TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I (*EE 552*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define instrumentation system with example. Explain its different components with the help of a block diagram. [6]
2. Explain the difference between static and dynamic characteristics of measurement system. Briefly explain following static performance parameter. [6]

   i) Accuracy (ii) Precision (iii) Sensitivity (iv) Resolution (v) Linearity
3. An AC bridge circuit is working at 1000 Hz. Arm AB has 0.2 μF pure capacitance, arm BC has 500Ω pure resistance, arm CD contains an unknown impedance, and arm DA has 300Ω resistance in parallel with 0.1 μF capacitor. Find the constants of arm CD considering it as a series circuit. [4]
4. What is piezo electric transducer? What are the materials used in such transducer? Define voltage sensitivity, charge sensitivity and derive the expression for the output voltage developed due to applied force. [6]
5. Explain how magnitude and direction of displacement can be measured using linear variable differential transformer. [6]
6. A linear resistance potentiometer is 50 mm long and is uniformly wound with a wire of total resistance 5000Ω. Under normal condition, the slider is at the centre of the potentiometer. Determine the linear displacement when the resistance of the POT as measured by a wheatstone bridge is 1850Ω. If it is possible to measure a minimum value of 5Ω resistance with the above arrangement determine the resolution of the POT in mm. [4]
7. Explain the features of instrumentation amplifier and derive the expression for its Gain. [6]
8. Explain the operation of sample and hold circuit with the help of circuit diagram. [6]
9. Design an Op-Amp summer circuit to obtain output voltage as $V_{out} = -(V_1 + 10V_2 + 25V_3)$. Use minimum value of resistance as 10kΩ. [4]
10. Explain how analog to digital conversion is achieved by using Dual ramp ADC. [6]
11. What are the drawbacks of weighted resistor network? With suitable diagram explain the R-2R ladder digital to analog converter. [6]
12. What will be a 4-bit successive approximation digital output for an analog input of 4.287V if full range of converter E_R is 5V. [4]
13. Describe the construction and working principle of a single phase induction type energy meter. [8]
14. Explain the operating principle of electrical resonance type frequency meter in detail. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Chaitra

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I (*EE 552*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is Instrumentation system? Describe the operation of the functional components of Instrumentation system with the help of block diagram. [1+5]

   b) What are the different parameters to define the static performance of an instrument? Distinguish between accuracy and precision of an instrument with a suitable example. [3+3]

   c) Describe the construction and working principle of permanent magnet moving coil instrument with neat and clean diagram. What will happen if we connect PMMC instrument for the measurement of AC quantity? [4]

2. a) Show how "Loading effect "causes a non-linear relationship between the input and output in a measurement made by a potentiometer. Also write the methods to reduce loading effect. [6]

   b) Explain how magnitude and direction of displacement can be measured with the help of inductive sensor. [6]

   c) An AC bridge working at 500 Hz has following parameters: [4]

   Arm AB, R = 500 Ω in parallel with L = 30 mH,
   Arm BC, R = 1000 Ω in parallel with C = 0.5 μ F,
   Arms CD, R = 800 Ω in series with C = 0.9 μ F.
   Determine the parameters of the remaining arm for the bridge to be balanced considering the possibility that the missing arm could be either in series or parallel.

3. a) Explain working principle of piezo-electric sensor and derive the expression for out-put voltage. Also explain its equivalent circuit. [6]

   b) Explain the working principle of hall- effect sensor. Also prove that this effect is more pronounced in the case of semiconductor that metal. [6]

   c) Determine the thermoelectric sensitivity and emf developed in a thermocouple made of copper and constantan for a temperature of 50°C between its junction. Given that thermo electric emf of copper and constantan against platinum are 7.4 μv/ °C and -34.4 μv/ °C respectively. [4]

4. a) Highlight the advantages of optical fiber transmission over conventional data transmission system. [6]

   b) Describe the instrumentation amplifier in detail with a circuit diagram. How is it better than other amplifiers? Also derive the expression for its gain. [10]

5. a) Describe the construction and working principle of a single- phase induction type" energy meter. Show that the total number of revolutions made by disc during particular time is proportional to the energy consumed. [8]

   b) Show how the instrument transformers are used to measure high voltage and current. And also explain why the secondary of current transformer should not be kept open circuited while primary is energized. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I (*EE 552*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define measurement and measurement system. Draw the block diagram of measurement system showing each component of measurement system and also explain the functions of each block. [2+4]
   b) Using statistical evaluation of random errors or data of measurement, explain how probable error in a measurement can be obtained. [6]
   Find out the probable error of the observation given in table below

Current readings in ampere	Number of readings
9.97	1
9.98	3
9.99	13
10.00	23
10.01	15
10.02	4
10.03	1

   c) If a voltmeter having accuracy of 1% and full scale range 100V is used to measure 80V and 12V. Calculate the possible percentage error of both readings. Comment on your answer. [4]
2. a) Explain how the nonlinear characteristics of a capacitive transducer used for the measurement of displacement using the principle of change in capacitance due to change in distance between plates can be made linear. [6]
   b) Explain the construction and working principle of a linear variable differential transformer. [6]
   c) A resistance gauge is used to measure stress on steel. The steel is stressed to $1400 Kg/m^2$. Assume Young's modulus of elasticity of steel is 2.1×10^6 Kg/cm^2. Calculate the % change of resistance of a strain gauge and poison's ratio assuming gauge factor equal to 2. [4]
3. a) Why signal conditioning is done in instrumentation system? Derive the expression for closed loop gain of op-amp in inverting mode. Also explain ideal characteristics of an operational amplifier. [6]
   b) Explain the features of instrumentation amplifier and derive the expression for its gain. [6]
   c) Determine the thermoelectric sensitivity and emf developed in a thermocouple made of Cu and Const for a temperature of 60°C between its junctions. Given that thermoelectric emf of Cu and Const against Pt are 7.4 μV/°C and -34.4 μV/°C [4]

