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Test ID:- E20



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**Full Length Test -E20**

Exam Date :- **15 March 2026**

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**2 Marks**

**Q.1****Sol.**

Main Causes of creeping

1. Over Compensation for friction is the main cause
2. Due to mechanical vibration
3. Due to stray magnetic field
4. Due to excessive voltage Across potential coil.

**Q.2****Sol.**

According to this theorem power in polyphase system consisting of 'N' Number of conductors can be Measured with 'N' Number of wattmeter by Connecting Current coil of wattmeter in series with each conductor and pressure coil between a common point and the corresponding conductor. If one of the conductors is taken as Common point then the Number of wattmeter required is (N-1).

**Q.3****Sol.**

Biasing refers to providing appropriate DC voltages and DC currents to an electronic device to operate it in a desired way. Biasing of BJT is done for following purposes:

- (i) To operate the BJT in active region so that it can be used as an amplifier.
- (ii) To maintain  $I_C$  stable so that operating point does not drift and thermal runaway cannot take place.

Commonly used biasing circuits are:

- (i) Fixed bias circuit.
- (ii) Collector to base bias circuit.
- (iii) Self bias circuit.

**Q.4****Sol.****AMPLITUDE MODULATION**

- In amplitude modulation, the amplitude of a carrier signal is varied in accordance with the instantaneous value of modulating signal, whose frequency is invariably lower than that of the carrier.
- In practice, the carrier may be high-frequency (HF) while the modulating signal is audio frequency (AF).

**Q.5****Sol.**

- Switch does not require any power to change its state.
- Completely controllable.
- Switch does not required an external signal.
- Low thermal impedance.

**Q.6****Sol.****Common Mode Rejection Ratio :**

The ability of a differential amplifier to reject a common-mode signal is described in terms of the Common Mode Rejection Ratio (CMRR). The CMRR is a figure of merit for the diff-amp and is defined as

$$CMRR = \left| \frac{A_d}{A_{cm}} \right|$$

For an ideal differential-amplifier,  $A_{cm} = 0$  and  $CMRR = \infty$ . Usually, the CMRR is expressed in decibels, as follows:

$$CMRR_{dB} = 20 \log_{10} \left| \frac{A_d}{A_{cm}} \right|$$



In practice, it is advantageous to use a differential amplifier with higher CMRR since this amplifier is better able to reject common-mode signals.

**Q.7**

**Sol.** Requirements for a SCR to be triggered by a gate pulse.

1. SCR should be forward bias mode.
2. A positive gate voltage between gate and cathode.
3. The gate pulse width should be chosen to ensure that anode current rises above the latching current.

**Q.8**

**Sol.** Full scale deflection voltage = 300 V

Guaranteed accuracy = 1%,

Voltage measured = 83 V.

% Limiting error

$$= \frac{\text{Full scale deflection} \times \% \text{ Guaranteed accuracy}}{\text{Voltage measured by the instrument}}$$

$$= \frac{300 \times 1\%}{83} = 3.62\%$$

**Q.9**

**Sol.** Centre zero PMMC reads only dc value

- 8 A

Moving iron instrument reads RMS value

$$\sqrt{(-8)^2 + \frac{(6\sqrt{2})^2}{2}} = 10 \text{ A}$$



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**Q.10**

**Sol.** A crystal oscillator is the only one of all used to produce sinusoidal signals i.e. crystal oscillators are best suitable for the use in timing circuits because of its high frequency stability. We can obtain precise, high and stable frequency of operation. There is very low frequency drift over time.

**Q.11**

**Sol.** SIM is Set Interrupt Mask, which is used to mask the hardware interrupts. RIM is Read Interrupt Mask which is used to check whether the interrupt is masked or not.

**Q.12**

**Sol.** It is Loading of energy meter for testing purpose to avoid unnecessary losses of energy during testing. In phantom Loading voltage coil is excited with Normal supply voltage and current coil is Supplied from a separate source having low voltage but supplied rated current to the current coil.

**Q.13**

**Sol.** The main and foremost advantage of the root locus is to check the system behavior by adjusting the value of gain  $k$ .

The adjustment in the value of  $k$  will trace the root accordingly on the R-H plane and will give the conditions for the system to be overdamped, underdamped, critically damped and undamped according to respective value of  $k$ . Also, the location of roots can give the idea of stability of the system.



Q.14

Sol. Single phase AC voltage controller is supplied from,

$$V_s = V_m \sin \omega t; \quad R = 50 \, \Omega, \quad X = 50 \, \Omega$$

Load impedance,

$$\bar{Z}_L = R + jX = Z \angle \phi_L$$

$\phi_L$  = power factor angle

$$Z_L = 50 + j50, \quad \phi_L = \tan^{-1} \left( \frac{X}{R} \right) = \tan^{-1}(1) = 45^\circ$$

$$Z_L = 50\sqrt{2} \angle 45^\circ$$

The output voltage is controllable when  $\alpha \geq \phi_L$ , therefore  $0 < \alpha < 45^\circ$  the output voltage is not controllable.

