_2$)

T_2
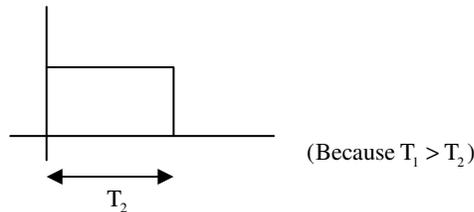
(1) Assume Initially if $Q_2 = 1$ (high state), then $\overline{Q}_2 = 0$ (low state)

Then output of AND gate is low, M_1(multi vibrator) it does not generates pulse width T_1(Because it is positive edge triggered),

(2) Output (Q_2), after T_2 duration , it is low (comes to stable state then $\overline{Q}_2$ is high, the output of And gate is high now, then M_1 multivibrator generates pulse width T_1 (Because it positive edge triggered), At this time Q_2 does not generates pulse width T_2 (Because it negative edge Triggered) then,at the end of T_1 pulse, M_2 multi vibrator generates T_2 pulse width (Because it is negative edge triggered)

(1)

$Q_2(t) = V_0(c)$

T_2

$Q_1(t)$

T_1
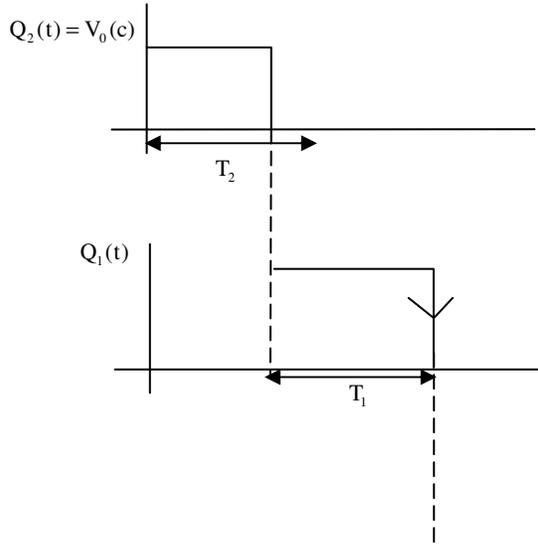
Then again $Q_2(t)$ is high at the end of T_1 pulse

$Q_2(t)$

T_2
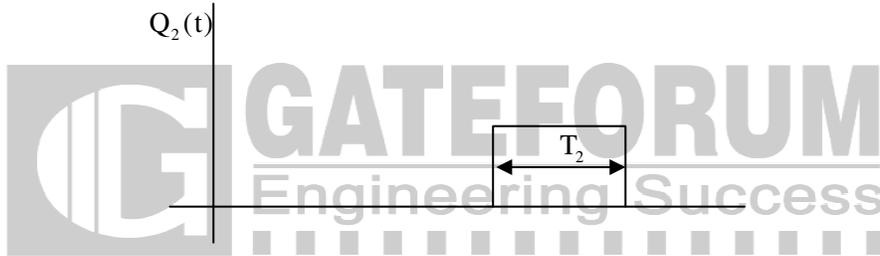
Overall output wave form

T_2 T_1 T_2 So ......on
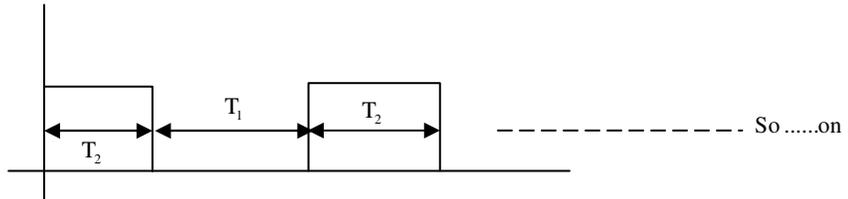
50.   The transfer characteristic of the Op-amp circuit shown in figure is

V_i R   R $+V_{sat}$ R $+V_{sat}$ V_o
        R $-V_{sat}$ R $-V_{sat}$
        R   R

(A)

(B)

(C)

