NEW SCHEME

EE43

Reg. No.

Fourth Semester B.E. Degree Examination, January/February 2006

Common to EC, TE, EE, IT, ML and BM

Control Systems

Time: 3 hrs.) (Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. **(a)** List the merits and demerits of open loop and closed loop control systems. Give at least one example for each. **(6 Marks)**

(b) For the mechanical system shown in Fig. 1.

i) Draw the mechanical network

ii) Write the differential equations governing its dynamic behaviour

iii) Write the Force - Current (F-I) and Force - Voltage (F-V) analogous electric networks

iv) List all the analogous quantities **(2+3+(3+4)+2=14 Marks)**

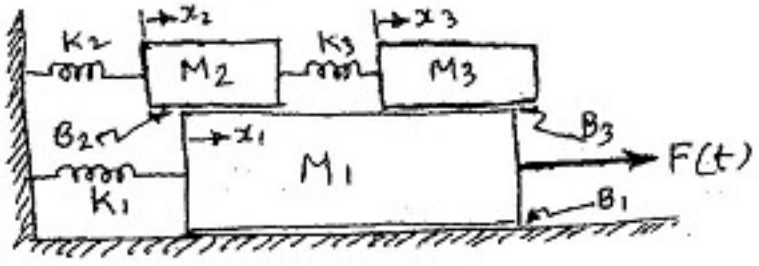


FIG. 1

2. **(a)** Define 'Transfer function' of a system
For a single loop unity feed back system the unit step response is given by

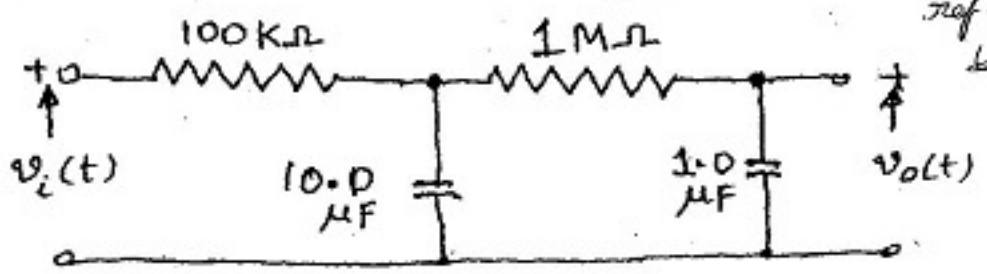
$$c(t) = 1 - 3e^{-2t} + 2e^{-3t}$$

Evaluate

i) Closed loop transfer function

ii) Open loop transfer function **(2+2+2 = 6 Marks)**

(b) For the electric circuit shown in Fig. 2 find $\frac{V_0(s)}{V_i(s)}$ using Mason's rule.



ref. pg. 174. Uday Sahi.

FIG. 2 **(6 Marks)**

(c) Obtain a block diagram representation and evaluate the transfer function of an armature controlled D-C motor. **(8 Marks)**

Contd.... 2

3. **(a)** With usual notations, derive an expression for the unit step-response of an under-damped second order system. Therefrom, derive expressions for peak time and percentage peak over shoot. **(6+4+2=12 Marks)**

(b) Step response of a certain control system is shown in Fig. 3. Assuming single loop unity feed back, determine its open loop and closed loop transfer functions.

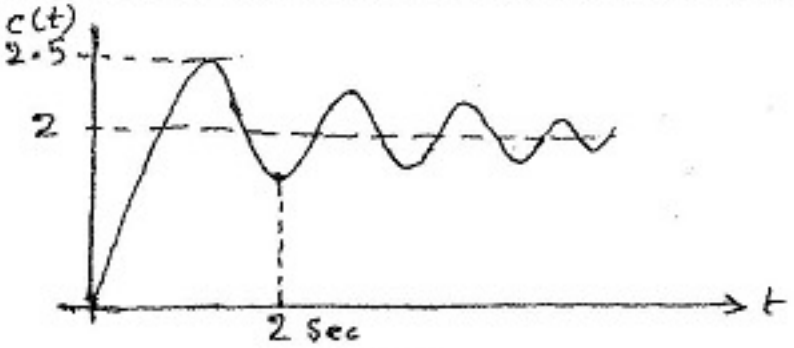


FIG. 3 **(8 Marks)**

4. **(a)** For the block diagram shown in fig. 4,

i) What 'Type' of system does $\frac{C(s)}{E(s)}$ represent ?