Q.15

Sol. The Wien bridge can be used for the following:

(i) If the input signal is not sinusoidal or signal containing harmonics then balancing of bridge is not possible null detector is sensitive to the frequency then with the help of Wien bridge we can measure the harmonic distortion.

(ii) It measures the frequency,

$$f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

So, the Wien bridge can be used for measurement of frequency and harmonic distortion.

Q.16

Sol. The minimum phase transfer function has no poles and zeros in the right half of the s-plane or on the j $\omega$ -axis excluding origin. It has all of the poles and zeros of its transfer function in the left half of the s-plane representation.

Q.17

Sol. In an 8085 microprocessor

XRA, A

Then,

MVI B, F0<sub>H</sub>

Then, B = F0<sub>H</sub>

SUB B

So, the resulted is 10<sub>H</sub>

$$A = 00_H$$

Q.18

Sol.

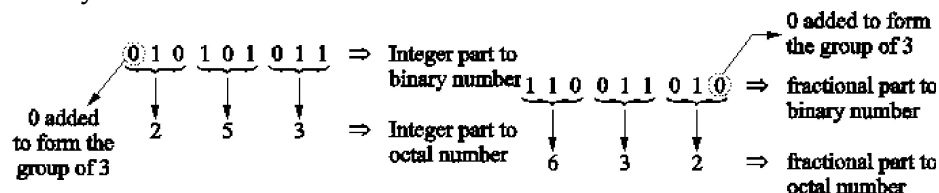
HEX number

A B . C D



Binary number

1010 1011 . 1100 1101



Thus, octal number is (253.632)<sub>8</sub>.



Q.19

Sol.

- Input PF is improved
  - Output voltage wave is improved,  $V_o \neq V_e$
  - $i_o$  wave form is improved i.e. closer to dc.
- 1- $\phi$  half wave rectifier  $\Rightarrow$  No. of pulses in  $V_o$  in  $2\pi$  is equal to 1.

Q.20

Sol. The biasing network associated with the transistor should meet the following requirements:

- (i) It should ensure proper zero signal collector current.
- (ii) It should ensure that  $V_{CE}$  does not fall below 0.5 V for Ge transistors and 1V for Si transistors at any instant.
- (iii) It should ensure the stabilisation of operation point.

5 Marks

Q.21

Sol. Electrostatic instruments are essentially voltmeters but they can be used for measurement of current and power with the help of external components. The principle of operation of such instruments is the force of attraction or repulsion between two charged bodies. The use of this force is made to produce deflection, which is a measure of the quantity. There are two types of such instruments namely the quadrature type (which is usually used for measurement up to 20 kV) and the attracted disc type (which is usually used for measurement above 20 kV).

Q.22

Sol. **Thermal Runaway:**

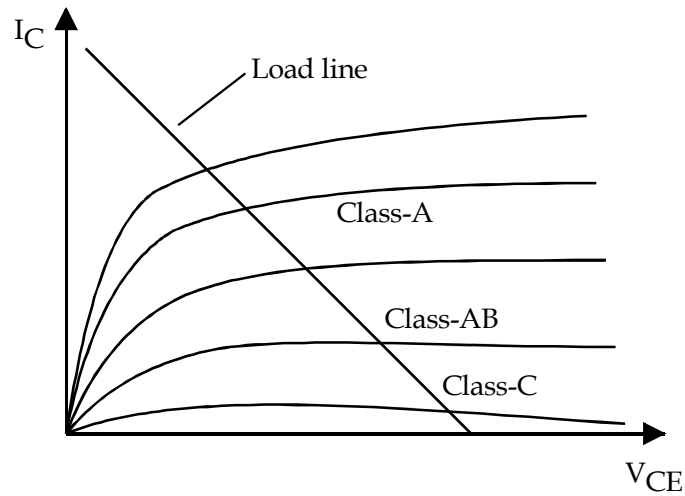
The maximum average power  $P_{D(max)}$  which a transistor can dissipate depends upon the transistor consideration and may lie in the range from a few milliwatts to 200 W. The maximum power is limited by the temperature that collector-to-base junction can withstand. The junction temperature may rise either due to rise in ambient temperature or due to self-heating. The maximum power dissipation is usually specified for transistor enclosure (case) of ambient temperature of 25°C. The problem of self-heating results from the power dissipated at collector junction. As a consequence of junction power dissipation, the junction temperature rises, and this in turn increases the collector current, with a subsequent increase in power dissipation. If this phenomenon, referred to thermal runaway, continues, it may result in permanent damage to the transistor.



Q.23

**Sol. Class-A Amplifier :**

An amplifier in which operating point is located approximately at the centre of the load line is known as class-A amplifier.



**Advantage:** It produces least distortion in the output among all power amplifiers.

**Drawback:** In this power amplifier quiescent power dissipation is very large which means transistor dissipates higher power when AC input is not applied.

**Application:** Class-A amplifier is used as voltage amplifier. It is not preferred as power amplifier due to greater quiescent power dissipation.