(D)
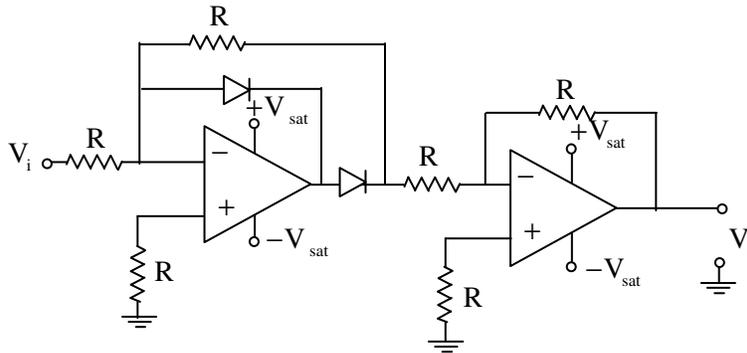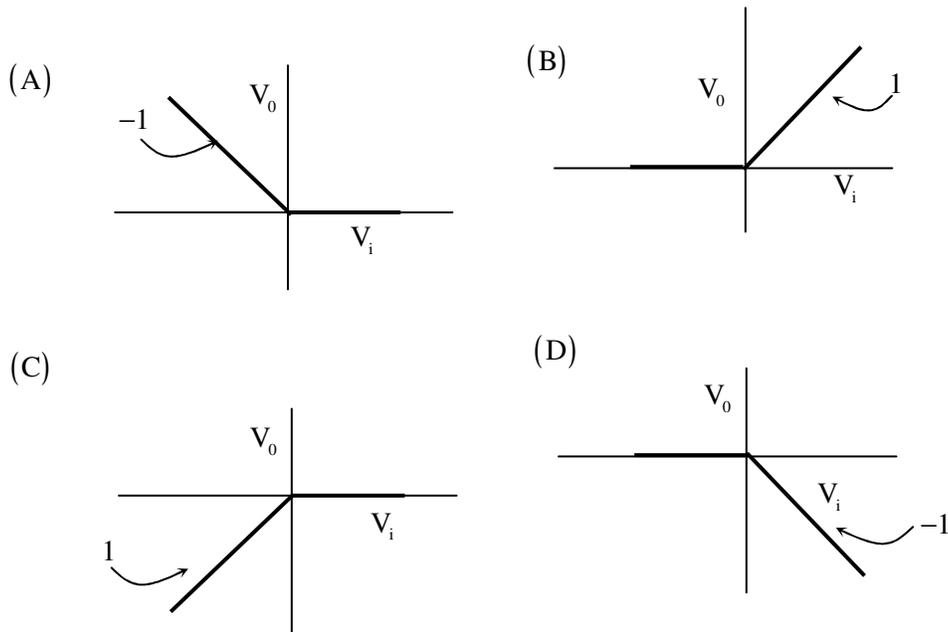
Answer: (C)

Exp:

When $V_i > 0$; $V_0 = 0 \Rightarrow$ slope $= 0$

When $V_i < 0$; $V_0 = V_i \Rightarrow$ slope $= 1$

Transfer characteristics are
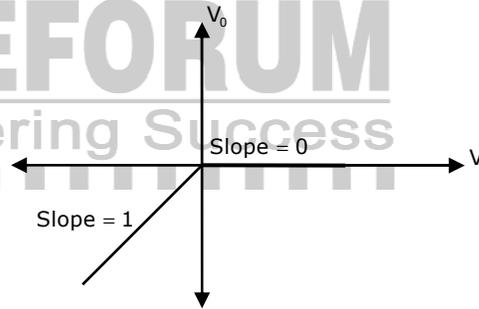
51. A 3-bit gray counter is used to control the output of the multiplexer as shown in the figure. The initial state of the counter is 000_2. The output is pulled high. The output of the circuit follows the sequence
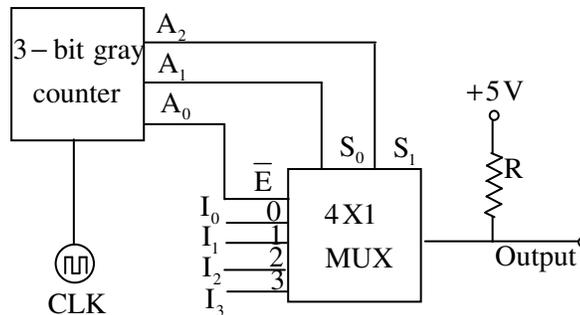
(A) I_0, 1, 1, I_1, I_3, 1, 1, I_2 (B) I_0, 1, I_1, 1, I_2, 1, I_3, 1

(C) 1, I_0, 1, I_1, I_2, 1, I_3, 1   (D) I_0, I_1, I_2, I_3, I0, I_1, I_2, I_3

Answer: (A)

Exp:

Decimal	Binary	Gray $A_2\ A_1\ A_0$	Output
0	0 0 0	0 0 0	I_0
1	0 0 1	0 0 1	1
2	0 1 0	0 1 1	1
3	0 1 1	0 1 0	I_1
4	1 0 0	1 1 0	I_3
5	1 0 1	1 1 1	1
6	1 1 0	1 0 1	1
7	1 1 1	1 0 0	I_2

A_0 is mapped to $\bar{E}$ of $4{:}1$ MUX it means when $A_0\left(\bar{E}\right)$ will be low then MUX will be enabled and as per $S_0\left(A_1\right)$ and $S_2\left(A_2\right)$ will produce the output and when $A_0\left(\bar{E}\right)$ will be high then $4{:}1$ MUX will be disabled and disabled output will be 1.

