Registration No. : | | | | | | | | | | |

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B. Tech

PCEI 4302

Fifth Semester (Back / Special) Examination – 2013

INSTRUMENTATION DEVICES AND SYSTEMS - I

BRANCH : AEIE, IEE

QUESTION CODE : D 285

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

   (a) Distinguish between "Systematic" and "statistical characteristics" of an instrument.

   (b) Why linearity of an instrument is an important specification ? How is it expressed ?

   (c) What are the various sources of systematic errors ? How do these errors influence accuracy of measurement ?

   (d) Explain, in brief, the need of differential push-pull arrangement of capacitive and inductive sensor.

   (e) Define the gauge factor of a metallic strain gauge.

   (f) Write a short note on Platinum resistance thermometer

   (g) What are thermistors ? Show how the resistance temperature characteristics of a thermistor look like and comment on its suitability for temperature measurement.

   (h) Discuss the advantages and disadvantages of an LVDT.

   (i) Draw the schematic diagram of strain gauge mounting on a cantilever platform like structure.

   (j) What are the advantages of an Instrumentation amplifier over practical DC operational amplifier ?

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2. (a) Derive step response of a first order and a second order system and hence define the following : 8

(i) Time Constant

(ii) Undamped Natural Frequency

(iii) Damping Ratio.

(b) State whether time response or frequency response is studied in order to understand the dynamic characteristics of the elements. Justify the answer. 2

3. (a) Show that the output of a variable Reluctance Tachogenerator is both amplitude modulated as well as frequency modulated signal of the speed. 3

(b) A variable reluctance tachogenerator consists of a ferromagnetic gear wheel with 22 teeth rotating close to a magnet and coil assembly. The total flux N linked by the coil is given by: $N(\theta) = 4.0 + 1.5 \cos 22\theta$ milliwebers, where θ is the angular position of the wheel relative to the axis of the magnet. Calculate amplitude and frequency of the output signal when the angular velocity of the wheel is 1000 rpm. 7

4. (a) What are the advantages of using a differential push-pull arrangement in a capacitive and inductive sensor ? Draw the circuit diagram of a variable plate capacitive sensor and variable reluctance type sensor in differential push-pull arrangement. 5

(b) A variable reluctance sensor consists of a core, variable air gap and an armature. The core is a steel rod of diameter of 1 cm, relative permeability 100, bent to form a semi-circle of diameter 4 cm. A coil of 500 turns is wound onto the core. The armature is a steel plate of thickness 0.5 cm and relative permeability 100. Assuming the relative permeability of air = 1.0 and permeability of free space = $4\pi \times 10^{-7}$ Hm^{-1}, calculate the inductance of the sensor for the air gaps of 1 mm. 5

5. (a) Describe all the thermocouple laws in details and also state the advantages of using the law of "intermediate temperature" for cold junction temperature compensation. 5

(b) A Platinum resistance sensor used to measure temperature between 0° to 200° C. Given that the resistance at T° C is given by the relation $R_t = R_o(1 + \alpha T + \beta T^2)$ and $R_o = 100.0$, $R_{100} = 138.50$, $R_{200} = 175.83$ ohms. Calculate : 5

(i) The values of α and β,

(ii) The nonlinearity at 100°C as a percentage of full scale deflection.

6. (a) Derive the theoretical and practical equations for incompressible flow through a differential pressure Flow Meter. 5

(b) Write the basic principle of operation of the following : 5

(i) Rotameter

(ii) Turbine Flowmeter.

7. (a) Explain, in details, about the open-loop 4 to 20 milliamperes modulated differential pressure transmitter with the help of a neat block diagram. Why open-loop transmitters are preferred over closed-loop transmitters ? 5

(b) With the help of neat schematic diagram describe the functionalities of a phase sensitive demodulator and its applications in instrumentation. 5

8. Write short notes on any **two** of the following : 5×2

(a) Thermocouple installation problem and cold junction compensation

(b) Electromagnetic sensors

(c) Semiconductor strain gauge

(d) IC temperature sensor.
