



MACHAKOS UNIVERSITY

University Examinations 2018/2019

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF
SCIENCE IN MECHANICAL AND MANUFACTURING ENGINEERING

EMM 313: MEASUREMENT AND INSTRUMENTATION

DATE: MAY 2019

TIME: 2 HOURS

INSTRUCTIONS

1. This examination contains **FIVE** questions
2. You are required to attempt **THREE** questions.
3. **QUESTION ONE** is **COMPULSORY** and contains **30 MARKS**. The remaining **FOUR** questions contain **20 MARKS** each.
4. All symbols have usual meaning unless otherwise stated
5. Use **CLEAR, NEAT** and **WELL-LABELLED** sketches

QUESTION ONE (30 MARKS)

a. Define the following terms:

[3 marks]

- | | |
|----------------|-----------------|
| i. Measurement | iii. Radian |
| ii. Measurand | iv. Steradian |
| v. SI unit | vi. Calibration |

- b. Highlight and explain three categories of SI unit system. [3 marks]
- c. Explain four reasons why an instrument may need to be calibrated. [4 marks]
- d. With the aid of a well labelled diagram, explain the various elements of a measurement system. [10 marks]
- e. Highlight two merits and demerits of gravity control in an analog instrument. [4 marks]
- f. Name four types of A.C bridges. [2 marks]
- g. Name four sources of external noise and interference. [4 marks]

QUESTION TWO (20 MARKS)

- a. Define the term first order instrument. [2 marks]
- b. Explain three static and dynamic characteristics of an instrument. [6 marks]
- c. Define the term an error then using examples, explain three sources of errors. [4 marks]
- d. Suppose that the length of a steel bar is measured by several different observers and the following sets of 11 measurements in Table Q 2 (d) are recorded (units mm). Determine the following: [7 marks]
 - i. Arithmetic mean ($\bar{X}$)
 - ii. Deviation from the mean (d)
 - iii. Average deviation (D)
 - iv. Standard deviation (σ)
 - v. Variance (ν)
 - vi. Probable error ($\pm r$)
 - vii. Which set of measurements is more accurate? Explain your answer. [1 mark]

Table Q 2 (d)

SET A	398	420	394	416	404	408	400	420	396	413	430
SET B	409	406	402	407	405	404	407	404	407	407	408

QUESTION THREE (20 MARKS)

- (a) Explain giving examples the various classifications of analog instruments. [3 marks]
- (b) With the aid of a well labelled diagram and an equation, explain the principle behind spring control in an analog instrument. [5 marks]
- (c) The control spring of an instrument has the following dimensions: length of strip = 370 mm, thickness of strip = 0.073mm, width of spring = 0.51 mm and the young's modulus is 112.8 GPa. What will be the torque exerted by spring when it's turned through 90 degrees? [2 marks]
- (d) Using a diagram, explain how eddy current damping is achieved. [3 marks]
- (e) Draw the schematic of a digital instrument. What advantages do these instruments offer over their analog counterparts. [4 marks]
- (f) Explain the working principle of ultrasonic transducers then give examples where such a principle can be applied. [3 marks]

QUESTION FOUR (20 MARKS)

- a. Fig. Q 4 (a) shows a bridge circuit with values of the circuit elements. The battery voltage is 5 V and the internal resistance is negligible. The galvanometer has a current sensitivity of 10 mm/ μ A and an internal resistance of 100 Ω . Calculate the deflection of the galvanometer caused by the 5 Ω unbalance in arm BC. [4 marks]

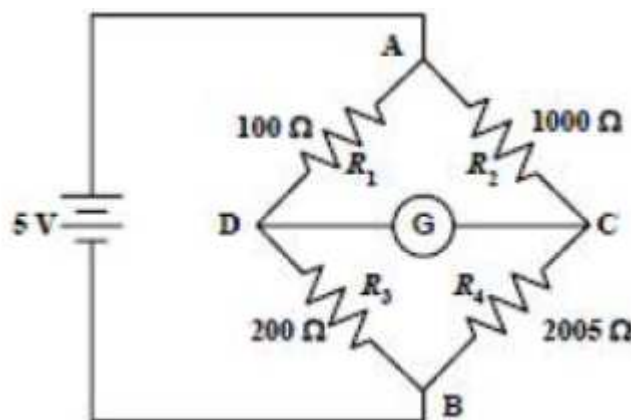


Fig. Q 4 (a)

- b. The impedance of a basic AC bridge are given as follows: $Z_1 = 100\Omega\angle 80^\circ$ (inductive impedance) $Z_2 = 250\Omega$ (pure resistance) $Z_3 = 400\Omega\angle 30^\circ$ (inductive impedance) and $Z_4 = \text{unknown}$. Determine the value of Z_4 in polar form. [3 marks]
- c. Explain why the secondary coil of a current transformer is never left open. [4 marks]
- d. A 250:5 current transformer is used along with an ammeter. If the ammeter reading is 3.5 A, estimate the line current. [2 marks]
- e. Explain using a diagram how a sample microprocessor-based instrumentation system for an industry can be used for measurements. [7 marks]

QUESTION FIVE (20 MARKS)

- a. Define the term signal conditioning. [1 mark]
- b. Explain the following signal conditioning techniques: [3 marks]
 - i. Attenuation
 - ii. Sampling
 - iii. Filtering
- c. Using diagrams, explain the four broad categories of filters. [9 marks]
- d. Other than filters, explain four other methods that can be used to reduce noise and interference. [7 marks]