

Level: Bachelor
Programme: BE
Course: Instrumentation (New)

Semester: Spring

Year : 2025
Full Marks : 100
Pass Marks : 45
Time : 3 hrs.

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Explain the basic block diagram of an instrumentation system with their function and example. 7
- b) A strain gauge having a resistance of $200\ \Omega$ and gauge factor of 2.5 is connected in series with a blast resistance of $400\ \Omega$ across 24V. Determine the change in the output voltage when a stress of $140\ \text{MN/m}^2$ is applied. The modulus of elasticity is $200\ \text{GN/m}^2$. 8

OR

The AC bridge is in balance with following constant,

AB, $R = 500\ \Omega$ in parallel with $C = 0.5\ \mu\text{F}$;

BC, $R = 800\ \Omega$ in series with $C = 1.5\ \mu\text{F}$;

CD, $L = 50\ \text{mH}$ in series with $R = 250\ \Omega$.

Find the constants of arm DA to balance the bridge.

2. a) Explain the working principle of LVDT in detail with necessary diagrams. 7
- b) Explain the construction and working principle of an Induction type wattmeter. 8
3. a) What is D' Arsonval principle? How is this principle used to create ammeter and voltmeter? 7
- b) What are the characteristics of an ideal op-amp. Derive the expression for voltage gain of an instrumentation amplifier. 8
4. a) Define Data Acquisition System. Explain the single channel type of DAS with necessary diagram. 7
- b) An 8-bit DAC has reference voltage of 12 V. Find the minimum value of the resistance R such that output current doesn't exceed 10 mA if it uses R-2R ladder network DAC. Find the smallest value of quantized current. 8

5. ~~a)~~ Why ADC is necessary in signal conditioning? Explain the successive approximation technique for A/D signal conversion with an example. 7

OR

- ~~✓~~ Explain delta-sigma ADC in detail with necessary block diagrams.
6. ~~b)~~ What is Wave Analyzer? Explain Frequency Selective Wave Analyzer with its block diagram. 8
- ~~✓~~ a) Explain the operation of ramp type digital voltmeter with necessary block diagram. 7
- ~~✓~~ b) What is a recorder? Draw and explain the strip-chart recorder in detail. 8
7. ~~✓~~ Write short notes on: (Any two) 2 x 5
- ~~✓~~ a) Errors in measurement
- ~~✓~~ b) Optical Fiber
- c) Magnetic tape recorders

POKHARA UNIVERSITY

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Attempt all the questions.

1. a) Define Instrumentation System? Explain Static Performance Parameters of instruments. 8
- b) An ac bridge with terminals ABCD has in arm AB, a pure resistance; arm BC, a resistance of $800\ \Omega$ in parallel with a capacitor of $0.5\ \mu\text{F}$; arm CD, a resistance of $400\ \Omega$ in series with a capacitor of $1.0\ \mu\text{F}$; and arm DA, a resistance of $1000\ \Omega$. 7
 - i. Obtain the value of frequency for which the bridge can be balanced.
 - ii. Calculate the value of resistance in arm AB to produce balance.

OR

An AC bridge circuit is working at $1000\ \text{Hz}$. Arm AB has $0.2\ \mu\text{F}$ pure capacitance, arm BC has $500\ \Omega$ pure resistance, arm CD contains an unknown impedance, and arm DA has $300\ \Omega$ resistance in parallel with $0.1\ \mu\text{F}$ capacitor. Find the constants of arm CD considering it as a series circuit.

2. a) Show that Gauge factor $G = 1 + 2\mu$; where symbols have their usual meanings. 8
- b) Illustrate working principle of Dynamometer Type Wattmeter with necessary expression and diagram. 7
3. a) What is data acquisition system? Explain the digital data acquisition system with necessary block diagrams. 7
- b) Describe an Op-amp? Derive the expression for gain of Instrumentation Amplifier. 8

OR

Design an summing circuit using op-amp to get output expression given by $V_0 = 2V_1 - 3V_2 - 5V_3$.

4. a) What will be the SA digital output for an analog input of 3.3V if $E_R=5V$? 8
b) Explain the R-2R ladder network DAC with necessary diagrams and derivations. 7
5. a) Define wave analyzer. Explain the heterodyne wave analyzer in detail with necessary block diagram. 8
b) What is meant by counter error? Explain the Integrating type digital voltmeter with the necessary block diagram. 7
6. a) What is an oscilloscope? Draw and explain the different parts of CRT. 8
b) A D' Arsonval meter movement with an internal resistance $R_m = 100 \Omega$ and full scale current of $I_m = 1mA$ is to be converted into a multi range dc voltmeter with range of 0-10 V, 0-50 V, 0-250 V, 0-500 V. Find the values of various resistances using the potential divider arrangement. 7
7. Write short notes on: (Any two) 2×5
 - a) Resistance Thermometer
 - b) Op-amp as an adder
 - c) Instrument Transformer

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Assume suitable data if necessary.

Attempt all the questions.

1. a) Define instrumentation system. What are the components of an instrumentation system explain with a block diagram. 8
- b) Describe the operation of LVDT for the measurement of direction of the movement. 7
2. a) A pressure gauge of range 50 bar is stated to have an error of 10.15 bar when calibrated by the manufacturer. Determine a) percentage error on the basis of maximum scale value. b) possible error as a percentage of the indicated value when a reading of 10 bar is obtained in a test. 8

OR

A strain gauge is bonded to a beam 0.1 m long and has cross-sectional area of 4 cm^2 . Young's modulus for steel is 2.7 GN/m^2 . The strain gauge has an unstrained resistance of 240Ω and gauge factor of 2. When a load is applied the resistance of gauge changed by 0.017Ω . Calculate the change in length of the steel beam and the length of the steel beam and the amount of force applied to the beam.

12. b) Describe the construction and working principle of an Induction type single phase energy meter. 7
3. a) Define power factor meter. Explain the working principle of single phase electrodynamicometer power factor meter with necessary expressions. 8
- b) Explain the single channel Data Acquisition System (DAS) with the help of block diagrams. 7
4. a) Define Instrumentation amplifier. Explain the working principle of an instrumentation amplifier. 8
- b) What digital output you will find of 7.27 volts input from 5-bit SA ADC with reference voltage of 11V. 7

5. a) Explain the working principle of delta-sigma ADC with necessary block diagram and steps. 7
- b) Define wave analyzer. Explain the frequency selective wave analyzer in detail with necessary block diagram. 8
6. a) Explain operation and application of Spectrum Analyzer. 7
- b) Explain about the working principle of oscilloscope with the help of its block diagram. 8

OR

What is a recorder? Draw and explain the strip-chart recorder in detail.

7. Write short notes on: (Any two) 2×5
 - a) Magnetic tape recorder
 - b) Digital Multimeter
 - c) RS-232 cable