

OLLSCOIL NA hÉIREANN, GAILLIMH  
NATIONAL UNIVERSITY OF IRELAND, GALWAY.

SUMMER EXAMINATION 2000

DIPLOMA IN QUALITY ASSURANCE

MEASUREMENT & CALIBRATION (IE884)

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**Instructions:** Time allowed: 2 hours  
**Attempt:** Any 3 questions. Graph paper available.

- Q1 a) Describe in detail a procedure that you are familiar with for installing electrical resistance strain gauges, paying particular attention to the following:
- i) Surface preparation,
  - ii) Gauge handling and alignment and
  - iii) Bonding.
- b) Electrical resistance strain gauges were used in a small force transducer. During calibration of this force transducer the following forces in Newtons were applied: 6.1N, 14.8N, 20.2N & 28.7N. The following output voltages respectively were measured for these forces: 0.5V, 1.0V, 1.5V & 2.0V. Plot this data on graph paper and fit a straight line by eye to the data. From this graph find the calibration factor for the transducer in Newtons per Volt.
- Q2 a) Below are listed some of the main requirements contained in the Calibration section of BSI 5781/ISO9002. Explain and discuss each heading within the context of an industrial calibration system.
- |  |                                       |
|--|---------------------------------------|
| 4.3 Planning of the Calibration System | 4.5 Documented Calibration Procedures |
| 4.6 Calibration Records                | 4.10 Invalidation of Calibration      |
| 4.13 Traceability                      | 4.15 Environmental Control            |
- b) Discuss the key issues involved in carrying out the Calibration Process and particularly outline what steps you would take to ensure that a Calibration System was fully effective and demonstrable.
- Q3 a) Explain using examples, the following terms in the context of measuring instruments;
- Accuracy
  - Precision
  - Repeatability
  - Linearity
  - Bias
  - Hierarchy of Standards
- b) For each of the following physical parameters, give two suitable measurement instruments; explain the principle involved and comment of their accuracy and range;
- 1) Temperature
  - 2) Pressure
  - 3) Torque
  - 4) Mass

Q4 Explain, using diagrams where appropriate, any three (3) of the following;

- a) Limit Gauges
- b) The principles and main uses of Air Gauging
- c) The main methods of taking angular measurements
- d) The principles and uses of a Stylus Instrument for measuring Surface Roughness
- e) The Lobe and Vee Block methods for measuring Roundness

- Q5 a) (i) Explain in qualitative terms what is meant by the viscosity of a fluid and in what way does this property affect an industrial process which involves fluids.
- (ii) An instrument returns the value of kinematic viscosity of a fluid as  $\nu = 5.5 \times 10^{-6} \text{ m}^2/\text{s}$ . If the fluid density is  $850 \text{ kg/m}^3$  what is the value of the coefficient of dynamic viscosity  $\mu$ ?
- b) (i) A classical Venturi Meter has the equation

$$Q = C_d \frac{A_1}{\sqrt{m^2 - 1}} \sqrt{2g \Delta H}$$

where  $m = A_1/A_2$  in the usual notation.

If inlet and throat diameters are 250 mm and 150 mm respectively and pressures at inlet and throat are 10 kPa and 4 kPa respectively determine the flow rate in  $\text{m}^3/\text{s}$ . The flowing fluid is oil of density  $\rho = 900 \text{ kg/m}^3$  and take  $C_d = 0.96$ .

- (ii) State briefly the principles involved in the operation of an ultrasonic (Doppler) flowmeter.