52. A hysteresis type TTL inverter is used to realize an oscillator in the circuit shown in the figure.
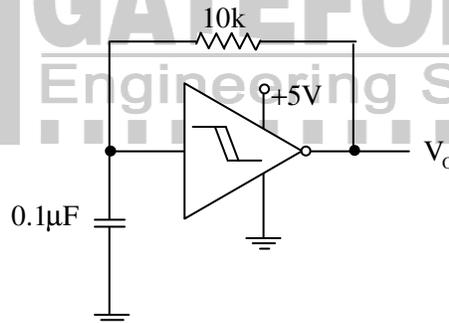
If the lower and upper trigger level voltages are 0.9 V and 1.7 V, the period (in ms), for which output is LOW, is _____.

Answer: 0.66

Exp: Given LTP = 0.9

UTP = 1.7

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

$LTP = 0 + \left(1.7 - 0\right)e^{-t/RC} = 0.9$

$\Rightarrow t = 0.635\,ms\left(Given\ R = 10k, C = 0.1\,\mu F\right).$

53. A three-phase fully controlled bridge converter is fed through star-delta transformer as shown in the figure.
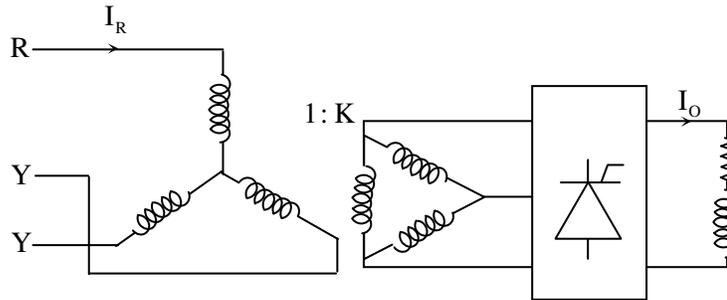

The converter is operated at a firing angle of 300. Assuming the load current (I0) to be virtually constant at 1 p.u. and transformer to be an ideal one, the input phase current waveform is
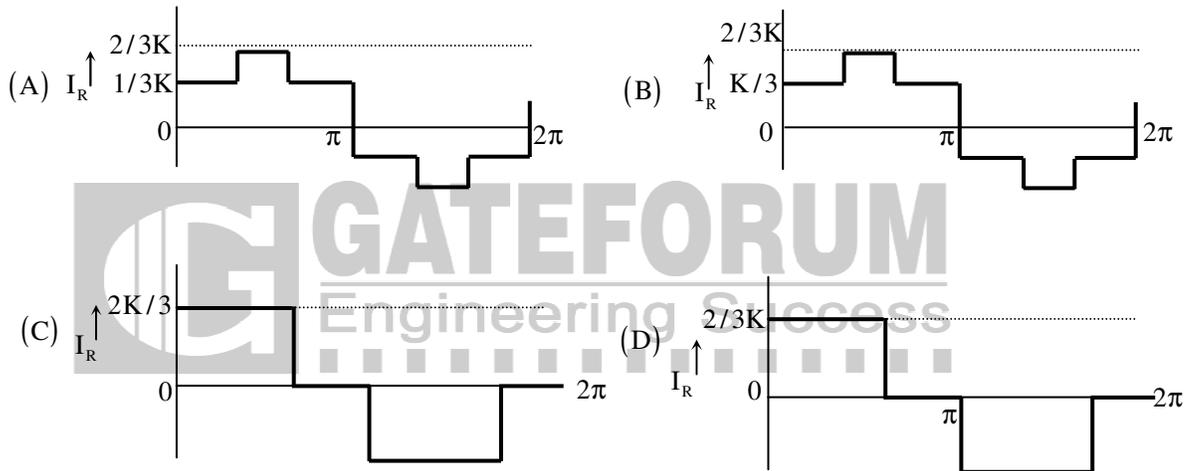
Answer: (B)

54. A diode circuit feeds an ideal inductor as shown in the figure. Given $v_s = 100 \sin(\omega t)$ V, where $\omega = 100\pi \, rad/s$, , and L = 31.83 mH. The initial value of inductor current is zero. Switch S is closed at t = 2.5 ms. The peak value of inductor current i_L (in A) in the first cycle is _____.
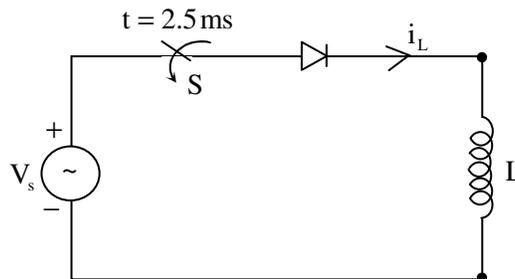

