No mobile phones

EE502

USN | 1 | M | S | | | | | | |

M S RAMAIAH INSTITUTE OF TECHNOLOGY

(AUTONOMOUS INSTITUTE, AFFILIATED TO VTU)

BANGALORE – 560 054

SEMESTER END EXAMINATIONS – DEC 2013 / JAN 2014

Course & Branch	:	**B.E.- Electrical & Electronics Engineering**	**Semester**	:	**V**
Subject	:	**Control Systems**	**Max. Marks**	:	**100**
Subject Code	:	**EE502**	**Duration**	:	**3 Hrs**

Instructions to the Candidates:

- Answer one full question from each unit.

UNIT – I

1. a) Derive the mathematical model of an armature controlled DC motor from basics. (08)

b) Obtain the nodal equations for the system shown in fig1b and obtain the F-V analogy. (06)

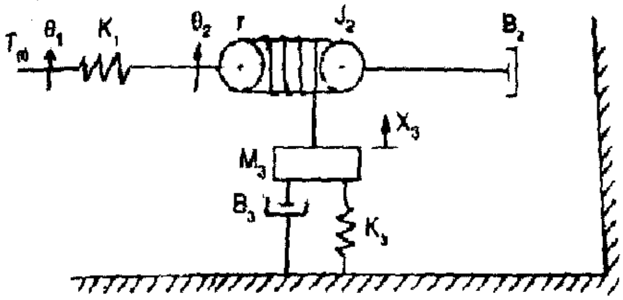


Fig 1b

c) For the mechanical system shown in fig 1c, write equations of motion in terms of the given mechanical quantities and draw the F-V analogous electric network. (06)

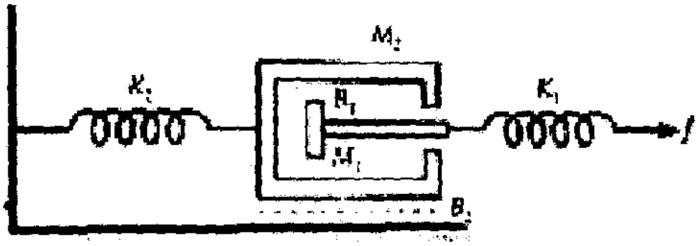
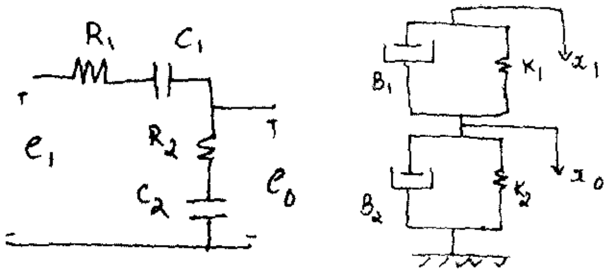


fig1c

2 a) Differentiate between Open-loop and Closed-Loop control systems with suitable examples. (06)

b) Obtain transfer functions for the systems shown in fig 2b and show that they are analogous. (08)



(a) (b)

Fig 2b

c) A mechanical system consisting of two discs has damping between them and also between each of them and the frame. Draw the equivalent mechanical network, write the performance equations and draw the T-I analogous network. (06)

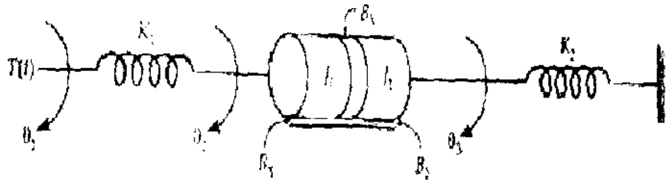


Fig 2C

UNIT - II

3. a) Using the block diagram reducing technique for the system shown in fig 3a, find the input-output relationship. (06)

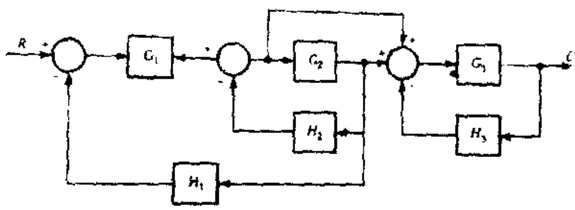


fig 3a

b) Derive the expressions for peak time and maximum overshoot for the response of a second order system. (06)

c) Sketch the response of a second order system for $\zeta = 0$,and justify. (04)

d) A feedback control system is described as (04)

$$G(s) = \frac{50}{s(s+2)(s+5)}, \quad H(s) = \frac{1}{s}$$

For a unit step input, determine the steady-state error constants and errors.