4. a) Using flowchart diagram, example the working of successive approximation ADC. What will be 4-bit, digital output for the analog impute of 3.217 V if E_R = 5V, using successive approximation ADC? [6]

   b) What is data acquisition system? Explain the function and objective of each component of a digital data acquisition system. [6]

   c) An 8-bit DAC has reference voltage of 12V. Find the minimum value of resistance R such that the output current doesn't exceed 10mA if it uses i) WRN DAC ii) R:2R ladder network DAC. Also, find the smallest value of the quantized current in both cases. [4]

5. a) Explain the working principle of dynamometer type wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both ac and dc circuit. [8]

   b) Explain the working principle of instrument transformer. Also explain why the secondary winding of current transformer should never be kept open circuited while primary is energized? [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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2077 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain how probable error can be calculated with the help of statistical analysis in a measurement system. [6]

   b) Explain the difference between static and dynamic characteristics of measurement system. Also explain following static performance parameter. [6]
   (i) Accuracy
   (ii) Precision
   (iii)Sensitivity

   c) Following readling were obtained in respect of a capacitor: 1.003μF, 0.998μF, 1.001μF, 1.009μF, 1.005μF, 0.991μF, 0.996μF, 0.997μF, 1.008μF, & 0.994μF. Calculate:
   (i) Arithmetic mean
   (ii) Deviation from mean
   (iii)Standard deviation [4]

2. a) Explain how the liquid level can be measured by using capacitive sensor. [6]

   b) Define transducer with example. Explain the working principle of strain gauge and derive the expression for the gauge factor. [6]

   c) A linear resistance potentiometer is 50mm long and is uniformly wound with a wire of total resistance of 20kΩ. Under normal conditions, the slider is at the center of the potentiometer. Determine the linear displacement when the resistance of the potentiometer, as measured by wheatstone bridge are 1550Ω and 5600Ω. Are the two displacements in the same direction? If it is possible to measure a minimum value of 10kΩ resistance with the above arrangement, determine the resolution of the potentiometer in mm. [4]

3. a) Explain how both direction & magnitude of the displacement can be measured with help of linear variable differential transformer. [6]

   b) Describe the circuit of 3 amplifier configuration of an instrumentation amplifier. Also derive the expression for output voltage in terms of two input voltage. [6]

   c) Hall effect element is used for the measurement of magnetic flux of $0.8 Wb/m^2$. The thickness of element is 2.5mm. If the current passed through the element is 5A, calculate the Hall emf developed. Given that $K_H=5\times10^{-7}$. [4]

4. a) Explain how analog to digital conversion is achieved by using ramp ADC. [6]

   b) What are the drawbacks of weighted resistor network? With suitable diagram explain the R-2R ladder digital to analog converter. [6]

   c) Given 12-bits, 10v successive approximation ADC that has 20μs conversion time and is used without sample and hold circuit. Find the maximum rate of change of input signal and its maximum frequency that can be applied. [4]

5. a) Explain the working principle of dynamometer type wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

   b) What is Data Acquisition system? Also explain the different component of analog data-acquisition system. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define Instrumentation system with example. Explain the main elements of measurement system with the help of block diagram. [6]
   b) Differentiate between static and dynamic performance parameter with describing each parameter in brief. [4]
   c) A 1000 Hz bridge has the following constants: [6]
   Arm AB: R=1000Ω in parallel with C=0.5μF
   Arm BC: R=1000Ω in parallel with C=0.5μF
   Arm CD: R=200Ω in parallel with L=30mH
   Find the constants of Arm DA to balance the bridge express the result as a pure R in parallel with a pure C or L.

2. a) Explain how magnitude & direction of displacement can be measured using inductive sensor. [6]
   b) Explain working principle of capacitive sensor. Also explain how linear relation between output & input can be obtained in the case of capacitive sensor working on the principle of change in separation distance. [6]
   c) A strain gauge is bonded to a beam which is 12cm long & has a cross-sectional area of 3.8cm^2. The unstrained resistance & gauge factor of the strain gauge are 220Ω & 2.2 respectively. On the application of load, the resistance of the gauge changes by 0.015Ω. If the modulus of elasticity for steel is 207 GN/m^2, calculate (i) the change in length of the steel beam. (ii) the amount of force applied to the beam. [4]

3. a) Explain the ideal characteristics of operational amplifier & derive the expression for closed loop gain in non-inverting mode. [6]
   b) Explain the "loading effect" on input-output relationship in measurement made by a potentiometer. How can the error due to loading be minimized? [6]
   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of inner cylindrical electrode is 3 mm and the dielectric medium is air. The inner radius of the outer electrode is 3.1mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrodes. Is it within safe limit? The length of electrode is 20mm. Calculate the change in capacitance if the inner electrode is moved through a distance of 2mm. the breakdown strength of air is 3KV/mm. [4]

4. a) Explain the method of Digital-Analog conversion using R-2R ladder network. Why do we prefer to use this DAC instead of WRN type, explain. [6]
   b) What is data acquisition system. Explain function of the different components of digital data acquisition system. [6]
   c) An 8 bit DAC has maximum supply voltage 12V. Find
      i) What voltage change does LSB represent?
      ii) What voltage change does MSB represent?
      iii) What voltage does 10111100 represent? [4]

5. a) State and explain Sampling theorem. What is aliasing? Define the terms analog signal and discrete signal. [8]
   b) Write short notes on: [2 x 4]
      i) Frequency meter
      ii) Instrument transformer

