Birla Institute of Technology & Science, Pilani
Department of Electrical & Electronics Engineering
Electronic Instruments and Instrumentation Technology (INSTR F311)

A

Max Time: 90 min **First Semester 2017-18 (11/10/2017)** **Max. Marks:** 75
(Closed Book)

ID: **Name:**

1. A PMMC galvanometer with 100 turns, cross sectional area 1200 mm^2 and internal resistance 40 Ω can measure current from 0 μA -100 μA. If 40 μA current is supplied to this PMMC mechanism, calculate the deflection angle θ in degree in steady state. Consider magnetic flux density B=0.15 T and stiffness of the torsional spring $\kappa = 1.5\times10^{-6}$ N.m/radian. If resonant frequency of the coil assembly of this PMMC mechanism is 5 Hz, calculate the moment of inertia of this coil assembly. Also calculate the maximum power dissipation of this PMMC galvanometer. [3+4+3=10]

2. A PMMC Galvanometer with 20 Ω internal resistance can draw maximum 50 mA current. The same meter is used to design a multi-range DC voltmeter (Figure1) to measure voltage ranges: 0-5 V, 0-10 V and 0-20 V. You have a pool of resistances ranging from 1 Ω to 1000 Ω of (¼) W power.

a. Calculate the values of R_1, R_2 and R_3 to design a multi-range voltmeter (Ref. Figure-1).
b. Calculate the maximum power dissipation in each resistance.
c. Which resistance can't be used from the pool and why?
c. If the pointer deflects 40^o in all three voltage ranges, calculate the input voltage in each case assuming the deflection scale $0\text{-}90^o$. [3+3+2+3=10]

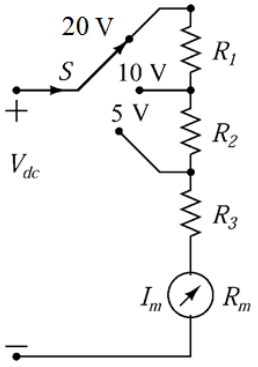

Figure-1

3. Design a symmetrical T-type attenuator to operate between 600 Ω resistances and to have an attenuation of 6 dB. What will be the error in the attenuation when the shunt arm is reduced by 5 per cent? [5+5=10]

4. A flash-type 2 bit ADC has a reference voltage of 1.8 V. How many voltage comparators does it require? How many resistors does it require? What is the increment between the voltages applied to the comparators considering all resistances are equal in magnitude? Draw the circuit diagram of a 2 bit flash-type ADC. If power dissipation in each resistor is 0.20 mW, calculate the value of each resistance? [2+2+2+2+2=10]

5. An inductance measurement bridge instrument is shown in Figure3. C_1=0.01 μF, R_1= 470 kΩ, R_2=5.1 kΩ, and R_3=100 kΩ. A coil is connected across the *a-b* terminals to measure the impedance of that coil. Derive the balanced condition for this bridge, and find out the inductance and internal resistance of that coil. Calculate the quality factor of that coil at 1 kHz frequency. [4+2+2+2=10]

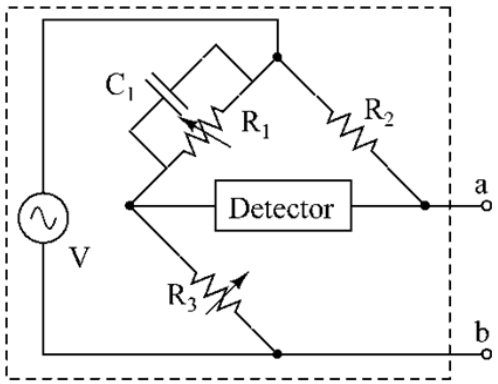

Figure-2

6. A voltage signal of frequency 75 Hz is fed to the horizontal deflection plates of a CRO. An unknown voltage signal of 1 V is fed to the vertical deflection plates. These two signals generate a Lissajous pattern as shown in Figure-3.
a. Calculate the frequency of that unknown voltage signal, which is fed to the vertical plates.
b. The same unknown voltage signal, which is coming from a source with internal resistance 600 Ω is connected to a DSO, which has an input impedance of R_i=1 MΩ in parallel with C_i=30 pF. A coaxial cable connecting this signal to the DSO has 100 pF capacitance. Calculate the oscilloscope terminal voltage. [5+5=10]

