



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, APRIL/MAY 2019

COURSE NO: EL 172
COURSE NAME: INSTRUMENTS AND MEASUREMENTS
CLASS: EL I **TIME:** 2¹/₂ HOURS

ANSWER ALL QUESTIONS

SECTION A

ANSWER TRUE OR FALSE in your answer booklet. Half mark will be deducted for every wrong answer given. You would be instructed as to how to arrange the numbering of your answers in your answer booklets. The question paper in this Section must be tied loosely *into* the answer booklet and therefore not leaving the Exams Room. **(35 marks)**

1. For multi-range voltmeters (MRV), the rotary switch used with the voltmeter should be a break-before make type.
2. A break-before make type of rotary switch is used in the MRV so that the moving contact will connect to one terminal before connecting to the next terminal.
3. The MRV has a uniformly divided scale.
4. The MRV has low power consumption.
5. The MRV has no error due to stray magnetic fields.
6. The MRV is suitable for both direct and alternating current.
7. Proper pivoting and balancing weight may reduce frictional errors associated with MRVs.
8. Ammeter sensitivity is determined by the amount of current required by the meter coil to produce full-scale deflection of the pointer.
9. The Wheatstone bridge is suitable for moderate resistance values.
10. The sensitivity of a galvanometer is governed by the voltage and internal resistance.
11. The Induction Wattmeter measures dc power only.
12. The Dynamometer Wattmeter is used as a standard for calibrated purposes due to their high degree of accuracy.
13. Induction Wattmeter has high power consumption.
14. Induction Wattmeters are free from the effects of stray fields.
15. The product of ammeter and voltmeter readings gives the actual power.
16. Induction Wattmeters have a uniform scale.
17. The sensing element produces a signal that is related to the quantity being measured.
18. An Intelligent Measuring System is an analogue measuring system.
19. The environment where a measure is taken cannot affect the results of the measure.

20. Resolution is the limits between which readings can be made on an instrument.
21. Damping torque is provided by the induced currents in a metal former or core on which the coil is wound or in the circuit of the coil itself.
22. Multi-range voltmeters can have their power consumption made very low.
23. For spiral springs and strip suspensions, the controlling torque is directly proportional to the angle of deflection of the coil.
24. At final deflected position, the controlling torque becomes equal and opposite to the damping torque.
25. In the moving coil instrument, the deflecting angle is directly proportional to the current in the movable coil.
26. If the ammeter resistance is not very much smaller than the load resistance, the load current can be substantially altered by the inclusion of the ammeter in the circuit.
27. To operate a moving coil instrument around a current level of say 5 A is impractical, owing to the bulk and weight of the coil that would be required.
28. The ammeter resistance must be very much smaller than the load resistance otherwise the load current can be substantially altered by the inclusion of the ammeter in the circuit.
29. The reduction in the amplitude of a vibration or oscillation is known as damping.
30. A Clamp ammeter is a convenient testing instrument that permits current measurement on a live conductor with circuit interruption.
31. The insulation resistance tester is usually known as meggar.
32. Ammeter sensitivity is greater when the amount of current required in producing a full-scale deflection of the pointer is high.
33. Proper pivoting and balancing weight may reduce frictional errors associated with MRVs.
34. Voltmeter range may be altered for a moving-iron voltmeter by connecting a resistance in series with the coil.
35. The damping force brings the moving system to rest at the deflected position reasonably quickly without any oscillation or negligible oscillation.
36. When current is passed through the coil windings, torque is developed on the coil by the interaction of the magnetic field and the field set up by the voltage in the coil.
37. The ammeter has a resistance but it is very small and will not affect any reading taken.
38. The cathode ray oscilloscope is probably the most versatile electrical measuring instrument available.
39. The cathode ray oscilloscope can measure phase relationship and frequency.

40. The horizontal scale of the oscilloscope can be used to measure displacement.
41. When two wires with similar electrical properties are joined at both ends and one junction is made hot and the other cold, a small electric current is produced proportional to the difference in the temperature.
42. The direct type of the thermocouple has the advantage of good sensitivity and slow activity.
43. The indirect type of the thermocouple is less sensitive and more sluggish in operation, but has applications for high currents.
44. Clamp meters are a very convenient testing instrument that permits voltage measurements on a live conductor without circuit interruption.
45. The value of control torque depends on the mechanical design of the control device.
46. A multirange ammeter can be constructed simply by employing several values of shunt resistances, with a rotary switch to select the desired range.
47. When an instrument is used as in the multirange ammeter, care must be taken to ensure that the shunt does not become short-circuited, even for a very short instant.
48. To minimize voltmeter loading in multi-range voltmeters, the voltmeter operating current should be very low.
49. To minimize voltmeter loading in multi-range voltmeters, the resistance connected in series with the coil should be high.
50. The moving coil instruments can be suitably modified to act either as an ammeter or as a voltmeter.

