

Bengal Engineering and Science University, Shibpur

B.E. (M.E.) 4th Semester Examination, 2013

Subject: Mechanical Measurement and Control (ME- 404)

Duration: 3 hours

Full Marks: 70

First Half

Answer question No. 1 and any two from the rest of this half

1. For the system shown in Figure 1, obtain the transfer function $X(s)/F(s)$. Also find the damping factor and natural frequency of the system. Calculate the percentage overshoot, peak time and settling time of the system's unit step response.

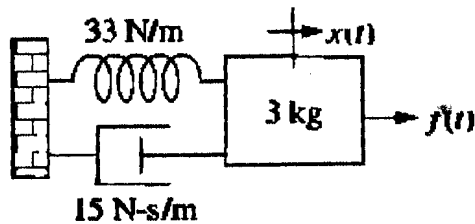


Figure 1

[9]

2. Find the value of K_1 and K_2 to yield a peak time of 1 sec. and settling time 2 sec. for the step response of the closed loop system shown in Figure 2.

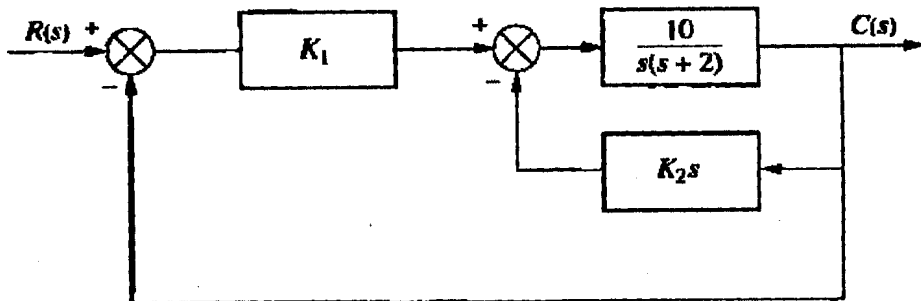


Figure 2

[13]

3. The unity feedback system shown in Figure 3, where $G(s) = \frac{K(s+\alpha)}{(s+\beta)^2}$ is to be designed to meet the following specifications: steady state error for a unit step input = 0.1; damping ratio = 0.5; natural frequency = $\sqrt{10}$. Find K , α , β .

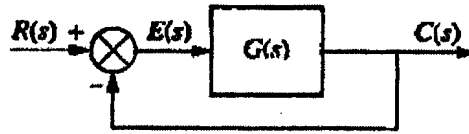


Figure 3

[13]

4. (a) Find the value of K for the system shown in Figure 4(a) that will place the pole as illustrated in Figure 4(b).

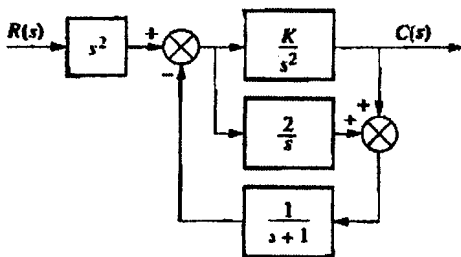


Figure 4(a)

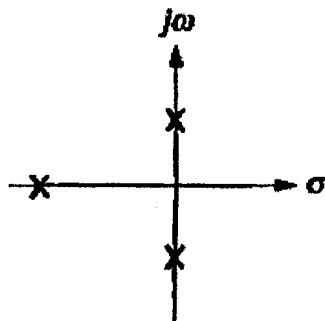


Figure 4(b)

- (b) The closed transfer function of a system is given by

$$T(s) = \frac{s^2 + K_1s + K_2}{s^4 + K_1s^3 + K_2s^2 + 5s + 1}$$

Find the range of K_1 such that the system is stable. What is the relationship between K_1 and K_2 for stability?

[5 + 8 = 13]

5. The open-loop transfer function of a control system is given by

$$GH(s) = \frac{8}{(s^2 + 3s + 1)(s + 4)}$$

- (a) Make a rough sketch of the Nyquist plot and comment on the stability of the closed-loop system.
 (b) Find the gain and phase margin of the closed-loop system.

[7 + 6 = 13]

SECOND HALF

Attempt any Three questions.

All questions carry equal marks.

- 6 ±. (a) State the various ways of measurement of forces? Deduce an expression for the sensitivity of an equal arm analytical balance.
- (b) Draw a neat sketch of a hydraulic Load cell and explain the method of measurement of forces by it.
- 7 ±. (a) What are the different methods of measurement of low pressures? Draw a neat labeled sketch of a McLeod gauge and explain the method of low pressure measurement by this gauge.
- (b) Explain the advantages of inclined tube manometer.
- 8 ±. (a) Define (i) Roughness & Waviness (ii) Lay and, (iii) Sampling length.
- (b) Which symbol is used to indicate Roughness in the drawing and which values are generally used to indicate Roughness? What is the difference between indirect and direct methods of measurement of surface roughness? Name three methods and three instruments.
- (c) Calculate the R_a value of a surface for which the sampling length was 0.8 mm. The graph was drawn to a vertical magnification of 1000 and a horizontal magnification of 100. The areas above and below the datum line were
- | | | | | |
|------------|----|-----|-----|---------------|
| Above: 180 | 90 | 155 | 55 | mm^2 |
| Below: 70 | 90 | 170 | 150 | mm^2 |
- 9 ±. (a) Briefly discuss about the Standard of temperature.
- (b) Draw a neat sketch and discuss about the measurement of temperature by Pressure thermometer.
- 10 ±. Write short notes on any three of the following:
- Bourdon tube pressure gauge
 - Capacitive fluid pressure transducer.
 - Calibration of strain gauges.
 - Resistance thermometer.
 - Metal bellows.