

INDIAN INSTITUTE OF TECHNOLOGY

Date 21-02-2014 ~~Exam~~/AN Time: 2 ~~1/2~~ Hrs. Full Marks 40 No. of Students 17
 Autumn / Spring Semester, 2013-14 Deptt. Agri & Food Engg Sub. No. AG 600 82
~~IV yr B.Tech. (H) / B.Arch. (H) / M.Sc.~~ Sub. Name Instrumentation & Research Tech.
 Instruction Answer all questions.

1. Explain how a drag cup rotor AC tacho-generator works. (5)
2. Explain how an AC impedance bridge can be used to measure the value of capacitance of a capacitor. (5)
3. Derive an expression for the approximate value of output voltage of a Wheatstone bridge circuit where resistances in all the arms can change. How the initial balancing is achieved? (5)
4. Explain how a hydraulic load cell works. (5)

Question 5: Each sub-question carries 2 marks. (2 × 10 = 20)

5 a) A capacitor discharges through a resistor according to the relation

$$\frac{E}{E_0} = e^{-t/(RC)}$$

Where

- E₀ = voltage at time zero;
- R = resistance; and
- C = capacitance.

Value of the capacitance is to be measured by recording the time required for the voltage to drop to a value E. Assuming that the resistance is known accurately, derive an expression for the percent uncertainty in the capacitance as a function of the uncertainties in the measurements of E and t.

- 5 b) A slide wire potentiometer having a length of 100 mm is fabricated by winding wire having a diameter of 0.10 mm around a cylindrical insulating core. Calculate the resolution limit of this potentiometer.
- 5 c) Four resistors having nominal values of 1, 1.5, 3.0 and 2.5 kΩ are connected in parallel. The uncertainties are ± 10 per cent. A voltage of 100 ± 1.0 V is impressed on the combination. Calculate the power drawn and its uncertainty.
- 5 d) A parallel plate capacitive transducer uses plates of area 500 mm² which are separated by a distance of 0.2 mm. Calculate value of capacitance when the dielectric is air having a permittivity of 8.85 × 10⁻¹² F/m. Calculate also the change in capacitance if a linear displacement reduces the distance between plates to 0.18 mm.
- 5 e) A variable reluctance sensor consists of a core, variable air gap and an armature. The core is a steel rod of diameter 1 cm, relative permeability 100, bent to form a semi-circle of diameter 4 cm. A coil of 500 turns is wound on to the core. The armature is a steel plate of thickness 0.5 cm and relative permeability 100. Assuming that the relative permeability of air = 1.0 and the permeability of free space = 4 π × 10⁻⁷ H m⁻¹, calculate the inductance of the sensor for air gaps of 1 mm and 3 mm.
- 5 f) A Wheatstone bridge circuit shown in Fig 1 has ratio arms R₂ = 6000 Ω and R₃ = 600 Ω. A galvanometer with a resistance of 70 Ω and a sensitivity of 0.04 μA/mm is connected between B and D and the adjustable resistance R₁ reads 340 Ω. The galvanometer