



COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

DIPLOMA IN ELECTRONIC ENGINEERING

EED520 – ELECTRONIC INSTRUMENTATION

FINAL EXAMINATION – SEMESTER 1, 2019

DATE: As per timetable

TIME: As per timetable

TIME ALLOWED: 2 HOURS 10 MINUTES

INSTRUCTIONS:

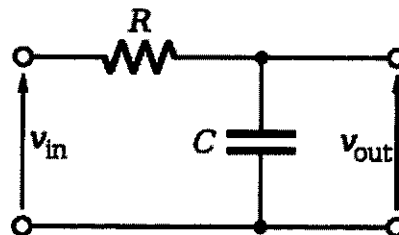
- 1. You are allowed 10 minutes Extra reading time during which you are NOT to write.*
- 2. Begin each section on a new page and use both sides of the sheet.*
- 3. Write your candidate-number at the top of each attached sheet.*
- 4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string.*
- 5. For all sheets of paper on which rough/draft work has been done, cross each one through and ATTACH these to your answer scripts.*
- 6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.*
- 7. Show all working clearly where necessary.*
- 8. Programmable calculators are not allowed, especially the ones that does the conversions of number systems.*
- 9. Check your work before leaving the exam hall.*
- 10. ANSWER ALL QUESTIONS.*

Section A – Multiple Choice

[20 marks]

Choose the appropriate answer from each question by writing the alphabet beside the question number in your answer booklet.

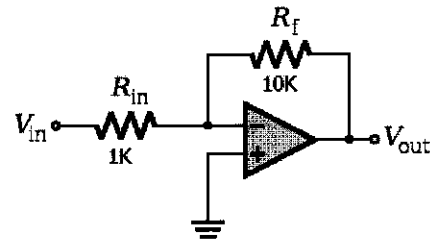
- Frequency can be measured by using
 - Wien bridge
 - Schering bridge
 - Maxwell bridge
 - Heaviside Campbell bridge
- The advantage of Hay's bridge over Maxwell's inductance–capacitance bridge is that
 - its final balance equations are independent of frequency
 - it reduces cost by not making capacitor or inductor as the variable parameters
 - it can be used measuring low Q inductors
 - it can be used measuring high Q inductors
- Thermocouples
 - require reference junction compensation
 - are most commonly used as temperature transducer
 - have an ion output voltage level
 - all of the above
- What is the sensitivity of an instrument whose output is 20mV for an input change of 10°C?
 - 2 mV/°C
 - 0.5 mV/°C
 - 2 °C/mV
 - 0.5 °C/mV
- The process of converting the analog sample into discrete form is called
 - Modulation
 - Multiplexing
 - Quantization
 - Demultiplexing
- The circuit shown on the right is of a;
 - Amplifier
 - Low Pass Filter
 - High Pass Filter
 - Comparator



Please Turn Over

7. Which of the following is NOT true regarding the advantages of Thermocouples?
- Linear, wide and high range
 - Wide and high range, inexpensive
 - Inexpensive, rugged
 - Nonlinear, require an external power supply

8. Using the amplifier circuit shown on the right, the signal V_{in} from the sensor will be amplified by a factor of;
- 10
 - 11
 - 0.1
 - 10.1

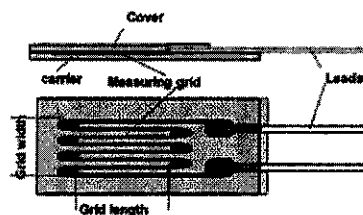


9. A strip chart recorder is a/an
- analog recorder
 - magnetic tape recorder
 - oscillographic recorder
 - none of the above
10. A LDR used as a light sensor is connected as a voltage divider circuit with a $1k\Omega$ resistor. If the supply voltage is 10V, what is the output voltage across the resistor with LDR having a resistance of $4k\Omega$?
- 8V
 - 2V
 - 2.5V
 - 10V
11. Which of the following is NOT a method of circuit protecting the next element of the control system?
- Series capacitor to limit line current
 - Fuse to break if the current does exceed a safe level
 - Zener diode circuit to protect against high voltage and wrong polarity.
 - Optoisolator to isolate circuits completely
12. What is the SI unit of Weight?
- Newton (N)
 - Gram (g)
 - Kilogram (kg)
 - Pascal (Pa)

Please Turn Over

13. The measured value of a resistance is 10.25Ω , whereas its value is 10.22Ω . Determine the absolute error of the measurement.
- 0.03Ω
 - 1.003Ω
 - 0.997Ω
 - 20.47Ω
14. The two types of errors, Instrumental error and Environmental error, are classified under;
- Systematic Error
 - Random Error
 - Human Error
 - Gross Error
15. In general, a multiplexer has
- one data input, several data outputs, and selection inputs
 - one data input, one data output, and one selection input
 - several data inputs, several data outputs, and selection inputs
 - several data inputs, one data output, and selection inputs
16. The smallest change in a measured variable to which an instrument will respond is;
- Precision
 - Resolution
 - Sensitivity
 - accuracy
17. The errors mainly caused by human mistakes are
- systematic error
 - instrumental error
 - random error
 - gross error
18. Which of the following is commonly used for the measurement of Force?
- Photodiode
 - Optical Pyrometer
 - Piezoelectric Material
 - Thermistor

19. The sensor shown is a;
- Strain Gauge
 - RTD
 - Flow Meter
 - Pyrometer



Please Turn Over

20. The output of a 1-to-4 Demultiplexer having a HIGH input and Data Selectors $S_1 = 1, S_0 = 0$ would give $D_3D_2D_1D_0$ as

- A. 1101
- B. 0010
- C. 0100
- D. LOW

Section B – Short Answers

[40 marks]

1. A simple closed-loop motor controller circuit is shown in figure 1 and its equivalent block diagram represented figure 2.