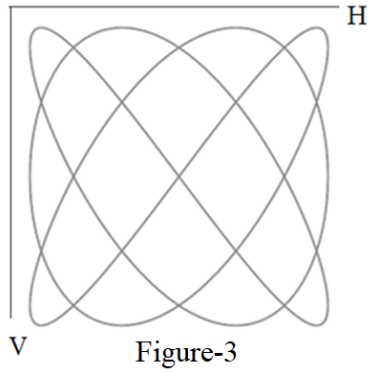

Figure-3

7. Draw the circuit diagram of a Colpitts oscillator. Label the tank circuit, and calculate the values of its components to design a Colpitts oscillator of frequency *f*=103 kHz. Consider feedback factor |β|=0.67 and series inductance of the tank circuit *L*= 20 mH. Suppose this Colpitts oscillator produces a pure sinusoidal voltage of 1.5 V, and the same signal is fed to the non-inverting input terminal of an opamp based comparator. What type of output you will get from this comparator? What will be the value of the reference voltage at the inverting input terminal of that comparator to produce a PWM signal of 25 % duty cycle? Finally draw the complete circuit including both the Colpitts oscillator and comparator. [3+4+1+4+3=15]

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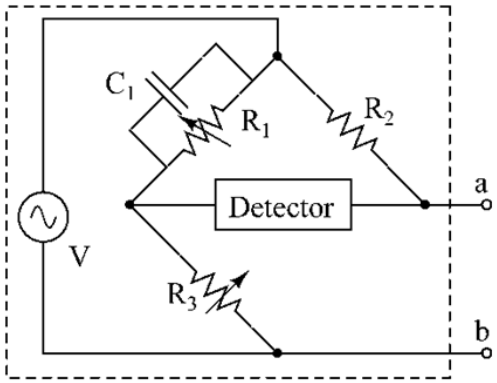
1. An inductance measurement bridge instrument is shown in Figure3. C_1=0.01 μF, R_1= 470 kΩ, R_2=5.1 kΩ, and R_3=100 kΩ. A coil is connected across the *a-b* terminals to measure the impedance of that coil. Derive the balanced condition for this bridge, and find out the inductance and internal resistance of that coil. Calculate the quality factor of that coil at 1 kHz frequency. [4+2+2+2=10]



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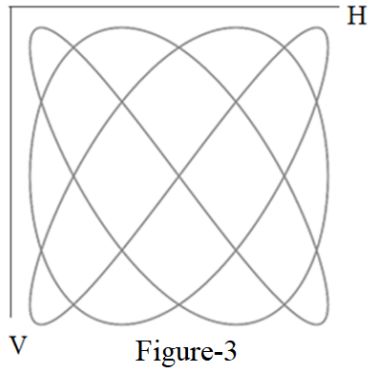

Figure-3

3. Design a symmetrical T-type attenuator to operate between 600 Ω resistances and to have an attenuation of 6 dB. What will be the error in the attenuation when the shunt arm is reduced by 5 per cent? [5+5=10]

PTO

4. Draw the circuit diagram of a Colpitts oscillator. Label the tank circuit, and calculate the values of its components to design a Colpitts oscillator of frequency f=103 kHz. Consider feedback factor $|\beta|$=0.67 and series inductance of the tank circuit L= 20 mH. Suppose this Colpitts oscillator produces a pure sinusoidal voltage of 1.5 V, and the same signal is fed to the non-inverting input terminal of an opamp based comparator. What type of output you will get from this comparator? What will be the value of the reference voltage at the inverting input terminal of that comparator to produce a PWM signal of 25 % duty cycle? Finally draw the complete circuit including both the Colpitts oscillator and comparator. [3+4+1+4+3=15]

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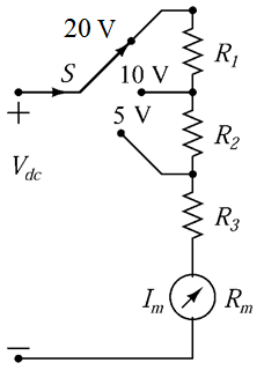

Figure-1

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