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INSTITUTE OF ENGINEERING

Examination Control Division

2076 Bhadra

Exam.	Regular		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the function of different stage of measuring system with the help of block diagram. [6]
   b) A voltmeter whose accuracy is 2% of the full scale reading is used on its 0-150V scale. It is used to measure a voltage of 75V and 37.5V. Calculate the maximum possible error of both readings. Comment on your answer. [4]
   c) How do you define error in a measurement system? How the Gaussian curves can be used to explain the normal distribution of random errors in a measurement? [6]
2. a) Which bridge is used for the measurement of unknown inductance of a coil having high quality factor? Explain how the measurement is done with the help of selected bridge and also explain the reasons behind the selection. [6]
   b) Define capacitive transducer. Explain how by using a differential arrangement a capacitive transducer which works on the principle of variation of capacitance with displacement between two plates the response can be made linear. [6]
   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of the inner electrode is 3mm and the dielectric medium is air. The inner diameter of the outer electrode is 3.1 mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrode. Is it within the safe limit? The length of the electrode is 20mm. Calculate the change in capacitance if the electrode is moved through a distance of 2mm. The breakdown strength of air is 3KV/mm. [4]
3. a) What is piezo electric transducer? What are the materials used in such transducer? Define voltage sensitivity, charge sensitivity and derive the expression for the output voltage developed due to applied force. [6]
   b) What are the ideal characteristics of an Op-amp? Derive the expression for close-loop gain in non-inverting mode of an Op-amp. [6]
   c) In a resistive potentiometer the maximum percentage error is 15 R_p / R_m where R_p and R_m are respectively the resistance of the potentiometer and the load respectively. A position measurement may have a maximum non-linearity of 0.5% when driving a load of 10 kΩ resistance. Find out the maximum value of resistance of potentiometer. [4]
4. a) Draw the block diagram of optical fiber communication system and write advantages of it. [6]
   b) Consider a 6-bit DAC with a resistance of 320 kΩ in LSB position. The converter is design with weighted resistor network. The reference voltage is 10V. The output of the resistive network is connected to an operational amplifier with a feedback resistance of 5 KΩ. What is the analog output for a binary input of 111010? [4]
   c) Describe the working principle of Successive Approximation ADC in detail with flowchart and diagram. [6]
5. a) Explain the working principle of dynamometer type wattmeter and prove that the deflection torque s directly proportion to power consumed by the load in both ac and dc circuit. [6]
   b) Show how the instrument transformers are used to measure high voltage and current. Also explain why secondary winding of CT should never be kept open circuited while primary is energized? [6]
   c) State and explain sampling theorem and define term analog signal and discrete signal. [4]

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12 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the difference between static and dynamic characteristics of measurement system. Also explain following static performance parameter. [6]
   i) Accuracy
   ii) Precision
   iii) Sensitivity
   iv) Resolution
   v) Linearity

   b) Explain quality factor in Maxwell's bridge. Why Maxwell bridge cannot be used for the measurement of inductance having quality factor less than 1 and greater than 10 (1<=Q<=10). [6]

   c) An AC bridge has following constants

   Arm AB, R = 1000 Ω in parallel with C = 0.5 μF
   Arm BC, R = 3000 Ω
   Arm CD, unknown capacitance C_x in series with R_x
   Arm DA, C = 0.55 μF
   Supply frequency 1000HZ

   Determine the unknown resistance Rx and capacitance Cx to make the bridge balance. [4]

2. a) Discuss the methods to reduce loading effect in a Potentiometer. Also prove that linearity and sensitivity of potentiometer is two conflicting requirements. [6]

   b) Explain how the nonlinear characteristics of a capacitive transducer used for the measurement of displacement using the principle of change in capacitance due to change in distance between plates can be made linear. [6]

   c) A rotatory POT having 100 turns and total resistance of 1000 Ω is made up of wire of 1 meter length. It has the power limit of 10 watt. Calculate the maximum excitation voltage that can be applied to the POT. Also calculate the resolution (in volts) of the potentiometer under that maximum excitation. [4]

3. a) Explain the working principle of Piezo-electric sensor and derive the expression for the output voltage in the piezo-electric Sensor. [6]

   b) What are the characteristics of an ideal operational amplifier? Derive the expression for close loop gain of operational amplifier in inverting and non-inverting mode. [6]

   c) Design an integrator circuit which will produce a ramp voltage of -20V/ms. [4]

4. a) Explain how analog to digital conversior can be achieved by using dual Ramp ADC. [8]

   b) A 6-bit DAC has 20 kΩ resistance in MSB position. The converter is designed with weighted resistor network. The reference voltage is 12 V. The output of the resistive network is connected to an op amp with a feedback resistance of 5 kΩ. What will be the analog output for a binary input of 111010? [8]

5. a) State and explain Nyquist criterion. Also explain the phenomenon a aliasing and the way to eliminate it. [4]

   b) Explain the function of sample and hold circuit with the help of circuit diagram. [6]

   c) Explain the construction and working of single phase electrodynamometer wattmeter with expression for ac operation. [6]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Sketch basic blocks of a generalized measurement system. Write function of each block. [6]

   b) Explain analog and digital modes of operation. Why digital instruments are becoming popular now? [4]

   c) An AC bridge circuit is working at 1000 Hz. Arm AB has 0.2 μF pure capacitance, arm BC has 500 Ω pure resistance, arm CD contains an unknown impedance and arm DA has 300 Ω resistance in parallel with 0.1 μF capacitor. Find the constant of arm CD considering it as a series circuit. [6]

2. a) What are the different parameters to define the static performance of an instrument? Distinguish between accuracy and precision of an instrument with a suitable example. [6]

   b) A strain gauge is bonded to a beam which is 12 cm long and has a cross sectional area of 3.8 cm^2. The unstrained resistance and gauge factor of the strain gauge are 220Ω and 2.2 respectively. On the application of load the resistance of the gauge changes by 0.015Ω. If the modulus of elasticity for steel is 207 GN/m^2, calculate [4]

   (i) the change in length of the steel beam
   (ii) the amount of force applied to the beam.

   c) Explain the working principle of a thermocouple for measuring temperature. State different laws associated with it. [6]

3. a) Explain the principles of operation of capacitive sensor. Also explain how linear relation between output and input can be obtained when capacitive sensor works on the principle of change in separation distance. [6]

   b) Explain the features of instrumentation amplifier and derive the expression for its Gain. [6]

   c) State and explain sampling theorem. [4]

4. a) A 6 bit DAC has a reference voltage of 11 volts if it uses

   (i) R-2R ladder network.
   (ii) Weighted resistive network.
   Find the minimum value of resistance in both cases such that the output current does not exceed 10mA. [4]

   b) What are the drawbacks of weighted resistor network? With suitable diagram explain the R-2R ladder digital to analog converter. [6]

   c) What is the purpose of using a S/H circuit in A/D conversion system. Explain its operation along with basic circuit and characteristic waveform. [6]

