Total No. of Questions : 5] [Total No. of Printed Pages : 4

Roll No. ....

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).

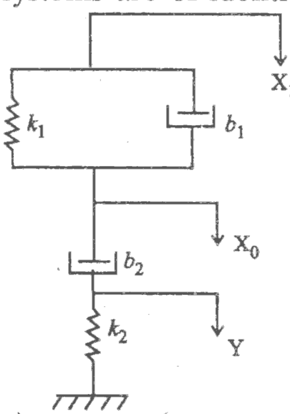

Fig. 1 (a)

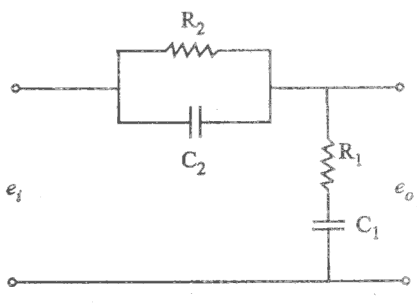

Fig. 1 (b)

P. T. O.

Or

The armature resistance of a separately exicted direct current motor is 20 ohms and inductance is negligible; its inertia is 2×10^{-6} 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 $0{\cdot}2$ 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) :

   (a) 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.

   (b) Determine the derivative feedback constant of which will increase the damping factor of the system to $0{\cdot}7$. What is the steady state error to unit-ramp input with this setting of the derivative feedback constant ?

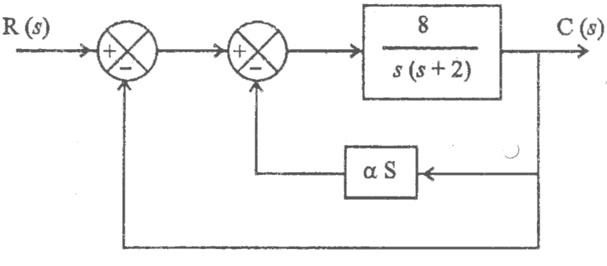

Fig. 2

Or

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

$$G(s) = \frac{40}{[s\,(0{\cdot}2\,s + 1)]}$$

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 :

$$G(s)\,H(s) = \frac{2(s + 0 \cdot 25)}{s^2 (s + 1)(s + 0 \cdot 5)}$$

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 $1 \cdot 5$ rad/sec.

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 :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -0{\cdot}5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0{\cdot}5 \\ 0 \end{bmatrix} u$$

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

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

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