

# JK LakshmiPat University, Jaipur

## Institute of Engineering and Technology

### End Term Examination

B.Tech. 3<sup>rd</sup> Year/5<sup>th</sup> Semester/2011-15

**Course Name:** Linear Control System

**Max Marks:** 40

**Course Code:** EE501

**Time:** 03.00 Hr

**Instructions:** 1. Attempt all sections.

2. Attempt four questions out of five questions of section B.

3. Get one semilog paper from the invigilator on duty.

### Section A

(10 Marks)

(0.5×10)

**Q.1.** Attempt all parts:

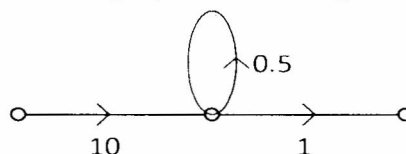
(i) Laplace transform of integral of  $f(t)$  is

- a)  $F(s)$                       b)  $sF(s)-f(0)$                       c)  $sF(s)$                       d)  $s^2F(s)$

(ii) Feedback control system is basically

- a) high pass filter              b) band pass filter              c) low pass filter              d) band stop filter

(iii) The transfer function of the signal-flow graph shown in figure below is



- a) 2                      b) 20                      c) 12                      d) 15

(iv) A control system is said to be good if it has

- a) good accuracy, good stability and fast response  
b) sufficient and economical power handling capacity  
c) no noise, no vibration and no overshoot  
d) none of the above

(v) For type-1 system, the steady state error due to step input is equal to

- a) infinity                      b) zero                      c) one                      d) none of them

(vi) The number of sign changes in the first column of Routh's array indicates

- a) the number of open-loop poles in RHP  
b) the number of roots of the characteristic equation in RHP  
c) the number of zeros of the system in RHP  
d) the number of open-loop zeros in RHP

(vii) The intersection of the root locus branches with the imaginary axis may be calculated by

- a) Nyquist criterion              b) Routh criterion              c) Polar plot                      d) Bode plot

(viii) Which is used to obtain high accuracy requirements

- a) derivative error compensation                      b) integral error compensation  
c) both a) and b)                      d) none of these

(ix) For  $0 < \xi \leq \frac{1}{\sqrt{2}}$ ,  $\omega_r$  is equal to

a) 0

b)  $\omega_n \sqrt{1 - 2\xi^2}$

c)  $\omega_n / \sqrt{1 - 2\xi^2}$

d)  $\omega_n \sqrt{1 - \xi^2}$

(x) A octave frequency range is specified by

a)  $\frac{\omega_2}{\omega_1} = 10$

b)  $\frac{\omega_2}{\omega_1} = 8$

c)  $\frac{\omega_2}{\omega_1} = 6$

d)  $\frac{\omega_2}{\omega_1} = 2$

Q.2. (a) Draw the polar plot of  $G(s) = s$ .

(2.5)

(b) For a unity feedback system having  $G(s) = \frac{35(s+6)}{s(s+1)(s+7)}$

(2.5)

Determine:

(i) the type of the system

(ii) all error coefficients

(iii) error for ramp input with magnitude 10.

## Section B

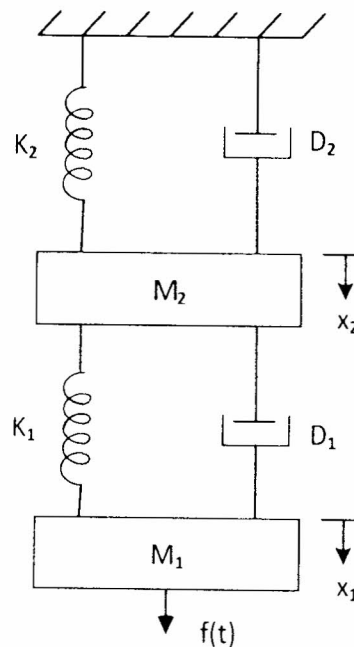
(20 Marks)

Q.3. Define control system and give its applications. What are the components of closed loop control system? Draw the control system of a 'man driving a car'.

