



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)  
Dundigal, Hyderabad - 500 043

## MECHANICAL ENGINEERING

### TUTORIAL QUESTION BANK

|                          |  |                  |                |                   |                |
|--------------------------|--|------------------|----------------|-------------------|----------------|
| <b>Course Title</b>      | <b>INSTRUMENTATION AND CONTROL SYSTEMS</b> |                  |                |                   |                |
| <b>Course Code</b>       | AME019                                     |                  |                |                   |                |
| <b>Program</b>           | B.Tech                                     |                  |                |                   |                |
| <b>Semester</b>          | SEVEN                                      |                  |                |                   |                |
| <b>Course Type</b>       | Core                                       |                  |                |                   |                |
| <b>Regulations</b>       | <b>IARE - R16</b>                          |                  |                |                   |                |
| <b>Course Structure</b>  | <b>Theory</b>                              |                  |                | <b>Practical</b>  |                |
|                          | <b>Lectures</b>                            | <b>Tutorials</b> | <b>Credits</b> | <b>Laboratory</b> | <b>Credits</b> |
|                          | 3  | 1                | 4              | 2                 | 1              |
| <b>Chief Coordinator</b> | Dr. GVR Seshagiri Rao, Associate Professor |                  |                |                   |                |

#### COURSE OBJECTIVES:

|  |   |
|--|---|
| <b>The students will try to learn:</b> |   |
| I                                      | The fundamental knowledge of measuring principles, configuration and functional description of instruments with static, dynamic inputs and error control. |
| II                                     | The concepts and working of instrumentation devices for displacement, flow, dynamic and other mechanical measurement applications.                        |
| III                                    | Instrumentation practices and automatic control system for monitoring industrial real time processes within limits of parameter specifications.           |

#### COURSE OUTCOMES:

At the end of the course the students should be able to:

| <b>Course Outcomes</b> |   | <b>Knowledge Level (Bloom's Taxonomy)</b> |
|------------------------|---|---|
| CO 1                   | <b>Recognize</b> the importance of basic principles, configuration and functional description of measuring instruments.               | Understand                                |
| CO 2                   | <b>Describe</b> performance characteristics of an instrument when the device is exposed for measure dynamic inputs and error control. | Understand                                |

|       |   |            |
|-------|---|------------|
| CO 3  | <b>Categorize</b> the measuring instruments based on the principle of working with the physical parameters such as displacement, temperature and pressure.                          | Analyze    |
| CO 4  | <b>Explain</b> calibration of instruments for measurement of all types of mechanical parameters.  | Understand |
| CO 5  | <b>Demonstrate</b> working principle of level measuring devices for ascertaining liquid level and choose appropriate device for controlling fluid level in industrial applications. | Understand |
| CO 6  | <b>Identify</b> the theory, phenomena and working principle of liquid level for flow measuring instruments.   | Apply      |
| CO 7  | <b>Make use of</b> appropriate instrument for measuring Speed, Acceleration and Vibration by considering different aspects.   | Apply      |
| CO 8  | <b>Demonstrate</b> the concepts for measurement of Stress, Strain, Humidity and their application in determining stress, strain, and humidity.                                      | Understand |
| CO 9  | <b>Describe</b> the principles of measurement of force, torque and power and their application in industries in finding force, torque and power.                                    | Understand |
| CO 10 | <b>Apply</b> relevant control systems for speed, position and control processes in practical applications.  | Apply      |

**MAPPING OF EACH CO WITH PO(s), PSO(s):**

| Course Outcomes | Program Outcomes |          |          |          |          |          |          |          |          |          |          |          | Program Specific Outcomes |          |          |          |
|-----------------|------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------------------|----------|----------|----------|
|                 | 1                | 2        | 3        | 4        | 5        | 6        | 7        | 8        | 9        | 10       | 11       | 12       | 1                         | 2        | 3        |          |
| CO 1            | 3                | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 2            | 3                | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 3            | 3                | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 4            | 3                | 1        | -        | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 5            | 3                | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 6            | 3                | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 7            | 3                | -        | -        | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 8            | 3                | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 9            | 3                | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 10           | 3                | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| CO 11           | 3                | 1        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| <b>TOTAL</b>    | 33               | 6        | -        | 2        | -        | -        | -        | -        | -        | -        | -        | -        | -                         | -        | -        | -        |
| <b>AVERAGE</b>  | <b>3</b>         | <b>1</b> | <b>-</b> | <b>1</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b> | <b>-</b>                  | <b>-</b> | <b>-</b> | <b>-</b> |

## TUTORIAL QUESTION BANK

| UNIT – I                          |   |                       |   |                |
|-----------------------------------|---|-----------------------|---|----------------|
| PRINCIPLES OF MEASUREMENT         |   |                       |   |                |
| PART - A (SHORT ANSWER QUESTIONS) |   |                       |   |                |
| S No                              | QUESTIONS   | Blooms Taxonomy Level | How does this subsume the level below   | Course Outcome |
| 1                                 | What is measurement?  | Remember              | ---   | CO 1           |
| 2                                 | List the two conditions to be satisfied for the result of measurement to be meaningful. | Remember              | ---   | CO 1           |
| 3                                 | Name two examples for primary measurement.  | Remember              | ---   | CO 1           |
| 4                                 | What is secondary measurement?  | Remember              | ---   | CO 1           |
| 5                                 | What is a primary sensing element?  | Remember              | ---   | CO 1           |
| 6                                 | Define the term ‘STANDARD’.   | Remember              | ---   | CO 1           |
| 7                                 | Define a measuring instrument.  | Remember              | ---   | CO 1           |
| 8                                 | What is null type instrument?   | Remember              | ---   | CO 1           |
| 9                                 | What are analog and digital instruments?  | Remember              | ---   | CO 1           |
| 10                                | Name two examples for automated and manually operated instruments.                      | Remember              | ---   | CO 2           |
| 11                                | Name two examples for non-contacting instruments.                                       | Remember              | ---   | CO 2           |
| 12                                | What are intelligent instruments?   | Remember              | ---   | CO 2           |
| 13                                | Compare the terms ‘accuracy’ and ‘precision’.   | Understand            | The learner to <b>Recall</b> the measuring units, <b>Understand</b> what accurate measurement is and apply them on various instruments. | CO 2           |
| 14                                | Define the term calibration.  | Remember              | ---   | CO 2           |
| 15                                | Why instruments are to be calibrated?   | Remember              | ---   | CO 2           |
| 16                                | What is meant by primary calibration?   | Remember              | ---   | CO 2           |
| 17                                | What is secondary calibration?  | Remember              | ---   | CO 2           |
| 18                                | What are mechanical instruments?  | Remember              | ---   | CO 2           |
| 19                                | List two deflection type instruments.   | Remember              | ---   | CO 2           |
| 20                                | What is a power operated instrument?  | Remember              | ---   | CO 2           |

