ESE-2016

Detailed Exam Solutions (Objective Paper-I) Electrical Engineering

In case there is any kind of discrepancy in solutions please write to us at ***ies_master@yahoo.co.in*** or call us at : **Ph: 011-41013406, 09711853908** for rectification/deletion/updation of the same.

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Explanation of Electrical Engg. Objective Paper-I (ESE - 2016)

SET - A

1. Permeance is inversely related to

(a) resistance (b) conductance

(c) reluctance (d) capacitance

Sol. (c)

Permeance [P] is a measure of the quantity of flux for a number of current turns in magnetic circuits. In electromagnetic theory, it is inverse of reluctance.

2. Consider the following statements regarding an ideal core material:

1. It has very high permeability.
2. It loses all its magnetism when there is no current flow.
3. It does not saturate easily.

Which of the above statements are correct ?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

Sol. (d)

An ideal core materials has

(i) It has very high permeability.

(ii) It loses all its magnetism when there is no current flow.

(iii) It does not saturate easily.

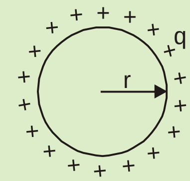
(iv) Has low I^2R loss due to eddy currents.

3. The capacitance of a conducting sphere of radius r with a total charge of q uniformly distributed on its surface is

(a) proportional to qr (b) independent of r

(c) proportional to $\frac{q}{r}$ (d) independent of q

Sol. (d)



Capacitance of a spherical capacitor is given by:

C = $4\pi \in r$ where $\in = \in_0 \in_r$

$\therefore$ C is independent of charge q.

4. The characteristic impedance of a transmission line depends upon

(a) shape of the conductor

(b) surface treatment of the conductor

(c) conductivity of the material

(d) geometric configuration of the conductor

Sol. (d)

The characteristic impedance of a transmission line is determined by the geometry and materials of the line. Also, for a uniform line it is not dependent on its length.

$$Z_o = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

R = Resistance per unit length

L = Inductance per unit length

G = Conductance of dielectric per unit length

C = Capacitance per unit length.

SCROLL DOWN

5. In a series R-L-C circuit supplied by a source of 125V at a resonant frequency of 220 Hz, the magnitudes of the voltages across the capacitor and the inductor are found to be 4150V. If the resistance of the circuit is 1Ω then the selectivity of the circuit is

(a) 33.20 (b) 3.32

(c) 0.0301 (d) 0.301

Sol. (a)

Quality factor is the measure of selectivity.

At resonance,

$$Q = \frac{V_L}{V_R}$$

$$= \frac{4150}{125}$$

$$= 33.2$$

6. The value of characteristic impedance in free space is equal to

(a) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ (b) $\sqrt{\mu_0\varepsilon_0}$

(c) $\sqrt{\frac{1}{\mu_0\varepsilon_0}}$ (d) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

Sol. (a)

The impedance/characteristic impedance of a meduim is gievn by: $\eta = \sqrt{\frac{\mu}{\epsilon}}$

For free space, it is given by:

$$\eta_0 = \sqrt{\frac{\mu_0}{\epsilon_0}}$$

where: μ_0 = Permeability of free space

ϵ_0 = Permittivity of free space.

7. The magnitude of magnetic field strength H is independent of

(a) current only

(b) distance only

(c) permeability of the medium only

(d) both current and distance

Sol. (c)

The dimension of Magnetic field strength H is Ampere/meter (A/m) and is independent of permeability of the medium.

It depends only on current carried by the conductor and distance of the point from the conductor where H is measured.

8. Consider the following types of transmission lines:

1. Open-wire line
2. Twin-lead wire
3. Coaxial cable

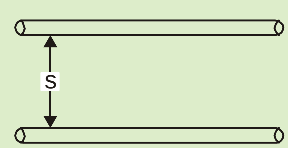
The capacitance per metre will be least in which of the above transmission lines?

(a) 1 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

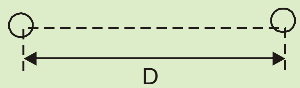
Sol. (a)

(1) Open wire line: r = radius of conductor



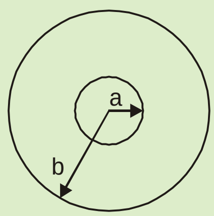
$$C = \frac{\pi \in}{\ln\left(\frac{s}{r}\right)} \text{ (F/m)}$$

(2) Twin lead wire : r = radius of conductor



$$C = \frac{\pi \in}{\ln\left(\frac{D}{r}\right)} \text{ (F/m)}$$

(3) Coaxial Cable:



$$C = \frac{2\pi \in}{\ln\left(\frac{b}{a}\right)} \text{ (F/m)}$$

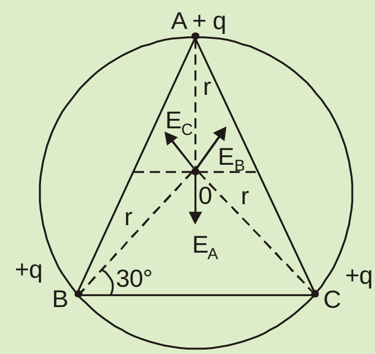
For a given radius r of the conductor, the distance between the condutors in Twin Lead wire is less than open wire line. Also, $\left(\frac{b}{a}\right)$ ratio in coaxial cable is small. Hence, Capacitance per unit length of open wire line is least.

9. Three equal point charges are located at the vertices of an equilateral triangle on the circumference of a circle of radius r. The total electric field intensity at the centre of the circle would be

(a) zero (b) $\frac{3q}{4\pi\varepsilon_0 r^2}$

(c) $\frac{q}{12\varepsilon_0 r^2}$ (d) $\frac{q}{3\pi\varepsilon_0 r}$

Sol. (a)



The magnitude of electric field due to charge +q (at A) at point O will be:

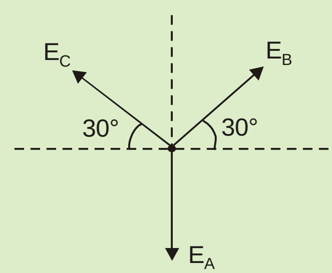
$$|\vec{E}_A| = \frac{1}{4\pi \in_0} \frac{q}{r^2}$$

Similarly,

$$|\vec{E}_B| = \frac{1}{4\pi \in_0} \frac{q}{r^2} = |\vec{E}_C|$$

Let $|\vec{E}_A| = |\vec{E}_B| = |\vec{E}_C| = K$

Now, the direction of the fields or as below:



Net field in the vertical direction

$$E_y = E_B \sin 30° + E_C \sin 30° - E_A$$

$$= \left(\frac{E_B + E_C}{2}\right) - E_A = \left(\frac{K+K}{2}\right) - K$$

Additional technical subjects as per ESE-2017 syllabus

Branch	Subjects
Civil	Dynamic analysis & earthquake resistant design Tender process, rate analysis, etc. Engineering Geology
Mechanical	Renewable source of energy, Mechatronics & Robotics
Electrical	Signal & System, Computer fundamental
Electronics	Advance Electronics Basics of Electrical Engineering Advance communication

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Previous Year IES Master Students : [Postal Program, OTS, Ex-IES Master, CQPP, Interview]	12500	2-3 Months Starting on : 21st June,16	3 Months Starting on : 16th July,16	1-1½ Months Starting on : 28th July,16
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Additional Technical Subjects Program Fee

	Fee (in ₹)
Previous Year IES Master Students : [Postal Program, OTS, Ex-IES Master, CQPP, Interview]	3500/- Per Subject
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(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Sol. (d)

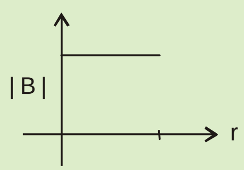
Square corner Reflector are directional antenna used at VHF and UHF. They have moderate gain (10 to 13 db), High Front to Back ratio and wide band width. Hence, they are extensively used in applications like:

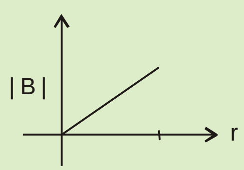
(1) Radio Astronomy

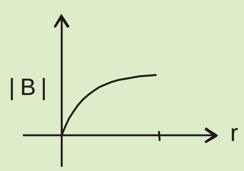
(2) Point to point Communication links & data links

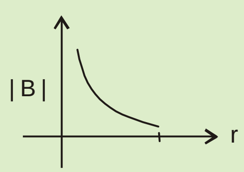
(3) Television Receiving antenna.

12. The variation of |B| with distance r from a very long straight conductor carrying a current I is correctly represented by

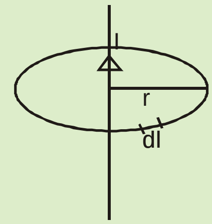
(a)


(b)


(c)


(d)


Magnetic field intensity (B) for a very long straight conductor carrying a current 'I' at a distance 'r':–



Applying Ampere's law

$$\oint H.dl = I$$

$$\Rightarrow \quad H\oint dl = I$$

$$\Rightarrow \quad H.\ 2\pi r = I$$

$$\therefore \quad H = \frac{I}{2\pi r}$$

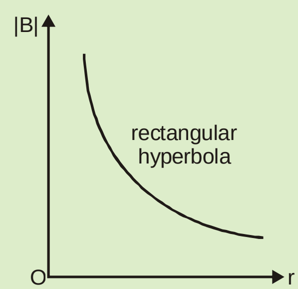
Since $B = \mu H$

$$B = \frac{\mu I}{2\pi r}$$

ie. $\boxed{B \propto \frac{1}{r}}$; rectangular hyperbola.

So,

Variation of B with 'r' is,



13. The resistivity of hard drawn copper at 20°C is $1.9\times10^{-6}\,\Omega$cm. The resistivity of annealed copper compared to hard drawn copper is

Sol. (d)

(a) lesser (b) slightly larger
(c) same (d) much larger

Sol. (a)

Localised strains produced by mechanical treatment of copper increases its resistivity. Hence, a hard drawn copper wire has higher resistivity than annealed copper. ie. the resistivity of annealed copper compared to hard drawn copper is lesser.

14. The number of electrons excited into the conduction band from valence band (with ΔE = forbidden energy gap and k = Boltzmann's constant) is proportional to

(a) $\exp\left(\frac{\Delta E}{kT}\right)$ (b) $\exp\left(\frac{2\Delta E}{kT}\right)$

(c) $\exp\left(-\frac{\Delta E}{kT}\right)$ (d) $\exp\left(-\frac{2\Delta E}{kT}\right)$

Sol. (c)

The number of electrons excited into the conduction band from valence band,

$n \propto e^{-(\Delta E/kT)}$

15. Superconductivity in a material can be destroyed by

1. increasing the temperature above a certain limit.
2. applying a magnetic field above a certain limit.
3. passing a current above a certain limit.
4. decreasing the temperature to a point below the critical temperature

Which of the above are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 3 only (d) 1, 2, 3 and 4

Sol. (c)

Superconductivity in a material can be destroyed by:–

i) increasing the temperature of material above transition temperature, T_c

ii) applying a magnetic field above a certain limit, called critical field, H_c

$$H_c = H_0\left[1-\left(\frac{T}{T_c}\right)^2\right]$$

iii) Passing a current above a certain limit, I_c.

$$I_c = 2\pi r H_c$$

where, H_c is critical field, and r is radius of superconductor wire.

16. The relative permeability of a medium is equal to (with M = magnetization of the medium and H = magnetic field strength)

(a) $1+\frac{M}{H}$ (b) $1-\frac{M}{H}$

(c) $1+\sqrt{\frac{M}{H}}$ (d) $1-\sqrt{\frac{M}{H}}$

Sol. (a)

Since, $B = \mu_0(H+M)$

$\Rightarrow \mu_0\mu_r H = \mu_0 (H+M)$

$\Rightarrow \mu_r H = H + M$

$\Rightarrow (\mu_r-1)H = M$

$\Rightarrow (\mu_r-1) = \frac{M}{H}$

ie. realtive permeability of a medium.

$$\boxed{\mu_r = 1+\frac{M}{H}}$$

17. The electrical resistivity of many metals and alloys drops suddenly to zero when they are cooled to a low temperature (i.e., nearly equal to liquid helium temperature). Such materials (metals and alloys) are known as

(a) piezoelectric materials

(b) diamagnetic materials

(c) superconductors

(d) high-energy hard magnetic materials

Sol. (c)

The electrical resistivity of many metals and alloys drops to zero when they are cooled to a low temperature, such materials are known as superconductors.

eg. (i) Mercury has zero resistivity below 4.2K.