Q.24

**Sol. Disadvantage of GTO compared to conventional thyristor :**

1. Magnitude of latching and holding currents is more in a GTO.
2. On state voltage drop and the associated loss is more in a GTO.
3. Due to multi cathode structure of GTO, Gate current is higher.
4. GTO has its reverse blocking capability less than its forward voltage blocking capability.
5. Gate drive circuit losses are more.

**Advantage of GTO over conventional thyristor :**

1. GTO has faster switching speed.
2. Its surge current capability is comparable with an SCR
3. It has more di/dt rating at turn-on.
4. Its circuit configuration has lower size and weight.
5. It has higher efficiency due to the elimination of forced commutation losses.
6. GTO unit has reduced electromagnetic noise due to elimination of commutation chokes.

Due to its faster switching speed and its elimination of forced commutation losses, mainly we use it in inverter and chopper circuits.

Q.25

**Sol. Gauge factor = 3**

$$\text{Stress} = 100 \text{ N/mm}^2$$

$$\text{Modulus of elasticity} = 2 \times 10^5 \text{ N/mm}^2$$

$$\text{Stress} \propto \text{strain}$$

$$\text{Strain} = \frac{\Delta L}{L}$$

$$\text{Stress} = \text{Elasticity (E)} \times \text{Strain}$$

$$100 = 2 \times 10^5 \times \text{Strain}$$

$$\text{Strain} = 0.5 \times 10^{-3}$$

$$\frac{\Delta L}{L} = 0.5 \times 10^{-3}$$

$$\text{Gauge-factor} = \frac{\frac{\Delta R}{R}}{\frac{\Delta L}{L}}$$

$$3 = \frac{\frac{\Delta R}{R}}{0.5 \times 10^{-3}}$$

$$\frac{\Delta R}{R} = 1.5 \times 10^{-3}$$

$$\% \frac{\Delta R}{R} = 1.5 \times 10^{-3} \times 100$$

$$\% \frac{\Delta R}{R} = 0.15$$

Q.26

Sol. **Slew Rate :**

Slew rate (SR) is defined as the maximum rate of change in output voltage per unit of time and is expressed in volts per microseconds. In equation form,

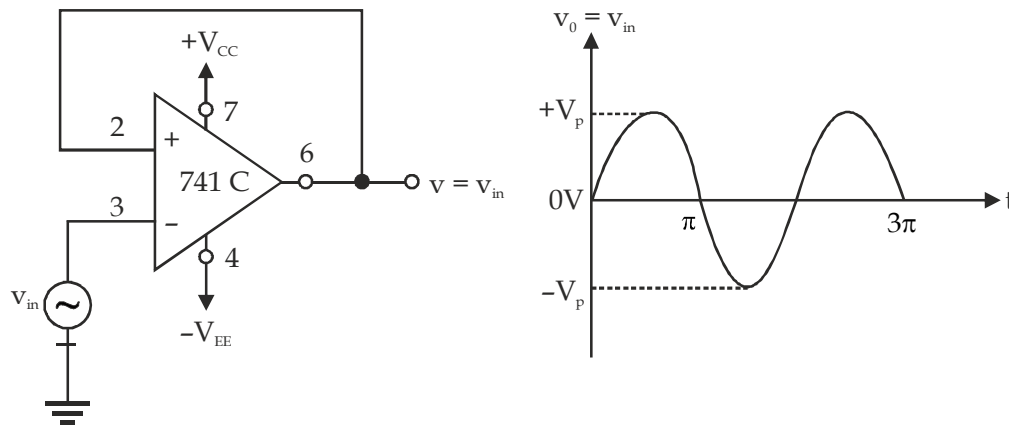
$$SR = \left. \frac{dV_o}{dt} \right|_{\text{maximum}} \text{ V } / \mu\text{s}$$

**Note:-**

- Slew rate indicates how rapidly the output of an op-amp can change in response to change in the input frequency.
- The slew rate of an op-amp is fixed; therefore, if the slope requirements of the output signal are greater than slew rate, then distortion occurs.

**Slew Rate Equation :**

Since the slew rate on a data sheet is generally listed for a unity gain, let us consider a voltage follower shown in figure. Furthermore, let us assume that the input is a large-amplitude and high-frequency sine wave.



