UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: December 2018

Module Number: EE4204 Module Name: Electrical and Electronic Measurements

[Three Hours]

[Answer **all questions**, each question carries ten marks]

Q1 a) State two differences between d'Arsonval meter movement and Electrodynamic meter movement.

[2 Marks]

b) A Permanent Magnet Moving Coil (PMMC) instrument with Full Scale Deflection (*FSD*) current, $I_{FSD} = 1$ mA and internal coil resistance 50 Ω is to be used in 0 to 1 V, 0 to 10 V and 0 to 100 V ranges in a multistage voltmeter.

i) Determine the values of the required multiplier resistors.

ii) Calculate the sensitivity of the voltmeter.

[3 Marks]

c) A PMMC instrument with $I_{FSD} = 50$ μA and internal coil resistance $R_m = 1700$ Ω is used in a half wave rectifier based voltmeter circuit shown in Figure Q1. The silicon diode (D_1) must have a minimum peak forward current of 100 μA when the measured voltage is 20% of *FSD*. The voltmeter is to indicate 50 V_{rms} at full scale. Calculate the values of the shunt resistance R_{SH} and series resistance R_S.

[5 Marks]

Q2 a) A Kelvin double bridge used to measure an unknown resistance (R_X) is shown in Figure Q2 a). All notations have the usual meaning.

i) State the main advantage of this bridge compared to the Wheatstone Bridge.

ii) If $aR_1 = bR_3$, show that the unknown resistance (R_X) is independent of a, b, R_y and E at the balanced condition.

[3 Marks]

b) i) Draw a circuit diagram to show how a Wein Bridge can be used to design a harmonic distortion analyzer.

ii) Briefly describe the operation of your design in part b) i).

[3 Marks]

c) i) State the type of the bridge shown in Figure Q2 c).

ii) Derive expressions to determine the unknown series resistance R_S, series inductance L_S and the quality factor Q.

iii) Given that, $R_1 = 470\ \Omega$, $R_2 = R_3 = 1\ k\Omega$ and $C_1 = 0.22\ \mu F$, determine the unknown impedance and its quality factor when the circuit is driven by a 2 kHz source.

[4 Marks]

Q3 a) The Cathode Ray Oscilloscope (CRO) is a type of electrical instrument, used for the measurements and analysis of waveforms.

i) Sketch the basic construction of a CRO.

ii) A 1 kHz triangular wave with peak amplitude 60 V is applied to the vertical deflecting plates of a CRO. A 500 Hz sawtooth wave with peak amplitude 100 V is applied to the horizontal deflecting plates. The CRO has a vertical deflection sensitivity of 0.1 cm/V, and a horizontal deflection sensitivity of 0.06 cm/V. Assuming that the two inputs are synchronized, determine the waveform display on screen.

[5 Marks]

b) Sketch the Lissajous patterns for a sine wave of 100 Hz applied to the vertical deflection plates of a CRO when the following sinusoidal signals are applied to the horizontal deflection plates.

i) 100 Hz with 90^0 phase difference

ii) 100 Hz with 180^0 phase difference

iii) 100 Hz with 45^0 phase difference

iv) 200 Hz

v) 50 Hz

[2.5 Marks]

c) A signal generator with signal amplitude 1 V and source resistance 600 Ω is connected via a 1:1 probe to an oscilloscope with an input resistance of 1 MΩ in parallel with an input capacitance of 30 pF. The coaxial cable of the probe has a capacitance of 100 pF.

i) Draw an equivalent circuit to show how the signal generator is connected to the oscilloscope via a 1:1 probe.

ii) Calculate the signal voltage level at the oscilloscope terminals when the signal frequency is 50 Hz.

ii) Will this probe give the same result in part c) ii) at 10 MHz signal frequency? Explain why?

[2.5 Marks]

Q4 a) Draw a block diagram of a digital frequency counter and briefly explain the operation of the time base generator unit.

[2 Marks]

b) Write short notes on the following:

i) Static and Dynamic performance characteristics

ii) Accuracy and Precision

[2 Marks]

c) Three resistors having nominal values of 120 Ω are connected in parallel. One has a ± 5% tolerance, and the other two have ± 10% tolerance. Calculate the total resistance and its relative error.

[3 Marks]

d) An 820 Ω resistance with an accuracy of ± 10% carries a current of 10 mA. The current was measured by an analog ammeter on 25 mA range with an accuracy of ± 2% full scale. Calculate the power dissipated in the resistor and determine the accuracy of the result.

[3 Marks]

Q5 a) i) State when to use a Logic Analyzer (LA).

ii) Give a functional block diagram for data transfer and acquisition from a target system to a Logic Analyzer.

iii) State two main requirements of probes in a LA and their importance.

[2.5 Marks]

b) i) State the meaning of the acronyms LTA and LSA and there difference.

ii) Sketch a memory map for a LA indicating the direction of data flow.

iii) Calculate the effective memory depth for a total time of data capture of 960 μs at a sampling interval of 30 ns.

iv) Explain the terms trace point and negative time in a LA.

v) Explain the use of Transition sampling and its advantage.

[4.5 Marks]

c) Explain how a real-time instruction trace is generated in a LSA.