**PART - B (LONG ANSWER QUESTIONS)**

|    |  |            |   |      |
|----|--|------------|---|------|
| 1  | Classify the methods of measurement. Explain each one of them in detail considering their applications and limitations.                    | Understand | The <b>learners</b> to recall the Concept of various measurement systems then <b>classify</b> the methods of measurements.                          | CO 1 |
| 2  | Explain generalized measurement system and explain its various elements with block diagram   | Understand | The <b>learner</b> to <b>recall</b> the Concept of various measurement systems then <b>Explain</b> the methods of measurements.                     | CO 1 |
| 3  | Explain the generalized measurement system with help of example  | Understand | The learners to recall the Concept of various measurement systems then explain the generalized measurement systems.                                 | CO 1 |
| 4  | Classify broadly the measuring instruments and explain the applications of measuring instruments in detail.                                | Understand | The learner to <b>recall</b> the concept of various measurement systems then <b>classifies</b> the instruments.                                     | CO 1 |
| 5  | List the various types of measuring instruments and explain any one of them briefly.   | Remember   | ---   | CO 1 |
| 6  | Explain the various static characteristics of a measurement system involving their importance in instrumentation.                          | Understand | The learner to <b>recall</b> the concept of various measurement systems then <b>explains</b> its characteristics.                                   | CO 1 |
| 7  | Explain the various elements of generalized measurement system with a neat sketch.   | Understand | The learner to <b>recall</b> the concept of various measurement systems then <b>explain</b> the various elements of generalized measurement system. | CO 1 |
| 8  | Explain the dynamic performance characteristics of measuring Instruments.  | Understand | The learner to <b>recall</b> the concept of various measurement systems then <b>Explain</b> the dynamic performance characteristics of instruments. | CO 1 |
| 9  | What is calibration of instrument and elaborate on the procedure adopted for calibrating instruments.                                      | Remember   | ---   | CO 1 |
| 10 | Explain how flow measuring instruments are calibrated by the primary and secondary calibration methods.                                    | Understand | The learners to recall the concept of various flow measurement systems then explain its calibration procedures.                                     | CO 1 |
| 11 | Demonstrate calibration of temperature measuring devices with suitable example.  | Understand | The learner to <b>recall</b> the concept of calibration procedures of measuring devices.  | CO 2 |
| 12 | Define measurement and explain its significance in our day-to-day life.  | Remember   | ---   | CO 2 |
| 13 | Illustrate error, correction curves and calibration curves.  | Understand | The learners to recall the accuracy of any measuring instruments then <b>illustrate</b> various curves.   | CO 2 |
| 14 | List the different sources of errors in measuring instruments and suggest the methods in detail for elimination or minimization of errors. | Remember   | ---   | CO 2 |
| 15 | Classify various errors and explain them in detail considering the importance of them in practical applications.                           | Understand | The learners to recall the accuracy of any measuring instruments then classify various errors.  | CO 2 |

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| 16  | Explain the following transducers with respect to their construction, working and characteristics:<br>a) Piezo-electric<br>b) Ionization                     | Understand | The learner to <b>recall</b> the various transducers and <b>explain</b> the working principles.  | CO 2 |
| 17  | Demonstrate primary, secondary and tertiary measurement with examples  | Understand | The learners to <b>recall</b> the concept of various measurement systems then <b>demonstrate</b> various measurements.   | CO 2 |
| 18  | Explain dynamic characteristics of a measuring instrument.   | Understand | The learner to <b>recall</b> the measurement systems then <b>explain</b> dynamic Characteristics of various measurement instruments.                               | CO 2 |
| 19  | Demonstrate seven static characteristics of an measuring Instrument  | Understand | The learner to <b>recall</b> the measurement instruments and then <b>demonstrate</b> the static Characteristics of various measurement instruments.                | CO 2 |
| 20  | Explain the stages of generalized measurement system with example.   | Understand | The learner to <b>recall</b> the various measurement systems then <b>explain</b> the stages of generalized measurement systems.                                    | CO 2 |
| <b>PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)</b> |  |            |  |      |
| 1   | a) Distinguish between direct and indirect methods of measurement with suitable examples.<br>b) Discuss propagation of uncertainties in measurement systems. | Analysis   | The learner to: <b>Recall</b> the measuring instruments, Understand what accurate measurement is and <b>apply</b> them on instruments.                             | CO 1 |
| 2   | Explain the functional description of various elements of a generalized measuring system with example.   | Understand | The learners to <b>recall</b> the concept of various measurement systems then <b>explain</b> the functional description of various elements of a measuring system. | CO 1 |
| 3   | Classify measuring instruments. Explain them in detail with neat sketches.   | Understand | The learner to <b>recall</b> the concept of various measurement instruments then <b>classify</b> and explaining the measuring instruments.                         | CO 1 |
| 4   | Explain the dynamic response characteristics of first order instruments to step, ramp and sinusoidal inputs.   | Understand | The learners to <i>recall</i> the concept of various measurement systems then <b>explain</b> the dynamic response.   | CO 1 |
| 5   | Classify the systematic errors and identify causes and actions to be initiated for elimination or reducing errors.   | Understand | The learners to <b>recall</b> the accuracy of measurement systems then <b>classify</b> the errors.   | CO 1 |
| 6   | Elaborate on the procedure adopted for calibration capacitance transducer for measurement of angular displacement.   | Understand | The learner to <b>recall</b> the classification of measurement systems.  | CO 2 |
| 7   | Explain how flow measuring instruments are calibrated by the primary and secondary calibration methods with suitable example                                 | Understand | The learner to <b>recall</b> the flow measuring instruments and <b>explain</b> the calibration procedure.  | CO 2 |
| 8   | Demonstrate on calibration of Resistance Temperature Detector for temperature measurement.   | Understand | The learners to recall the Classification of measurement systems then demonstrate calibration procedure of RTD.  | CO 2 |