**CHOOSE WHICH DOES NOT BELONG FROM QUESTIONS 51 TO 70 and ANSWER A, B, C
or D IN YOUR ANSWER BOOKLET.**

- | | | | | |
|-----|----|--------------------|----|--------------------------------|
| 51. | A. | Johnson Noise | B. | Internal Noise |
| | C. | Thermal Noise | D. | White Noise |
| 52. | A. | Signal Conditioner | B. | Signal Transmitter |
| | D. | Signal Processor | D. | Signal Converter |
| 53. | A. | Man-made-noise | B. | Atmospheric Noise |
| | C. | External Noise | D. | Space Noise |
| 54. | A. | Ignition Systems | B. | Spark-producing Mechanisms |
| | C. | Fluorescent Lights | D. | Commutators in Electric Motors |
| 55. | A. | Random Errors | B. | Observational Errors |
| | C. | Stochastic Errors | D. | Human Errors |
| 56. | A. | Resistance | B. | Multiplier |
| | C. | Fixed Coil | D. | Movable Coil |
| 57. | A. | Vertical Amplifier | B. | Horizontal Amplifier |
| | C. | Oscilloscope | D. | Sweep Generator |

- | | | | | |
|------------|----|-----------------------------------|----|-------------------------------------|
| 58. | A. | Current to Voltage Conversion | B. | Clamping |
| | C. | Rectifying | D. | Analogue to Digital Conversion |
| 59. | A. | Accuracy | B. | Performance |
| | C. | Stability | D. | Precision |
| 60. | A. | Electromagnetic | B. | Electro-thermic |
| | C. | Thermocouple | D. | Electrostatic |
| 61. | A. | Controlling device | B. | Deflecting device |
| | C. | Damping device | D. | Calibration device |
| 62. | A. | Balance weight | B. | Gravity control |
| | C. | Control weight | D. | Spindle |
| 63. | A. | Air friction | B. | Fluid friction |
| | C. | Damping force | D. | Eddy current |
| 64. | A. | Sensing element | B. | Signal converter |
| | C. | Display element | D. | Signal transmitter |
| 65. | A. | Instrument noise | B. | Man-made-noise |
| | C. | Atmospheric noise | D. | Space noise |
| 66. | A. | Calibration Errors | B. | Construction Errors |
| | C. | Approximation Errors | D. | Ageing Errors |
| 67. | A. | Panel instrument | B. | Indicating instrument |
| | C. | Integrating instrument | D. | Recording instrument |
| 68. | A. | Scale | B. | Moving Coil |
| | C. | Spring | D. | Iron Core |
| 69. | A. | Control spring | B. | Pointer |
| | C. | Spindle | D. | Balance weight |
| 70. | A. | Repulsion moving –iron instrument | B. | Attraction moving –iron instrument |
| | C. | Moving –iron instrument Vane | D. | Single-iron moving –iron instrument |

SECTION B Answer all two questions in this section

QUESTION 1

- a) i) Define electrical noise? (2 marks)
- b) ii) Distinguish between *external* and *internal noise* and give two examples each to buttress your understanding of the difference between them. (4 marks)
- c) i) Explain briefly the three basic parts of measuring instruments? (3 marks)
- ii) State two advantages and disadvantages of the Induction Wattmeter. (4 marks)
- iii) What role do you think the damping device plays? (3 marks)
- iv) Draw the multi-range voltmeter using the series-connected multiplier resistor for resistors R_1 , R_2 and R_3 . (3 marks)
- d) i) What is a clamp ammeter? (4 marks)
- ii) Name one salient advantage of the clamp ammeter? (2 marks)

(Total marks = 25)

QUESTION 2

- a) i) What is the null method of operation as employed in bridge circuits? (3 marks)
- ii) Draw the circuit diagram of a Wheatstone bridge showing all current directions and appropriately labelling them. (5 marks)
- iii) Using the circuit diagram of the Wheatstone bridge and all its designations, find the expressions of the following:
- a) the Thevenin's voltage, V_{TH} ;
- b) the Thevenin's resistance, R_{TH} ; and
- c) and expression of the galvanometer current, I_g . (10 marks)
- iii) Using the circuit diagram of a Wheatstone bridge in Q2 a) ii) above with the values of the bridge elements as: $R_1 = 100 \Omega$, $R_2 = 1000 \Omega$, $R_3 = 200 \Omega$ and $R_4 = 2005 \Omega$; the battery voltage is 5 V and its internal resistance negligible. The galvanometer has a current sensitivity of 15 mm/ μ A and an internal resistance of 150 Ω . Using Thevenin's theorem, calculate the deflection of the galvanometer caused by the 5 Ω unbalance in one of the arms. (10 marks)
- b) i) Give two advantages and disadvantages of multi-range voltmeter. (2 marks)
- ii) Using the multi-range voltmeter with a coil resistance of 150 Ω and a full scale deflection current of 100 μ A to be used as a voltmeter in i), determine the required value of resistances for each range with the following voltmeter ranges: 50 V, 150 V and 175 V. (3 marks)
- c) i) How are measuring instruments *broadly* classified? (3 marks)
- ii) Explain the difference between *Indicating Instruments* and *Integrating Instruments*? (4 marks)

(Total marks = 40)

Examiners: C. K. Amuzuvi /J. Annan