Answer: 17.07A

Exp: When S is closed

$V_L = V_s$

$\therefore L\dfrac{di}{dt} = V_m \sin \omega t$

$V_s = 100 \sin \omega t$
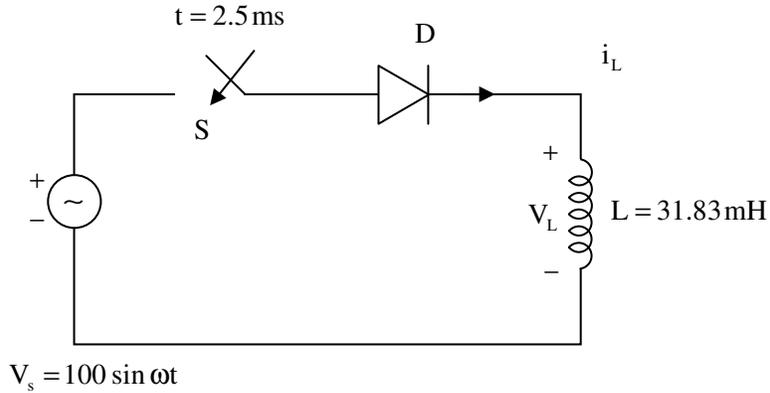
$di = \dfrac{V_m}{L} \sin \omega t.dt \quad$ but $\ \omega = 100\pi \ \text{rad/sec}$

$f = 50\,\text{Hg} \Rightarrow T = 20\,\text{msa}$

Integrate on both sides
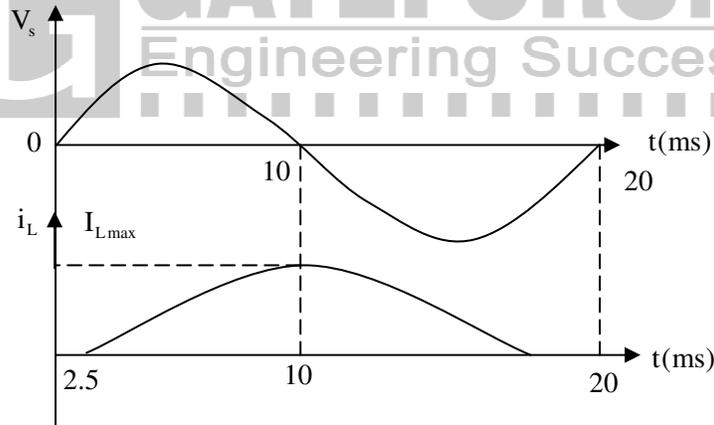
$\displaystyle\int_{2.5\times10^{-3}}^{10\times10^{-3}} di = \dfrac{V_m}{L} \int_{2.5\times10^{-3}}^{10\times10^{-3}} \sin \omega t.dt$

Current I_c is changing from 0 to mgx density their period.

$\therefore I_{max} = -\dfrac{V_m}{\omega L}\Big[\cos \omega t\Big]_{2.5\times10^{-3}}^{2.5\times10^{-3}} = -\dfrac{V_m}{\omega L}\Big[\cos(100\pi\times10\times10^{-3}) - \cos(100\pi\times2.5\times10^{-3})\Big]$

$= -\dfrac{V_m}{\omega L}\left(\cos\pi - \cos\dfrac{\pi}{4}\right)$

$I_{max} = \dfrac{100}{100\pi\times31.83\times10^{-3}}\big[1+0.707\big]$

$\therefore \boxed{I_{max} = 17.07\text{A}}$

55. A single-phase voltage source inverter shown in figure is feeding power to a load. The triggering pulses of the devices are also shown in the figure.
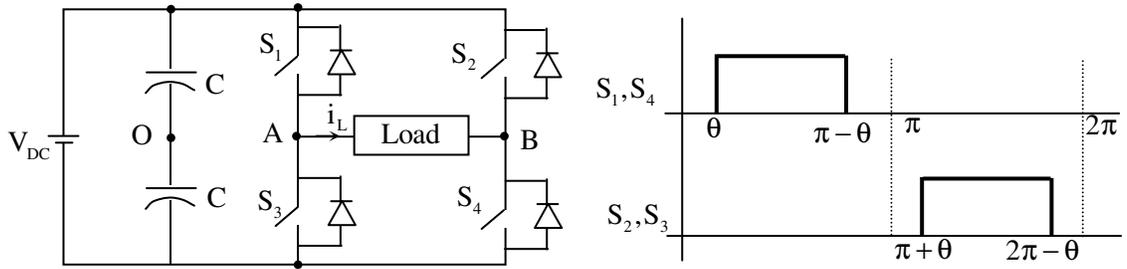
If the load current is sinusoidal and is zero at 0, x, 2x...., the node voltage V_{AO} has the waveform

Answer: (D)