(ii) Aluminium has zero resistivity at 1.19K

18. The dielectric strength of rubber is 40000 V/mm at frequency of 50 Hz. What is the thickness of insulation required on an electrical conductor at 33 kV to sustain the breakdown

(a) 0.33 mm (b) 8.3 mm

(c) 8.3 cm (d) 0.083 mm

Sol. (a)

Thickness of the insulation required

$$= \frac{\text{Applied Voltage}}{\text{dielectric strength}}$$

$$= \frac{33\times10^3}{40000}\text{mm}$$

= 0.825mm

To sustain the breakdown, the thickness of the insulating material should be more than the thickness calculated above.

19. The conductivity of insulating materials (a very small value) is called as

(a) residual conductivity

(b) dielectric conductivity

(c) ionic conductivity

(d) bipolar conductivity

Sol. (c)

The conductivity 'σ' of the insulator is very small but not zero. It is associated with the motion of ions and is therefore called ionic conductivity.

20. An intrinsic semiconductor has equal number of electrons and holes in it. This is due to

(a) doping (b) free electrons

(c) thermal energy (d) valence electrons

Sol. (c)

In intrintic semiconductor, all carriers from the electron-holes pairs generated when thermal energy breaks the covalent bonds. Electrons and holes are thus always present in equal concentration in an intrintic semiconductor. ie. $n_e = n_h$.

21. When a very small amount of higher conducting metal is added to a conductor, its conductivity will

(a) increase

(b) decrease

(c) remain the same

(d) increase or decrease depending on the impurity

Sol. (b)

Alloying elements invariably decreases the conductivity of the metal to which they are added ie. it does not depend on whether the added metal has higher conductivity or, lower conductivity than the metal to which it is added.

22. An electrically balanced atom has 30 protons in its nucleus and 2 electrons in its outermost shell. The materials made of such atom is

(a) a conductor

(b) an insulator

(c) a semiconductor

(d) a superconductor

Sol. (a)

Since atomic number = number of protons in an atom = 30

Electronic configuration is,

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

Given , number of electrons in outermost shell = 2

The elements having small number of valence electrons, which are loosely held, forms metallic bond. However a valence electron of a metal atom has a small ionization energy, and in the solid state this valence electron is relatively free to leave one atom in order to assoicate with another nearby. Such a free electrons can be moved under the influence of an electric field, and it is responsible for the electrical conductivity of the metal. Hence, the material made of such atom is a conductor.

23. The temperature coefficient of resistanc of a doped semiconductor is

(a) always positive

(b) always negative

(c) zero

(d) positive or negative depending upon the level of doping

Sol. (d)

Doped semiconductor or extrinsis semiconductor have very complicated temperature profile. As temperature increases starting from absolute zero, resistance first decreases steeply as the carriers leave the donors or acceptors. After most of the donors or acceptors have lost their carriers, the resistance starts to increase again slightly due to the reducing mobility of carriers. At higher temperatures, they behave like intrinsic semiconductors as the carriers from the donors/acceptors become insignificant compared to the thermally generated carriers.

24. In the slice processing of an integrated circuit

(a) components are formed in the areas where silicon dioxide remains

(b) components are formed in the areas where silicon dioxide has been removed

(c) the diffusing elements diffuse through silicon dioxide

(d) only on diffusion process is used

Sol. (a)

In the slice processing of an integrated circuit, the surface of the wafer are coated with a layer of silicon dioxide (SiO_2) to from an insulating base and to present any oxidation of the silicon which would cause impurities. The SiO_2 is formed by subjecting the wafer to superheated steam at about 1000°C under several atmospheres of pressure to allow the oxygen in the water vapour to react with the silicon. Controlling the temperature and length of exposure controls the thickness of the SiO_2 layer.

25. Permanent magnet loses the magnetic behaviour when heated because of

1. atomic vibration
2. dipole vibration
3. realignment of dipoles

Which of the above are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 1, 2 and 3 (d) 2 and 3

Sol. (a)

Permanent magnetism is lost upon heating because of alomic vibrations and dipole vibrations. Due to heat, domain gets jumbled and lose their alignment.

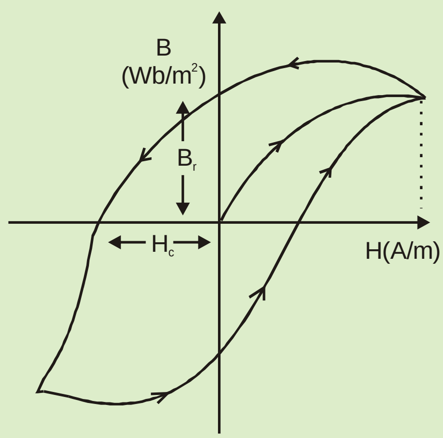
26. The magnetic field required to reduce the residual magnetization to zero is called

(a) retentivity (b) coercivity

(c) hysteresis (d) saturation

Sol. (b)

The magnetic field required to reduce the residual magnetization to zero is called 'coercivity' This magnetic field is applied externally in the opposite direction.



In the B-H curve shown above, B_r is residual magnetization and H_c is coercivity.

27. A certain fluxmeter has the following specifications:

Air gap flux density = 0.05 Wb/m^2

Number of turns on moving coil = 40

Area of moving coil = 750 mm^2

If the flux linking 10 turns of a search coil of 200 mm^2 area connected to the fluxmeter is reversed in a uniform field of 0.5 Wb/m^2, then the deflection of the fluxmeter will be

(a) 87.4° (b) 76.5°

(c) 65.6° (d) 54.7°

Sol. (b)

Flux meter: Specification

Air gap flux density = 0.05 wb/m^2

Number of turns on moving coil = 40

Area of moving coil = 750 mm^2

Now,

N = 10

A = 200 mm^2

B = 0.5 wb/m^2

Deflection $\theta = ?$

Constant of flux meter, G = NBA

$G = 40 \times 0.05 \times 750 \times 10^{-6} = 1500 \times 10^{-6}$

Flux linking with search coil

$= 0.5 \times 200 \times 10^{-6}$

$= 100 \times 10^{-6}$ Wb

$\therefore$ Change in flux linking the coil

$= 2 \times 100 \times 10^{-6}$ (since flux meter is reversed)

$= 200 \times 10^{-6}$

$\therefore$ Change in flux, $\phi = \frac{G}{N} \times \theta$

$\therefore \quad \theta = \frac{N}{G}\phi = \frac{10}{1500 \times 10^{-6}} \times 200 \times 10^{-6}$ rad

$= \frac{4}{3}$ rad

$\therefore \quad \theta = 76.5°$

28. Consider the following statements:

1. Both ferromagnetic and ferrimagnetic materials have domain structures; each domain has randomly oriented magnetic moments when no external field is applied.
2. Both ferromagnetic and ferrimagnetic

FEATURES

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Examination Date:

30 May 2016, 7 June 2016, & 12 June 2016

Examination Time:

6:00 PM To 8:00 PM

Examination Pattern:

- Entire paper will be objective type
- Each question will be provided by 4 alternatives.
- Total questions - 100
  (General Aptitude-50 & Engineering Discipline-50)
- Exam Duration - 2 hour

Registration:

Registration Starting Date:
18th April, 2016.

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Syllabus:

General Aptitude & Engineering Discipline

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materials make those domains that have favourable orientation to the applied field grow in size.

3. The net magnetic moment in ferromagnetic materials is higher than that in ferrimagnetic materials.
4. The net magnetic moment in ferrimagnetic materials is higher than that in ferromagnetic material.

Which of the above statements are correct?

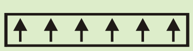
(a) 1 and 4 only (b) 1, 2 and 4

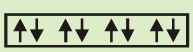
(c) 2 and 4 only (d) 1, 2 and 3

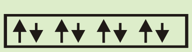
Sol. (d)

Like antiferromagnetic material, ferrimagnetic materials have magnetic moments of adjacent atoms which are aligned in opposite direction. But the magnetic moments are not equal so that there is a net magnetic moment ie. net magnetic moment are not zero or, material exhibits a net magnetic moement.

But the net magnetic moment in ferrimagnetic material is lesser than that of ferromagnetic material

Ferromagnetic :  $p_m \neq 0$

Antiferromagnetic :  $p_m = 0$

Ferrimagnetic  $p_m \neq 0$

So,

Statement (3) is correct.

Hence option (d)

29. The Hall voltage, V_H, for a thin copper plate of 0.1 mm carrying a current of 100 A with the flux density in the z-direction, B_z = 1 Wb/m^2 and the Hall coefficient, $R_H = 7.4 \times 10^{-11}$ m^3/C, is

(a) 148 μV (b) 111 μV

(c) 74 μV (d) 37 μV

Sol. (c)

Hall voltage, $V_H = R_H \dfrac{IB}{t}$

where, R_H is Hall coefficient,

I is current flowing in the material,

B is applied magnetic flux density,

and t is thickness of material.

So,

$$V_H = 7.4 \times 10^{-11} \times \frac{100 \times 1}{0.1 \times 10^{-3}} \text{ volt}$$

$$= 7.4 \times 10^{-5} \text{ volt}$$

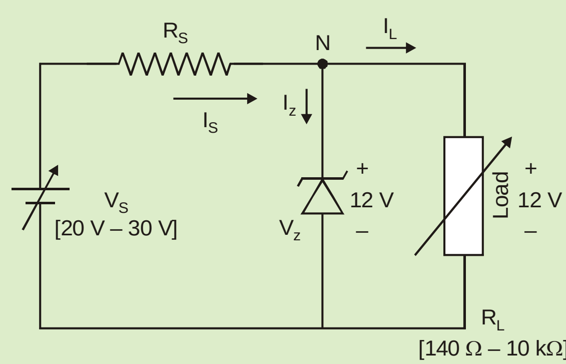
$$= 74\ \mu V.$$

30. A Zener regulator has an input voltage varying between 20 V and 30 V. The desired regulated voltage is 12 V, while the load varies between 140Ω and 10kΩ. The maximum resistance in series with the unregulated source and Zener diode would be

(a) 3.3Ω (b) 6.6Ω

(c) 36.6Ω (d) 93.3Ω

Sol. (d)



Applying KVL,

$$I_S = \frac{V_s - V_z}{R_s}$$

Now, If R_s is maximum

$\Rightarrow$ I_s will be minimum

Applying KCL at N

$I_s = I_z + I_L$

Now, for Zener diode to work as a voltage regulator the current through the series resistor must satisfy

$$I_S \geq (I_Z)_{min} + (I_L)_{max}$$

So, at limiting case,

$(I_Z)_{min} = 0$

and $I_S = (I_Z)_{min} + (I_L)_{max}$

$\Rightarrow$ $I_S = (I_L)_{max}$

Hence, $(I_L)_{max} = \frac{V_L}{(R_L)_{min}} = \frac{12}{140} = 0.0857\text{ A}$

Now, $I_s = \frac{V_S - V_z}{R_s}$

$\Rightarrow$ $1.2\times10^{-3} = \frac{20-12}{R_s}$

[$\because$ I_s is to be minimised $\therefore$ V_s has to be minimized so that $V_s - V_z$ is minimised]

$\Rightarrow$ $R_s = \frac{8}{0.0857} = 93.3\Omega$

31. A short in any type of circuit (series, parallel or combination) causes the total circuit

1. resistance to decrease
2. power to decreases
3. current to increase

Which of the above are correct?

(a) 2 and 3 (b) 2 and 4

(c) 1 and 4 (d) 1 and 3

Sol. (d)

Short circuit reduces the resistance of network and as a result current from the source also increase.

Hence, the correct option will be 'd'.

32. An air-cored soleniod of 250 turns has a cross-sectional area A = 80 cm^2 and length l = 100 cm. The value of its inductance is

(a) 0.425 mH (b) 0.628 mH

(c) 0.751 mH (d) 0.904 mH

Sol. (b)

$$\text{Inductance (L)} = \frac{\mu_o N^2 A}{l}$$

Putting all the values

$$L = \frac{\mu_o \times 250^2 \times 80 \times 10^{-4}}{100 \times 10^{-2}}$$

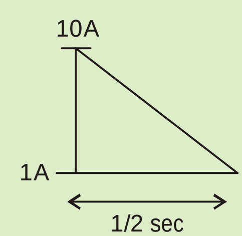
= 0.628mH.

