THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY

DEAE5/DICE5/DEPE5/DEPE5E/DEAE6

INSTRUMENTATION TECHNOLOGY 2

END OF SEMESTER EXAMINATIONS

SERIES: AUGUST/SEPTEMBER 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Question paper*
- *Answer booklet*

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

This paper consists of **FIVE** printed pages

Question 1 (30 Marks)

a) (i) State at least four reasons why an intermediate element is required in a measurement system. (2 marks)

(ii) A compound lever is designed as shown in the figure 1.0 below. Derive the expression that relates F_1 to F_3 (3 marks)

Figure 1.0

(iii) What are the limitation of such type of amplifiers (2 marks)

b) The figure 2.0 below shows a non inverting amplifier. If $R_1 = 2k\Omega, R_f = 10k\Omega$ and the input voltage is given by $V_i = 5\sin \omega t$ in mV, calculate;

Figure 2.0

i) The output of the amplifier

ii) What is the maximum frequency of the input at which the output will be undistorted? Assume the amplifier is initially nulled and the slew rate of the op amp is 0.5V/μ s. (4 marks)

iii) Using relevant expression, define common mode rejection ratio and explain the significance of a very large CMRR. (3 marks)

c) (i) With the aid of a diagram, describe how a parallel comparator ADC works (5 marks)

(ii) An analog to digital converter has a clock frequency of 1 MHz. the full scale output of the D/A converter is 8.19V with a 12 bit input. The comparator threshold is 1mV, if the analog input is 4.528V, determine;

a) The number of steps (2 marks)
b) Conversion time (2 marks)
c) Percentage resolution (2 marks)
d) Digital data obtained from the conversion (2 marks)

Question 2 – (20 marks)

a) A flow meter is made of Differential Pressure (DP) sensor and an analog meter. The meter begins by concerting flow rate into differential pressure, the differential pressure is then converted into current and the current is indicated on an analog meter. If the equation for the DP sensor is $\Delta P = 2\times106Q^2$, where P is pressure in bars and Q is flow in m^3/s; and that of the pressure to current converter is $I = 20\Delta P$, where I is current in mA and the ammeter angular displacement equation is given by $\theta = 14I$, where θ is in degrees. When the flow rate is $0.004m^3/s$. calculate;

i) The differential pressure (3 marks)
ii) The current from the pressure converter (2 marks)
iii) The angle of the needle on the dial (2 marks)
iv) Draw a neat labeled block diagram of the flow meter (3 marks)

b) An instrument system consists of pressure transducer with a range of 3 to 15 Psi and a corresponding output of 0 to 10mV. The output is connected to an electronic processor which converts the output into a current in the range 4 to 20 mA, and an analogue meter which indicates the measured pressure.

i) Draw a neat labeled block diagram of the system (2 marks)
ii) Deduce and write down the gain equation linking the output and input of the pressure transducer. (2 marks)
iii) Deduce and write down the equation linking the input and output of the processer. (3 marks)
iv) The output of the signal processor is 12mA. Deduce the indicated pressure. (3 marks)

Question 3 – (20 marks)

a) (i) Give at least five characteristics of an ideal op amp (5 marks)

(ii) Design a combination of a summing amplifier and an inverting amplifier such that the arrangement procedures an output V_o given by the equation $V_0 = -1(2+3e_1)$ if the summing amplifier has 2V and e_1

as the inputs. (6 marks)

b) (i) Using a well labeled diagram, explain the working principal of binary weighted resistor DAC's (5 marks)

(ii) In a 4 bit binary weighted DAC, the highest weighted resistor has a value of 400KΩ. Determine the resistance of the other resistors. (4 marks)

Question 4 – (20 marks)

a) Discuss using relevant expressions and diagrams how lissajous figures can be used to measure the frequency of an unknown signal and the phase difference of signals with the same frequency. (6 marks)

b) Figure 3.0 shows the features of a cathode ray tube.

Figure 3.0

i) Name the parts labeled A and B. (2 marks)
ii) Explain how the electrons are produced in the tube (2 marks)
iii) State two functions of the anodes (2 marks)
iv) Why is a vacuum created in the tube? (1 mark)

c) The graph in figure 4.0 was obtained on a cathode ray oscilloscope (CRO) screen when the output of an a.c generator was connected to the input of the CRO. The time-base calibration of the CRO was set at 20 milliseconds per centimeter and the y-gain at 5 volts centimeter.

Figure: 4.0

i) Determine the pick voltage of the generator (2 marks)
ii) Determine the frequency of the voltage (3 marks)
iii) What will happen when the time base calibration is set at 40 milliseconds per centimeter and y – gain at 10 volts per centimeter? (2 marks)

Question 5 – (20 marks)

a) A low pass RC filter is designed by using a 100KΩ resistor and a capacitor of unknown capacitance. Find the value of the unknown capacitor if the frequency range is between 500Hz to 10KHz. (5 marks)

b) Describe using relevant equations and diagrams how this filter works (7 marks)

c) Draw a high pass filter and describe how it works. (8 marks)