4 a) A system is represented by the following set of equations. Construct the signal flow graph and find the closed loop transfer function. (06)

$x = x_1 . t_3 u$

$\dot{x}_1 = q_1 x_1 + x_2 + t_2 u$

$\dot{x}_2 = -q_2 x_1 + t_1 u$

b) Define steady state error constants and obtain expressions for each of them. (06)

c) A servo system for the positional control of a rotatable mass is stabilized by viscous-friction damping which is three quarters of that needed for critical damping. The un-damped frequency of oscillation of the system is 12Hz. Derive an expression for the output of the system if the input control is suddenly moved to a new position, the system being initially at rest. Hence find the first overshoot and the time required for the same. (08)

UNIT – III

5. a) A unity feedback system has an open loop transfer function given by, (13)

$$G(s) = \frac{K}{s(s^2+2s+5)}$$. Sketch the root loci of the system.

b) The open loop transfer function of a system is given by (07)

$$G(s) = \frac{K(s+4)(s+20)}{s^3(s+100)(s+500)}$$.

Using R-H criterion, find the value of K that will cause oscillations in the system and the frequency of oscillations.

6. a) The open loop transfer function of a system is given by (13)

$$G(s) = \frac{K(s+12)}{s^2(s+20)}$$. Sketch the root loci of the system.

b) A system given by the open loop transfer function (07)

$$G(s) = \frac{K(s+1)}{s^3 + as^2+2s+1}$$

oscillates with a frequency of ω if it has poles at $s= +\text{or}-j\omega$ and no poles in the right half of the s-plane. Determine the values of K and a so that the system oscillates with a frequency of 2rad/sec

UNIT – IV

7. a) The open loop transfer function of a feedback system is (14)

$$G(s) = \frac{K_1(1+K_2s)}{s(s-1)}$$.

Using Nyquist stability criteria, comment on the stability of closed-loop system with respect to the values of K_1 and K_2

b) Find the frequency domain specifications for the unity feedback system having (06)

$$G(s) = \frac{36}{s(s+8)}$$

8. a) Plot the Nyquist plot for a negative feedback control system having open-loop transfer function given by (10)

$$G(s) = \frac{5}{s(1-s)}$$. Investigate closed-loop stability.

b) Sketch the polar plot of $G(s) = 1/s^2$ (06)

c) Define the frequency domain specifications: (04)

(i) Cutoff frequency

(ii) Bandwidth

(iii) Gain Margin

(iv) Phase Margin

UNIT – V

9. a) The open-loop transfer function of a unity feedback system is (12)

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

Draw the Bode plot and determine

(i) Limiting value of K for the system to be stable

(ii) Value of K for Gain margin of 7dB

(iii) Value of K for phase margin of 40deg.

b) Describe a Phase-Lag compensator and derive the relationship between maximum lag angle φ_m and β (where $\beta = (R_1+R_2)/R_2$) (08)

10. a) Determine the open-loop transfer function of a system whose magnitude plot is shown in fig 10a (12)

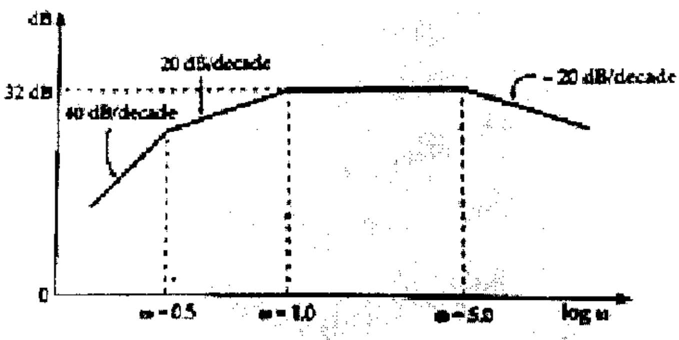


fig 10a

b) Explain Gain margin and Phase margin in a Bode plot and how are they determined from a Bode Plot. (08)

****