33. The current in a coil changes uniformly from 10 A to 1 A in half a second. A voltmeter connected across the coil gives a reading of 36 V. The self-inductance of the coil is

(a) 0.5 H (b) 1 H

(c) 2 H (d) 4 H

Sol. (c)



$$\Rightarrow \quad \left|\frac{di}{dt}\right| = \frac{10-1}{1/2} = 9\times 2 = 18$$

Voltmeter reading is 36 V

$$\therefore \quad L\frac{di}{dt} = 36$$

$$L = \frac{36}{18} = 2H$$

34. In a mutually coupled circuit, the primary current is reduced from 4A to zero in 10 μs. A voltage of 40000 V is observed across the secondary. The mutual inductance between the coils is

(a) 100 H (b) 10 H

(c) 0.1 H (d) 0.01 H

Sol. (c)

$$\text{Secondary induced voltage } (v_2) = \frac{Mdi_1}{dt}$$

$$\left|\frac{di_1}{dt}\right| = \frac{4-0}{10\times 10^{-6}}$$

$$M\left(\frac{4-0}{10\times 10^{-6}}\right) = 40000$$

$$\Rightarrow \quad M = 0.1 \text{ H}$$

35. N resistors each of resistnace R when connected in series offer an equivalent resistance of 50Ω and when reconnected in parallel the effective resistance is 2Ω. The value of R is

(a) 2.5Ω (b) 5Ω

(c) 7.5Ω (d) 10Ω

Sol. (d)

NR = 50Ω (when connected in series)..(1)

$\frac{R}{N}$ = 2 (when connected in series) ...(2)

By equation (1) & (2)

$$\Rightarrow R = \sqrt{100} = 10\Omega$$

36. For a series R-L circuit

$$i(t) = \sqrt{2}\sin(\omega t - 45^\circ)$$

If $\omega L = 1\Omega$, the value of R is

(a) 1Ω (b) 3Ω

(c) $\sqrt{3}\Omega$ (d) $3\sqrt{3}\Omega$

Sol. (a)

Here $\phi = 45^\circ$

$$\tan\phi = 1 = \frac{X_L}{R}$$

$$\Rightarrow \quad R = \omega L$$

$$\therefore \boxed{R = 1}\,\Omega$$

37. A single-phase full-wave rectifier is constructed using thyristors. If the peak value of the sinusoidal input voltage is V_m and the delay angle is $\frac{\pi}{3}$ radian, then the average value of output voltage is

(a) $0.32V_m$ (b) $0.48V_m$

(c) $0.54V_m$ (d) $0.71V_m$

Sol. (a)

Average value of output voltage of single phase full wave rectifier is

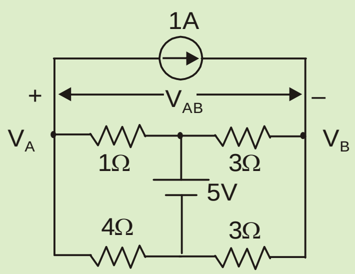
$$V_0 = \frac{2Vm}{\pi}\cos\alpha$$

$$\alpha = \frac{\pi}{3} = 60^\circ$$

$$V_0 = \frac{2Vm}{\pi}\cos 60^\circ$$

$$= 0.32V_m$$

38. The potential difference V_{AB} in the circuit



is

(a) 0.8 V (b) –0.8 V
(c) 1.8 V (d) –1.8 V

Sol. (b)

Writing node equations:

$$\frac{V_A - 5}{1} + \frac{V_A}{4} + 1 = 0 \quad \text{... (i)}$$

and $$\frac{V_B - 5}{3} + \frac{V_B}{3} = 1 \quad \text{... (ii)}$$

By (i) & (ii),

We get, $V_A = 16/5$

$V_B = 4$

$\Rightarrow V_{AB} = V_A - V_B = -0.8$

39. Two bulbs of 100 W/250 V and 150 W/250 V are connected in series across a supply of 250 V. The power consumed by the circuit is

(a) 30 W (b) 60 W
(c) 100 W (d) 250 W

Sol. (b)

Resistance of first bulb $(R_1) = \frac{250^2}{100}$

& Resistance of second bulb $(R_2) = \frac{250^2}{150}$

Total power consumed $= \frac{V^2}{R_1 + R_2}$

$$= \frac{250^2}{\frac{250^2}{100} + \frac{250^2}{150}}$$

$= 60$ W

40. Thevenin's equivalent of a circuit, operating at $\omega = 5$ rad/s, has

$$V_{OC} = 3.71 \angle -15.9°V$$

$$Z_O = 2.38 - j0.667\,\Omega$$

At this frequency, the minimal realization of the Thevenin's impedance will have

(a) a resistor, a capacitor and an inductor
(b) a resistor and a capacitor
(c) A resistor and an inductor
(d) a capacitor and an inductor

Sol. (b)

Given $Z_0 = 2.38 - j0.667\,\Omega$

Here $R = 2.38$

and $X = -0.667$

$\Rightarrow$ This represent a capacitance (as it is negative).

41. Analog-to-digital convertor with the minimum number of bits that will convert analog input signals in the range of 0–5 V to an accurancy of 10 mV is

(a) 6 (b) 9
(c) 12 (d) 15

Sol. (b)

Analog to digital converter:

Range of input signals = 0–5 V

Accuracy = 10 mV

Minimum number of bits required = ?

$$\text{Accuracy} = \frac{\text{Full Scale Voltage}}{2^n}$$

$$\therefore \quad 2^n = \frac{5V}{10 \times 10^{-3}\ V}$$

$$\Rightarrow \ 2^n = 5 \times 10^2$$

$$\Rightarrow \ 2^n = 500$$

$$\boxed{n \cong 9}$$

Option = (b)

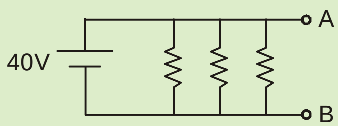
42. Three 30Ω resistors are connected in parallel across an ideal 40 V source. What would be the equivalent resistance seen by the load connected across this circuit?

(a) 0Ω (b) 10Ω

(c) 20Ω (d) 30Ω

Sol. (a)

Given



Equivalent resistance seen by load is the thevenin resistance of this circuit across AB.

Since, $R_{TH} = 0$

$\therefore$ Load will see zero resistance.

43. The current i(t) through a 10Ω resistor in series with an inductance is given by

i(t) = 3+4 sin (100t+45°) + 4 sin (300t+60°)A

The RMS value of the current and the power dissipated in the the circuit are respectively

(a) 5A and 150 W

(b) 11A and 250 W

(c) 5A and 250 W

(d) 11A and 150 W

Sol. (c)

RMS value of current

$$i_{rms} = \sqrt{3^2 + \left(\frac{4}{\sqrt{2}}\right)^2 + \left(\frac{4}{\sqrt{2}}\right)^2}$$

$$= \sqrt{25}$$

$$= 5A$$

$\therefore$ Power dessipated $= i_{rms}^2 R$

$$= 25 \times 10$$

$$= 250 \text{ Watts}$$

44. Thevenin's equivalents of the network in Fig. (i) are 10 V and 2Ω. If a resistance of 3Ω is connected across terminals AB as shown in Fig. (ii), what are Thevenin's equivalents?

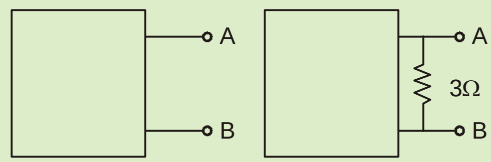
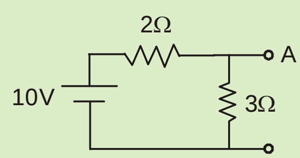


Fig. (i) Fig. (ii)

(a) 10V and 1.2Ω (b) 6V and 1.2Ω

(c) 10V and 5.2Ω (d) 6V and 5.2Ω

Sol. (b)



$$V_{AB} = \frac{3}{3+2} \times 10$$

$$= \frac{3}{5} \times 10$$

$$= 6V$$

$$R_{TH} = 3||2$$

$$= \frac{3 \times 2}{5}$$

$$= 1.2\Omega$$

45. A voltage source, connected to a load, has an e.m.f. of 10V and an impedance of

$(500+j100)\Omega$. The maximum power that can be transferred to the load is

(a) 0.2 W (b) 0.1 W

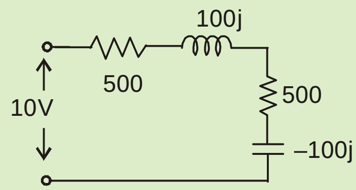
(c) 0.05 W (d) 0.01 W

Sol. (c)

For transfer of maximum power

$$Z_L = 500 - j100$$

$\therefore$ Circuit will be like =



$\therefore$ Power transferred to load = $\left(\frac{V_L^2}{R}\right)$

$$= \frac{(10/2)^2}{500}$$

$$= 0.05 \text{ W}$$

46. An ideal transformer is rated 220/110 V. A source of 10V and internal impedance of 2Ω is connected to the primary. The power transferred to a load Z_L connected across the secondary would be a maximum, when $|Z_L|$ is

(a) 4Ω (b) 2Ω

(c) 1Ω (d) 0.5Ω

Sol. (d)

Turn ratio (a) = $\frac{220}{110} = 2$

Transferring load to primary side:

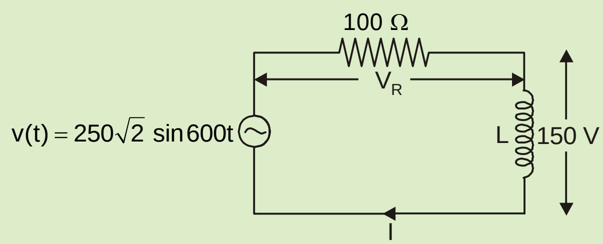
Z_L will become $a^2 Z_L$

$\therefore$ For maximum power transfer

$$|a^2 Z_L| = 2$$

$$\Rightarrow \quad |Z_L| = \frac{2}{4} = .5$$

47. Consider the following values for the circuit shown below:



1. $V_R = 100\sqrt{2}$ V
2. I = 2A
3. L = 0.25 H

Which of the above values are correct?

(a) 2 and 3 only (b) 1 and 2 only

(c) 1 and 3 only (d) 1, 2 and 3

Sol. (*)

None of the options is correct.

$$V = [V_R^2 + V_L^2]^{1/2}$$

$$V_R = \sqrt{250^2 - 150^2}$$

$$= 200V.$$

$$I_R = \frac{200}{2} = 100A$$

and $V_L = I \times X_L$

$$150 = 2\times(600)\times L$$

$$L = 0.125H$$

48. The response of a series R-C circuit is given by

$$I(s) = \frac{\frac{2V}{\pi} - \frac{q_0}{C}}{R\left(s + \frac{1}{RC}\right)}$$

where q_0 is the initial charge on the capacitor. What is the final value of the current?

(a) $\frac{1}{R}\left(\frac{2V}{\pi}-\frac{q_0}{C}\right)$ (b) $\frac{e^{t/RC}}{R}\left(\frac{2V}{\pi}-\frac{q_0}{C}\right)$

(c) Infinity (d) Zero

Sol. (d)

$$i(t)|_{t\to\infty} = \lim_{s\to 0} sI(s)$$

$$= \lim_{s\to 0}\frac{s\left[\frac{2V_s}{\pi}-\frac{q_0}{C}\right]}{R\left(S+\frac{L}{RC}\right)}$$

$$= 0$$

∴ Final value of current is zero.

49. What should be done to find the initial values of the circuit variables in a first-order R-C circuit excited by only initial conditions?

(a) To replace the capacitor by a short circuit

(b) To replace the capcitor by an open circuit

(c) To replace the capacitor by a voltage source

(d) To replace the capacitor by a current source

Sol. (c)

For findng the initial values of the circuit variables, capacitor is replaced by a voltage source.

50. In a parallel resistive circuit, opening a branch results in

1. increase in total resistnace
2. decreas in total power
3. no change in total voltage and branch voltage

(a) 1 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

Sol. (d)

In a parallel resistive circuit opening a branch results in (i) increase in total resistance (ii) total power decreases (iii) voltage and branch voltage do not change.