ii) Find $\frac{C(s)}{R(s)}$

iii) Find the position, velocity and acceleration error constants

iv) If $r(t) = 10u(t)$, evaluate C_{SS}

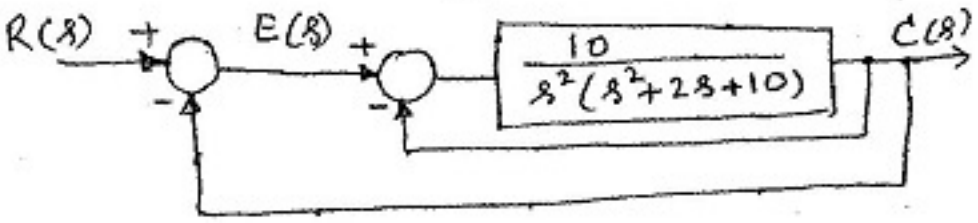


FIG. 4

(2+2+3+2=9 Marks)

(b) The open loop transfer function of a unity feed back system is $G(s) = \frac{K(s+2)}{s(s+3)\ (s^2+5s+10)}$

i) Find the value of K so that the steady state error for the input $r(t) = tu(t)$ is less than or equal to 0.01.

ii) For the value of K found in part i), verify whether the closed loop system is stable or not, using R-H criterion. **(4+7 Marks)**

5. **(a)** Using angle criterion , prove that the complex part of the root locl for the loop transfer function

$$G(s)\ H(s) = \frac{K(s+6)}{(s+2)\ (s+4)}$$

is circular. What is the centre ? What is its radius ? **(6 Marks)**

(b) Following all the 10 steps, draw the root locus diagram for the loop transfer function.

$$G(s)\ H(s) = \frac{K}{s(s^2+8s+17)}$$

From the diagram evaluate the value of K for a system damping ratio of 0.5. **(14 Marks)**

Contd.... 3

6. (a) State and explain 'Nyquist stability criterion'. **(6 Marks)**

(b) Sketch the complete Nyquist diagram and find the range of K for closed loop stability for the loop transfer function

$$G(s)\,H(s) = \frac{K}{s(s+1)\,(s+2)}$$ **(8 Marks)**

(c) Define the terms 'Gain Margin' and 'phase margin'. Explain how these can be determined from polar plots. **(6 Marks)**

7. (a) With usual notations, derive expressions for resonant peak and resonant frequency of a unity feed back second order system. **(3+4=7 Marks)**

(b) Find the open loop transfer function of a unity feed back second order control system for which resonant peak = 1.1 units and resonant frequency = $11.2 rad/sec$ **(6 Marks)**

(c) Compute analytically the gain margin and phase margin if

$$GH(s) = \frac{200}{s(s^2+12s+100)}$$ **(3+4=7 Marks)**

8. (a) The open loop transfer function of a unity feed back system is

$$G(s) = \frac{K}{s(1+0.2s)\,(1+0.05s)}$$

Draw the bode asymptotic magnitude plot and phase plot. From the graph

i) Find gain limit

ii) Determine the value of K for a gain margin of 10dB. What is the corresponding phase margin.

iii) Determine the value of K for a phase margin of 40^0. What is the corresponding gain margin ? **(3+3+2+3+3=14 Marks)**

(b) Find the transfer function which has the asymptotic bode magnitude plot showing Fig. 5.