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| 9  | What is meant by statistical analysis of random errors? Explain the terms involved in it.                      | Remember | ---   | CO 2 |
| 10 | Analyze the influence of desired, modifying m interfering inputs for a measurement system on the final output. | Analyze  | The learner to: <b>Recall</b> the measuring units, <b>Understand</b> what accurate measurement is and <b>apply</b> them on various instruments. | CO 2 |

## UNIT – II

### MEASUREMENT OF DISPLACEMENT, TEMPERATURE, PRESSURE

#### PART – A (SHORT ANSWER QUESTIONS)

|    |  |            |  |      |
|----|--|------------|--|------|
| 1  | Define the term transducer.  | Remember   | ---  | CO 3 |
| 2  | What is meant by loading?  | Remember   | ---  | CO 3 |
| 3  | Compare primary transducer with secondary transducer.                  | Understand | The learner to <b>recall</b> the principle of transducer then comparing various transducers.                                     | CO 3 |
| 4  | Compare active and passive transducers.                                | Understand | The learner to <b>recall</b> the principle of transducer then <b>compare</b> active and passive transducers.                     | CO 3 |
| 5  | What is an elastic transducer?   | Remember   | ---  | CO 3 |
| 6  | Compare analog and digital transducers.                                | Understand | The learners to <b>recall</b> the classification of measurement systems then <b>compare</b> analog and digital transducers.      | CO 3 |
| 7  | What is an electric transducer?  | Remember   | ---  | CO 3 |
| 8  | What is a mechanical transducer?                                       | Remember   | ---  | CO 3 |
| 9  | What is meant by displacement measurement?                             | Remember   | ---  | CO 3 |
| 10 | Name various transducers used for displacement measurement.            | Remember   | ---  | CO 3 |
| 11 | What is the basic principle behind a resistance potentiometer?         | Remember   | ---  | CO 4 |
| 12 | List three areas where temperature measurement is important.           | Remember   | ---  | CO 4 |
| 13 | Define temperature.  | Remember   | ---  | CO 4 |
| 14 | Explain the basic principle on which the bimetallic thermometer works. | Understand | The learner to <b>recall</b> the Thermodynamic principles. Then <b>explain</b> the basic principles of bi-metallic thermometers. | CO 4 |
| 15 | List the common metals used in bimetallic strips.                      | Remember   | ---  | CO 4 |
| 16 | What is a pressure thermometer?  | Remember   | ---  | CO 4 |
| 17 | What are the limitations of thermistor?                                | Remember   | ---  | CO 4 |
| 18 | List the laws of a thermocouple?                                       | Remember   | ---  | CO 4 |

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| 19                                      | List characteristics of a thermopile?   | Remember   | ---  | CO 4 |
| 20                                      | What is pyrometer? Outline its applications.  | Remember   | ---  | CO 4 |
| <b>PART - B (LONG ANSWER QUESTIONS)</b> |   |            |  |      |
| 1                                       | Demonstrate measurement system for displacement measurement using LDR (Light dependent resistor) as sensor.                           | Understand | The learner to <b>recall</b> the principles of light. Then demonstrating measurement system.   | CO 3 |
| 2                                       | Explain the principle and working of a pyrometer with neat sketch mentioning its advantages.  | Understand | The learner to <b>recall</b> the principles of light and electronics then <b>explain</b> the principle and its working.                | CO 3 |
| 3                                       | Explain the temperature measurement by thermocouples and resistance thermometers.   | Understand | The learner to <b>recall</b> the Thermodynamic principles then <b>Explain</b> the temperature measurement.                             | CO 3 |
| 4                                       | Compare RTD and Thermistor with respect to principle, construction, working and applications.   | Analysis   | The learner to: <b>Recall</b> the measuring instruments, Understand the thermodynamic principles and <b>apply</b> them on instruments. | CO 3 |
| 5                                       | Demonstrate Laws of thermocouples useful construction of thermocouples for measurement of temperature.                                | Remember   | ---  | CO 3 |
| 6                                       | a) Differentiate between rare metal thermocouples and base metal thermocouples.<br>b) Why protection is needed for a sensing element? | Analysis   | The learner to: <b>Recall</b> the measuring instruments, Understand the thermodynamic principles and <b>apply</b> them on instruments. | CO 3 |
| 7                                       | Explain the working of a helix and spiral bimetallic thermometer for measurement of temperature.                                      | Understand | The learner to <b>recall</b> the Thermodynamic principles then <b>explain</b> its working.   | CO 3 |
| 8                                       | Demonstrate principle and working of Resistance Temperature Detector for measuring temperature of hot water with neat diagram.        | Understand | The learner to <b>recall</b> the Thermodynamic principles then <b>demonstrate</b> its working principle.                               | CO 3 |
| 9                                       | What is a thermistor? How is it used for temperature measurement? Explain its applications, advantages and limitations.               | Remember   | ---  | CO 3 |
| 10                                      | Explain the working principle, construction and characteristics of Linear Variable Differential Transformer (LVDT).                   | Understand | The learner to <b>recall</b> the Thermodynamic principles then <b>Explain</b> the working principle of LVDT.                           | CO 3 |
| 11                                      | With the help of line diagrams, explain the construction, working and advantages of thermal conductivity gauges.                      | Apply      | The learner to: <b>Recall</b> the measuring instruments, Understand the thermodynamic principles and <b>apply</b> them on instruments. | CO 3 |
| 12                                      | With the help of a suitable diagram, explain the construction, working and principle features of bourdon tube pressure gauge.         | Apply      | The learner to: <b>Recall</b> the measuring instruments then <b>explain</b> with a suitable diagram.                                   | CO 4 |
| 13                                      | a) Explain the working principle of diaphragm gauge with a neat diagram.<br>b)  | Understand | The learner to <b>recall</b> the Various gauges Then <b>explain</b> its working principle.   | CO 4 |