51. The precision resistors are

(a) carbon composition resistors

(b) wire-wound resistors

(c) resistors with a negative temperature coefficient

(d) resistors with a positive temperature coefficient

Sol. (b)

Variable resistor are two types: general purpose resistors and precision resistors. The general-purpose resistors may be sub-divided into wire-wound and carbon-composition type. Precision resistor are always wire-wound.

52. In nodal analysis, the preferred reference node is a node that is connected to

1. ground
2. many parts of the network
3. the highest voltage source

Which of the above is/are correct?

(a) 1 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

Sol. (d)

53. Two networks are said to be dual when

(a) their node equations are the same

(b) the loop equaitons of one network are analogous to the node equations of the other

(c) their loop equations are the same

(d) the voltage sources of one network are the current sources of the other

Sol. (d)

54. Reciprocity theorem is applicable to a network

1. containing R, L and C elements
2. whcih is initially not a relaxed system
3. having both dependent and independent sources

Which of the above is/are correct?

(a) 1 only (b) 1 and 2 only

(c) 2 and 3only (d) 1, 2 and

Sol. (a)

Limitations of reciprocity theorem

1. Applicable to only single source network

2. Network should be linear

3. Network should not have any time varying element

55. Which of the following is true for the complete response of any network voltage or current variables for a step excitation to a first-order circuit?

(a) It has the form k_1e^{-at}

(b) It has the form k

(c) It may have either the form (a) or the form of (a) plus (b)

(d) It has the form e^{+at}

Sol. (c)

Complete response of any network voltage or current variable is in the form $A+Be^{-t/\tau}$

Where 'A' and 'B' are constants and τ is the time constant of circuit.

56. A piezoelectric crystal has a coupling coefficient K of 0.32. How much electrical energy must be applied to produce output energy of 7.06 × 10^{-3} J?

(a) 25.38 mJ (b) 22.19 mJ

(c) 4.80 mJ (d) 2.26 mJ

Sol. (none)

Coupling coefficient (k) =

$$\sqrt{\frac{\text{mechanical energy stored}}{\text{electrical energy applied}}}$$

$$0.32 = \sqrt{\frac{7.06\times10^{-3}}{\text{electrical energy applied}}}$$

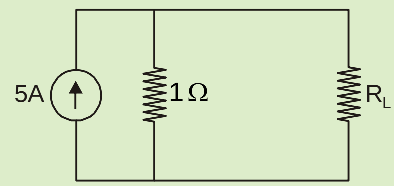
Electrical energy applied = 68.94 mJ

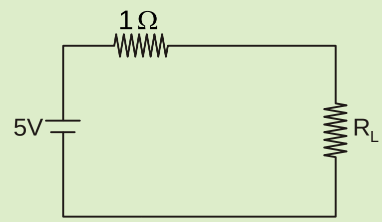
57. If a constant current generator of 5 A, shunted by its own resistance of $1\,\Omega$, delivers maximum power P in watts to its load $R_L\,\Omega$, then the voltage across the current generator and P are

(a) 5 V and 6.25 (b) 2.5 V and 12.5

(c) 5 V and 12.5 (d) 2.5 V and 6.25

Sol. (d)





convert it in voltage source.
for maximum power transfer R_L should be 1Ω

$$\text{Power transferred to R} = \frac{(2.5)^2}{1} = 6.25 \text{ W}$$

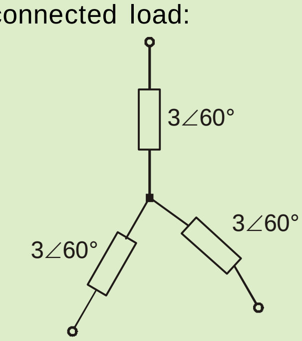
58. Three star-connected loads of $3\angle60°\Omega$ each and three delta-connected loads of $9\angle60°\Omega$ each are connected in parallel and fed from a three-phase balanced source having line-to-netural voltage of 120V. The line currents drawn from the supply will be

(a) 10 A each (b) 20 A each

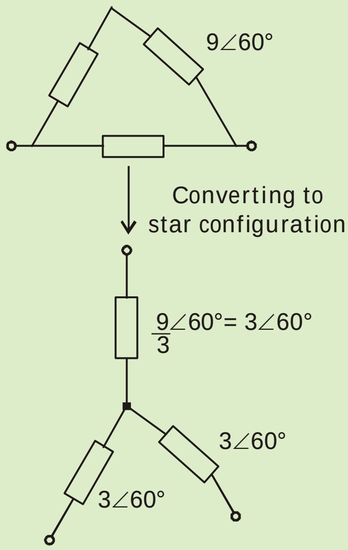
(c) 80 A each (d) 160 A each

Sol. (c)

Star connected load:

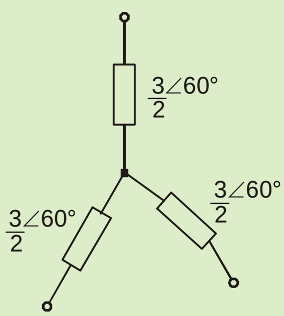


Delta connected load:



Now these two loads are connected in parallel.

$\therefore$ Equivalent load =



$\therefore$ Line current = $\frac{120}{3/2} = 80A$

59. A wattmeter reads 10 kW, when its current coil is connected in R phase and the potential coil is connected across R and neutral of a balanced 400 V (RYB sequence) supply. The line current is 54 A. If the potential coil reconnected across B-Y phases with the current coil in R phase, the new reading of the wattmeter wil be nearly

(a) 10 kW (b) 13 kW

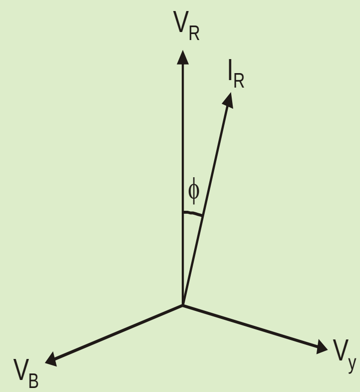
(c) 16 kW (d) 19 kW

Sol. (b)

Given, Line current = 54 A

Line voltage = 400 V

Case I: When current coil is connected to R-phase and potential coil is connected between R-phase and neutral.

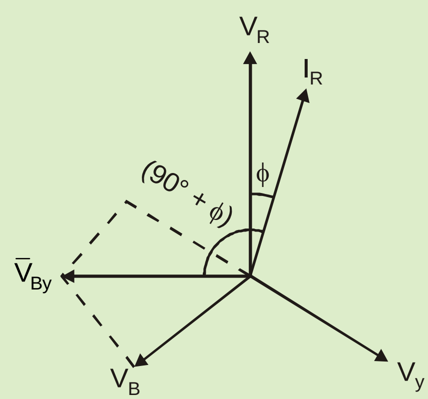


Wattmeter reading, $P = V_{RN} \cdot I_R \cdot \cos\phi$

$$\Rightarrow 10 \times 10^3 = \frac{400}{\sqrt{3}} \times 54 \times \cos\phi$$

$$\Rightarrow \cos\phi = 0.80$$

Case II: When current coil is connected to R-phase and potential coil between B and y phase.



So, wattmeter reading,

$$P = |\bar{V}_{By}|\cdot|I_R|\cdot\cos(90^\circ+\phi) = V_{By}\cdot I_R\cdot\sin\phi$$

$$= 400 \times 54 \times 0.6 = 12.96\text{ kW} \approx 13\text{ kW}$$

60. The phase voltage of a three-phase, star-connected alternator is V. By mistake, the connection of R phase got reversed. the new line voltages will have a relationship

(a) $V_{RY} = V_{BR} = \frac{V_{YB}}{\sqrt{3}}$

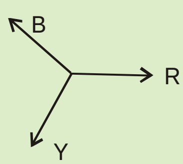
(b) $V_{RY} = V_{YB} = \frac{V_{BR}}{\sqrt{3}}$

(c) $V_{YB} = V_{BR} = \frac{V_{RY}}{\sqrt{3}}$

(d) $V_{RY} = V_{YB} = V_{BR}$

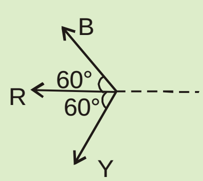
Sol. (a)

Under normal condition, phases are like this:



But in question R phase is reversed:

$\therefore$ Phasor diagram becomes



Clearly $|V_{RY}| = |V_{RB}| \neq |V_{BY}|$

$\therefore$ Correct options is 'a'

61. Two -wattmeter method of power measurement in three-phase system is valid for

(a) balanced star-connected load only

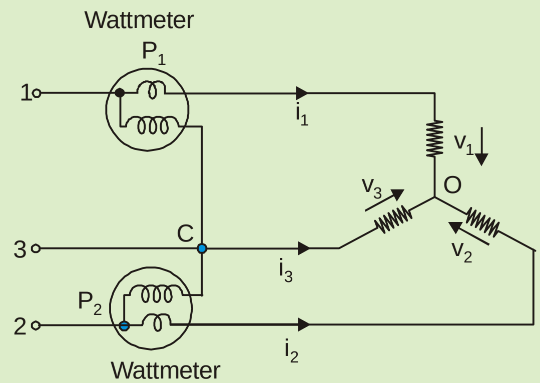
(b) unbalanced star-connected load only

(c) balanced delta-connected load only

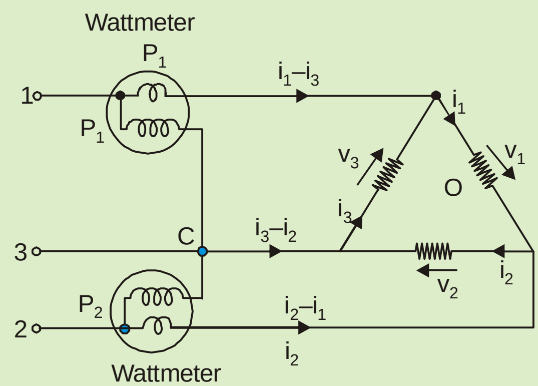
(d) balanced or unbalanced star as well as delta-connected loads

Sol. (d)

Two wattmeter method:



Two wattmeter method Star connection



Two wattmeter method Star connection

- Sum of instantaneous readings of two wattmeters, whether connected in star or Delta = $v_i i_1 + v_2 i_2 + v_3 i_3$
- Therefore, the sum of the two wattmeter reading is equal to the power consumed by the load. This is irrespective of whether the load is balanced or unbalanced.

Note: However, One wattmeter method can be used only when the load is balanced.

62. Consider the following statements regarding the effect of adding a pole in the open-loop transfer function on the closed-loop step response:

1. It increases the maximum overshoot.
2. It increases the rise time.
3. It reduces the bandwidth.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

Sol. (a)

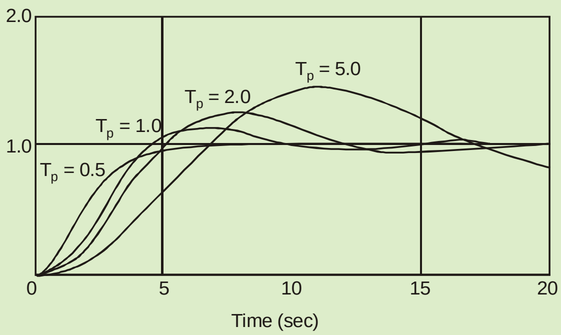
To study the general effect of the addition of a pole, and its relative location, to a forward-path transfer function of a unity-feedback system, consider the transfer function

$$G(s) = \frac{\omega_n^2}{s(s+2\zeta\omega_n)(1+T_p s)}$$

The pole at $s = -1/T_p$ is considered to be added to the prototype second-order transfer function. The closed-loop transfer function is written

$$M(s) = \frac{Y(s)}{R(s)} = \frac{G(s)}{1+G(s)}$$

$$= \frac{\omega_n^2}{T_p s^3 + (1+2\zeta\omega_n T_p)s^2 + 2\zeta\omega_n s + \omega_n^2}$$



Unit-step resopnses of the system with the closed-loop transfer function in above equation

$\zeta = 1,\ \omega_n = 1$, and $T_p = 0, 1, 2$, and 5

Fugure illustrates the unit-step tesponses of the closed-loop system when $\omega_n = 1, \zeta = 1$, and T_p = 0,1,2 and 5. These responses again show that the addition of a pole to the forward-path transfer function generally has the effect of increasing the maximum overshoot of the closed-loop system.

