BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
First Semester 2023-2024
Mid-semester exam (Open book)
INSTR F311-Electronic Instruments and Instrumentation Technology

Time: 90 Minutes **Max Marks:60** **Date 11.10.2023**

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1) (a) A PMMC meter with 50 Ω internal resistance can draw a maximum 100 mA current. The same meter is used to design a multi-range DC voltmeter to measure voltage ranges: 0-10 V, 0-20 V, and 0-40 V respectively as shown in ***Figure 1***. You have given a pool of 1 W power rating resistors having resistance values in multiples of 10 (10 Ω, 20 Ω, 30 Ω, 40 Ω, 50 Ω ---------- 390 Ω, 400 Ω).

(i) The theoretical values of R_1, R_2 and R_3 to design a multi-range voltmeter with given ranges.

(ii) To realize this multi-range DC voltmeter practically, which resistors one should choose from the given pool of 1 W resistors for R_1, R_2, and R_3? Justify your answer.

(iii) If the pointer deflects 90^o in all three voltage ranges, calculate the input voltage in each case assuming the range of deflection scale is $0\text{-}150^o$. **[3+3+2]**

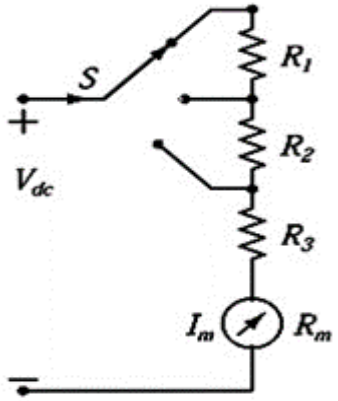


Figure 1

1) (b) A PMMC meter with 900 Ω coil resistance and a maximum meter current of 75 μA is to be used with a full wave rectifier circuit as an AC voltmeter along with a shunt resistance connected in parallel to the meter. Silicon diodes are used with a forward voltage drop of 0.7 and a minimum peak diode forward current of 80 μA when the meter indicates 0.4FSD (full-scale deflection). Draw the circuit diagram showing the values of shunt and multiplier resistance that are required for the AC voltmeter to indicate 100V rms at its full scale. **[8]**

2) (a) A galvanometer has a coil wound on a rectangular aluminum former of resistivity 27×10^{-9} Ωm. The length and width of the former are 40 mm and 25 mm respectively. The former moves in a uniform magnetic flux density of 0.15 T against a controlling torque produced by a spring of constant 15×10^{-6} Nm/rad. The moment of inertia of the moving system is found to be 60×10^{-9} Kgm^2. Determine the cross-sectional area of the aluminum former if it is to provide critical damping by neglecting the other sources of damping in the galvanometer. **[9]**

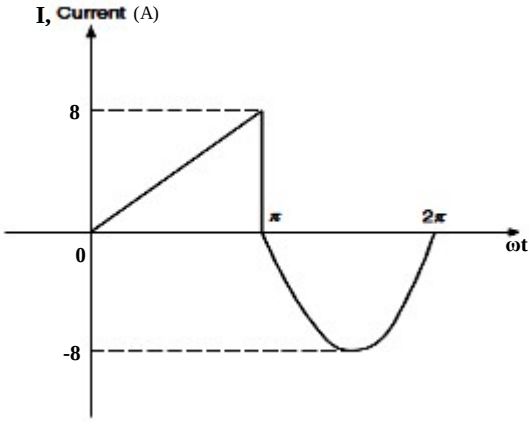
2) (b) An electrodynamometer wattmeter has a current coil of 0.2 Ω resistance with a reactance of 0.08 Ω. The potential coil is assumed to be purely resistive and the total potential coil circuit has a resistance of 7500 Ω. Calculate the percentage errors in the indicated power by the wattmeter for the below two configurations of current and potential coils, if the load takes 12 A current at a voltage of 250 V with a power factor of 0.6.