5. a) Describe the construction and working principle of a single phase induction type energy meter. Show that the total number of revolution made by disc during particular time is proportional to the energy consumed. [8]

b) Explain the working principle of instrument transformer. Also explain why the secondary winding of current transformer should never be kept open circuited while primary is energized? [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you understand by an instrumentation system, explain the function of each of its component with the help of a block diagram? [6]

   b) The wire in a strain gauge is 0.1 m long and has an initial resistance of 120Ω. On application of a force the wire length increases by 0.1 mm and resistance increases by 0.21Ω, determine the gauge factor of the device. [4]

   c) How do you define error in a measurement system? How the Gaussian curves can be used to explain the normal distribution of random errors in a measurement. Also state the properties of the curve. [6]

2. a) Explain how magnitude and direction of displacement can be measured with the help of inductive sensor. [6]

   b) What do you mean by piezoelectric effect? Explain how this effect can be the design basis of piezoelectric pressure transducer. Define voltage sensitivity and charge sensitivity. Give its equivalent circuit and derive the expression for the output voltage by making suitable assumptions. [6]

   c) A linear resistance potentiometer is 50 mm long and is uniformly wound with a wire of total resistance 5000Ω. Under normal conditions, the slider is at the centre of the potentiometer. Determine the linear displacement when the resistance of the pot as measured by a wheatstone bridge is 1850 Ω. If it is possible to measure a minimum value of 5 Ω resistence with the above arrangement determine the resolution of the pot in mm. [4]

3. a) Why signal conditioning is done in instrumentation system? Derive the expression for closed loop gain of op-amp in inverting mode. Also explain ideal characteristics of operational amplifier. [6]

   b) Design an integrator circuit which will produce a ramp voltage of -20 V/msec. [4]

   c) Draw the block diagram of optical fiber communication system and write advantages of it. [6]

4. a) Explain how analog to digital conversion is achieved by using Dual Ramp ADC. [6]

   b) Explain the operation of sample and hold circuit. Also explain aperture time and acquisition time of the circuit. [6]

   c) What will be a 4-bit successive approximation digital output for an analog input of 4.287V if full range of converter (ER) is 5V? [4]

5. a) What is wattmeter? Write is types. Explain the wattmeter which can measure ac as well as dc power with the help of construction and working principle. [8]

   b) What is data acquisition system? Explain the function of different component of digital data acquisition system. [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

(55)

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Point out the difference between analog and digital measurement system. Explain the functional elements of an Instrumentation system with block diagram. [6]
   b) Explain different types of errors in measurement with their remedies. [6]
   c) A capacitive transducer uses two quartz diaphragm of area 600 mm^2 separated by a distance of 2.5 mm. A pressure of 8×10^5 N/m^2, when applied to the top diaphragm causes a deflection of 0.5 mm. The capacitance is 400×10^{-12} F when no pressure is applied to the diaphragm. Determine the value of capacitance after the application of 8×10^5 N/m^2. [4]
2. a) Explain how can the response of capacitive transducer, which works on the principle of variation of capacitance with displacement between two plates, be made linear. Also give the sensitivity of such an arrangement. [6]
   b) Show that Hay's Bridge can be used to measure the value of unknown inductance of a coil having high quality factor. [6]
   c) Determine the thermo electric sensitivity and emf developed in a thermocouple made of copper and constantan for a temperature of 50°C between its junction. Given that thermo electric emf of copper and constantan against platinum are 7.4μv/°C and -34.4 μv/°C respectively. [4]
3. a) Derive voltage gain of 3 Op-Amp Instrumentation amplifiers. Write the advantages of fiber optical communication. [6]
   b) Explain how A/D conversion can be achieved by using dual slope analog to digital converter. [6]
   c) The basic step of a 9 bit DAC is 10.3 mV (000000000) represents .0V, what O/P is produced if the input is (101101111)? [4]
4. a) Describe the constructional details and working of a ferro dynamic type of frequency meter for the measurement of frequency. [8]
   b) Draw the block diagram of Digital Data Acquisition System (DAS). Explain each block briefly. Differentiate analog DAS and digital DAS in terms of their scope. [6+2]
5. a) Explain the requirement of a sample and hold circuit. Explain its operation and discuss its characteristic waveform to illustrate its specifications. [8]
   b) Explain ideal characteristics of operational amplifier. Also explain different application of operational amplifier in measurement system. [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is an instrumentation system? Explain its different components with the help of a block diagram. [6]

   b) What is random error? Which method do you think is the most appropriate to find its distribution among a given set of data, make a complete analysis and hence define probable error. [6]

   c) The output of an LVDT is connected to a 5V voltmeter through an amplifier whose amplification factor is 250. An output of 2 m V appears across the terminals of LVDT when core moves through a distance of 0.5 mm. calculate the sensitivity of LVDT and that of whole set-up. The milli-voltmeter scale has 100 divisions. The scale can be reads to 1/5 of divisions. Calculate the resolution of the instrument in mm. [4]

2. a) Explain the principle of operation of an inductive transducer used for the measurement of linear displacement. Why differential arrangement of such a transducer is required? [8]

   b) "Maxwell's bridge is not suitable for the measurement of high Q-coils", verify the statement and draw and explain the modified bridge which can measure the inductance of high Q-coils. [8]

3. a) Explain the construction and working of a megger used for the measurement of high resistance. [4]

   b) Describe how digital to analog conversion is achieved by using the R-2R ladder network. How this DAC over comes the limitations of WRN type of DAC? [8]

   c) An analog to digital converter having an input of (0-8)V is able to distinguish a change of 10.3 mv in its input signal, calculate: [4]

      i) The number of bits
      ii) What voltage change does each LSB represent
      iii) What voltage does IMSB represent

4. a) Explain the working principle of dy-nanometer type, wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

   b) What do you understand by a Data Acquisition system? Explain with a neat sketch, the role of multiplexer in a DAS. [8]

5. a) What do you understand by sample and hold circuit. Explain its functioning with the help of circuit diagram. [6]

   b) Explain the working and application of OP-amp as [6]

      i) an integrator
      ii) a differentiator and
      iii) a substractor

   c) A piezoelectric pressure transducer having unknown charge sensitivity is connected to a charge amplifier, the gain being set to 5 mv/PC. The amplifier output is connected to an ultraviolet chart recorder, whose sensitivity is set to 25 mm/volt. Determine the sensitivity of the piezoelectric transducer if deflection of chart recorder is 100 mm due to a pressure of 300 N. [4]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Distinguish between static and dynamic characteristic of a measurement system. Define the various parameter used to study these characteristics.

   b How an unknown inductance can be measured from Maxwell's Bridge circuit and Hay's Bridge circuit. Why these different bridge circuits are used for measurement of unknown inductance instead of using single Bridge circuit, Explain.