The equation for the sine wave is

$$v_{in} = V_m \sin \omega t$$

or

$$v_0 = V_m \sin \omega t$$

The rate of change of the output is

$$\frac{dv_0}{dt} = v_m \omega \cos \omega t$$

and the maximum rate of change of output occurs when  $\cos \omega t = 1$ . That is.

$$\left. \frac{dv_0}{dt} \right|_{\max} = V_m \omega$$

or

$$SR = 2\pi f V_m \text{ V} / \mu\text{sec}$$

$\Rightarrow$

$$SR = \frac{2\pi f V_m}{10^6} \text{ V} / \mu\text{sec}$$

where,

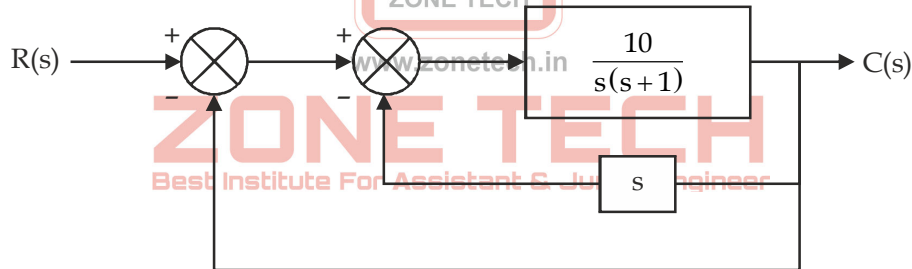
SR = slew rate V / ( $\mu\text{sec}$ )

f = input frequency (Hz)

$V_m$  = peak value of the output sine wave (volts).

Q.27

Sol. Transfer function system  $\frac{C(s)}{R(s)}$  is equal to the



$$= \frac{\frac{10}{s(s+1)}}{1 + s \times \frac{10}{s(s+1)}} \left\{ \begin{array}{l} \text{Closed loop system} \\ \frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)} \end{array} \right.$$

$$= \frac{\frac{10}{s(s+1)}}{\frac{s(s+1) + 10s}{s(s+1)}}$$

$$= \frac{10}{s(s+1) + 10s}$$

$$= \frac{\frac{10}{s(s+1) + 10s}}{1 + \frac{10}{s(s+1) + 10s} \times 1} = \frac{\frac{10}{s(s+1) + 10s}}{\frac{s(s+1) + 10s + 10}{s(s+1) + 10s}}$$

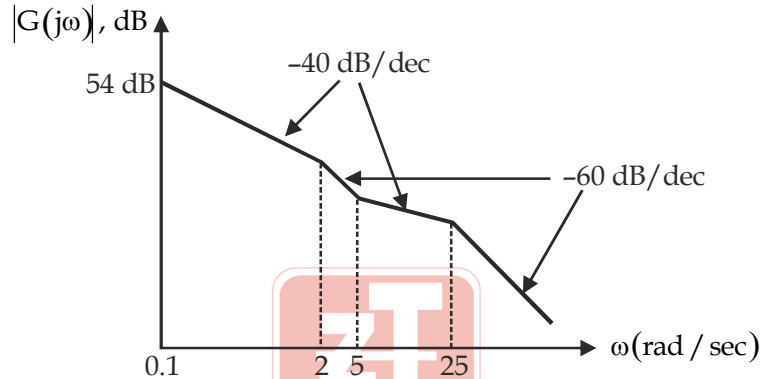
$$= \frac{10}{s(s+1)+10s+10} = \frac{10}{s^2 + s + 10s + 10}$$

$$\frac{C(s)}{R(s)} = \frac{10}{s^2 + 11s + 10}$$

$$\text{Transfer function} = T(s) = \frac{C(s)}{R(s)} = \frac{10}{s^2 + 11s + 10}$$

Q.28

Sol. The given Bode-magnitude plot is shown below,



The initial slope is  $-40$  dB/dec and this corresponds to a factor  $s^2$  in the denominator of the transfer function (**two poles at origin**).

For the given Bode magnitude plot, there are three corner frequencies:  $\omega_1 = 2$ ,  $\omega_2 = 5$  and  $\omega_3 = 25$  rad/sec.

At  $\omega_1 = 2$ , the slope changes by  $-20$  dB/dec so resultant slope will be  $-60$  dB/dec and this is due to

the factor  $\left(1 + \frac{s}{2}\right)$  in the denominator of the transfer function.

At  $\omega_2 = 5$ , the slope changes by  $+20$  dB/dec so resultant slope will be  $-40$  dB/dec and this is due to

the factor  $\left(1 + \frac{s}{5}\right)$  in the numerator of the transfer function.

At  $\omega_3 = 25$ , the slope changes by  $-20$  dB/dec so resultant slope will be  $-60$  dB/dec and this is due

to the factor  $\left(1 + \frac{s}{25}\right)$  in the denominator of the transfer function.

**Calculation of K :**

$$54 = 20 \log K - 40 \log(0.1)$$

$$K = 5$$

The overall transfer function can be written as,

$$G(s) = \frac{K \left(1 + \frac{s}{\omega_2}\right)}{s^2 \left(1 + \frac{s}{\omega_1}\right) \left(1 + \frac{s}{\omega_3}\right)}$$

$$G(s) = \frac{5\left(1 + \frac{s}{5}\right)}{s^2\left(1 + \frac{s}{2}\right)\left(1 + \frac{s}{25}\right)}$$

$$G(s) = \frac{50(s+5)}{s^2(s+2)(s+25)}$$

Q.29

Sol.

