

EC-402(NGS)

B. E. (Fourth Semester) EXAMINATION, June, 2012

(Non-Grading System)

CONTROL SYSTEM

[EC-402(NGS)]

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt *one* question from each Unit. All questions carry equal marks. Suitable data can be assumed if necessary.

Unit-I

1. Show that the systems in Fig. 1 (a) and (b) are analogous systems. (Show that the transfer functions of the two systems are of identical form).

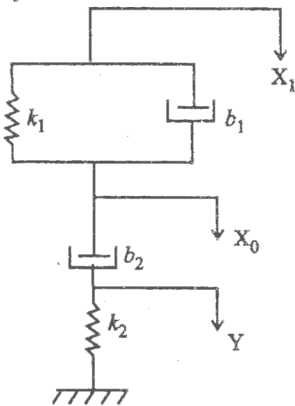


Fig. 1 (a)

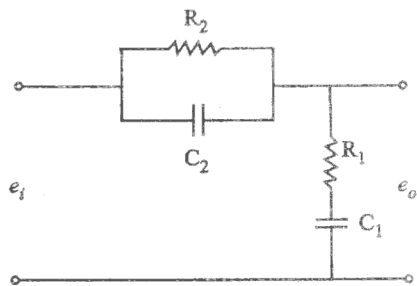


Fig. 1 (b)

Or

The armature resistance of a separately excited direct current motor is 20 ohms and inductance is negligible; its inertia is $2 \times 10^{-6} \text{ kg-m}^2$. A counter e.m.f. of 100 V is generated for a speed of 100 revolutions per minute, and the torque developed is 0.2 N m/A . Find the equivalent electrical capacitance and time constant of the motor.

Unit – II

2. The system illustrated in Fig. 2 is a unity feedback control system with a minor feedback loop (output derivative feedback) :
- In the absence of derivative feedback ($\alpha = 0$), determine the damping factor and natural frequency. Also determine the steady state error resulting from a unit ramp input.
 - Determine the derivative feedback constant of which will increase the damping factor of the system to 0.7. What is the steady state error to unit-ramp input with this setting of the derivative feedback constant ?

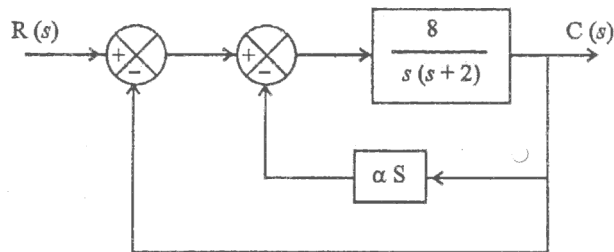


Fig. 2

Or

The open loop transfer function of a unity feedback is given by :

$$G(s) = \frac{40}{[s(0.2s + 1)]}$$

Determine steady state error using error series for the input $r(t) = (3 + 4t)t$.

Unit – III

3. (a) Consider the following characteristics equation :

$$s^4 + k s^3 + s^2 + s + 1 = 0$$

Determine the range of 'k' for stability.

- (b) Determine the phase margin for a unity feedback standard second order system.

Or

- (a) Obtain the polar plot of the following transfer function :

$$G(j\omega) = \frac{e^{-j\omega t}}{1 + j\omega T}$$

- (b) Sketch the Bode Plot for the transfer function :

$$G(s)H(s) = \frac{2(s + 0.25)}{s^2(s + 1)(s + 0.5)}$$

Determine :

- (i) The phase crossover frequency
- (ii) The gain crossover frequency
- (iii) The gain margin
- (iv) The phase margin
- (v) Stability

Unit – IV

4. Design a PD controller for the unity feedback system having open loop transfer function :

$$G(s)H(s) = \frac{10}{s(s + 1)}$$

So that its phase margin will be 50° at 1.5 rad/sec.

P. T. O.

Or

A unity feedback system having open loop transfer function :

$$G(s)H(s) = \frac{100}{(s+4)(s+5)(s+7)}$$

is to have a phase margin of 50° at a frequency of 2 rad/sec.
Design a PI controller to achieve this.

Unit-V

5. Obtain the time response of the following system :

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

$$\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

where $u(t) = 0$ for $t < 0$ and $u(t) = e^{-t}$ for $t > 0$.

Or

Obtain the response $y(t)$ of the following system :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$$

$$\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$y = [1 \ 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

where $u(t)$ is the unit step input occurring at $t = 0$, or
 $u(t) = 1(t)$.