CHAPTER-7
POTENTIOMETERS

Two Mark Questions

10. Ans: (b)

Sol: Measurement of reactance of a coil by using
Polar type ac potentiometer
Given that $I = 12\angle 13.8^0$, $V = 27.8\angle 29.7^0$

$Z = \frac{V}{I}\angle\theta_C - \theta_S$

Reactance $X = Z\sin(\theta_C - \theta_S)$, Where $\theta_C = 29.7^0$, $\theta_S = 13.8^0$

$$Z = \frac{27.8}{12}\angle 29.7 - 13.8$$

$$Z = 2.31\angle 15.9\Omega$$

Reactance $X = 2.31\sin(29.7 - 13.8)$

$$X = 0.632\Omega$$

11. Ans: (b)

Sol: The voltage read by potentiometer is 1.2V
The voltmeter reads 0.6V with 20,000Ω/V on 5V range
Input resistance $R_V = S_{DC} \times$ voltage
$R_V = 20{,}000 \times 5$
$R_V = 1{,}00{,}000\Omega$

12. Ans: (a)

Sol: Given that
Working current $I_w = 10mA$
Dial resistor having 15 steps of 10Ω each
i.e. = 150Ω
slide wire resistance is = 10Ω
Total resistance = 150 + 10 = 160Ω
Range of voltage = $I_W \times R_{total}$
$= 10 \times 10^{-3} \times 160 = 1.6V$

Resolution: slide wire provide with 100 divisions and since the total resistance of slide wire (10Ω) corresponding to a voltage drop of (10mA × 10Ω = 0.1V), each division of slide wire corresponds to = $\frac{0.1}{100} = 0.001$

With certainly the reading upto $\frac{1}{5}$ of scale division

Then resolution is $\frac{1}{5} \times 0.001 = 0.2mV$

13. Ans: (a)

Sol: For the voltage division $\left(\frac{V_0}{V_{in}}\right)$ is independent of frequency, the impedance ratio should also be independent of frequency

$$\frac{Z_1}{Z_2} = \frac{R_1 \frac{1}{j\omega c_1}}{R_1 + \frac{1}{j\omega C_1}} \times \frac{R_2 + \frac{1}{j\omega c_2}}{R_2 \times \frac{1}{j\omega c_2}}$$

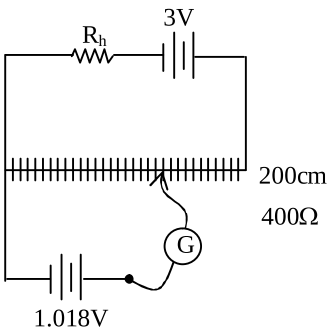
$$= \frac{R_1}{1 + j\omega c_1 R_1} \times \frac{1 + j\omega c_2 R_2}{R_2}$$

$$= \frac{R_1}{R_2} \cdot \frac{1 + j\omega c_2 R_2}{1 + j\omega c_1 R_1} \Rightarrow C_2R_2 = C_1R_1$$

$$C_1 = \frac{C_1R_1}{R_2} = \frac{1\times10^{-6}\times10}{1\times10^{3}} = 10\mu F$$

15. Ans: (a)

Sol: Given that,



Working battery is 3V
Slide wire is 400Ω
Length L = 200 cm
Let 10cm = 2Ω
Standard cell voltage is 1.018V
Sliding contact at 101.8cm
Sliding contact resistance = 2 × 101.8 = 203.6Ω
Current through the slide wire is
$1.018V = I_W \times 203.6$
$I_W = 5\times10^{-3}$
$I_W = \frac{E}{R_h + 400} \Rightarrow R_h + 400 = \frac{3}{5\times10^{-3}} = 600$
$R_h = 600 - 400 = 200\Omega$

16. Ans: (a)

Sol: Resistance of unknown resistor $R = \frac{V_R}{V_S}.S = \frac{0.4221}{1.0235}\times0.1 = 0.041208\Omega$