As the value of T_p increases, the pole at $-1/T_p$ moves closer to the origin in the s-plane, and the maximum overshoot increases. These responses also show that the added pole increases the rise time of the step response. This is not surprising. since the additional pole has the effect of reducing the bandwidth of the system, thus cutting out the high-frequency components of the signal transmitted through the system.

63. A CRO screen has 10 divisions on the horizontal scale. If a voltage signal 5 sin (314t + 45°) is examined with a line base setting of 5 ms/div, the number of signals displayed on the screen will be

(a) 1.25 cycles (b) 2.5 cycles
(c) 5 cycles (d) 10 cycles

Sol. (b)

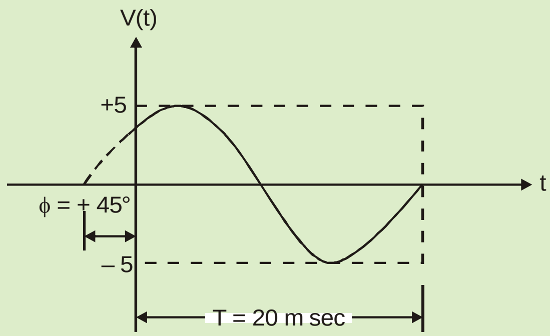
Given 10 divisions on horizontal scale.

V(t) = 5 sin (314t + 45°)

Here, f = 50 Hz

$\Rightarrow$ T = 20 m sec.

Meaning: V(t) has the waveform extending upto 20 msec.



Now, Line base setting = 5 ms/div, and total division present = 10

$\therefore$ Total time span = 5 ms/div × 10 div
= 50 msec.

Hence, number of cycle = $\frac{50\text{ m sec}}{20\text{ m sec}} = 2.5$ cycle.

64. A series R-L-C circuit is connected to a 25 V source of variable frequency. The circuit current is found to be a maximum of 0.5 A at a frequency of 400 Hz and the voltage across C is 150 V. Assuming ideal components, the values of R and L are respectively

(a) 50 Ω and 300 mH

(b) 12.5 Ω and 0.119 H

(c) 50 Ω and 0.119 H

(d) 12.5 Ω and 300 mH

Sol. (c)

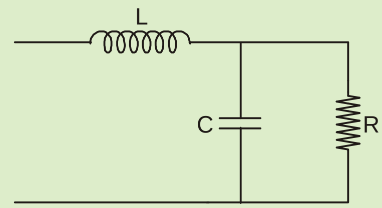
$$R = \frac{25}{0.5}$$
$$= 50\,\Omega$$

At resonance $\Rightarrow |V_L| = |V_C|$

$\therefore$ 150 = 0.5 × 2π × 400 XL

$$\Rightarrow \quad L = \frac{150}{2\pi \times 0.5 \times 400}$$
$$= 0.119 \text{ H}$$

65. The resonant frequency for the circuit



for L = 0.2 H, $R = 1\,\Omega$ and C = 1 F, is

(a) 1 rad/s (b) 2 rad/s

(c) 3 rad/s (d) 4 rad/s

Sol. (b)

$$Z = j\omega L + \frac{R}{1 + j\omega CR}$$

At resonance, imaginary part of Z is zero.

$$\omega L - \frac{\omega CR^2}{1 + (\omega CR)} = 0$$

$$L = \frac{R^2 C}{1 + (\omega CR)^2}$$

put all values

$$\omega = 2 \text{ rad/sec.}$$

66. Which one of the following conditions will be correct when three identical bulbs forming a star are connected to a three-phase balanced supply?

(a) The bulb in R phase will be the brightest

(b) The bulb in Y phase will be the brightest

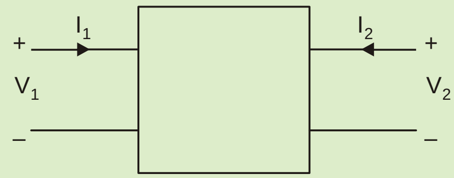
(c) The bulb in B phase will be the brightest

(d) All the bulbs will be equally bright

Sol. (d)

All the bulbs will be equally bright because line current will be same in all three branches.

67. For the two-port network shown in the figure



$V_1 = 60I_1 + 20I_2$ and $V_2 = 20I_1 + 40I_2$

Consider the following for the above network:

1. The network is both symmetrical and reciprocal
2. The network is reciprocal
3. A = D
4. $y_{11} = \frac{1}{50}$

Which of the above is/are correct?

(a) 2 only (b) 2 and 4

(c) 1 only (d) 1 and 3

Sol. (b)

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 60 & 20 \\ 20 & 40 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$z_{11} \neq z_{22}$ $\Rightarrow$ Network is not symmetrical

$z_{12} = z_{21}$ $\Rightarrow$ Network is reciprocal

ABCD parameters:

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} 1/20 & 2 \\ 3 & 100 \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

$\Rightarrow$ A $\neq$ D

Y parameters:

$$[y] = \begin{bmatrix} 0.02 & -0.01 \\ -0.01 & 0.03 \end{bmatrix} = z^{-1}$$

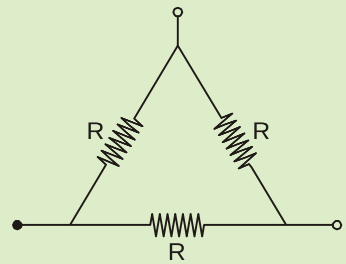
$y_{11} = 1/50.$

68. If the total powers consumed by three identical phase loads connected in delta and star configuration are W_1 and W_2 respectively, then W_1 is

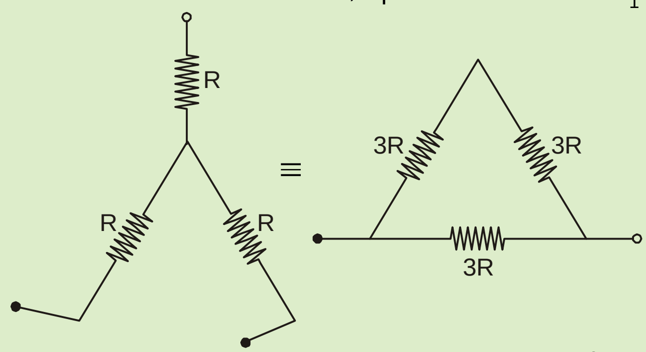
(a) $3W_2$ (b) $\frac{W_2}{3}$

(c) $\sqrt{3}\,W_2$ (d) $\frac{W_2}{\sqrt{3}}$

Sol. (b)



$\Rightarrow$ power consumed w_1



$\Rightarrow$ power consumed w_2

When load is delta connected. Power consumed = w_1. When load is star connected power consumed = w_2

for example take only resistive network

power consumed w_1

power consumed w_2

clearly $w_2 = 3w_1$

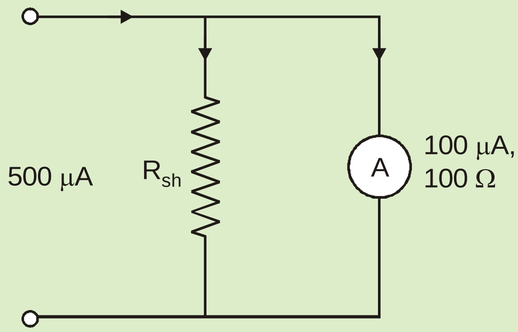
$$w_1 = \frac{w_2}{3}$$

69. A 100 μA ammeter has an internal resistance of 100Ω. For extending its range to measure 500 μA, the required shunt resistance is

(a) 10Ω (b) 15Ω

(c) 20Ω (d) 25Ω

Sol. (d)



From above circuit,

$$100\,\mu A = \frac{R_{sh}}{R_{sh}+100} \times 500\,\mu A$$

$$1 = \frac{R_{sh}}{R_{sh}+100} \times 5$$

$R_{sh} + 100 = 5\ R_{sh}$

$4\ R_{sh} = 100$

$R_{sh} = 25\,\Omega$

Alternate

$I = 500\ \mu A$

$I_m = 100\,\mu A$, $R_m = 100\,\Omega$

$$\therefore \quad R_{sh} = \frac{R_m}{m-1} = \frac{100}{5-1} = \frac{100}{4} = 25\,\Omega$$

70. A 200 V PMMC voltmeter is specified to be accurate within ±2 of full scale. The limiting error, when the instrument is used to measure a voltage of 100V, is

(a) ±8% (b) ±4%

(c) ±2% (d) ±1%

Sol. (d)

% limiting error for voltage measurement

$$= \pm \frac{\text{Full scale deflection} \times (\%\text{ accuracy})}{\text{Voltage measured}}$$

$$= \pm \frac{200 \times 2}{100} = \pm 4\%$$

Alternate

Full scale deflection, $A_s = 200$ V

Accuracy = ± 2% of full scale.

$\therefore$ Magnitude of limiting error of voltmeter

$$\delta A = \varepsilon_r A_s = 0.02 \times 200 = 4\ \text{V}$$

$\therefore$ % limiting error is:

$$= \pm \frac{4}{100} \times 100 = \pm 4\%$$

71. How many poles does the following function have? $F(s) = \dfrac{s^3 + 2s + 1}{s^2 + 3s + 2}$

(a) 0 (b) 1

(C) 2 (d) 3

Sol. (c)

$$F(s) = \frac{s^3 + 2s + 1}{s^2 + 3s + 2}$$

$$F(s) = \frac{(s+0.453)(3-0.226+j1.46)(s-0.226-j1.46)}{(s+1)(s+2)}$$

$\therefore F(s)$ has 2 poles.

72. The degree to which an instrument indicates the changes in measured variable without dynamic error is

(a) repeatability (b) hysteresis

(c) precision (d) fidelity

Sol. (d)

Fidelity: It is defined as the degree to which a measurement system is capable of faithfully reproducing the changes in the input, without any dynamic error.

Fidelily is the dynamic characteristics of a measurement system

However, repeatability, hysteresis and precesion are the static characteris of a measurement system.

Repeatability: It is defined as the variation of scale reading and is random in nature.

Precesion: It is a measure of the reproducibility of the measurements i.e. given a fixed value of a variable, precesion is a measure of the degree to which successive measurements differ from one another.

Therefore, precesion refers to the degree of agreement within a group of measurements or instruments.

Hysteresis: It is a phenomenon which depicts different output effects when loading and unloading whether it is a mechanical system or an electrical system.

Hysteresis, in a system, arises due to the fact that all the energy put into the stressed parts when loading is not recoverable upon unloading.

73. Loading by the measuring instruments introduces an error in the measured parameter. Which of the following devices gives most accurate result?

(a) PMMC (b) Hot-wire

(c) CRO (d) Electrodynamic

Sol. (c)

CRO has the higher input impedance than PMMC, hot wire and electrodynamic instruments and hence errors in the measured parameter due to loading effects will be lesser. Therefore, CRO gives the most accurate result.

74. A moving-coil galvanometer can be used as a DC ammeter by connecting

(a) a high resistance in series with the meter

(b) a high resistance across the meter

(c) a low resistance across the meter

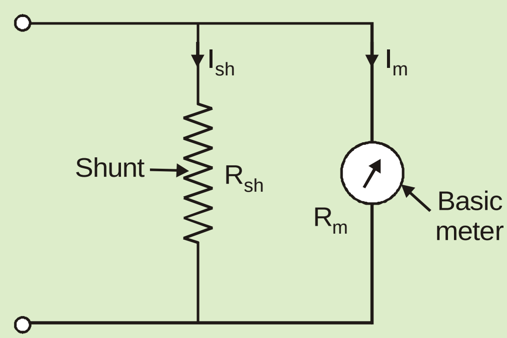
(d) a low resistance in series with the meter

Sol. (d)

A moving-coil galvanometer can be used as a DC ammeter by connecting a low resistance across the meter.

Explanation:

- The coil winding of a basics moving coil galvanometer is small and light and can carry very small currents since the construction of an accurate instrument with a moving coil to carry currents greater than 100 mA is impracticable duie to bulk and weight of the coil that would be required.
- When heavy currents are to be measured, the major part of the current is bypassed through a low resistance called a "shunt".



