



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 313: MEASUREMENT AND INSTRUMENTATION

DATE: 23/5/2019

TIME: 8.30-10.30 AM

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
 - ii. Measurand
 - iii. SI unit
 - iv. Radian
 - v. Steradian
 - 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)
- Arithmetic mean ($\bar{X}$)
 - Standard deviation (σ)
 - Deviation from the mean (d)
 - Variance (v)
 - Average deviation (D)
 - Probable error ($\pm r$)
 - 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)

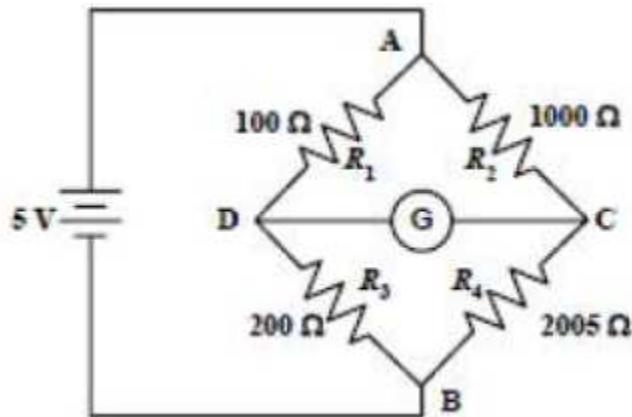


Fig. Q 4 (a)

- 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 =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)
- Attenuation
 - Sampling
 - 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)