[3 Marks]

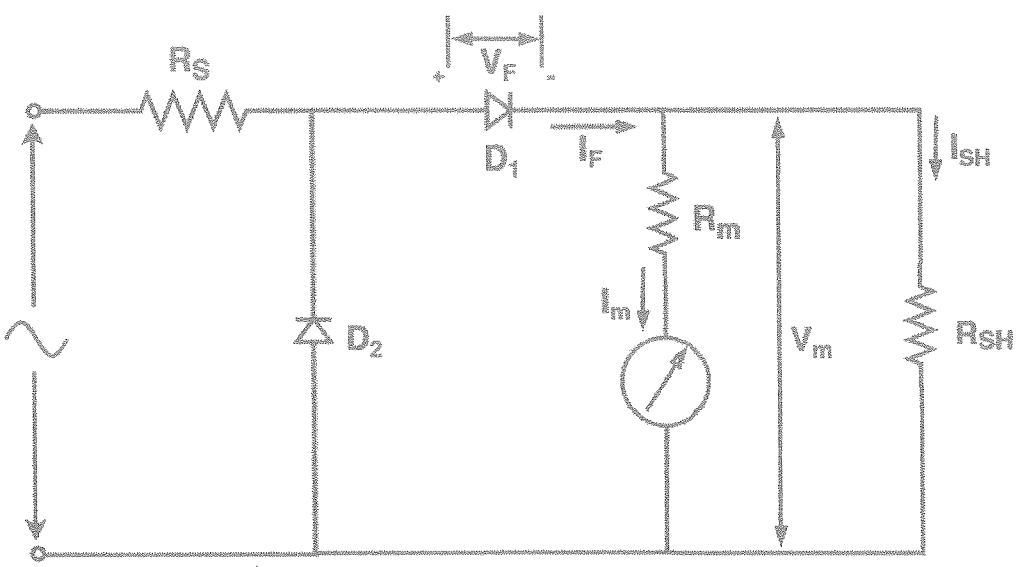

Figure Q1: Voltmeter Circuit

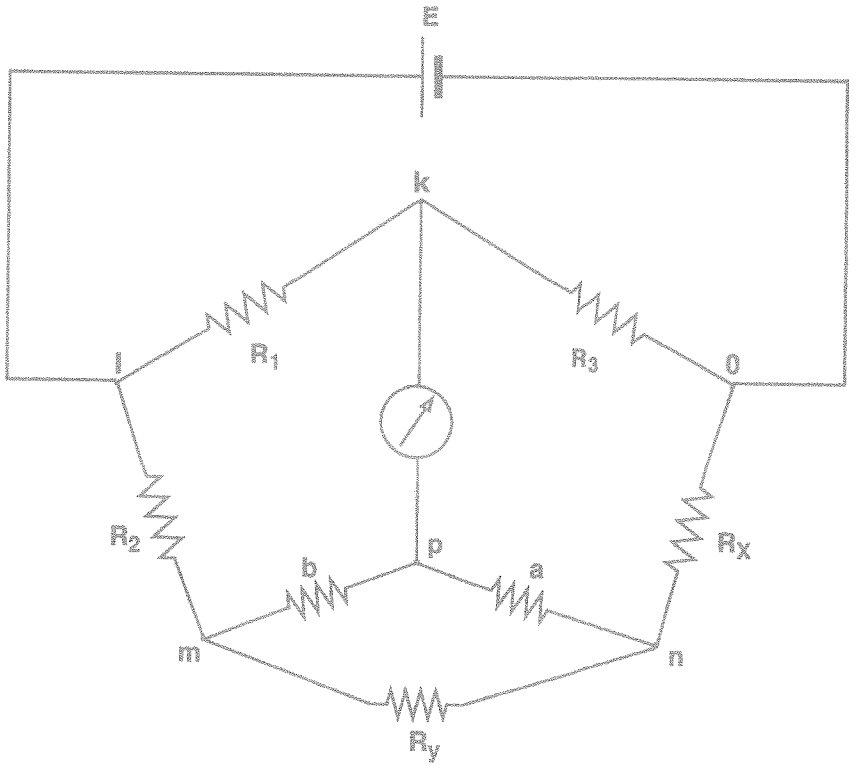

Figure Q2 a)

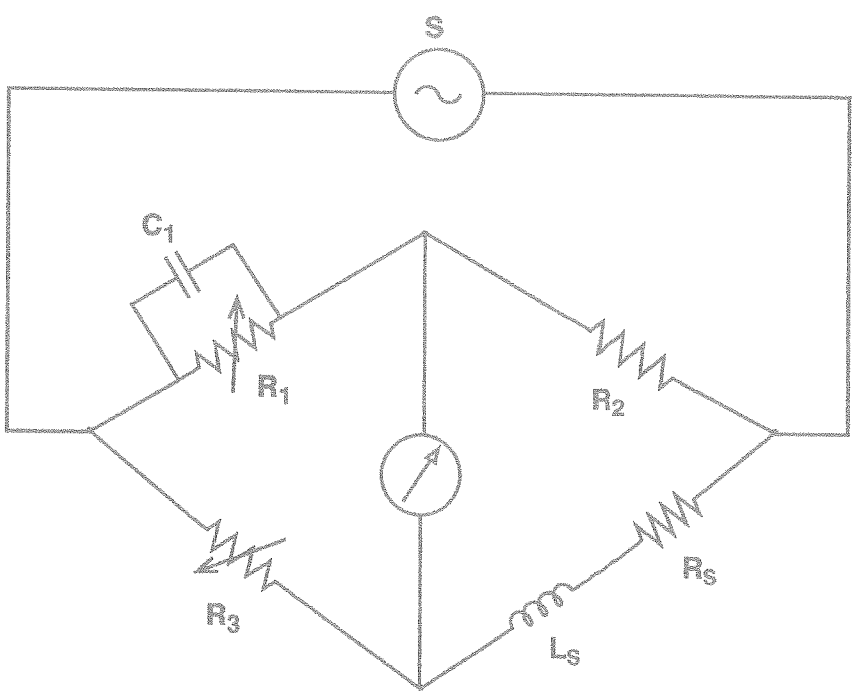

Figure Q2 c)