75. Consider the following types of damping:

1. Air-friction damping

2.Fluid-friction damping

3.Eddy-current damping

PMMC type instruments use which of the above?

(a) 1 only b) 2 only

(c) 3 only (d) 1,2 and 3

Sol. (c)

– PMMC type instruments use Edely-current damping.

– Eddy current damping is very convenient to use in instruments where a metallic disc or a former and a permanent magnet already from part of the operating system. For these reasons this method is used in hot wire, moving coil, and induction type instruments.

– Air friction damping is used in hot wire and moving iron instruments.

– Fluid-friction damping is suitable for instruments such as electrostatic type where the movement is suspended rather than pivoted.

76. In data acquisition system, analog data acquisition system is used

(a) for narrow frequency width, while digital data acquisition system is used when wide frequency width is to be monitored

(b) for wide frequency width, while digital data acquisition system is used when narrow frequency width is to be monitored

(c) when qunatity to be monitored varies slowly, while its counterpart is preferred if the qunatity to be monitored varies very fast

(d) when qunatity to be monitored is time-variant, while digital data acquisition system is preferred when quantitiy is time invariant.

Sol. (b)

– Analog data system are used when wide bandwidth is required and lower accuracy can be tolerated.

– Digital data acquisition system are used when narrow bandwidth, high accuracy and low per channel cost is required.

– Digital data acquisition systems are used when the physical process being monitored is slowly varying (example: temperature) i.e., narrow bandwidth required.

– Digital data acquisiton systems are in general more complex than analog systems, both in terms of the instrumentation involved and the volume and complexity of input data they can handle.

77. During the measurement of resistance by carey foster bridge, no error is introduced due to

1.contact resistance

2. Connecting leads

3.thermoelectric e.m.f.

which of the above are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1,2 and 3

Sol. (a)

During the measurement of resistance by Carey Foster bridge, the errors due to contact resistances and the resistances of connecting loads are eliminated.

Note: The effect of thermo-electric emfs can be eliminated by making two sets of measurement, one with normal battery connection and second one with the battery connection reversed. The true value of resistance will be then the mean of the two readings.

78. Schering bridge is a very versatile AC bridge and is used for capacitor testing in terms of

1. capacitance value (magnitude)
2. loss angle measurement
3. simple balance detector like PMMC instrument
4. Providing safety to operators by incroporating Wagner earthing device

Which of the above are correct?

(a) 1 and 3 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

Sol. (c)

Statements (1), (2) and (4) are correct wrt Schering bridge.

Vibrational galvanometer is used as a balance detector in place of PMMC instrument.

79. Consider the following instruments:

1. MI instrument
2. Electrostatic instrument
3. Electrodynamometer instrument

which of the above instruments is/are free from hysteresis and eddy-current losses?

(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

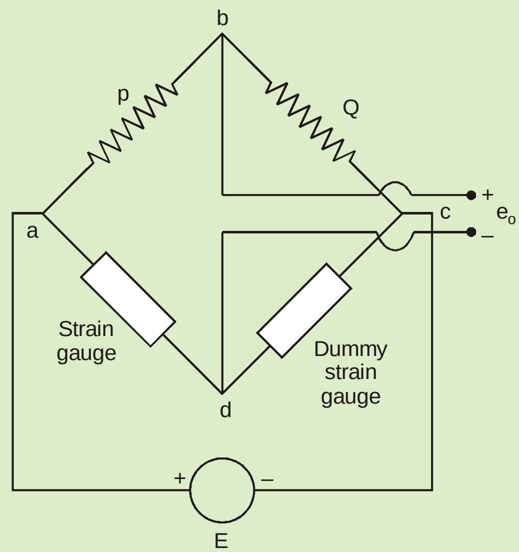
Sol. (b)

Electrostatic instrument is free from hysteresis and eddy-current losses. However, MI instruments and Electrodynamometer instruments are subjected to serious errors due to hysteresis and eddy-current losses.

80. Dummy strain gauges are used for

(a) compensation of temperature changes
(b) increasing the sensitivity of bridge
(c) compensating for different expansions
(d) calibration of strain gauge

Sol. (a)



As pressure under measurement changes ΔR changes and this change in Resistance is sensed using wheatstone bridge. If pressure is not applied $e_0 = 0$. But, if temperature changes, then resistance of strain gauge will also change even though pressure is not applied. So to compensate this error due to rise in temperature, a dummy strain gauge is used which cancels the effect of change in resistance due to rise in temperature of actual strain guage.

81. A wattmeter is measuring the power supplied to a circuit whose power factor is 0.7. The frequency of the supply is 50 c/s. The wattmeter has a potential coil circuit of resistance 1000Ω and inductance 0.5H. The error in the meter reading is

(a) 4% (b) 8%
(c) 12% (d) 16%

Sol. (d)

$$\cos\phi = 0.7 \Rightarrow \phi = 45.57°$$
$$f = 50 \text{ Hz}$$
$$R_P = 1000\Omega$$
$$L_P = 0.5 \text{ H}$$

$\therefore \quad X_P = \omega L_P = 2\pi f \times L_P$
$= 2\times3.14\times50\times0.5$
$= 314\times0.5$
$= 157\Omega$

$\therefore \quad \tan\beta = \frac{X_P}{R_P} = \frac{157}{1000}$

$\therefore \quad \tan\phi = \tan 45.57° = 1.02$

$\therefore$ Percentage error = $\tan\phi \tan\beta\times100$

$= 1.02\times \frac{157}{1000}\times100$

$\cong 16\%$

82. A moving-coil instrument gives full scale deflection of 10mA, when a potential difference of 10mV is applied across its terminals. To measure currents up to 100A, the same instrument can be used

(a) with shunt resistance of 0.0001Ω

(b) with series resistance of 0.01Ω

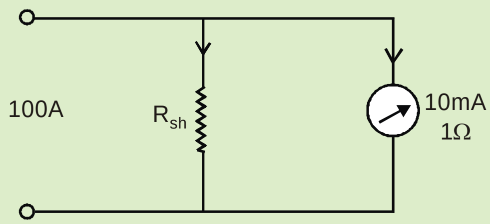
(c) with shunt resistance of 0.01Ω

(d) with series resistance of 0.0001Ω

Sol. (a)

Resistance of moving coil instrument .

$R_m = \frac{100mV}{10mA} = 1\Omega$



From above circuit,

$10mA = \frac{R_{sh}}{R_{sh}+1}\times100$

$0.01(R_{sh} + 1) = 100\ R_{sh}$

$0.01R_{sh} + 0.01 = 100R_{sh}$

$100R_{sh} - 0.01\ R_{sh} = 0.01$

$99.99R_{sh} = 0.0001\Omega$

Alternate

$I = 100\ A$

$I_m = 10\ mA, \quad R_m = 1\Omega$

$\therefore$ multiplying factor, $m = \frac{I}{I_m} = \frac{100}{10\times10^{-3}}$

$\therefore R_{sh} = \frac{R_m}{m-1} = \frac{1}{10000-1} \approx 0.0001\Omega$

83. A 400V, three phase, rated frequency balanced source is supplying power to a balanced three phase load carrying a line current of 5 A at an angle of 30° lagging. The readings of the two wattmeters W_1 and W_2 used for measuring the power drawn by the circuit, are respectively.

(a) 2000 W and 1000 W

(b) 1500 W and 1500 W

(c) 2000 W and 1500 W

(d) 1500 W and 1000 W

Sol. (a)

Total power = $\sqrt{3}\times400\times5\times\cos30°$

= 3000 watts.

w_1 & w_2 are same when power factor is unity

So, correct option will be (a)

84. A current of $-4+3\sqrt{2}\sin(\omega t+30°)$ A is passed through a centre zero PMMC meter and a moving iron meter. The two meters will read respectively.,

(a) –4 A and –5 A (b) 4 A and –5 A

(c) –4 A and 5 A (d) 4 A and 5 A

Sol. (c)

• PMMC always reads DC (or) average value. Hence, PMMC will read = –4 A.

• Moving iron meter reads RMS value.

$$\text{Hence } i_{RMS} = \sqrt{(-4)^2 + \left(\frac{3\sqrt{2}}{\sqrt{2}}\right)^2}$$

$$\Rightarrow i_{RMS} = \sqrt{16+9} = \sqrt{25}$$

$$\therefore i_{RMS} = 5A$$

85. A structural member is compressed to produce a strain of 5μm. The nickel wire strain gauge has a gauge factor of –12.1. The pre-stress resistance of the gauge is 120Ω. The change in resistance due to compressive stain will

(a) increase the resistance by 7.26 mΩ

(b) decrease the resistance by 7.26 mΩ

(c) increase the resistance by 49.6 mΩ

(d) decrease the resistance by 49.6 mΩ

Sol. (b)

Strain = 5μm/m

gauge factor = -12.1

R = 120Ω

ΔR = ?

$$\text{Gauge factor} \quad G_f = \frac{\Delta R/R}{\text{strain}}$$

$$12.1 = \frac{\Delta R/R}{5\times10^{-6}}$$

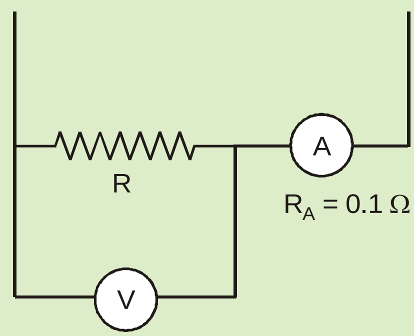
$$\therefore \frac{\Delta R}{R} = 12.1\times5\times10^{-6}$$

$$\Delta R = 12.1\times5\times10^{-6}\times120$$

$$\Delta R = 7.26\text{m}\Omega$$

Since guage factor is in negative, therefore change in resistance due to compresive strain will decrease the resistance by 7.26mΩ

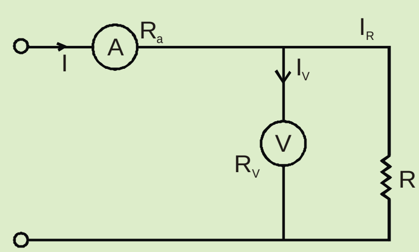
86. The values of ammeter and voltmeter resistances are 0.1Ω and 2000Ω respectively as shown in the figure below. The percentage error in the calculated value of R=100Ω (voltmeter reading 200 V/ammeter reading 2 A) is nearly.



(a) –2% (b) –5%

(c) 2% (d) 5%

Sol. (b)



The given circuit arragngment may be redrawn as shown above. In this circuit the voltmeter measures the true value of voltage but the ammeter measures the sum of currents through the resistance and the voltmeter.

$$\therefore \text{The percentage error} = -\frac{R}{R_v}\times100\%$$

$$= -\frac{(200V/2A)}{2000}\times 100$$

$$= -\frac{100}{2000}\times 100$$

$= -5\%$

87. What is the multiplying power of a shunt of 200Ω resistance when used with a galvanometer of 1000Ω resistance?

(a) 4 (b) 6

(c) 12 (d) 20

Sol. (b)

$R_{sh} = 200\Omega$

$R_m = 1000\Omega$

we know,

$$R_{sh} = \frac{R_m}{m-1}$$

$$m-1 = \frac{R_m}{R_{sh}} = \frac{1000}{200} = 5$$

m-1 = 5

m = 6

88. The mesh current method

1. works with both planner and non planar circuits
2. uses Kirchhoff's voltage law

which of the above is/arer correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

Sol. (b)

Mesh current method does not work in non planar circuit.

89. An 8-bit successive approximation A to D converter is driven by a 2 MHz clock. Its conversion time is

(a) 18 μs (b) 16 μs

(c) 8 μs (d) 4.5 μs

Sol. (d)

A n bit SAR A to D converter takes maximum n clock cylces for conversion.

∴8 bit SAR will take 8 clock cycles.

$$\therefore \text{time} = 8\times\frac{1}{2\times 10^6}\text{ sec.}$$

= 4μsec

Correct option will be (d).

90. In using instrument transformers, care should be taken not to open circuit the

(a) primary of a voltage transformer when the secondary is connected to the rated load

(b) secondary of a voltage transformer when the primary is energized with the rated voltage.

(c) primary of a current transformer when the secondary is connected to the reated load

(d) secondary of a current transformer when the primary is carrying the rated current

Sol. (d)

Current transformer is used in series for protection and metering purpose.