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|   | c) State the advantages and disadvantages of diaphragm gauge.   |            |  |      |
| 14  | a) Explain the working principle of manometers for pressure measurement.<br>b) List out various types of manometers used for pressure measurement and discuss their specific characteristics.                                 | Understand | The learner to <b>recall</b> the velocity and pressure principles and formulae then <b>explain</b> its working.  | CO 4 |
| 15  | How do you measure the pressure with the help of U-tube manometer and micro-manometer?  | Understand | The learner to <b>recall</b> the velocity and pressure principles and formulae.  | CO 4 |
| 16  | Explain the basic principle in thermal conductivity gauge? And the working principle of thermocouple type conductivity gauge.   | Understand | The learner to <b>recall</b> the Thermodynamic principles and formulae.  | CO 4 |
| 17  | Explain the construction and working principle of Ionization pressure gauge.  | Understand | The learner to <b>recall</b> the velocity and pressure principles and formula then <b>explain</b> the construction and working principle of ionization pressure gauge. | CO 4 |
| 18  | a) Explain absolute, gauge and vacuum pressure<br>b) Explain with the help of suitable sketches, the difference between a Bellow gauge and a diaphragm gauge for pressure measurement.  | Understand | The learner to <b>recall</b> the properties of gasses and ionization principles then <b>explain</b> various pressures.   | CO 4 |
| 19  | State the principle of diaphragm gauges. How an elastic diaphragm gauge is used to measure pressure?  | Remember   | ---  | CO 4 |
| 20  | Explain the construction, working principle and features of Pirani thermal conductivity gauge.  | Remember   | ---  | CO 4 |
| <b>PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</b> |   |            |  |      |
| 1   | Demonstrate the calibration process of thermocouple for measurement of temperature.   | Understand | The learner to <b>recall</b> the Thermodynamic principles and accuracy then <b>demonstrating</b> the calibration process of thermocouple.                              | CO 3 |
| 2   | State the three laws of thermocouples. Discuss their importance and practical applications in engineering.  | Remember   | ---  | CO 3 |
| 3   | Explain the working of total radiation pyrometer and indicate its applications.   | Understand | The learner to <b>recall</b> the Thermodynamic and optical principles then <b>explain</b> the working of total radiation pyrometer.                                    | CO 3 |
| 4   | Demonstrate the principle, working of optical pyrometer for measurement of temperature of molten steel.   | Understand | The learner to <b>recall</b> the light and optical principles.   | CO 3 |
| 5   | A platinum resistance thermometer has a resistance of 140.5 $\Omega$ and 100.0 $\Omega$ at 100° and 0° respectively. If its resistance becomes 305.3 $\Omega$ when it is in contact with a hot gas, determine the temperature | Apply      | The learner to: <b>Recall</b> the measuring instruments, <b>Understand</b> what is pressure measurement and their <b>formula</b> .                                     | CO 3 |



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|    | of gas. Take the temperature coefficient of platinum as $0.0039^{\circ}\text{C}^{-1}$ .   |            |  |      |
| 6  | What is a dead weight tester? How is a dead weight tester used to calibrate pressure measuring devices?   | Remember   | ---  | CO 4 |
| 7  | A McLeod gauge having $V = 200 \text{ cm}^3$ and a capillary diameter of 20mm is used to measure the gas pressure. What will be the pressure of the gas corresponding to a capillary of 4 cm? | Apply      | The learner to: <b>Recall</b> the measuring instruments, <b>Understand</b> what is pressure measurement and their <b>formula</b> . | CO 4 |
| 8  | Explain the working of a bourdon tube pressure gauge. What are its advantages and limitations?  | Understand | The learner to <b>recall</b> the pressure gauges principles then <b>explain</b> the working of bourdon tube pressure gauge.        | CO 4 |
| 9  | What are bellows gauges? Explain the bellows gauge used to measure gauge pressure.  | Remember   | ---  | CO 4 |
| 10 | Explain the bellows arrangement used to measure differential pressure. Give their advantages and limitations.   | Understand | The learner to <b>recall</b> the pressure gauges principles then <b>explain</b> the working of bellows.                            | CO 4 |

### UNIT-III

#### MEASUREMENT OF LEVEL, FLOW, SPEED , ACCELERATION AND VELOCITY

#### PART - A (SHORT ANSWER QUESTIONS)

|    |  |            |  |      |
|----|--|------------|--|------|
| 1  | What is working principle of displacer type liquid level measuring method? | Remember   | ---  | CO 5 |
| 2  | Compare direct and indirect liquid level measuring devices                 | Understand | The learner to <b>recall</b> the various measuring devices. Then <b>compare</b> direct and indirect measuring devices.         | CO 5 |
| 3  | Explain the basic principle behind electric liquid level sensors.          | Understand | The learner to <b>recall</b> the concept of sensors. Then <b>explain</b> the basic principle of electric liquid level sensors. | CO 5 |
| 4  | List the importance of flow measurement.                                   | Remember   | ---  | CO 5 |
| 5  | What is working principle of capacitance level indicator?                  | Remember   | ---  | CO 5 |
| 6  | What is basic principle of an obstruction meter?                           | Remember   | ---  | CO 5 |
| 7  | List the applications of flow meters.                                      | Remember   | ---  | CO 5 |
| 8  | What is an ultrasonic flow meter?  | Remember   | ---  | CO 5 |
| 9  | What is the principle of Rotometer? Outline its applications.              | Remember   | ---  | CO 5 |
| 10 | What is the principle of Electromagnetic flow meter?                       | Remember   | ---  | CO 5 |
| 11 | What is a Tachometer? List the types of tachometers.                       | Remember   | ---  | CO 6 |
| 12 | List any three mechanical tachometers used to measure angular velocity     | Remember   | ---  | CO 6 |

