



MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS 2018/2019 ACADEMIC YEAR *FOURTH YEAR FIRST SEMESTER*

SCHOOL OF SCIENCE BACHELOR OF SCIENCE (PHYSICS)

COURSE CODE: PHY 424E

**COURSE TITLE: MEASUREMENT AND
INSTRUMENTATION**

DATE: 14TH December 2018

TIME: 0830-1030

INSTRUCTIONS TO CANDIDATES

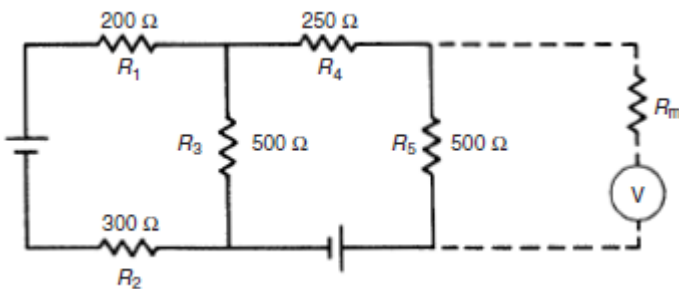
1. Answer Question **ONE** and any other **TWO** questions
2. Use of sketch diagrams where necessary and brief illustrations are encouraged.
3. Read the instructions on the answer booklet keenly and adhere to them.

Question one (30 marks)

- a) Define
- i) Measurement (2marks)
 - ii) Instrumentation (2marks)
 - iii) Loading effect as applies to ammeters and voltmeters (3marks)
- b) By definitions distinguish between the following types of sensors
- i) Photomultiplier (1mark)
 - ii) Phototube (1mark)
 - iii) Photoresistor (1mark)
 - iv) Photodiode (1mark)
- c) Define a Gaussian curve, what is its relevance in measurements (3marks)
- d) A circuit requirement for a resistance of 550Ω is satisfied by connecting together two resistors of nominal values 220Ω and 330Ω in series. If each resistor has a tolerance of $\pm 2\%$, what is the error in the sum? (4marks)
- e) State any four quantities whose standard unit of measurement includes the derived m^2 in its composition (4marks)
- f) With the aid of circuit diagrams, explain the working of an electro-dynamometer instrument as:
- i) An ammeter (4marks)
 - ii) A wattmeter (4marks)

Question Two (20 marks)

- a) Analyze and evaluate the error in measurement when a voltmeter of internal resistance 9750Ω is used to measure the voltage across resistor R_5 in the circuit below. What decision would you make from your analysis? (15marks)



- b) Differentiate between analogue and digital instruments (2marks)
- c) Explain the terms precision, repeatability and reproducibility as used in measurement and instrumentation (3marks)

Question Three (20 marks)

- a) Define the term transducer and name any three classes of transducers
(4marks)
- b) What is a sensor
(1mark)
- c) i) Explain the derivation of the expression $\ddot{\theta} + \frac{K_i^2 \dot{\theta}}{JR} + \frac{K_s \theta}{J} = \frac{K_i V_t}{JR}$ describing the dynamic response of a chart recorder following a step change in the electrical voltage output of a transducer connected to its input. Explain also what all the terms in the expression stand for. (Assume that the impedances of both the transducer and recorder have a resistive component only and that there is negligible friction in the system. (12marks)
- ii) What are expressions for the measuring system natural frequency, ω_n , the damping factor, ξ , and the steady-state sensitivity. (3marks)

Question Four (20 marks)

- a) Briefly explain the physics principle applied in the working of following measurement techniques
- i. Infrared spectroscopy (3marks)
 - ii. Ultra violet/visible absorption spectroscopy (3marks)
 - iii. Nuclear magnetic resonance spectroscopy (3marks)
 - iv. Mass spectroscopy (3marks)
 - v. Atomic absorption spectroscopy (3marks)
- b) State one application for each of the techniques in (a) above. (4marks)