2. a) Define transducer with example. Explain the working principle of strain gauge and derive the expression for the gauge factor.

   b) A barium titanate pickup has the dimensions of 5mm×5mm×1.25mm. The force acting on it is 5N. The charge sensitivity of barium titanate is 150pC/N and its permittivity is 12.5×10^{-9} F/m. if the modulus of elasticity of barium titanate is $12\times 10^{6}N/m^{2}$, calculate the strain. Also calculate the charge and the capacitance.

3. a) Explain ideal characteristics of operation amplifier. Also explain different application of operational amplifier in measurement system.

   b) Explain how data can be transferred by Optical Fiber Cable and write advantages of optical fiber communication.

4. a) What are the advantages of inverted R-2R DAC over others DAC? Derive its output expression for R-2R DAC.

   b) What will be 6 bit successive approximation digital output of the analog input 6.127 V if V_R is 8V?

5. a) Explain the operating principle of electrical resonance type frequency meter in detail.

   b) Show how the instrument transformers are used to measure high voltage and current. And also explain why the secondary of current transformer should not be kept open circuited while primary is energized.

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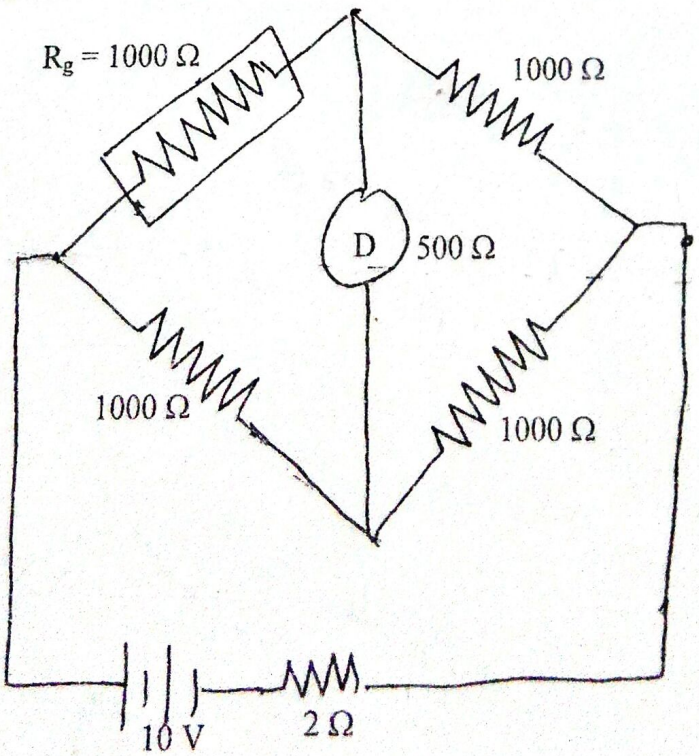
32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *<u>All</u> questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss different errors in measurement system and the methods to minimize them. [8]
   b) Differentiate between analog and digital measurement system. [4]
   c) A voltmeter whose accuracy is 2% of the full scale reading is used on its 0-50V scale. It is used to measure a voltage of 15 V and 42 V. Calculate the possible error of both readings. Comment on your answer. [4]
2. a) What is piezoelectric transducer? Define the voltage sensitivity and charge sensitivity. Give the equivalent circuit for piezoelectric transducer. Derive the expression for the output voltage by making suitable assumptions. [6]
   b) A capacitive transducer is made up of two concentric cylindrical electrodes. The length of electrodes is 0.025 m, the inner diameter of the outer cylindrical electrode is4.2 mm and the outer diameter of inner cylindrical electrode is 4.0 mm. Assume air medium. Determine the change in capacitance for a displacement of the inner electrode of 0.0025 m. Determine also the electric stress when a voltage of 150 V is applied across the electrodes. [4]
   c) What is Linear variable differential transformer (LVDT). Point out its merits and demerits. [6]
3. a) Explain the loading effect on a potentiometer and explain the effect of load resistance on the Linearity of the potentiometer. Also show that the error occurs at the mid-point of the potentiometer. [8]
   b) A strain gauge is connected in the bridge circuit shown in figure below. Find the deflection in the detector for a applied strain of 0.5%, if the detector has a sensitivity of 10 mm/μA and an internal resistance is 500 Ω. The guage factor of strain guage is 2. [8]



4. a) Describe at least two methods of analog to digital conversion. [8]

   b) Derive maximum allowable rate of change of input and maximum allowable frequency to the n bit ADC. [4]

   c) The basic step of a 9 bit DAC is 10.3 mV. If (000000000) represent OV, what output is produced if the input is (101101111)? [4]

5. a) What is meant by sampling? Define the terms analog signal, discrete signal, discrete pulse in instrumentation system. Discuss data acquisition system in brief. [8]

   b) Describe the construction and working principle of a single phase induction type energy meter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed. [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you understand by an instrumentation system? Explain the different components the system possesses, in detail. [8]

