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

Total number of printed pages – 2

B. Tech

PEEL 5301

Fifth Semester Back Examination – 2014
SENSORS AND TRANSDUCERS
BRANCH(S) : EEE, ELECTRICAL
QUESTION CODE : L 275

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) Justify the statement : "Tolerance is the statistical variations amongst a batch of similar elements".

(b) Write one example of "direct equation" and "inverse equation" for a thermocouple with reference junction at 0°C.

(c) Draw the circuit diagram of a Kelvin Double Bridge and write the equation at balance.

d) Draw the time response curve of a 1st order system when subjected to
   (i) unit step input and
   (ii) unit ramp input.

(e) What do you mean by reference junction compensation of a thermocouple ?

(f) The output voltage of a LVDT is 1.5 V at maximum displacement. At a load of 0.5 MΩ , the deviation from linearity is maximum, and it is ±0.003 V from a straight line through origin. Find the linearity at the given load.

(g) Write the formula for the resistance R of a thermistor as a function of absolute temperature T, coefficient β, reference temperature T_0 and reference resistance R_0.

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

(i) What are the advantages of using a Differential Push-pull arrangement in capacitive and inductive sensors ? Also draw the circuit diagram of a variable plate capacitive sensor and variable reluctance type sensor in differential Push pull arrangements.

(j) A lowpass filter is specified to have A_{max} = 1dB and A_{min} = 10dB. It is found that these specifications can be met with a single-time-constant RC circuit having a time constant of 1 sec and a dc transmission of unity. What must be the ω_p and ω_s of this filter ?

2. (a) Give an example of a second order system and derive its transfer function. Also, find the step input response of the system. 5

P.T.O.

(b) Define the terms : 5

(i) Time constant and

(ii) Damping ratio, used in describing dynamic characteristics of measurement system.

3. (a) Describe the Thevenin's equivalent circuit of a thermocouple temperature measurement system. Write the expression of the measured temperature. 5

(b) Explain the operating principles of pressure measurement using a diaphragm. 5

4. A variable reluctance sensor, consist 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 onto the core. The armature is a steel plate of thickness 0.5 cm, calculate the inductance of sensor for air gap of 1 mm. Given: the relative permeability of air = 1.0 and the permeability of free space = $4\pi \times 10^{-7}$. 10

5. (a) Explain the operating Principle of an LVDT and function of phase sensitive demodulator circuit associate with LVDT. 5

(b) Define Gauge factor of a strain gauge and derive an expression for it. Derive the output voltage for four element strain gauge bridge. 5

6. (a) Draw the circuit diagram and list the important characteristics of an instrumentation amplifier. Derive the expression of the output voltage. Explain how the GAIN is adjusted. 5

(b) Derive the transfer function of the circuit shown in Figure 1 below (for an ideal op-amp) and show that it can be written in the form 5

$$\frac{V_0}{V_i} = \frac{-\frac{R_2}{R_1}}{\left[1+\frac{\omega_1}{j\omega}\right]\left[1+j\left(\frac{\omega_1}{\omega_2}\right)\right]},$$

where $\omega_1 = \frac{1}{C_1R_1}$ and $\omega_2 = \frac{1}{C_2R_2}$.

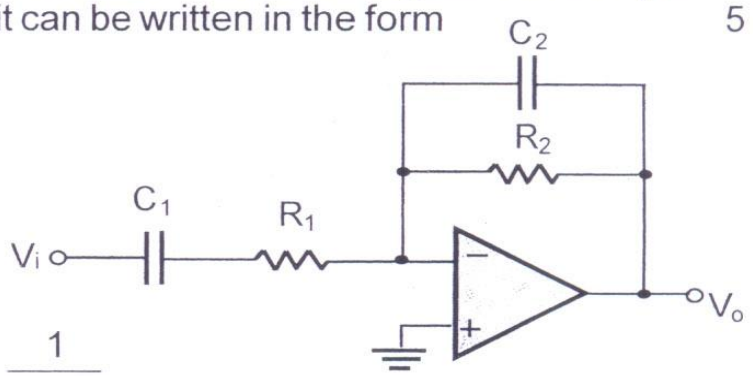

Figure 1

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

(b) Discuss dynamic errors in instrumentation systems. 5

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

(a) Electromagnetic sensors

(b) Semiconductor strain gauge

(c) IC temperature sensor

(d) AC carrier systems.