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| 13                                      | List the basic principle behind tachogenerators  | Remember   | ---   | CO 6 |
| 14                                      | List the list of various contactless electrical tachometers  | Remember   | ---   | CO 6 |
| 15                                      | Explain about vibration and its characteristics.   | Understand | The learner to <b>recall</b> the concept of vibration. Then <b>explain</b> its characteristics.                                     | CO 6 |
| 16                                      | What is piezo – electric effect?   | Remember   | ---   | CO 6 |
| 17                                      | What is basic principle on which a seismic displacement sensing accelerometer works?                                 | Remember   | ---   | CO 6 |
| 18                                      | State the basic principle on which a strain gauge accelerometer works  | Remember   | ---   | CO 6 |
| 19                                      | List various instruments which are used for measuring vibrations   | Remember   | ---   | CO 6 |
| 20                                      | List any three measurement devices for measurement of linear velocity  | Remember   | ---   | CO 6 |
| <b>PART – B (LONG ANSWER QUESTIONS)</b> |  |            |   |      |
| 1                                       | Explain briefly with neat sketches:<br>a) Hook level indicator<br>b) Cryogenic fuel method                           | Understand | The learner to <b>recall</b> the concept of indicators. Then <b>explain</b> the methods involved.                                   | CO 5 |
| 2                                       | Explain briefly with neat sketches:<br>a) Bubbler level indicator<br>b) Ultrasonic level method                      | Understand | The learner to <b>recall</b> the concept of indicators. Then <b>explain</b> the methods involved.                                   | CO 5 |
| 3                                       | Compare the direct and indirect modes of level measurement with example.   | Understand | The learner to <b>recall</b> the various measuring devices. Then <b>compare</b> direct and indirect measuring devices.              | CO 5 |
| 4                                       | Explain any one float operated liquid level gauge in detail.   | Understand | The learner to <b>recall</b> the various measuring gauges. Then <b>explain</b> float operated liquid level gauge.                   | CO 5 |
| 5                                       | Explain any one purge system to measure liquid level in detail.  | Understand | The learner to <b>recall</b> the various measuring gauges. Then <b>explain</b> purge system to measure liquid level.                | CO 5 |
| 6                                       | What is the principle of working of a magnetic flow meter? What are its advantages over other types of flow meters?  | Remember   | ---   | CO 5 |
| 7                                       | a) Demonstrate the construction of bubbler level indicator.<br>b) Explain the use of rotameter for flow measurement. | Understand | The learner to <b>recall</b> the various measuring level indicators. Then <b>explain</b> its construction in detail.                | CO 5 |
| 8                                       | a) Explain the principle, construction working of ultrasonic flow meter with neat sketch.                            | Understand | The learner to <b>recall</b> the various measuring flow meters. Then <b>explain</b> the working principle of ultrasonic flow meter. | CO 5 |
| 9                                       | Explain the construction and working principle of turbine flow meter with a neat sketch.                             | Understand | The learner to <b>recall</b> the various measuring flow meters. Then <b>explain</b> the working principle of ultrasonic flow meter  | CO 5 |

|   |  |            |   |      |
|---|--|------------|---|------|
| 10  | Explain the principle of operation, construction details, advantages and limitations of rotameter                | Understand | The learner to <b>recall</b> the various measuring flow meters. Then <b>explain</b> the working principle of rotameter.                                   | CO 5 |
| 11  | Illustrate the working of moving magnet type and moving coil type velocity transducer with a neat sketch.        | Understand | The learner to <b>recall</b> the various transducers. Then <b>explain</b> the working principle of moving magnet and moving coil type transducers.        | CO 6 |
| 12  | Explain with neat sketch the working of slipping clutch and centrifugal tachometer                               | Understand | The learner to <b>recall</b> the various clutches. Then <b>explain</b> the working principle of slipping type clutch.                                     | CO 6 |
| 13  | Explain with neat sketch the working of vibration measurement using stroboscope                                  | Understand | The learner to <b>recall</b> the various vibration measuring instruments. Then <b>explain</b> the working principle of stroboscope.                       | CO 6 |
| 14  | Explain with neat sketch the working of commutated capacitor tachometer  | Understand | The learner to <b>recall</b> the various tachometers. Then <b>explain</b> the working principle of commutated capacitor.                                  | CO 6 |
| 15  | Explain with neat sketch the working of DC and AC Tachogenerator   | Understand | The learner to <b>recall</b> the various tachogenerators. Then <b>explain</b> the working principle of DC and AC tachogenerators.                         | CO 6 |
| 16  | Show the working of Inductive pickup and stroboscope tachometer with neat sketch.                                | Remember   | ----  | CO 6 |
| 17  | Explain with neat sketch the working of photo electric and capacitor tachometer                                  | Understand | The learner to <b>recall</b> the various tachometers. Then <b>explain</b> the working principle of photo electric and capacitor tachometers.              | CO 6 |
| 18  | List applications and with neat sketch the working of vibrating reed and drag cup tachometer                     | Analyze    | The learner to <b>recall</b> the various tachometers. Then <b>Analyze</b> the working principle of vibrating reed and drag cup tachometers.               | CO 6 |
| 19  | Explain with neat sketch the working of piezo-electric accelerometer   | Understand | The learner to <b>recall</b> the various accelerometers Then <b>explain</b> the working principle of piezo-electric accelerometer.                        | CO 6 |
| 20  | Explain with neat sketch the working of linear and rotational seismic displacement sensing accelerometer         | Understand | The learner to <b>recall</b> the various sensing accelerometers Then <b>explain</b> the working principle of liner and rotational seismic instruments.    | CO 6 |
| <b>PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</b> |  |            |   |      |
| 1   | Explain the working principle and working of capacitive liquid level sensor for measurement of liquid level.     | Understand | The learner to <b>recall</b> the various measuring sensors for liquid levels Then <b>Explain</b> the working principle of capacitive liquid level sensor. | CO 5 |
| 2   | Outline the principle, working of a rotameter with diagram neatly and mention its advantages and limitations.    | Understand | The learner to <b>recall</b> the various flow measuring meters Then <b>Explain</b> the working principle of rotameter with a neat sketch.                 | CO 5 |
| 3   | Explain with neat sketch principle and working of Laser Doppler Anemometer mention advantages and disadvantages. | Understand | The learner to <b>recall</b> the various anemometers Then <b>Explain</b> the  | CO 5 |