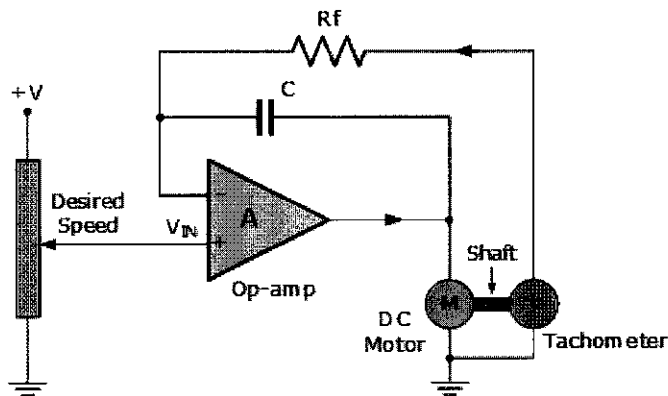


Fig. 1 – Closed-loop Motor Controller Circuit

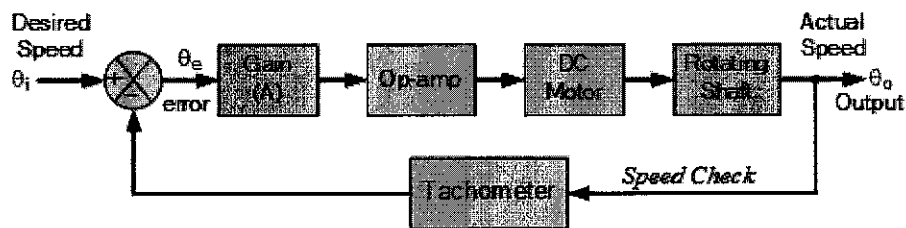


Fig. 2 – Block Diagram for the Feedback Controller

Identify the following elements from the above figures;

- A. Sensor
- B. Actuator
- C. Controller
- D. Feedback

(4 marks)

2. Explain clearly the Seebeck Effect.

(2 marks)

3. Give two advantages of Electrical Signal Conditioning.

(2 marks)

Please Turn Over

4. Discuss one of the advantages and disadvantages of Maxwell's bridge for measurement of unknown inductance. (2 marks)
5. What do you understand by Signal Conditioning? (2 marks)
6. Explain how you will read the change in thermistor output in terms of voltage when it is used for temperature measurement. (3 marks)
7. List any two methods of force measurement. (2 marks)
8. List and describe any three specifications for a sensor/transducer that you will carefully consider before selecting for the measurement of weight of the cane trucks in sugar mills. (6 marks)
9. With an aid of a diagram, briefly explain the principle operation of Optical Pyrometers. (5 marks)
10. In terms of their principle operation, how does a Thermocouple differ from a RTD? (2 marks)
11. What are the two advantages of automatic control over manual control? (2 marks)
12. Explain the difference between accuracy and precision in an instrument. (2 marks)
13. What were the most common errors you encountered while taking the measurements in the lab during your lab practical's. List any two of them. (2 marks)
14. Name the sensor/transducer that is used for the following measurements;
 - A. Flow (1 mark)
 - B. Displacement (1 mark)
15. What is a NTC Thermistor and how does it functions? (2 marks)

Please Turn Over

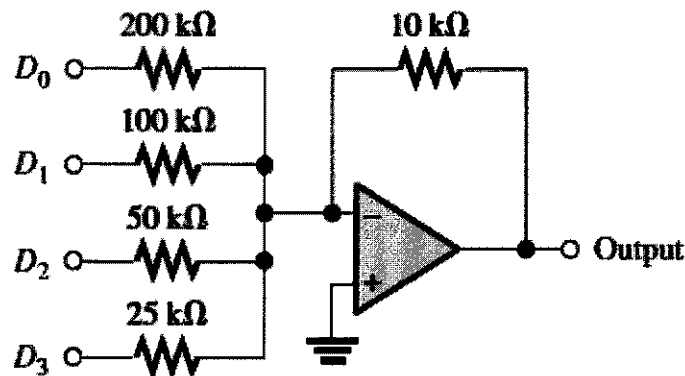
Section C – Calculations & Diagrams

[40 marks]