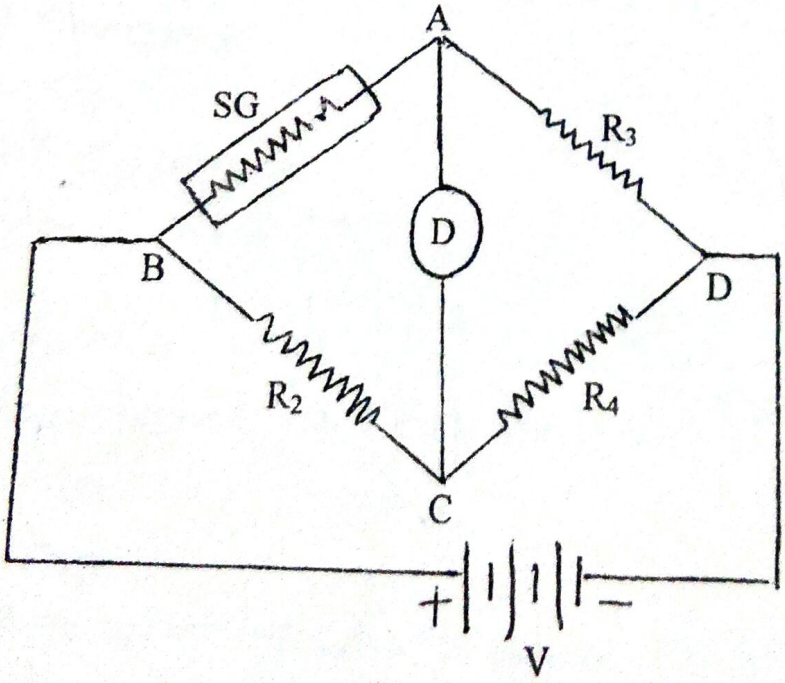
   b) What are the different parameters to define the static characteristics of an instrumentation system, explain establish a co-relation between linearity and sensitivity of an instrument with suitable example. [8]

2. a) Explain how the non-linear characteristics of a capacitive transducer, used for the measurement of displacement using the principle of change in capacitance due to change in distance between plates can be made linear. [8]

   b) Obtain the balance equation for an ac bridge and explain with diagram how Schering bridge can be used to measure unknown capacitance. [8]

3. a) Explain how flow rate of conducting fluid can be measured by using electromagnetic flow meter. Also explain disadvantage of d.c. excition used in it. [8]

   b) A strain gauge of resistance 200Ω and gauge factor 2 is connected in the arm AB of the bridge as shown below. [8]



The resistance of arms CD and DA are 100Ω each. R_2 is adjusted for balance under unstrained condition. The supply voltage to the bridge is 10V connected across BD. Determine the output voltage when a detector of infinite resistance is connected across output terminals and strain is of 500μ strain. Determine the current flowing through the detector for the same strain if resistance of detector is 250Ω.

4. a) State and explain sampling theorem. What is "aliasing" and how can it be avoided? [8]

   b) Explain how A/D conversion can be achieved by using dual slope analog to digital analog. [8]

5. a) Explain the method of D/A conversion using R-2R ladder network. Why do we prefer to use this DAC instead of WRN type, explain. [8]

   b) Explain the working principle of dynamometer type wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

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35 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the analog and digital measurement system with the help of their respective block diagrams. [6]

   b) An ac bridge circuit is working at 1000 Hz. Arm AB has 0.2 μF pure capacitance, arm BC has 500 Ω pure resistance, arm CD contains an unknown impedance and arm DA has 300 Ω resistance in parallel with 0.1 μF capacitor. Find the constant of arm CD considering it as a series circuit. [10]

2. a) What is loading effect of a potentiometer? Show that the error will be maximum when the slider of the potentiometer is at midpoint of the potentiometer. [8]

   b) Determine the thermoelectric sensitivity and emf developed in a thermocouple made of copper and constantan for a temperature of 50°C between its junction. Given that thermo electric emf of copper and constantan against platenium are 7.4 μV/°C and –34.4 μV/°C respectively. [4]

   c) Explain how the flow of fluid can be measured by using Hot Wire Anemometers. [4]

3. a) Prove that "Linear relationship between capacitance and separation distance between two plates can be achieved by using differential arrangement". [8]

   b) Describe the construction and working of linear variable differential transformer for the measurement of displacement. [8]

4. a) Show how can an R-2R ladder network be used to generate a binary weighted sequence of current. [6]

   b) Highlight the advantages of optical fiber transmission over conventional data transmission system. [4]

   c) What is an instrumentation amplifier? Derive the expression for its gain. [6]

5. a) Explain the constructional detail and operating principle of a single phase induction type energy meter. [8]

   b) A 3-bit DAC has a voltage range of (0 - 12) V. Calculate the [8]

      i) weight of LSB
      ii) weight of MSB
      iii) exact range of the converter
      iv) percentage error

      If now, the bit of the converter is increased to 6, show by how much amount the error is increased or decreased? Justify your answer.

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs

Subject: - Instrumentation I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

06829

1. a) Explain different component of measurement system with suitable examples. [4]

b) A balanced AC bridge has the following constants [6]

arm AB: R = 1000 Ω in parallel with C = 0.5 μF
arm BC: R = 1000 Ω in series with C = 0.5 μF
arm CD: R = 200 Ω in series with L = 30 mH

Find the constant of arm CD. Express the result as a pure R in parallel with pure C or L.

c) Using statistical analysis of random error of data measurement, explain how probable error in measurement can be obtained. [6]

2. a) Explain how can the response of capacitive transducer, which works on the principle of variation of capacitance with displacement between two plates, be made linear. Also give the sensitivity of such an arrangement. [6]

b) Explain ideal characteristics of operation amplifier. Also explain different application of operational amplifier in measurement system. [6]

c) A piezo-electric pressure transducer having sensitivity of 4×10^{-12} C/N is connected to a charge amplifier, the gain being set to 10 mV/pc. The amplifier output is connected to a ultra-violet chart recorder whose sensitivity is set in such a way that the deflection of the chart recorder due to a force of 400 N is 100 mm. Find the overall sensitivity of the device and the sensitivity of the chart recorder. [4]

3. a) Explain how analog to digital conversion can be obtained by using flash ADC. [6]

b) State and explain Nyquist criterion. Also explain the phenomenon of aliasing and the way to eliminate it. [4+2]

c) Consider a 6-bit digital to analog converter with a resistance of 20 KΩ in MSB position. The converter is designed with weighted resistive network. The reference voltage is 12 V. The output of the resistive network is connected to an operational amplifier with a feedback resistance of 10 KΩ. What is the analog output for a binary input of 101011? [4]