|    |   |            |   |      |
|----|---|------------|---|------|
|    |   |            | working principle of laser Doppler anemometer.  |      |
| 4  | Explain the principle, working of a magnetic flow meter for measuring flow.   | Understand | The learner to <b>recall</b> the various flow meters for measuring flow. Then <b>Explain</b> the working principle of magnetic flow meter.    | CO 6 |
| 5  | Explain the various applications of ultrasonic waves in engineering? Explain the ultrasonic flow meter using the travel time difference method.   | Understand | The learner to <b>recall</b> the various flow meters for measuring flow. Then <b>Explain</b> applications of ultrasonic waves in engineering. | CO 6 |
| 6  | List out the Importance of the speed measurement requirement in engineering. Explain with neat sketch the working of revolution counter and timer | Analyze    | The learner to <b>recall</b> the various measuring instruments Then <b>Evaluate</b> the working principle of revolution counter and timer.    | CO 6 |
| 7  | Explain with neat sketch the working of Tachoscope and indicate its advantages and limitations.   | Understand | The learner to <b>recall</b> the various measuring instruments Then <b>Explain</b> the working principle of tachoscope and its limitations.   | CO 6 |
| 8  | Show the importance of speed measurement? Explain with neat sketch the working of hand speed indicator.   | Understand | The learner to <b>recall</b> the various measuring instruments Then <b>Explain</b> the importance of speed measurement.                       | CO6  |
| 9  | Explain with neat sketch the working of variable induction accelerometer in engineering applications.   | Understand | The learner to <b>recall</b> the various accelerometers Then <b>Explaining</b> the working of variable induction accelerometer.               | CO 6 |
| 10 | Explain with neat sketch the working of reed type vibrometer and indicate its applications, advantages and limitations.                           | Understand | The learner to <b>recall</b> the various vibrometers Then <b>Explain</b> it's working and advantages, limitations.                            | CO 6 |

#### UNIT-IV

#### MEASUREMENT OF STRESS–STRAIN, HUMIDITY, FORCE, TORQUE AND POWER

#### PART – A (SHORT ANSWER QUESTIONS)

|    |   |          |     |      |
|----|---|----------|-----|------|
| 1  | What is axial strain?                               | Remember | --- | CO 7 |
| 2  | Define strain gauge and its importance.             | Remember | --- | CO 7 |
| 3  | What is Poisson's ratio?                            | Remember | --- | CO 7 |
| 4  | What is gauge factor?                               | Remember | --- | CO 7 |
| 5  | What is bonded strain gauge?                        | Remember | --- | CO 7 |
| 6  | What is gauge rosette?                              | Remember | --- | CO 7 |
| 7  | What is self-temperature compensation?              | Remember | --- | CO 7 |
| 8  | List the materials used for fine wire strain gauges | Remember | --- | CO 7 |
| 9  | What is piezo-resistivity?                          | Remember | --- | CO 8 |
| 10 | Define humidity and give its engineering concepts.  | Remember | --- | CO 8 |

|    |  |          |     |      |
|----|--|----------|-----|------|
| 11 | Define dry air and enumerate its importance.             | Remember | --- | CO 8 |
| 12 | What is moist air?                                       | Remember | --- | CO 8 |
| 13 | Define saturated air                                     | Remember | --- | CO 8 |
| 14 | What is absolute humidity?                               | Remember | --- | CO 8 |
| 15 | What is relative humidity?                               | Remember | --- | CO 8 |
| 16 | Define humidity ratio in the concept of instrumentation. | Remember | --- | CO 8 |
| 17 | What is percentage humidity?                             | Remember | --- | CO 8 |
| 18 | What is wet bulb depression?                             | Remember | --- | CO 8 |
| 19 | Define dew point temperature.                            | Remember | --- | CO 8 |
| 20 | Define force in the concept of instrumentation.          | Remember | --- | CO 8 |

**PART – B (LONG ANSWER QUESTIONS)**

|    |  |            |  |      |
|----|--|------------|--|------|
| 1  | Explain briefly on the various bonded strain gauges. Give their classification considering engineering applications. | Understand | The learner to <b>recall</b> the various strain gauges and Then <b>explain</b> bonded strain gauges.   | CO 7 |
| 2  | Explain briefly on the surface preparation and bonding techniques for mounting bonded strain gauges                  | Understand | The learner to <b>recall</b> the various bonding techniques and Then <b>explain</b> the surface preparation.   | CO 7 |
| 3  | Explain the essential characteristics required for the backing material of a bonded strain gauge.                    | Understand | The learners to <b>recall</b> the various bonded strain gauges and Then <b>explain</b> its characteristics.  | CO 7 |
| 4  | Develop the procedure to mount a strain gauge with paper backing on the surface under study.                         | Apply      | The learner to <b>recall</b> the various strain gauges Then <b>develop</b> a procedure for mount a strain gauge.   | CO 7 |
| 5  | Explain one method of temperature compensation using an adjacent arm compensating gauge                              | Understand | The learner to <b>recall</b> the various stain gauges Then <b>develop</b> a procedure for mount a strain gauge.  | CO 7 |
| 6  | Explain how a sling psychrometer is used to determine the dry and wet bulb temperatures                              | Understand | The learner to <b>recall</b> the various terms in psycho meter chart. Then <b>explain</b> a procedure for determining the wet and dry bulb temperatures. | CO 7 |
| 7  | Classify the hygrometer types. Explain the working of any one of the absorption hygrometers.                         | Understand | The learner to <b>recall</b> the various hygrometers Then <b>classify</b> various hygrometers and <b>explain</b> its working principle                   | CO 7 |
| 8  | Explain how a dew point meter is used to measure the dew point temperature.  | Understand | The learner to recall the various terms in psycho meter chart. Then explain a procedure to Measure the dew point temperature.                            | CO 7 |
| 9  | Explain the details of a pendulum scale and discuss the applications with diagram.                                   | Understand | The learner to recall the various measuring scales Then explain the pendulum scale with diagram.   | CO 7 |
| 10 | What is the practical application of unequal arm balance in engineering?   | Remember   | ---  | CO 7 |

