UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: November 2017

Module Number: EE4204 Module Name: Electrical and Electronic Measurements

[3 Hours]

[Answer all questions, each question carries ten marks]

Q1 a) Sketch a circuit diagram to show how a Permanent Magnet Moving Coil (PMMC) is used to design a three-stage ammeter in universal arrangement.

[1.5 Mark]

b) A PMMC instrument with Full Scale Deflection (FSD) = 1 mA and internal resistance 50 Ω is to be used in 0 to 1 A, 0 to 5 A and 0 to 10 A ranges in a universal arrangement ammeter. Determine the values of the required shunt resistors.

[3.5 Marks]

c) A rectifier ammeter circuit shown in Figure Q1 is to give FSD for a primary current of 250 mA. The PMMC instrument has FSD = 1 mA and R_m = 1700 Ω. The current transformer has N_s =500 and N_p =4. The diodes each have V_F =0.7 V, and the series resistance R_S =20 kΩ.

i) Calculate the required value of R_L.

ii) What is the sensitivity of the ammeter?

[5 Marks]

Q2 a) A Wheatstone bridge has a supply voltage 20 V and the known resistor values 1 kΩ. The resistance to be measured is a thermistor, which has a positive temperature coefficient of 5 Ω/°C. At 50 °C, the resistance of the thermistor is 1 kΩ. What is the temperature when the Thevenin voltage of the bridge equals 50 mV?

[2 Marks]

b) i) Draw the block diagram of a Fundamental Suppression Harmonic Distortion Analyzer.

ii) Briefly describe the operation of the rejection amplifier.

ii) Sketch the frequency response of a fundamental suppression analyzer.

[4 Marks]

c) A Wien bridge used in a harmonic distortion analyzer is shown in Figure Q2.

i) Derive an expression to find the tuned frequency of the Wien bridge under balanced condition.

ii) Given that, R_3=1.5 kΩ, R_4=1.2 kΩ and C_1= 4.7 μF, calculate the required capacitance value C_2 to tune the bridge at 50 Hz.

[4 Marks]

Q3 a) Sketch the basic construction of a Cathode Ray Oscilloscope (CRO). Explain briefly the operation of the following sections.

i) Triode Section
ii) Focusing Section
iii) Deflection Section

[3 Marks]

b) A 500 Hz triangular wave with peak amplitude 40 V is applied to the vertical deflecting plates of a CRO. A 250 Hz sawtooth wave with peak amplitude 50 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 0.08 cm/V. Assuming that the two inputs are synchronized, determine the waveform display on screen.

[4 Marks]

c) A signal generator with signal amplitude 1 V supply and source resistance 1 kΩ is connected to an oscilloscope with an input impedance of 1 MΩ in parallel with an input capacitance of 25 pF. The coaxial cable of the probe has a capacitance of 90 pF.

i) Calculate the signal voltage level at the oscilloscope terminals when the signal frequency is 100 Hz and the probe operates in 1:1 mode.
ii) Calculate the signal frequency at which the signal voltage level at the oscilloscope terminals is 3 dB below supply voltage.
iii) Determine the value of the compensation capacitor required when the same probe operates in 10:1 mode.

[3 Marks]

Q4 a) Write short notes on the following under the performance characteristics of measuring instruments.

i) Static and dynamic performance characteristics
ii) Accuracy and precision
iv) Fidelity

[3 Marks]

b) A DC power supply provides currents to four electronic circuits. The currents are 37 mA, 42 mA, 13 mA and 6.7 mA. The first two are measured to an accuracy of ±3%, and the other two are measured to ±1% accuracy. Determine the accuracy of the total supply current.

[2 Marks]

c) Two currents (I_1 and I_2) from different sources flow in opposite directions through a resistor. I_1 is measured as 79 mA on a 100 mA analog instrument with an accuracy of ±3% of full scale. I_2 is determined as 31 mA, as measured on a digital instrument with ±100 μA accuracy. Calculate the maximum and minimum levels of the current in the resistor.

[2 Marks]

d) The voltages at opposite ends of a 5.6 kΩ ± 5% resistor R are measured as, V_1 =15 V and V_2 =6 V. The measuring accuracies are ±0.5 V for V_1 and ±1% for V_2.

i) Calculate the level of current I in the resistor and specify its accuracy.
ii) Determine the maximum and minimum power dissipation in the resistor (Hint: Use $P=I^2R$ to calculate the power).

[3 Marks]

Q5 a) The performance of a Logic Analyzer is similar to a Digital Oscilloscope. But its functionality is quite different.

i) State when to use a Digital Oscilloscope.

ii) State the meaning of the acronyms SOC and VLSI.

iii) State the main limitation with Digital Oscilloscopes when we want to study the performance of a VLSI chip.

[1.5 Marks]

b) i) Give a block diagram to demonstrate the funcuonality of a Logic Analyzer.

ii) State the two modes of operation of a Logic Analyzer and how they are selected.

iii) Explain two main requirements of the probes in a Logic Analyzer.

iv) Explain the use of Transition Sampling and its advantage.

[5.5 Marks]

c) Some of the real-time instruction trace across the Logic Analyzer bus is given in Table 1.

i) Explain how the data in Table 1 is generated from the timing diagrams.

ii) How many channels in the Logic Analyzer are considered for the data in Table1?

iii) State another method of displaying the data in Table 1.

[3 Marks]

Table 1

Sample	Counter	Instruction	Time Stamp
0	7E00	MOVEQ #0000,07	0
1	1E15	MOVE,B (A5), 07	30ns
2	6600	BNE.W _uprint+22	60ns
3	2004	MOVE, L 04,D0	90ns
4	4FEF	LEA (0036,A7),A7	120ns

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