Primary current,

$I_1 = I_o + I_2'$

when secondary of the current transformer is left open, then I_2' becomes zero,. Since, primary is carrying the rated current, hence.

$I_0 = I_1 \quad [\because I_2' = 0]$

i.e. No-load component of current (or magnetising current) would be equal to the primary rated current which is very high. Hence, the core of the instrument transformer leads to deep saturation and may damaged permamently.

Hence, secondary of instrument transformer is never left open circuit.

91. An inverse z-transform x(kT) of

$$X(z) = \frac{1-e^{-aT}}{(z-1)(z-e^{-aT})}$$ is

(a) $1-e^{-akT}$ (b) $1+e^{-akT}$

(c) $1-e^{akT}$ (d) $1+e^{akT}$

Sol. (*)

No option is correct

$$x(z) = \frac{1-e^{-aT}}{(z-1)(z-e^{-aT})}$$

By partial fraction

$$\frac{1-e^{-aT}}{(z-1)(z-e^{-aT})} = \frac{1}{(z-1)} - \frac{1}{(z-e^{-aT})}$$

$$\frac{1}{(z-1)} = z^{-1}\frac{z}{z-1}$$

$$\frac{1}{z-e^{aT}} = z^{-1}\frac{z}{z-e^{-aT}}$$

Inverse z-transfer of $\frac{z}{z-1} \leftrightarrow (1)^k$

$$\frac{z}{z-z^{-aT}} \leftrightarrow e^{-akT}$$

Also $Z^{-n} f(z) \leftrightarrow f(k-n)$

so $z^{-1}\frac{z}{z-1} \leftrightarrow (1)^{k-1}$

$$z^{-1}\frac{z}{z-e^{-aT}} \leftrightarrow e^{-a(k-1)}T$$

So, $x(KT) = (1)^{K-1} - e^{-a(K-1)T}$

$= 1- e^{-a(k-1)}T$

No given option is correct.

92. A system has a transfer function $\frac{c(s)}{R(s)} = \frac{4}{s^2+1.6s+4}$ for a unit-step response and 2% tolerance band, the settling time will be

(a) 5 seconds (b) 4 seconds

(c) 3 seconds (d) 2 seconds

Sol. (a)

$$\frac{(s)}{R(s)} = \frac{4}{s^2+1.6s+4}$$

Now,

$S^2+2\xi\omega_n s+\omega_n^2 = s^2 + 1.6s + 4$

Here,

$2\xi\omega_n = 1.6$ and $\omega_n^2 = 4$

$\xi\omega_n = 0.8$, $\omega_n = 2$

$\therefore \xi\omega_n = \xi \times 2 = 0.8$

$= 0.4$

for a unit step function, settling time is given by

$$t_s = \frac{4}{\xi\omega_n}$$

$$t_s = \frac{4}{0.4\times 2} = \frac{4}{0.8}$$

$t_s = 5$ sec.

93. Consdier the following statements with reference to the response of a control system:

1. A large resonant peak corresponds to a small overshoot in transient response.
2. A large bandwidth corresponds to slow response.
3. The cut-off rate indicates the ability of the system to distinguish the signal from noise.
4. Resonant frequency is indicative of the speed of transient response.

which of the above statements are correct?

(a) 1 and 2 (b) 2 and 3
(c) 1 and 4 (d) 3 and 4

Sol. (d)

Rise time, $t_r = \frac{0.35}{f_H} = \frac{0.35}{BW}$

$\therefore$ If BW increases, rise time (t_r) decreases and hence response will be faster.

Hence option (2) is wrong.

Moreover, resonant frequency indicates the speed of transient response. Hence option (4) is correct.

Further, the cut-off rate indicates the ability of the system to distinguish the signal from noise.

94. The open-loop transfer function of a unity feedback system is $\frac{K}{s(s+4)}$ for a damping factor of 0.5, the value of the gain K must be set to

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

Sol. (d)

$G(s) = \frac{k}{s(s+4)}$

$H(s) = 1$

$$\therefore \frac{c(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$

$$\frac{c(s)}{R(s)} = \frac{\frac{k}{s(s+4)}}{1+\frac{k}{s(s+4)}}$$

$$\frac{c(s)}{R(s)} = \frac{k}{s^2+4S+k}$$

Now,

$S^2 + \xi 2\omega_n s + \omega_n^2 = s^2 + 4s + k$

Here

$2\xi\omega_n = 4$ and $\omega_n^2 = k$

$\xi\omega_n = 2 \quad \omega_n = \sqrt{k}$

at $\xi = 0.5$

$0.5 \times \omega_n = 2$

$\omega_n = \frac{2}{0.5} = 4$

$\therefore \omega_n = \sqrt{k}$

$\therefore k = \omega_n^2$

$k = 4^2 = 16$

Hence $k = 16$

95. For a unity feedback control system, the forward path transfer function is given by $G(s) = \frac{40}{s(s+2)(s^2+2s+30)}$ the steady state error of the system for the input $\frac{5t^2}{2}$ is

(a) 0 (b) ∞
(c) $20t^2$ (d) $30t^2$

Sol. (b)

Unit Parabolic Input: For a unit parabolic input, the steady state error in terms of acceleration given as

$$e(ss) = \frac{1}{K_a}, \text{ where } K_a = \lim_{s\to 0} s^2G(s)$$

Table below summarises the value of K_a as a function of type of system and corresponding steady state errors

Type of System	Position constant	Steady state error
0	0	0
1	K_a	$\frac{1}{K_a}$
2	∞	0
.	.	.
.	.	.
.	.	.
n, where n > 2	∞	0

From the results summariesed in Table we can compare the capabilities of various types of systems. It is very evident that error constants are either zero, finite or infinite. The magnitude of error constant will proportionally increase, if the inputs are greater than the unit value.

96. When gain K of the open loop transfer function of order greater than unity is varied from zero to infinity, the closed loop system.

(a) may become unstable

(b) stability may improve

(c) stability may not be affected

(d) will become highly stable

Sol. (a)

When gain K of the open loop transfer function of order greater than unity is varied from zero to infinity, the closed loop system may become unstable.

97. The frequency of sustained oscillation for marginal stability, for a control system G(s)H(s) $= \frac{2K}{s(s+1)(s+5)}$ and operating with negative feedback, is

(a) $\sqrt{5}$ r/s (b) $\sqrt{6}$ r/s

(c) 5 r/s (d) 6 r/s

Sol. (a)

characteristic equation = 0

C.E = 1+G(s) H(s) = 0

$$\text{C.E.} = 1+\frac{2K}{s(s+1)(s+5)}=0$$

s(s+1)(s+5) +2k = 0

$s(s^2+6s+5) +2k = 0$

$s^3+6s^2 + 5s +2k = 0$

R-H Table is

s^3	1	5
s^2	6	2K
s^1	(30–2K)/6	0
s^0	2K	0

for marginal stability Odd row should be zero

$$\frac{30-2k}{6}=0$$

30–2k = 0

2k = 30

k = 15

Now,

$6s^2 + 2k = 0$

$6s^2 + 30 = 0$

$6s^2 = 30$

$s^2 = -5$

$\therefore s = \pm\sqrt{5} = \pm j\omega_n$

$\therefore \omega_n = \sqrt{5}$ r/s.

98. Consider the following statements:

1. Adding a zero to the G(s)H(s) tends to push root locus to the left.
2. Adding a pole to the G(s)H(s) tends to push root locus to the right.
3. Complementary root locus (CRL) refers to root loci with positive K.
4. Adding a zero to the forward path transfer function reduces the maximum overshoot of the system.

which of the above statements are correct?

(a) 1,2 and 3 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

Sol. (c)

Effects of the Addition of Poles. The addition of a pole to the open-loop transfer funciton has the effect of pulling the root locus to the right, tending to lower the system's relative stability and to slow down the settling of the response.

Effects of the Additon of Zeros. The addition of a zero to the open-loop transfer function has the effect of pulling the root locus to the left, tending to make the system more stable and to speed up the settling of the response.

Moreover, Complementary root locus (CRL) refers to root loci with negative K.

99. An R-C network has the transfer function $G_c(s) = \dfrac{s^2+10s+24}{s^2+10s+16}$ The network could be used as

1. lead compensator
2. lag compensator
3. lag lead compensator

which of the above is/are correct?

(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

Sol. (c)

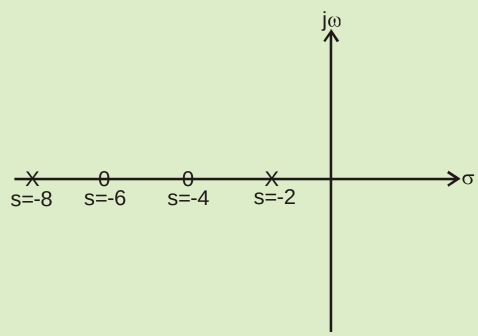
Given,

$$G_c(s) = \frac{s^2+10s+24}{s^2+10s+16}$$

$$G_c(s) = \frac{(s+4)(s+6)}{(s+2)(s+8)}$$

$s_z = -4, -6$

$s_p = -2, -8$



The pole-zero plot indicates lead lag compensator.

100. The partial fraction expansion of the function

$$f(z) = \frac{4z^2-2z}{z^3-5z^2+8z-4} \text{ is}$$

(a) $\dfrac{2}{z-1} + \dfrac{12}{(z-2)^2}$

(b) $\dfrac{2}{z-1} + \dfrac{2}{z-2} + \dfrac{2}{(z-2)^2}$

(c) $\dfrac{1.5}{z-1} + \dfrac{12}{(z-2)^2}$

(d) $\dfrac{1.5}{z-1} + \dfrac{1.5}{z-2} + \dfrac{1}{(z-2)^2}$

Sol. (b)

$$f(z) = \frac{4z^2-2z}{z^3-5z^2+8z-4}$$

$$f(z) = \frac{4z^2 - 2z}{(z-1)(z-2)^2} = \frac{A}{z-1} + \frac{B}{z-2} + \frac{C}{(z-2)^2}$$

Now,

$4z^2 - 2z = (z-2)^2 A + (z-1)(z-2)B + (z-1)C$

at Z= 1,

$4(1)^2 - 2(1) = (-1)^2 A$

$4 - 2 = A$

$A = 2$

at Z = 2,

$4(2)^2 - 2(2) = (2-1)C$

$C = 12$

at Z = 0,

$4(0)^2 - 2(0) = 8 + 2B - 12$

$4 = 2B$

$B = 2$

Hence,

$$F(z) = \frac{2}{z-1} + \frac{2}{z-2} + \frac{12}{(z-2)^2}$$

101. If an energy meter makes 5 revolutions in 100 seconds, when a load of 225 W is connected, the meter constant is

(a) 800 rev/kWh (b) 222 rev/kWh
(c) 147 rev/kWh (d) 13 rev/kWh

Sol. (a)

Energymetere:

- Load = 225W
- 5 revolutions in 100sec

Energy supplied $= 225 \times \frac{100}{3600}$ Wh

$= \frac{225}{36}$ Wh

$= 0.00625$kWh

$\therefore$ Meter constant $= \frac{\text{Revolutions}}{\text{KWh}}$

$= \frac{5}{0.00625}$

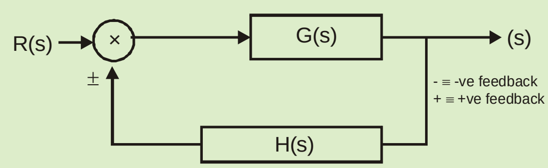
= 800 rev/kWh

102. In a closed loop control system

(a) control action is independent of output
(b) output is independent of input
(c) there is no feedback
(d) control action is dependent on output

Sol. (d)

A closed loop control system is generally represented as



from the given diagram it is clear that control action depends on output.

103. The characteristic polynomial of a system can be defined as

(a) denominator polynomial of given transfer function
(b) numerator polynomial of given transfer function
(c) numerator polynomial of a closed loop transfer function
(d) denominator polynomial of a closed loop transfer function

Sol. (d)

The characteristic equation polynomial of a system is always represented as the denominator polynomial of a closed loop tranfer function.