|   |   |            |   |      |
|---|---|------------|---|------|
|   | Discuss in detail on an unequal arm balance.  |            |   |      |
| 11  | Tell the various types of pendulum scales for different engineering applications. Explain with a diagram a pendulum scale of multi lever type.          | Remember   | ---   | CO 7 |
| 12  | Find various engineering applications where the measurement of force is important. Explain the method of measuring force using a strain gauge load cell | Remember   | ---   | CO 8 |
| 13  | How hydraulic load cells are used to measure a force  | Remember   | ---   | CO 8 |
| 14  | Explain the method of measuring force using a pneumatic load cell   | Understand | The learner to <b>recall</b> the various measuring scales Then <b>explain</b> the pneumatic load cell.                                  | CO 8 |
| 15  | How a stroboscope is used to measure a torque   | Remember   | ---   | CO 8 |
| 16  | Find various engineering applications where the measurement of torque is important. Explain the measurement of torque by optical torsion meter          | Remember   | ---   | CO 8 |
| 17  | Tell the applications, advantages and limitations of measurement of torque using slotted discs.   | Remember   | ---   | CO 8 |
| 18  | Explain about strain gauges on rotating shafts. Enumerate their advantages and limitations.   | Understand | The learner to <b>recall</b> the various measuring scales Then <b>explain</b> the pneumatic load cell.                                  | CO 8 |
| 19  | Explain with a neat diagram, the working of a Prony brake for estimating power.   | Understand | The learner to <b>recall</b> the various brakes for estimating power Then <b>explain</b> its working.                                   | CO 8 |
| 20  | What are dynamometers? Discuss briefly the working and advantages of fluid friction dynamometers.   | Remember   | ---   | CO 8 |
| <b>PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</b> |   |            |   |      |
| 1   | What is strain? Compare and explain the difference between positive strain and negative strain.   | Remember   | ---   | CO 7 |
| 2   | Define gauge factor. Spell out what does it indicate if a strain gauge has a low gauge factor?  | Remember   | ---   | CO 7 |
| 3   | Identify the importance of strain measurement. Explain how an Unbounded strain gauge is used to measure strain.   | Apply      | The learner to <b>recall</b> the strain measurement gauges and Then <b>Identify</b> the <b>importance</b> of strain measurement gauges. | CO 8 |
| 4   | Classify the strain gauges. Discuss the advantages and disadvantages of unbounded strain gauges.  | Understand | The learner to <b>recall</b> the strain measurement gauges and Then <b>Classify</b> the strain gauges.                                  | CO 8 |
| 5   | Compare the n – type and p – type sensing elements of a semi – conductor strain gauge.  | Understand | The learner to <b>recall</b> the sensing element types and Then <b>compare</b> the n-type and p-type sensing elements.                  | CO 8 |

|    |   |            |  |      |
|----|---|------------|--|------|
| 6  | Tell the importance of measurement of humidity in engineering applications. Give various instruments for humidity measurement.    | Remember   | ---  | CO 8 |
| 7  | Explain the importance of measurement of strain in engineering applications.  | Understand | The learner to <b>recall</b> the measuring gauges and Then <b>explain</b> the importance of strain gauges.                             | CO 8 |
| 8  | Explain the purpose of providing backing for bonded strain gauges and temperature compensation with respect to strain gauges?     | Apply      | The learner to <b>recall</b> the measuring gauges and Then <b>explain</b> the importance of bonded strain gauges.                      | CO 8 |
| 9  | Tell the various engineering applications where force is to be measured. What is a proving ring? How is it used to measure force? | Remember   | ---  | CO 8 |
| 10 | Explain the importance of dynamometers in measuring instruments. Explain driving and transmission dynamometers.                   | Understand | The learner to <b>recall</b> the measuring instruments and Then <b>explain</b> the importance of dynamometer in measuring instruments. | CO 8 |

## UNIT-V

### ELEMENTS OF CONTROL SYSTEMS

#### PART – A (SHORT ANSWER QUESTIONS)

|    |  |            |   |       |
|----|--|------------|---|-------|
| 1  | Define a system and a control system.                      | Remember   | ---   | CO 9  |
| 2  | List the requirements of a control system                  | Remember   | ---   | CO 9  |
| 3  | List the elements of a control system.                     | Remember   | ---   | CO 9  |
| 4  | Define actuating signal in the concept of instrumentation. | Remember   | ---   | CO 9  |
| 5  | Define disturbance in the concept of instrumentation.      | Remember   | ---   | CO 9  |
| 6  | List the classification of control systems                 | Remember   | ---   | CO 9  |
| 7  | Define open-loop control system.                           | Remember   | ---   | CO 9  |
| 8  | List the elements of open-loop control system              | Remember   | ---   | CO 9  |
| 9  | Outline the open-loop control system.                      | Understand | The learner to <b>recall</b> the concept of open –loop control system. Then <b>explain</b> an open-loop control system. | CO 10 |
| 10 | List the advantages of open-loop control system            | Remember   | ---   | CO 10 |
| 11 | List the limitations of open-loop control system           | Remember   | ---   | CO 10 |
| 12 | List two examples for open-loop control system             | Remember   | ---   | CO 10 |
| 13 | Define closed-loop control system.                         | Remember   | ---   | CO 10 |
| 14 | List the elements of closed-loop control system            | Remember   | ---   | CO 10 |



