1. (20%) For DC analog ohmmeter, assumed the PMMC (Permanent Magnet Moving Coil) meter’s accuracy to ±1% of FSD, the battery standard voltage is 10 V, the center scale is 50 kΩ (0 Ω at full scale and ∞ Ω at zero). (1) Find the resistance value with relative error as the pointer stays at 0.25 FSD (10%); (2) if the battery voltage is decreased to 8 volts, as the pointer stays at 0.25FSD find the actual resistance value and the accumulated relative error in comparison to the reading value at the ohmmeter.

2. (20%) The FET input voltmeter circuit shown below has the following components: \( R_1 = 6.8 \, k\Omega \), \( R_2 = R_3 = 4.7 \, k\Omega \), \( R_4 = 1.5 \, k\Omega \), \( R_5 = 500 \, \Omega \), \( R_6 = 3.3 \, k\Omega \), \( R_s + R_m = 20 \, k\Omega \). The meter full-scale current is 50 \( \mu \)A, the supply voltage is \( \pm 10 \) V, the transistors have \( h_{FE} = 80 \), and the FET gate-source voltage is \( V_{GS} = -3 \) V. Determining the values of \( V_P \), \( I_S \), \( I_2 \), \( I_3 \), and \( I_4 \) when \( E = 0 \). Also, calculate the range of adjustment for \( V_P \).

3. (20%) A multirange voltmeter is shown in Fig. 2. Assumed \( V_{FSD} = 10 \) V, 1 V, and 100 mV and \( I_{FSD} = 50 \, \mu \)A and \( R_m = 300 \, \Omega \) for the PMMC meter, find the multiplier resistor \( R_1, R_2, R_3 \).
4. **(20%)** For the **series ohmmeter** shown in **Fig. 3**, determine the resistance scale markings at \( R_x = 0 \), \( R_x = R_1 \), and \( R_x = \infty \). Also, determine the resistance scale markings at 1/3 and 2/3 of full scale.

![Fig. 3 A series ohmmeter for electronic instrument.](image)

5. **(20%)** A PMMC instrument with \( I_{FSD} = 100 \, \mu A \) (average) and \( R_m = 200 \, \Omega \) is used in the **half-wave rectifier voltmeter** circuit as shown below. Diodes D1 and D2 have an average forward resistance of 50 \( \Omega \) and are assumed to have an infinite resistance in the reverse direction. \( R_{SH} = 200 \, \Omega \) and \( V_{FSD} = 10 \, V \, (rms) \). Calculate the value of the multiplier \( R_S \).

![Fig. 4 A half-wave rectifier voltmeter.](image)