4. a) Describe the construction and working of a single phase induction type energy meter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed. [8]

b) Show how the instrument transformers are used to measure high voltage and current. [4]

c) The basic step of a 9 bit DAC is 10.3 mV. If (000000000) represents 0 V, what O/P is produce if the input is (101101111)? Write the advantages of R-2R ladder type DAC over WRN type. [2+2]

5. a) List out different types of frequency meter. Explain the constructional detail and working principle of any one of them to measure frequency. [8]

b) What do you understand by communication of data in an instrumentation system? Explain the principle of optical fibre data communication system and highlight its advantages over conventional data communication system. [8]

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INSTITUTE OF ENGINEERING

Examination Control Division

2070 Magh

Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Draw the functional block diagram of an instrumentation system. Explain each block briefly. [6]

   b) Explain how inductance of a coil can be measured using Hay's Bridge. Also explain why this bridge is suitable for the measurement of inductance of coil having high quality factor. [6]

   c) Show how the capacitor transducer can be used to measure the liquid level. [4]

2. a) What is an electrical transducer? How can it be classified? Also explain how direction and magnitude of displacement can be measured with Linear variable differential transformer [LVDT]. [6]

   b) In order to measure the strain in a cantilever beam a single strain guage of resistance 1000 Ω and gauge factor 2 is mounted on the beam and connected to arm AB of the bridge circuit. The other arms BC, CD and DA of the bridge have a resistance of 1000 Ω each. A d.c. voltage of 10 V is applied to terminal AC. Find: [6]
      i) The output voltage across terminal BD for 0.1 percent strain.
      ii) The output voltage across BD for the same strain if a voltmeter having internal resistance 2000 Ω is connected across BD.

   c) An operation amplifier is used as in integrator to produce a ramp signal of -10 V/ms. Design the circuit for this. [4]

3. a) Explain the loading effect on the accuracy of a resistance potentiometer transducer when used for the measurement of displacement. Also show that maximum error occurs at the mid-point of the potentiometer. [6]

   b) Explain the purpose and operation of Dual slope ADC with necessary figures. [6]

   c) What is a Data Acquisition system? Draw the block diagram of Digital Data Acquisition System. Explain its operation. [4]

4. a) How can ac power be measured using dynamometer type wattmeter? Explain with the help if its construction and operation in detail. [8]

   b) Explain the purpose of using instrument transformers in measurement. [4]

   c) An analog voltage signal whose highest significant frequency is 1 KHZ is to be digitally coded with a resolution of 0.01% covering a voltage range of 0-10 V. Determine: [4]
      i) Minimum number of bits in the digital code
      ii) Analog value of LSB
      iii) Minimum sampling rate
      iv) Aperture time required for the A/D converter

5. a) Explain the purpose and use of S/H circuit with necessary circuit diagrams. Discuss its various characteristics with the help of waveform associated. [6]

   b) Define precision and resolution in measurement. Explain the working principle of Meg[illegible]r. [4]

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>**Full Marks**</u>.*
- ✓ *Assume suitable data if necessary.*

1. a) Distinguish between analog and digital system of measurement. [6]

   b) A 0-150V voltmeter has guaranteed accuracy of 1% of full scale reading. The volt measured by this instrument is 75V and 37.5V. Calculate the possible percentage error of both readings. Comment upon the result. [4]

   c) A balanced AC bridge has the following constants: [6]
   arm AB, R = 2000Ω in parallel with C = 0.047μF
   arm BC, R = 1000Ω in series with C = 0.47μF
   arm CD, unknown R
   arm DA, C = 0.5μF

   The frequency of oscillator is 1000Hz. Find the constant of arm CD.

2. a) Obtain the balance equation for Hay's bridge and explain why it is most suitable for the measurement of inductance of a coil having high quality factor. [6]

   b) Show how "Loading effect" causes a non linear relationship between the input and output in a measurement made by a potentiometer. Also prove that the maximum error occurs at the mid-point of the pot wire. [6]

   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of the inner electrode is 4mm and the dielectric medium is air. The inner diameter of the outer electrode is 4.1mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrode. Is it within safe limit? The length of electrode is 20mm. Calculate the change in capacitance if the electrode is moved through a distance of 2mm. [4]

3. a) Describe the circuit of 3 amplifier configuration of an instrumentation amplifier. Also derive the expression for output voltage in terms of two input voltage. [6]

   b) In order to measure the strain in a cantilever beam, a single strain gauge of resistance 2KΩ and gauge factor 2 is mounted on the beam and connected to one arm of the bridge circuit. The other arms of the bridge have a resistance of 2KΩ each. Calculate the detector deflection for 1000 micro-strain if the detector 0sensitivity is 10mm/μA and its internal resistance is: (i) 100Ω (ii) 200Ω. the supply to the bridge is 10V. [4]

   c) Explain how digital to analog conversion can be achieved by using R-2R ladder network DAC. Discuss its advantages over WRN type of DAC. [6]

4. a) Describe in detail the successive approximation method of analog to digital (A/D) conversion taking an example of 4-bit converter having full range of 5V and input of 3.215V. [6]

b) An 11-bit ADC has conversion time of 20μS and full scale voltage of 10V. Find the maximum rate of change of input signal and maximum input frequency that the analog input signal may have in order that the converter can resolve the input signal into 11-bit number in a signal conversion. [4]

c) What is data acquisition system? Explain the function and objective of each component of an analog data acquisition system. [6]

5. a) Explain the construction and working principle of a single phase electro-dynamometer type of wattmeter and derive the expression of deflection for both ac and dc operation. [8]

b) What do you understand by sample and hold circuit. Explain its functioning with the help of circuit diagram and also discuss about its characteristics to define its specification. [8]

