Printed Pages—4 **EIC501**

(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 2121** **Roll No.**

**B.Tech.**

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2013-14

**CONTROL SYSTEMS—I**

*Time : 3 Hours* *Total Marks : 100*

**Note :**— Attempt **all** questions.

1. Attempt any **four** parts :— **(5×4=20)**

(a) How many types of feedbacks are there ? Explain the advantages and disadvantages of each.

(b) Find the transfer function $Y_7/Y_1$ of the signal flow graph shown below in Figure 1.

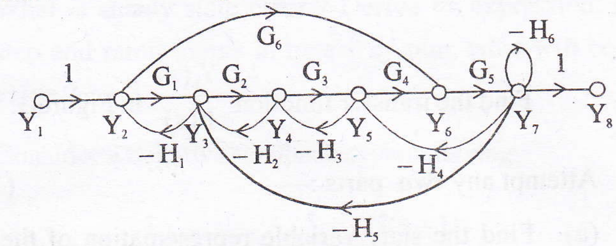


**Figure 1**

(c) Draw the signal flow graph and find the expression for $\frac{Y(s)}{R(s)}$ in Figure 2.

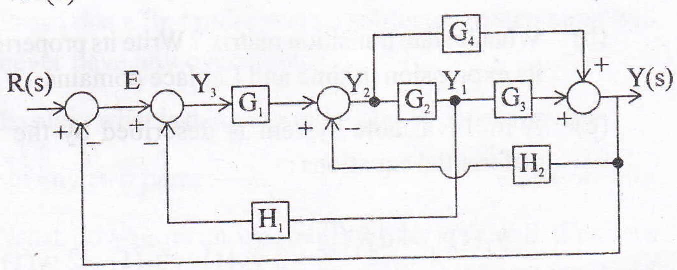


**Figure 2**

(d) What is the role of sensors and encoders in control system ? Explain the construction and principle of operation of a potentiometer.

(e) Explain the mathematical modelling of a DC motor as used in control system.

(f)

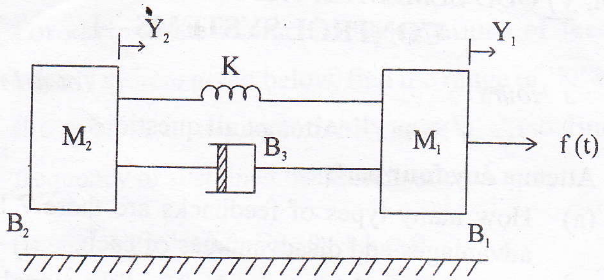


**Figure 3**

Find the transfer function $\frac{Y_1(s)}{F(s)}$ in Figure 3.

2. Attempt any **two** parts :— **(10×2=20)**

(a) Find the state variable representation of the following transfer function :

$$\frac{Y(s)}{u(s)} = \frac{2s^2+6s+5}{(s+1)^2(s+2)}.$$

(b) What is state transition matrix ? Write its properties. Derive its expression in time and Laplace domains.

(c) A multivariable system is described by the following differential equations :

$$\frac{d^2y_1(t)}{dt^2} + \frac{4\,dy_1(t)}{dt} - 3\,y_2(t) = u_1(t) + 2\,w(t)$$

$$\frac{dy_1(t)}{dt}+\frac{dy_2(t)}{dt}+y_1(t)+2y_2(t)=u_2(t)$$

Deduce the above equations in state variable form. Also find the state transition matrix.

3. Attempt any **four** parts :— **(5×4=20)**

(a) What are the typical test signals for the time response of control systems ? Explain.

(b) Derive the expressions for the peak overshoot and peak time of a second order underdamped feedback system subjected to unit step input.

(c) What is steady state error ? Derive its expression. For step and ramp inputs in type 1 system, what will be its value ?

(d) Consider a negative feedback system having :

$$G(s)=\frac{1}{s^2(s+12)} \text{ and } H(s)=\frac{5(s+1)}{s+5}$$

Find the steady state error when this system is subjected to a unit ramp input.

(e) Prove that a first order system subjected to step input will never have any overshoot.

(f) Explain what is damping ratio. Derive its expression.

4. Attempt any **two** parts :— **(10×2=20)**

(a) What do you mean by stability of a system ? What are absolute and relative stabilities ? What are zero input and zero state responses ?

(b) Assess the stabilities of following systems having characteristic equations as given :

(i) $s^4 + s^3 + 2s^2 + 2s + 3 = 0$

(ii) $s^5 + 4s^4 + 8s^3 + 8s^2 + 7s + 4 = 0$

(c) For each of the characteristic equations of feedback control system given below, find the range of 'K' so that the system is asymptotically stable. Also find the frequency of sustained oscillation in each case :

(i) $s^4 + 25s^3 + 15s^2 + 20s + k = 0$

(ii) $s^4 + 12.5s^3 + s^2 + 5s + k = 0$

5. Attempt any **two** parts :— **(10×2=20)**

(a) What are the major frequency domain specifications ? Derive their expressions. What is the role of a damping ratio of 0.707 in frequency response analysis ?

(b) What is the effect of adding a zero to the forward path transfer function ? Explain with relevant characteristics.

(c) What are gain margin and phase margin ? Explain their meanings in both Nyquist analysis and Bode plot analysis.

A single loop feedback control system has loop transfer function $G(s)\,H(s) = \dfrac{K}{s(s+2)(s+10)}$.

Find the value of 'K' for which the Nyquist plot will intersect the (–1, 0) point. Also draw the Nyquist plot assuming K = 1.