|   |   |            |  |       |
|---|---|------------|--|-------|
| 15                                      | Define open-loop control system.  | Remember   | ---  | CO 10 |
| 16                                      | Explain manual closed loop system.  | Understand | The learner to <b>recall</b> the concept of closed – loop control system. Then <b>explain</b> the closed-loop system.  | CO 10 |
| 17                                      | Define automatic control system.  | Remember   | ---  | CO 10 |
| 18                                      | Define a command in the system.   | Remember   | ---  | CO 10 |
| 19                                      | Define a controlled variable.   | Remember   | ---  | CO 10 |
| 20                                      | Define regulator.   | Remember   | ---  | CO 10 |
| <b>PART - B (LONG ANSWER QUESTIONS)</b> |   |            |  |       |
| 1                                       | What is a control system? Explain the various elements of control system in detail.   | Remember   | The learner to <b>recall</b> the learned terms related to the control systems.   | CO 9  |
| 2                                       | What is the role of control system in engineering applications? Explain four examples of control system applications.                               | Remember   | The learner to <b>recall</b> the learned terms related to the control systems.   | CO 9  |
| 5                                       | Explain the importance and classification of control systems in engineering and the applications of control system in various areas of engineering. | Understand | The learner to <b>recall</b> the <b>importance</b> and classification of control systems Then <b>explain</b> the applications of control system in various areas of engineering. | CO 9  |
| 6                                       | Explain open-loop control system with neat sketch. Give the applications of open-loop control system.   | Understand | The learner to <b>recall</b> the <b>importance</b> and classification of control systems Then <b>explain</b> the applications of open-loop control system.                       | CO 9  |
| 7                                       | Explain the advantages and limitations of closed-loop control system with an example of closed-loop control systems.                                | Understand | The learner to <b>recall</b> the control systems Then <b>explain</b> the advantages and limitations of closed-loop control systems.  | CO 9  |
| 8                                       | List the major classification of control systems. Explain advantages and disadvantages of open-loop control system                                  | Analyze    | The learner to: <b>Understand</b> the control systems <b>Recall</b> their <b>classification</b> of control systems <b>Analyze</b> .  | CO 9  |
| 9                                       | List the classification of control systems in application point of view. Explain advantages and disadvantages of closed-loop control system.        | Analyze    | The learner to: <b>Understand</b> the control systems <b>Recall</b> their <b>classification</b> of control systems and <b>Analyze</b> .  | CO 10 |
| 10                                      | What is the role of feedback in control systems? Explain the characteristics of feedback.   | Remember   | ---  | CO 10 |
| 11                                      | Extend the importance of automation in control systems. Explain automatic control system.   | Understand | The learner to <b>recall</b> the control systems Then <b>explain</b> the <b>importance</b> of automatic control system.  | CO 10 |
| 12                                      | Explain the advantages and limitations of automatic control system along with its applications.   | Understand | The learner to <b>recall</b> the control systems Then <b>explain</b> the advantages and limitations of automatic control systems.  | CO 10 |
| 13                                      | Outline block diagram and Explain the steps in developing a block diagram for an engineering problem.   | Remember   | ---  | CO 10 |



|   |   |            |  |       |
|---|---|------------|--|-------|
| 14  | Compare the pneumatic control systems with hydraulic control systems.   | Analyze    | The learner to <b>Understand</b> the control systems <b>Recall</b> their <b>classification</b> of control systems and <b>Compare</b> . | CO 10 |
| 15  | Explain with neat sketch the working of hydraulic control systems.  | Understand | The learner to <b>recall</b> the control systems Then <b>explain</b> the working of hydraulic control systems.                         | CO 10 |
| 16  | Explain in detail about system error in the concept of instrumentation.   | Understand | The learner to <b>recall</b> the system error <b>explain</b> the concept of instrumentation  | CO 10 |
| 17  | Discuss about reference input in the concept of instrumentation.  | Remember   | ---  | CO 10 |
| 18  | Explain in detail about Block diagram in the concept of instrumentation.  | Understand | The learners to <b>recall</b> the block diagram <b>explain</b> the concept of instrumentation.   | CO 10 |
| 19  | Explain in detail about Stability in the concept of instrumentation.  | Understand | The learner to <b>recall</b> the stability <b>explain</b> the concept of instrumentation   | CO 10 |
| 20  | Explain in detail about system error in the concept of instrumentation.   | Understand | The learner to <b>recall</b> the system error and then <b>explain</b> the concept of instrumentation.                                  | CO 10 |
| <b>PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</b> |   |            |  |       |
| 1   | Explain the importance of control systems and briefly explain the advantages and disadvantages of pneumatic control systems | Apply      | The learner to <b>recall</b> the control systems Then <b>explain</b> the <b>importance</b> of control systems.                         | CO 9  |
| 2   | Explain the importance of control systems and briefly explain the advantages and disadvantages of hydraulic control systems | Apply      | The learner to <b>recall</b> the control systems Then <b>explain</b> the <b>importance</b> of hydraulic control systems.               | CO 9  |
| 3   | Explain the applications of pneumatic control systems in engineering. Enumerate their limitations.                          | Understand | The learner to <b>recall</b> the applications of control system <b>explain</b> the pneumatic control systems                           | CO 9  |
| 4   | Explain the applications of hydraulic control systems in engineering. Enumerate their limitations.                          | Understand | The learner to <b>recall</b> the applications of control system <b>explain</b> the hydraulic control systems                           | CO 9  |
| 5   | Explain the advantages of control systems in engineering. Explain the requirements of control systems.                      | Understand | The learner to <b>recall</b> the advantages of control system <b>explain</b> the requirements of control systems.                      | CO 10 |
| 6   | What are the applications of servo systems in engineering? Explain the features of servo-mechanism.                         | Remember   | ---  | CO 10 |
| 7   | Explain with block diagrams any one position control system.  | Understand | The learner to <b>recall</b> the block diagrams of control system <b>explain</b> the <b>concept</b> of one position control system.    | CO 10 |
| 8   | Explain with block diagrams any one temperature control system.   | Understand | The learner to <b>recall</b> the diagrams related to temperature control systems.  | CO 10 |
| 9   | Explain with block diagrams any one speed control system.   | Understand | The learner to <b>recall</b> diagrams related to the control systems and then explain with block diagrams                              | CO 10 |
| 10  | Spell out the various engineering applications where measuring systems are involved with instruments.                       | Remember   | ---  | CO 10 |

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