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Poush

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the function of different components of a measurement system with example. [6]
   b) Explain the construction and working principle of a linear variable differential transformer. [6]
   c) Obtain the balanced condition for Schering's Bridge and Also explain how this can be used to measure unknown capacitance. [4]
2. a) What is piezo-electric transducer? What are the materials used in such transducer? Also derive the expression for the output voltage developed due to applied force. [6]
   b) A piezo-electric pressure transducer having unknown sensitivity is connected to a charge amplifier, the gain being set to 10mV/pc. The amplifier output is connected to a ultraviolet chart recorder. whose sensitivity is set to 50 mm/V. Determine the sensitivity of piezo-electric pressure transducer if a deflection of 100 mm occurs in the chart recorder due to a force of 200N applied to the piezo-electric pressure transducer. [4]
   c) What are the characteristics of an ideal operational amplifier? Derive the expression for close loop gain of operational amplifier in inverting and non-inverting mode. [6]
3. a) Explain the principle of operation of capacitive displacement transducers. Also explain how can the response of the capacitive transducer. which works on the principle of variation of capacitance with the displacement between two plates, be made linear. Also give the sensitivity of such arrangement. [6]
   b) A voltage dividing potentiometer is used to measure an angular displacement. The angle of displacement is 120° and total angle of travel is 355°. Calculate the voltage out-put on open circuit if the potentiometer is excited by 120V source. Calculate the actual value of the out-put voltage at this setting of a voltmeter of 2 MΩ is connected across the output. The resistance of the potentiometer is 2 kΩ. Also calculate the percentage error. [4]
   c) State and explain sampling theorem in digital instrumentation system. [6]
4. a) Explain the special feature of instrumentation amplifier and also derive the expression for its gain. [6]
   b) Describe with the help of block diagram and flowchart, the method of conversion of analog signal to digital using successive approximation ADC. [6]
   c) An analog voltage signal whose highest significant frequency is 1 KHZ is to be digitally coded with a resolution of 0.01% covering a voltage range of 0-10V. Determine: (i) Minimum number of bits in the digital code (ii) Analog value of LSB (iii) Minimum sampling rate (iv) Aperture time required for the [4]
5. a) Explain the features and working principle of sample and hold circuit. [6]
   b) Mention the different types of energy meter. Also show that the deflection torque is directly proportional to the power consumed by the load. [6]
   c) What is data acquisition system? Also explain different component of digital data acquisition system. [4]

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Bhadra

Exam.		Regular	
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

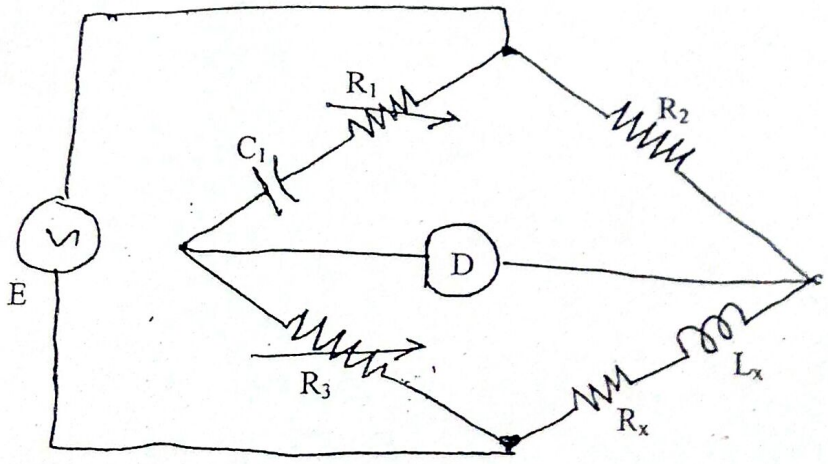
Subject: - Instrumentation I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define measurement and measurement system. Also explain various types of errors encountered in electrical measurement. [8]

   b) The value of power consumed was determined by measuring current "I" flowing through the resistance with an error of ±1.5 percent and resistance "R" with an error of ±1 percent. Determine the maximum possible relative error to be expected on measuring power "P" from formula $P = I^2R$. [8]

2. a) The AC bridge shown in the figure is used to measure the unknown induction (L_x) of a coil having quality factor greater than 10. Show that $L_x = R_2R_3C_1$, when the bridge is balanced. [8]



   b) Explain how low-resistance can be measured with the help of ammeter-voltmeter method. [8]

3. a) Explain the working principle of current transformer along with its connection in a circuit. What will happen if the secondary circuit of the current transformer is open circuited while the primary carries current? Explain. [8]

   b) The output of a potentiometer is to be read by a recorder of 10 KΩ input resistance. Non-linearity must be held to 1 percent. A family of poteniometers having a thermal rating of 5W and resistances ranging from 100Ω to 10,000Ω in 100Ω steps are available. Choose, from this family, the potentiometer that has the greatest possible sensitivity and meets other requirements. What is the sensitivity if the potentiometer are single turn (360°) unit? [8]

4. a) Define piezo-resistive effect and gauge factor of a resistance strain gauge and derive the expression for the gauge factor. [10]

b) A barium titanate piezo-electric pick-up has dimensions of 12mm×12mm×3mm and a voltage sensitivity of 0.015 Vm/N. Relative permittivity of barium titanate is 1400 and modulus of elasticity of barium titanate is 10×10^{10} N/m^2. If the force applied is 20N, determine (i) the output voltage (ii) charge sensitivity (iii) strain (iv) charge generated (v) the capacitance of the pick up. [6]

5. a) Explain different applications of operational amplifier in measurement system. Also show that if a d.c. voltage is applied to an integrator it will produce a ramp voltage. [8]

b) A 6-bit DAC has 20 KΩ resistance in MSB position. The converter is designed with weighted resistive network. The reference voltage is 12V. The output of the resistive network is connected to an operation amplifier with a feedback resistance of 5KΩ. What will be analog output for a binary input of 101101? [8]

6. a) Describe the construction details and working of a single phase electro-dynamometer type of wattmeter. Also derive the expression for deflection for ac operation. [10]

b) A 10 bit, 10V successive approximation ADC has 20μS conversion time. Find the maximum rate of change of input signal and maximum input frequency. [6]

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