| S.N. | Combinational circuits                                                                                                      | Sequential circuits                                                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | In combinational circuits, the output variables are at all times dependent on the combination of input variables.           | In sequential circuits, the output variables dependent not only on the present input variables but they also depend upon the past history of these input variables. |
| 2.   | Memory unit is not required in combinational circuits.                                                                      | Memory unit is required to store the past history of input variables in the sequential circuit.                                                                     |
| 3.   | Combinational circuits are faster in speed because the delay between input and output is due to propagation delay of gates. | Sequential circuits are slower than the combinational circuits.                                                                                                     |
| 4.   | Combinational circuits are easy to design.                                                                                  | Sequential circuits are comparatively harder to design.                                                                                                             |
| 5.   | Parallel adder is a combinational circuit.                                                                                  | Serial adder is a sequential circuit.                                                                                                                               |

Q.30

Sol.

$$G(s)H(s) = \frac{(1-s)}{(1+s)(2+s)}$$

$$s = j\omega$$

For phase margin we need, gain cross over

$$\left| \frac{(1-j\omega)}{(1+j\omega)(2+j\omega)} \right| = 1$$

$$\frac{\sqrt{1+\omega^2}}{\sqrt{1+\omega^2}\sqrt{4+\omega^2}} = 1$$

$$1 = 4 + \omega^2$$

$$\omega^2 = -3$$

$$\omega = \sqrt{3j^2}$$

$$\omega_{gc} = j\sqrt{3}$$

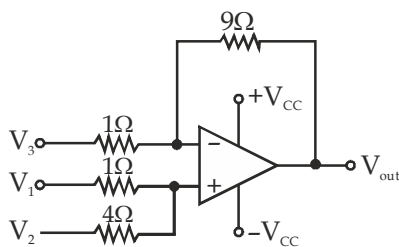
$$\therefore \omega_{gc} = \text{imaginary}$$

Hence, phase margin = Infinity

Q.31

Sol.

Given circuit is shown below,



Applying KCL at non-inverting terminal,

$$\frac{V_+ - V_1}{1} + \frac{V_+ - V_2}{4} = 0$$

$$\frac{5}{4} V_+ = V_1 + \frac{V_2}{4}$$

$$V_+ = \frac{4V_1}{5} + \frac{V_2}{5} \quad \dots (i)$$

Applying KCL at inverting terminal,

$$\frac{V_- - V_3}{1} + \frac{V_- - V_{out}}{9} = 0$$

$$\frac{10}{9} V_- = \frac{V_{out}}{9} + V_3$$

$$V_- = \frac{V_{out}}{10} + \frac{9V_3}{10} \quad \dots (ii)$$

By virtual ground concept,

$$V_+ = V_- \quad \dots (iii)$$

From equation (i), (ii) and (iii)

$$\frac{V_{out}}{10} + \frac{9V_3}{10} = \frac{4}{5} V_1 + \frac{V_2}{5}$$

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

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

Q.32

**Sol. Thermistor** is a contraction of a term "thermal resistors". Thermistors are generally composed of semi-conductor materials. Although positive temperature co-efficient of units are available, most thermistors have a negative coefficient of temperature resistance. The negative temperature coefficient of resistance can be as large as several percent per degree celsius. This allows the thermistor circuit to detect very small changes in temperature which could not be observed with an RTD or a thermocouple.

This high sensitivity to temperature changes makes thermistors extremely useful for precision temperature measure-ments control and compensation.



20 Marks

Q.33

**Sol. Linear Variable Differential Transformer LVDT)-** LVDT is the most widely used inductive transducer for translating the linear motion into an electrical signal. LVDT is a differential transformer consisting of one primary winding P and two identical secondary windings  $S_1$  and  $S_2$ , wound over a hollow bobbin of non-magnetic and insulating material.

The displacement to be measured is applied to the arm attached to the soft iron core. When the core is in the centre, called the reference position, the induced voltages  $E_1$  and  $E_2$  are equal and opposite. Hence they cancel out and the output is zero. As the core is moved toward left from its voltage  $V_{out}$  null position, the voltage induced in secondary winding  $S_1$  increases whereas the voltage induced in secondary winding  $S_2$  decreases. The movement of the core toward right will have opposite effect. Secondary windings  $S_1$  and  $S_2$  are connected in series opposition so that the difference of the voltages induced in the secondary windings  $S_1$  and  $S_2$  provides the measurement of displacement.

Difference of induced voltages in secondary windings gives the amount of displacement following a linear law within a limited range of motion. In either direction of movement of the core, difference of induced voltages increases or decreases giving the idea of direction of movement.

Sensitivity of LVDT is given by expression

$$\text{Sensitivity} = \frac{\text{Output voltage}}{\text{Displacement}} \text{ in volts/mm}$$

In commercially available LVDTs, normally range for displacement varies from  $\pm 0.01$  mm to  $\pm 25$  mm.

Primary winding is connected to an ac source of voltage varying from 5 to 25 V and of frequency ranging from 50 Hz to 20 kHz.