Current through the resistor $= \frac{V_S}{S} = \frac{1.0235}{0.1} = 10.235A$

Power loss in unknown resistance $= I^2R = (10.235)^2 \times 0.041208 = 4.316W$

17. Ans: (b)

Sol: Voltage drop per unit length $= \frac{1.45}{50} = 0.029V/cm$

Voltage drop across 75 cm length = 0.029× 75 = 2.175V

Current through resistor $= \frac{2.175}{0.1} = 21.75A$

PREVIOUS IES QUESTIONS

03. Ans: (c)

Sol: Voltage drop per unit length $= \frac{1.45}{50} = 0.029\text{V/cm}$

Voltage drop across 70 cm length = 0.029 × 70= 2.03V

$\therefore$ Current through resistor $= \frac{2.03}{1} = 2.03\text{A}$

PREVIOUS GATE QUESTIONS

One Mark Questions:

02. **(GATE-EE-1994)**

Sol: Standard cell e.m.f = 1.18V

And balanced at 600 mm

$$\therefore \text{ Working current Iw} = \frac{1.18\text{V}}{600\times10^{-3}} = 1.967\times10^{-3}\text{ A}$$

Test cell balanced at 680 mm

680 × Iw = test cell voltage (V)

$\therefore$ V = 680 × 1.96 × 10^{-3} =1.34 V

Two Marks Questions

06**. GATE – IN – 1996**

Ans: (a)

Sol: Under balanced condition

$$I_W = \frac{E}{R_h + R_{slide}}$$

$$= \frac{3.2}{200+200+2800} = 1\times10^{-3}\text{A}$$

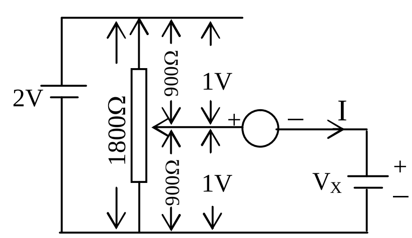
Then,

$$E_x = I_\omega \times 200 = 2\times10^{-3}\times200 = 200\text{mV}$$

07**. GATE ,IN– 2003**

Ans:(c)

Sol: Before reversing of V_x



$$I = 0.2\times10^{-3}\text{A}$$

$$-V_x - IR_m - 1v = 0$$

$$V_x = -\left(0.2\times10^{-3}\times R - 1\right)\text{------------(1)}$$

After reversing of V_x

$$I = 3.8\times10^{-3}\text{A}$$

$$V_x = 3.8\times10^{-3}\times R - 1\text{-------------- (2)}$$

Equating (1) & (2)

$$-\left[0.2\times10^{-3}R-1\right]=\left[3.8\times10^{-3}\times R-1\right]$$

$$R=\frac{2}{4\times10^{-3}}=500\Omega$$

From (2) $V_x=3.8\times10^{-3}\times500-1$

$V_x=0.9V$

08. **GATE – IN – 2004**

Ans:(a)

Sol: from the circuit

$$V=-\frac{R_f}{R}\times V_i=-\frac{15\times10^3}{10\times10^3}\times1V=-1.5V$$

09.**GATE – IN – 2004**

Ans(a)

Sol: E_x balances at 10 m 18cm

i.e 10.18m = 10.18Ω

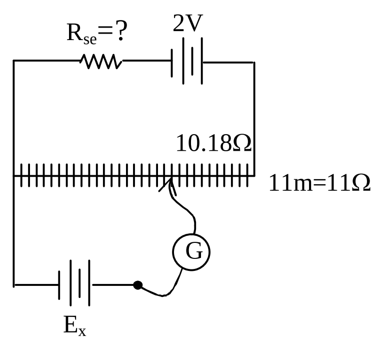
$E_x = I_w\times$ resistance of slid wire at balance

$$I_w=\frac{1.018}{10.18}=0.1A$$

$$I_W=\frac{E}{R_{SC}+11}$$

$$R_{se}+11=\frac{2}{0.1}$$

$$R_{se}=20-11=9\Omega$$



10**. GATE – IN – 2006**

Ans:(c)

Sol: Voltage across 1000Ω resistance on slide wire by

Using voltage division $=1.6\times\frac{1000}{1000+500+100}=1V$

Apply KVL

$E_V=IgR_S+1V$

$E_V=10\times10^{-6}\times100+1$

$Ev = 1.001V$