104. For a critically damped system, the closed loop poles are

(a) purely imaginary
(b) real, equal and negative
(c) complex conjugate with negative real part
(d) real, unequal and negative

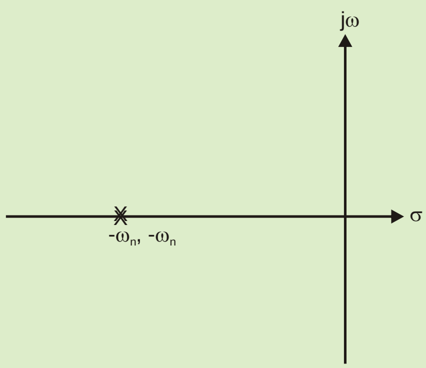
Sol. (b)

For critically damped system $\xi = 1$

$$S_{1,2} = -\xi\,\omega_n \pm j\omega_n\sqrt{1-\xi^2}$$

at $\xi = 1$

$$S_{1,2} = -\omega_n$$



Both the roots are real, negative and equal.

105. A second order position control system has an open loop transfer function $G(s) = \dfrac{57.3K}{s(s+10)}$ What value of K will result in a steady state error of 1°, when the input shaft rotates at 10 r.p.m.?

(a) 21.74 (b) 10.47
(c) 5.23 (d) 0.523

Sol. (b)

Input, $r(t) = (10\times2\pi\times180°/60\pi)t$

$= 60t$ degree/sec.

$R(s) = 60/s^2$

So, steady state error,

$$e_{ss} = \underset{s\to0}{\text{Lt}}\frac{s.R(s)}{1+G(s)H(s)}$$

$$\Rightarrow \quad 1° = \underset{s\to0}{\text{Lt}}\frac{s.(60/s^2)}{1+\dfrac{57.3K}{s(s+10)}}$$

$$\Rightarrow \quad K = 10.47$$

106. Gain margin is the factor by which the system gain can be increased to drive it to

(a) stability
(b) oscillation
(c) the verge of instability
(d) critically damped state

Sol. (c)

Gain margin is the factor by which the system gain can be increased to drive it to the verge of instability.

107. Nichols chart is used to determine

(a) transient response
(b) closed-loop frequency response
(c) open loop frequency response
(d) settling time due to step input

Sol. (b)

The Nichol's chart is useful for determining the frequency response of the closed loop from that of the open loop.

108. For a type-I system, the intersection of the initial slope of the Bode plot with 0dB axis gives

(a) steady-state error

(b) error constant

(c) phase margin

(d) cross-over frequency

Sol. (b)

Type of system (N)	Initial Slope	Intersection with 0 DB axis at
0	Initial Slope	Parallel to 0 db axis
1	– 20 db decade	$\omega = K$
2	– 40 db decade	$\omega = K^{1/2}$
3	– 60 db/decade	$\omega = K^{1/3}$
—	—	—
—	—	—
—	—	—
N	–20 N db decade	$\omega = K^{1/N}$

For the type zero system draw a line upto 1st corner frequency (lowest) having 0 db/ dec

For the type 1 system draw a line having a slope of –20 db/dec upto $\omega = K$.
For type 2 system draw line having slope of –40 db/dec upto $\omega = \sqrt{K}$

Now draw a line upto 2nd corner frequency by adding the slope of next pole or zero to the previous slope and so on
Hence, for type-1 system, it represents error constant.

109. The desirable features of a servomotor are

(a) low rotor inertia and low bearing friction

(b) high rotor inertia and high bearing friction.

(c) low rotor inertia and high bearing friction

(d) high rotor inertia low bearing friction

Sol. (a)

The desirable features of a servomotor are:

(i) Low rotor inertia to obtain good accelerating characteristics.

(ii) Low bearing friction to obtain maximum torques.

(iii) X/R ratio is kept high.

(iv) Diameter of the rotor is small.

Direction:

Each of the followin eleven (1) items consists of two statements, one labelled as statement (I) and the other as statement (II). Examine these two statements carefully and select the answers to these items using the code given below:

Code:

(a) Both statement (I) and statement (II) are individually true and statement (II) is the correct explanation of statement (I).

(b) Both statement (I) and statement (II) are individually true but statement (II) is not the correct explanation of statement (I)

(c) Statement (I) is true but statement (II) is false

(d) Statement (I) is false but statement (II) is true.

110. Statement (I):

For type-II or higher systems, lead compensator may be used.

Statement (II):

Lead compensator increases the margin of stability.

111. Statment (I):

Stability of a system deteriorates when integral control is incorporated into it.

Statement (II):

With integral control action, the order of a system increases and higher the order of the system, more the system tends to become unstable.

Sol. (a)

If more integrator is used in control action, then order of the system starts to increase and hence the system tend to become unstable.

112. Statement (I):

Self-loops can exist in block diagram but not in signal flow graph.

Statement (II):

Both block diagram and signal flow graphs are applicable to linear time invariant systems.

Sol. **(d)**

Self loop exist in signal flow graph but not in block diagram.

113. Statement (I):

The gauuge factor of a strain gauge is the ratio of strain to per unit change in resistance.

Statement (II):

Poisson's effect is defined as producing less strain with opposite sign on the plane perpendicular to the applied load.

Sol. (d)

Statement (I) is false becaue guage factor of a strain guage is the ratio of per unit change in resistance to strain.

$$G_f = \frac{\Delta R / R}{\Delta L / L} = \frac{\Delta R / R}{\varepsilon}$$

where ε = strain = $\frac{\Delta L}{L}$

114. Statement (I):

Voltage is the energy per unit charge created by charge separation.

Statement (II):

Power is energy per unit of time.

Sol. (b) SI : Voltage is energy per unit charge created by charge separation and has the unit of Volt

$$\left(V = \frac{dw}{dq}\right).$$

SII : Power is energy per unit time and also is the product of terminal voltage and current. It has the unit watt

$$P = \frac{dw}{dt}$$

Statement I and Statement II are individually correct but statement II is not the correct explanation of statment I.

115. Statement (I):

The electrical conductivity of a solid solution alloy drops off rapidly with increased alloy content.

Statement (II):

A solid solution has a less regular structurer than a pure metal.

Sol. (a)

The electrical conductivity of a solid solution alloy drops off rapidly with increased alloy content because the lattice periodicity gets destroyed and led to new scattering centres for the conduction electrons.

116. Statement (I):

In type-0 and type-1 systems, stable operation is possible if gain is suitably reduced.

Statement (II):

Any one of the compensators lag, lead, lag-lead may be used to improve the performance.

Sol. **(b)**

Both statements are correct individually but statement (II) is not the correct explanation of A.

117. Statement (I):

Open loop system is inaccurate and unreliable due to internal disturbances and lack of adequate calibration.

Statement (II):

Closed loop system is inaccurate as it can not account environmental or parametric changes and may become unstable.

Sol. (c)

Open loop system is inaccurate and unreliable due to internal disturbances and lack of adequate caliberation.

Closed loop system can account environmental or parametric changes and may also become unstable. The parametric change is sensed and minimised due to presence of feedback mechanism and error at output is reduced.

118. Statement (I):

A constant temperature type hot wire anemometer is suitable for turbulent flow measurements.

Statement (II):

When the resistance of the hot wire is kept constant by incroporating current feedback, the bandwidth is increased.

Sol. (a)

Statement (II) is the correct expalantion of statement (I).

119. Statement (I):

Optical pyrometers are used as transducers for the measurement of flame temperature in a boiler.

Statement (II):

Non-invasive methods are suitable for flame temperature measurement in a boiler.

Sol. (a)

Statement (I) is true. Optical pyrometers are used for measurement of very high temperature where physical contact with the process to be measured is impracticable or impossible.

Statement (II) is also true. Since flame temperature in a boiler is very high and rapidly moving, hence non-invasive methods such as optical pyrometers are suitable.

Therefore statement (II) is the correct explanation of statement (I).

120. Statement (I):

The null voltage of an LVDT can not be reduced to an insignificant value.

Statement (II):

Hall effect transducers are primarily used to measure flux density.

Sol. (b)

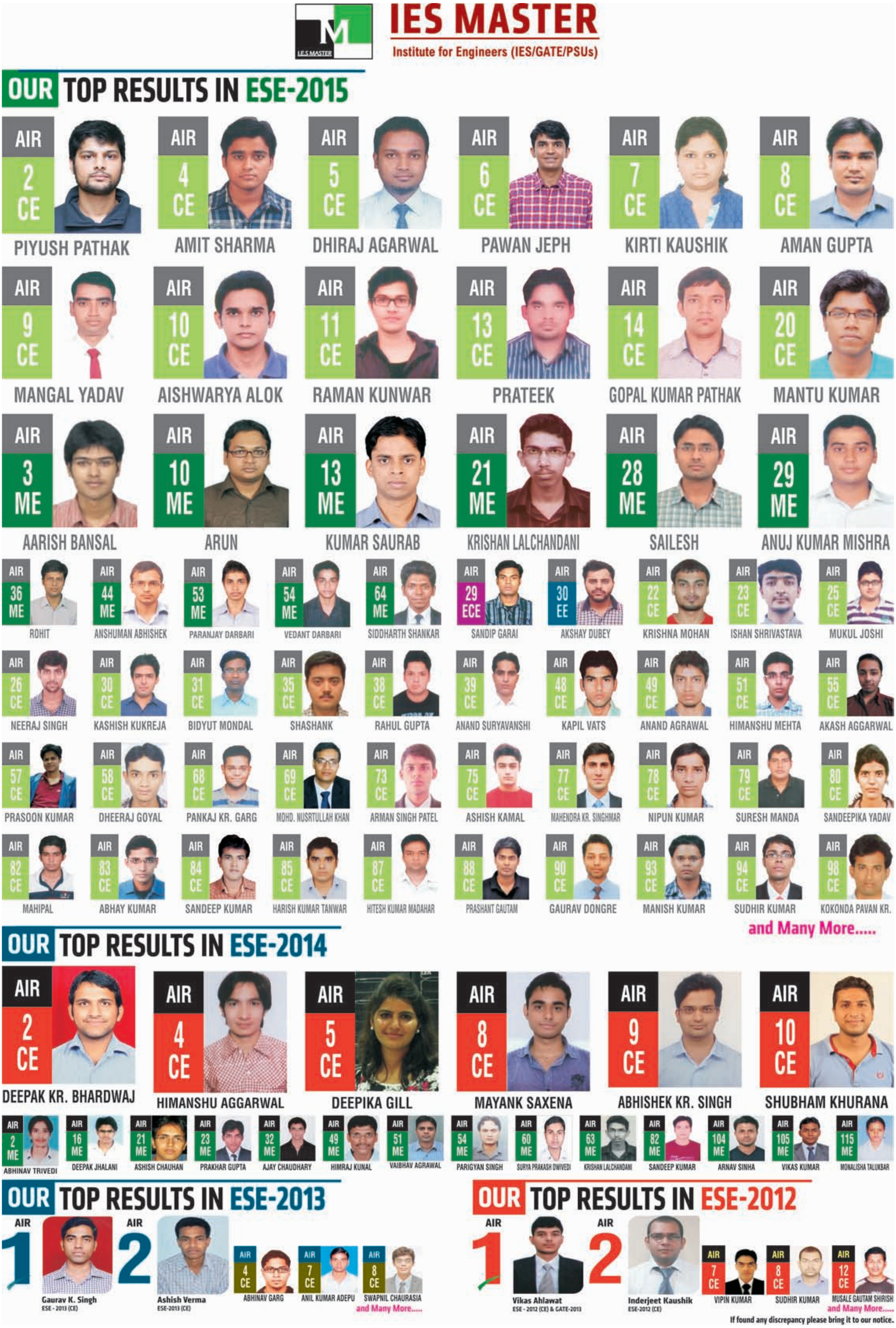
Statemennt (I) is true. The null voltage of an LVDT can not be reduced to an insignificant value. To make null voltage equal to zero, we need core made of infinite permeability which is not possible in practical.

Note. In practice, the core of LVDT is made of high permeability, nickle iron which is hydrogen annealed. This gives low harmonics, low null voltage and a high sensitivity. This is slotted longitudinally to reduce eddy current losses.

Statement (II) is alse true. Hall effect transducers are primarily used to measure

1. Flux density
2. Measurement of displacement
3. Measurerment of current
4. Measurement of power.

Individually, both statements (I) & (II) are correct. But statement (II) is not the correct explanation of statement (I). Hence answer will be (b).



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AIR 14 CE GOPAL KUMAR PATHAK
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AIR 3 ME AARISH BANSAL
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