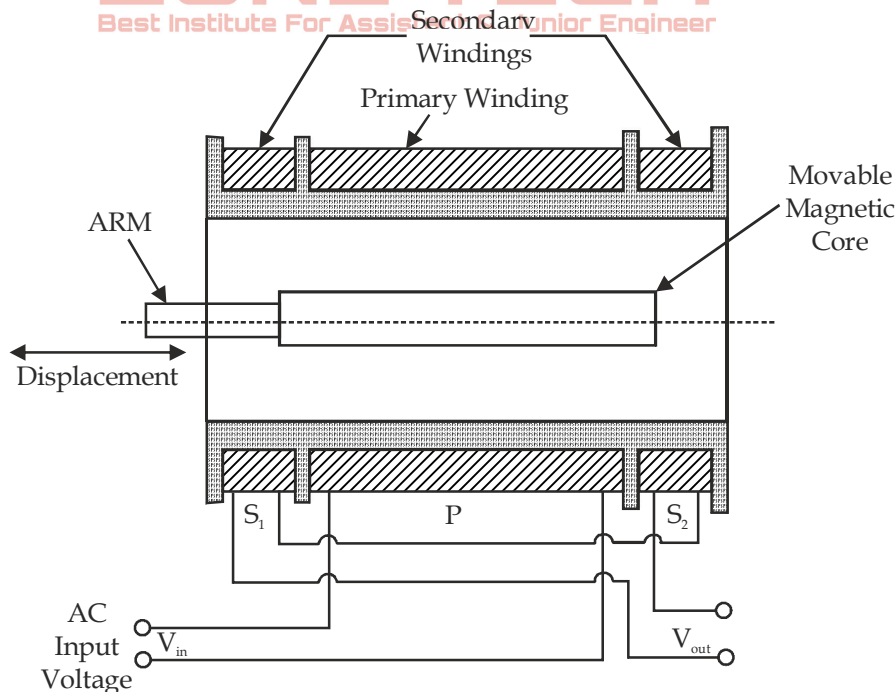


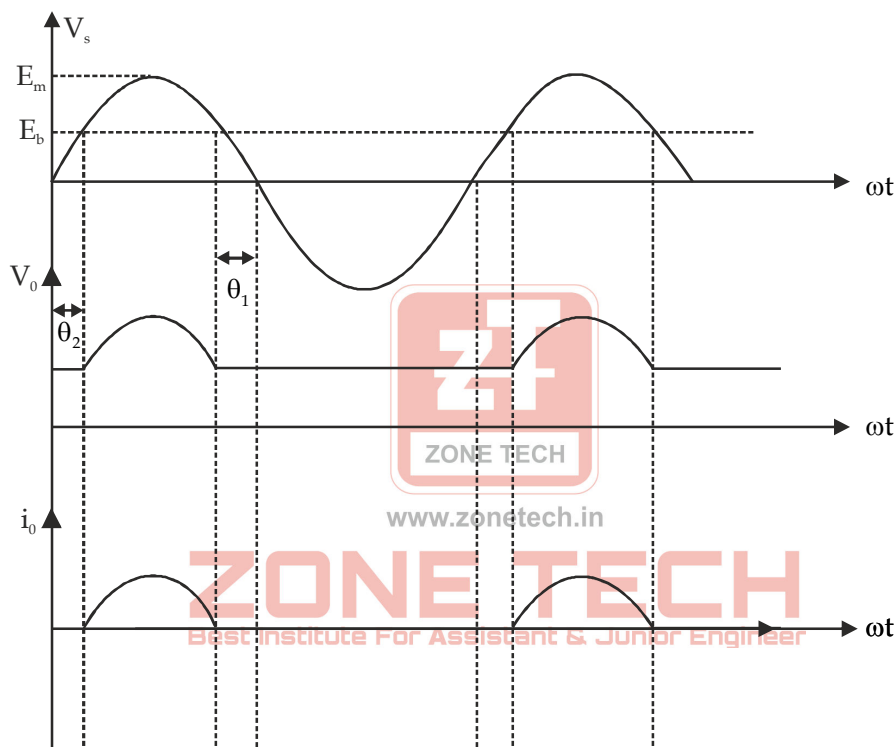
Fig.:- LVDT

LVDTS are suitable for use in applications where the displacements are too large for strain gauges to handle. For example, LVDTS can be employed for measurement of displacements that range from a fraction of a mm to a few cm.

Since the LVDTS can also be connected to other transducers, whose outputs are mechanical displacements, these are often employed together with other transducers for measurement of force, weight, pressure etc.

Q.34

Sol.