(i) when the current coil is on the load side.

(ii) when the potential coil is on the load side. **[4+4]**

3) (a) Calculate the reading that would be observed on a moving coil ammeter and moving iron ammeter when it is measuring current in a circuit whose waveform for one cycle is shown in ***Figure 2***. **[9]**

Figure 2



3) (b) A shunt-type ohm-meter with a battery voltage of V volts shown in ***Figure 3*** uses an electronic voltmeter with a full-scale reading of V/4 volts, which measures the voltage across the unknown resistance R_x as E_v between the terminals A & B respectively.

(i) What should be the relation between R_1 and R_2 to get a full-scale reading in the electronic voltmeter?

(ii) Determine the unknown resistance R_x in terms of R_1 and R_2, if the electronic voltmeter indicates one-fourth of its full-scale reading. **[2+4]**

4) (a) Draw a practical emitter follower voltmeter circuit specifying all the missing component values by utilizing the data given below:

Supply voltages ±8V, $I_3 = I_2 = 3.07$ mA, $h_{FE} = 100$, $I_4 = 2.53$ mA, $R_4 = R_6 = 3$ kΩ, $R_m = 1$ kΩ, and meter gives full-scale deflection at 100 μA when E =1 V (consider V_{BE} for the transistors as 0.7V). **[8]**

4) (b) An AC electronic voltmeter circuit shown in ***Figure 4*** has $R_1 = 10$ kΩ, $R_2 = 3.2$ kΩ, $R_3 = 6.8$ kΩ, and $R_m = 0.5$ kΩ respectively. The meter gives full-scale deflection (FSD) for 200 μA. Calculate

(i) rms input voltage E for meter FSD.

(ii) rms output voltage V_{out} for 0.5FSD. **[2+2]**

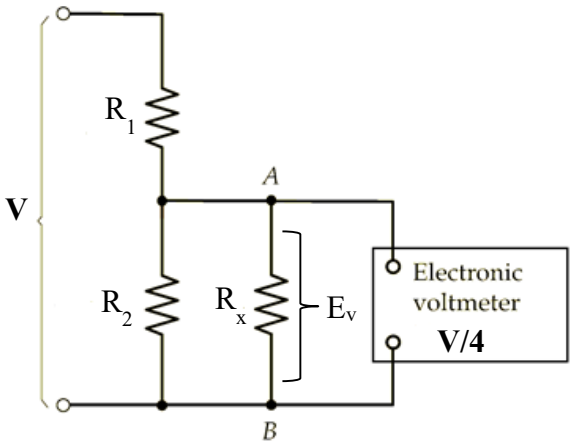
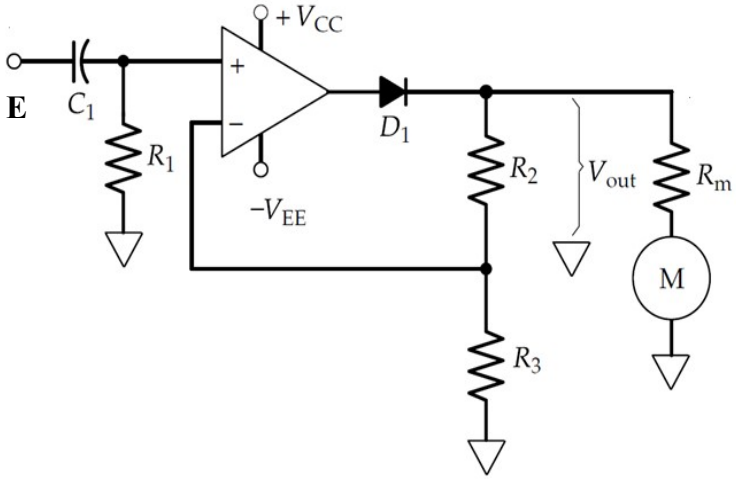


Figure 3



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