T.E. (SEM.-V)(CBSGS) (MECHANICAL ENGG.) 19th May, 2015
MECHANICAL MEASUREMENT AND CONTROL

**QP Code : 3258**

[1]

**03 Hrs** **[Total Marks 80]**

**N.B.:**
(1) **Question No.1 is compulsory**
(2) Attempt any **three** questions out of remaining **five** questions
(3) Figures to right indicate full marks
(4) Assume suitable data if **necessary**.
(5) Notations carry usual meaning.

Q.1 (A) Explain generalized measurement system elements with block diagram. Describe its functions with suitable example. 10

(B) Classify control systems and explain the significance of transfer function in control systems 05

(C ) Write short note on ON-OFF control system. 05

Q.2 (A) Explain the following terms with respect to the measurement system: 05
(i) Accuracy (ii) Hysteresis (iii) Resolution (iv) Span and Range (v) Drift

(B) With a neat sketch explain the working of optical encoder 05

(C) Convert the following state-space system of a single input single output system into a transfer function: 10

$$\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} = \begin{bmatrix} -3 & 2 \\ 1 & 1 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 2 \end{Bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix}.$$

Here $x_1$ and $x_2$ are state-variables, u(t) is a force vector and y(t) being the system response.

Q.3(A) With neat sketches discuss significance of followings aspects of signal conditionings for any one of the sensor: amplification, conversion filtering, modulation/demodulation, and grounding. 10

(B) The open loop transfer function of unity feedback system is 10

$$G(s) = \frac{K}{s(Ts+1)}$$

By what factor the gain 'K' should be multiplied so that damping ratio is increased from 0.3 to 0.8. By what factor time constant 'T' should be multiplied so that damping ratio is reduced from 0.6 to 0.4.

**[PTO**

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Q.4 (A) Consider a single strain gage of resistance 120 Ω mounted along the axial direction of an axially loaded specimen of steel (E=200 GPa). If the percentage change in length of the rod due to loading is 3% and the corresponding change in resistivity of the strain gage material is 0.3%, estimate the percentage change in the resistance of the strain gage and its gage factor; Poisson ratio=0.3. If the strain gage is connected to a measurement device capable of determining change in resistance with an accuracy of ±0.02 Ω, what is the uncertainty in stress that would result in using this resistance measurement device? 10

(B) The forward transfer function of a unity feedback system is given by 10

$$G(S)=\frac{1}{(S^2+2S+3)}$$

Using first principles

(i) Determine the position error and steady state error for a unit step input

(ii) Obtain the equation for close loop response in time domain C(t) due to step input

(iii) What is steady state error of close loop response for ramp and parabolic inputs?

Q.5(A) Sketch Bode plot and assess the stability for the control system having open loop transfer function 10

$$G(S)H(S)=\frac{120}{(S+2)(S+10)}$$

(B) With a neat sketch explain the constructional feature and working of (i) McLeod Gauge, (ii) Resistance thermometer 10

Q.6 (A) Draw the root-locus of the control system whose open-loop transfer function is given by

$$G(S)H(S)=\frac{K(S+4)(S+5)}{(S+3)(S+1)}$$ 10

(B) With a neat sketch explain the constructional feature and working of (i) digital tachometer, (ii) Magnetic flowmeter 10

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