The voltage equation is,

$$E_m \sin \omega t = E_b + i_o R$$

$$i_o = \frac{E_m \sin \omega t - E_b}{R}$$

SCR is turned on when  $E_m \sin \theta_1 = E_b$  and is turned off when  $E_m \sin \theta_2 = E_b$

Where  $\theta_2 = \pi - \theta_1$

The charging current of the battery is equal to average value of the output current.

$$\text{Where } i_o = \begin{cases} \frac{E_m \sin \omega t - E_b}{R}, & \theta_1 < \theta < \pi - \theta_1 \\ 0, & \text{else} \end{cases} \quad (\because E_m = \sqrt{2} E)$$

$$\therefore \text{average current} = I_{o(av)} = \frac{1}{2\pi} \int_0^{2\pi} i_o d\theta$$

$$\begin{aligned}
 &= \frac{1}{2\pi R} \int_{\theta_1}^{\pi-\theta_1} (E_m \sin \omega t - E_b) d\theta \\
 &= \frac{1}{2\pi R} (2E_m \cos \theta_1 - E_b(\pi - 2\theta_1)) \\
 &= \frac{1}{2\pi \times 10} [2 \times \sqrt{2} \times 220 \times \cos \theta_1 - 100(\pi - 2\theta_1)]
 \end{aligned}$$

Where  $\theta_1 = \sin^{-1} \frac{100}{\sqrt{2} \times 220} = 18.75^\circ = 0.327 \text{ rad}$

$\therefore I_{av} = 5.42$

The power supplied to battery =  $E \times I_{av} = 100 \times 5.42 = 542 \text{ W}$

Q.35

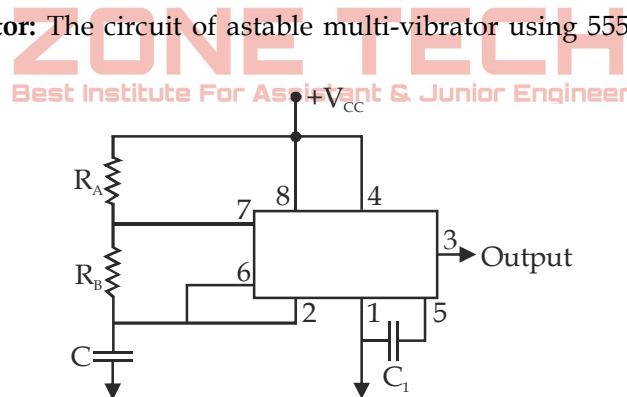
**Sol. Astable Multi-vibrator:** There is not any stable state in a stable multi-vibrator. This circuit does not require an external trigger to change the state of the output; hence it is also called free running multi-vibrator.

**Mono-stable Multi-vibrator:** A mono-stable multi-vibrator has one stable state and one quasi-stable state. the circuit remains in its stable until a triggering signal causes a transition to the quasi-stable state.

Then, after a time T, the circuit returns to its stable state. Hence a single pulse is generated and therefore, the circuit is referred to as a one-shot multi-vibrator.

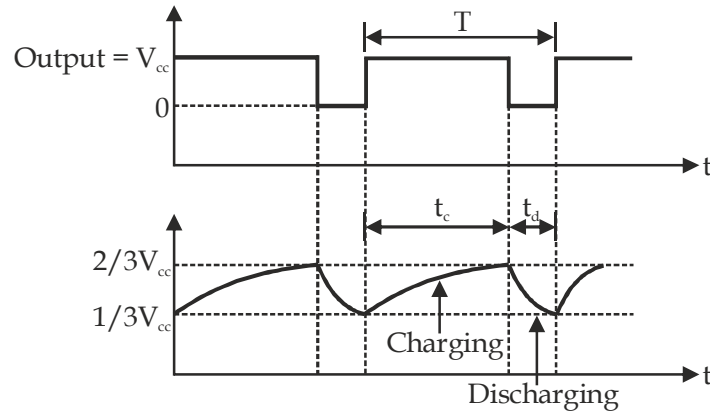
**Bistable Multi-vibrator:** A bistable multi-vibrator has two stable states. Since it may store one bit of information, it is a 1-bit memory unit or a 1-bit storage cell. Its most important application is flip-flop.

**Astable Multi-vibrator:** The circuit of astable multi-vibrator using 555 timers is shown below:



(i) Initially when the output is high, capacitor C starts charging toward  $V_{cc}$  through  $R_A$  and  $R_B$ . However as soon as voltage across the capacitor equals  $2/3 V_{cc}$ , the output switches low. Now capacitor C starts discharging through  $R_B$ . When the across C equals  $1/3 V_{cc}$ , the output goes high. Then the cycle repeats.

(ii) The output voltage and capacitor voltage waveforms are shown below.



(iii) The time when capacitor charges is:

$$t_c = 0.69(R_A + R_B)C$$

(iv) The time during which capacitor discharges is:

$$t_d = 0.69(R_B)C$$

(v) The total period of output waveform is:

$$T = t_c + t_d = 0.69(R_A + 2R_B)C$$

(vi) Thus, the frequency of oscillation is:

$$f_0 = \frac{1}{T} = \frac{1.45}{(R_A + 2R_B)C}$$

(vii) Percentage duty cycle =  $\frac{t_c}{T} \times 100 = \frac{R_A + R_B}{R_A + 2R_B} \times 100$

Q.36

Sol.