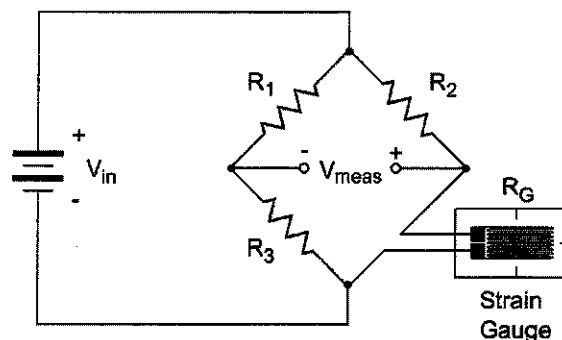
1. A Maxwell-Wien bridge uses a standard capacitor of $C = 0.1\mu\text{F}$ and operates at a supply frequency of 100Hz . Balance is achieved when $R_2 = 1.26\text{k}\Omega$, $R_3 = 500\Omega$, and $R_4 = 470\Omega$.
Calculate the inductance and resistance of the measured inductor.
(3 marks)
2. An LDR varies between 500Ω and $12\text{k}\Omega$ according to the level of light intensity on it. If it is used in a potential divider in conjunction with a 15V power supply and a $2.0\text{k}\Omega$ fixed resistor;
 - A. Show with a schematic diagram how the LDR will be connected in this potential divider. (2 marks)
 - B. Calculate the range of voltages that can be tapped off across the fixed resistor. (2 marks)
3. For one of the applications, you are required to filter the signals below 15kHz . Draw the passive filter circuit you would use and calculate the value of the resistor if you are given a value of capacitance as 470pF .
(3 marks)
4. Given a 3-bit DAC with a 1V full-scale voltage and accuracy $\pm 0.2\%$, find in terms of voltage the;
 - A. Resolution (2 marks)
 - B. Accuracy (2 marks)
5. A sensor is designed for measuring temperature from -30°C to $+80^\circ\text{C}$ and it outputs 1.2V to 2.5V .
Find the;
 - A. Range and Span of the sensor, (1 mark)
 - B. Sensors input full scale reading, (1 mark)
 - C. Output full scale reading. (1 mark)
6. A motor running one of the processes in the factory is extremely heating up due to its continuous operation. You are required to switch off the motor when it reaches a critical temperature of 45°C .
 - A. Name the sensor will you select for this application? (1 mark)
 - B. Draw the signal conditioning circuit you will use for this application. (2 marks)
7. An 8-bit ADC is converting a temperature signal which has a measuring range of 0°C to 800°C . Calculate the resolution of the temperature measuring instrument. (2 marks)

Please Turn Over

8. Determine the output of the DAC shown below if a 4-bit number 1010 is applied to the inputs. The data inputs have a low value of 0V and a high value of +5V. (3 marks)



9. A strain gauge was connected to a Wheatstone bridge circuit as shown below. Calculate the output voltage across the V_{meas} terminals of the bridge circuit if the strain resistance of the strain gauge is 120Ω , and $R_1 = R_2 = R_3 = 100\Omega$. (2 marks)

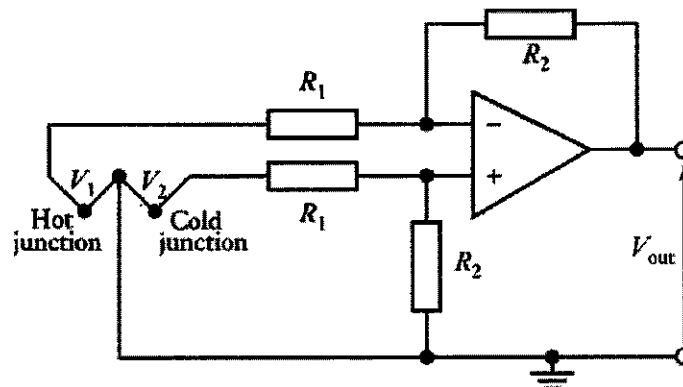


10. A pressure gauge with a measurement range of 0 to 10 bar has a quoted inaccuracy of $\pm 1.0\%$ of the full-scale reading.
- What is the maximum measurement error expected for this instrument? (2 marks)
 - What is the likely measurement error expressed as a percentage of the output reading if this pressure gauge is measuring a pressure of 1 bar? (2 marks)
11. The width of a room is measured 10 times by an ultrasonic rule and the following measurements are obtained (units of meters): 4.292, 4.295, 4.296, 4.293, 4.292, 4.294, 4.293, 4.290, 4.294, and 4.291. The width of the same room is then measured by a calibrated steel tape that gives a reading of 4.276m, which can be taken as the correct value for the width of the room.
- What is the measurement precision of the ultrasonic rule? (2 marks)

Please Turn Over

B. What is the maximum measurement inaccuracy of the ultrasonic rule? (3 marks)

12. The difference in voltage between the emfs of the two junctions of the thermocouple is being amplified. A temperature difference between the thermocouple junctions of 25°C produces an emf difference of 620µV, with an output of 10mV.



A. Calculate the ratio of the resistance, R_2/R_1 (2 marks)

B. If $R_1 = 10\text{k}\Omega$, calculate the value of R_2 . (2 marks)

The End

-----GOOD LUCK-----