(1+2+2)

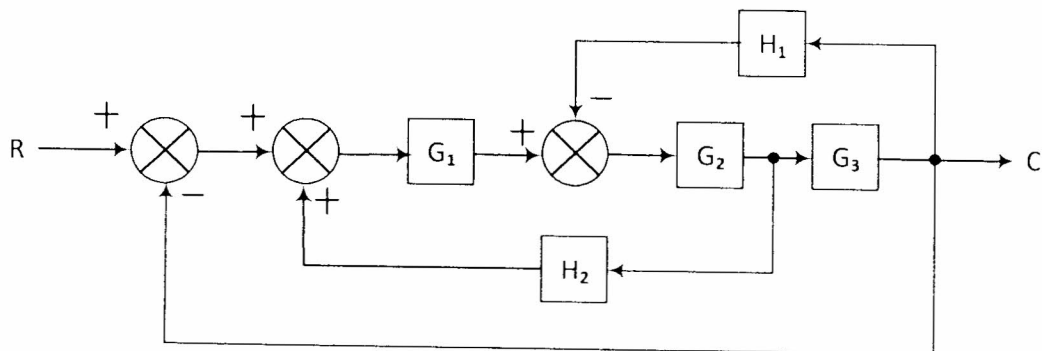
Q.4. Draw force-voltage analogy table. Obtain the differential equations describing the complete dynamics of the mechanical system shown below.

(2+3)



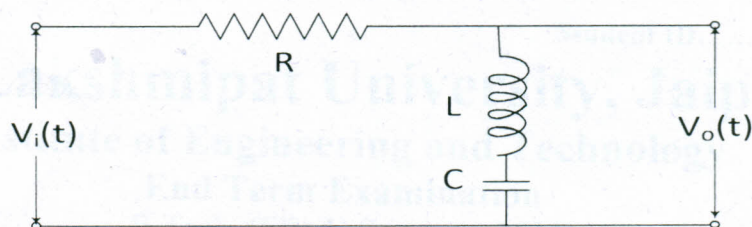
Q.5. (a) Determine the transfer function of the block diagram shown in figure below.

(2.5)



(b) Determine the transfer function of the network shown using Mason's gain formula.

(2.5)



Q.6. (a) Closed loop transfer function is given by  $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$ .

Calculate the value of  $\xi$  and  $\omega_n$  so that the system responds to a step input with peak overshoot of 15% and with a settling time of 3 seconds.

(b) For a unity feedback control system having open-loop transfer function

(2.5)

$$G(s) = \frac{K}{s(1 + 0.6s)(1 + 0.4s)} \text{ and } H(s) = 1$$

Determine the range of values of K, marginal value of K and frequency of sustained oscillations.

Q.7. Give the correlation between time and frequency response specifications for a second order system. Also give advantage and disadvantages of frequency domain analysis.

(3+2)

### Section C

(10 Marks)

Q.8. Discuss lead compensator. Sketch the bode plot of a lead compensator. Give the design steps of a lead compensator using bode plot and root locus method.

(2+1+2)

OR

Discuss lag compensator. Sketch the bode plot of a lag compensator. Give the design steps of a lag compensator using bode plot and root locus method.

(2+1+2)

Q.9. For a system having  $G(s) = \frac{K}{s(s+3)(s+5)}$  and  $H(s) = 1$ , find the range of K for stability and instability. Also find the value of gain K for marginal stability by Nyquist criterion.

(5)

OR

The open-loop transfer function of a unity feedback system is  $G(s) = \frac{K}{s(s+1)(s+10)}$ . Draw the bode plot and determine

(5)

- Limiting value of K for system to be stable
- The value of K for gain margin to be 7 db
- Value of K for phase margin to be 40°.