$$G(s)H(s) = \frac{K}{(s+2)(s+5)}$$

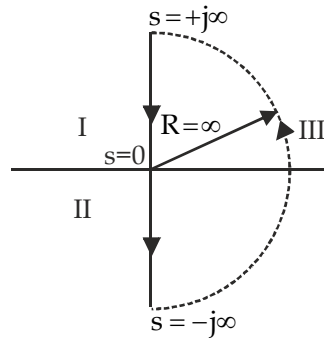
$$G(j\omega)H(j\omega) = \frac{K}{(j\omega+2)(j\omega+5)}$$

$$|G(j\omega)H(j\omega)| = \frac{K}{(\sqrt{\omega^2+4})(\sqrt{\omega^2+25})}$$

$$\angle G(j\omega)H(j\omega) = -\tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}\left(\frac{\omega}{5}\right)$$

- No open loop pole in right hand side of s-plane hence  $P = 0$
- No open loop pole at origin hence nyquist path is as shown in figure below





- Section I :  $s = +j\omega$  to  $s = 0$

|                                    |                               |               |                                                        |
|------------------------------------|-------------------------------|---------------|--------------------------------------------------------|
| $\omega \rightarrow +\infty$ start | $0 \angle -180^\circ$         | $\Rightarrow$ | $0^\circ - (-180^\circ) = +180^\circ$<br>Anticlockwise |
| $\omega = 0$ end                   | $\frac{k}{10} \angle 0^\circ$ |               |                                                        |

- Section II:  $s = j0$  to  $s = -j\infty$

This is mirror image of section-I about real axis

- Section III:  $s = -j\infty$  to  $s = +j\infty$

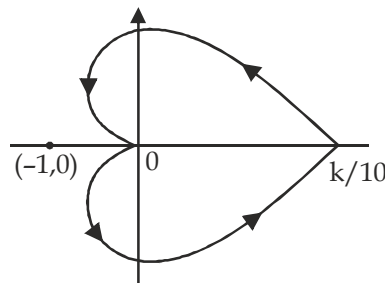
|                                    |                       |               |                                                    |
|------------------------------------|-----------------------|---------------|----------------------------------------------------|
| $\omega \rightarrow +\infty$ start | $0 \angle 180^\circ$  | $\Rightarrow$ | $-180^\circ - 180^\circ = -360^\circ$<br>Clockwise |
| $\omega = \infty$ end              | $0 \angle -180^\circ$ |               |                                                    |

The mapping of section III has radius 0 hence it is around origin with  $360^\circ$  clockwise rotation with radius tending to zero. This is generally not required for the closed loop stability as it does not affect the encirclements of critical point  $-1 + j0$

$$G(j\omega)H(j\omega) = \frac{k(2-j\omega)(5-j\omega)}{(\omega^2+4)(\omega^2+25)} = \frac{k(10-\omega^2)}{(\omega^2+4)(\omega^2+25)} - j \frac{7k\omega}{(\omega^2+4)(\omega^2+25)}$$

The imaginary part is zero for  $\omega = 0$

$$G(j\omega)H(j\omega)|_{\omega=0} = \frac{10k}{4 \times 25} = \frac{k}{10}$$

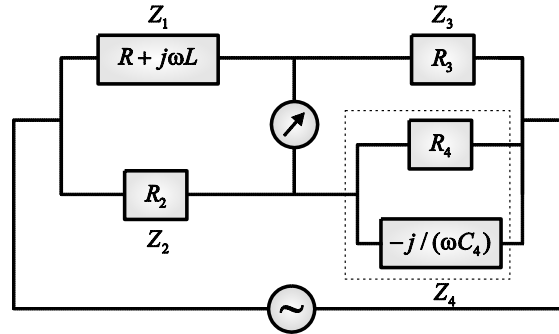


- Critical point  $(-1+j0)$  is not encircled by the Nyquist plot hence  $N = 0$ ,  $Z = N + P$ ,  $Z = 0$ . Hence the system is absolutely stable.

Q.37

Sol.

Given :

From figure,  $Z_1 = R + j\omega L$ 

$$Z_2 = R_2, Z_3 = R_3$$

$$Z_4 = R_4 \parallel \frac{1}{j\omega C_4} = \frac{R_4 \times \frac{1}{j\omega C_4}}{R_4 + \frac{1}{j\omega C_4}}$$

$$Z_4 = \frac{R_4}{1 + j\omega C_4 R_4}$$

Since, bridge is balanced.

Applying bridge balance condition.

$$Z_1 Z_4 = Z_2 Z_3$$

$$(R + j\omega L) \left( \frac{R_4}{1 + j\omega C_4 R_4} \right) = R_2 R_3$$

$$R_4 (R + j\omega L) = R_2 R_3 (1 + j\omega C_4 R_4)$$

$$RR_4 + j\omega LR_4 = R_2 R_3 + j\omega R_2 R_3 C_4 R_4$$

Equating real and imaginary terms,

$$RR_4 = R_2 R_3 \Rightarrow R = \frac{R_2 R_3}{R_4}$$

$$\text{and } \omega LR_4 = \omega R_2 R_3 C_4 R_4 \Rightarrow L = R_2 R_3 C_4$$

