Reg. No.

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION –MAY 2016

SUBJECT: CONTROL SYSTEMS (EE 241)

(BRANCH: COMP ENGG/E&C/E&E)

25^{TH} MAY, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**

1A. Determine the transfer function $\frac{X_2(s)}{F(s)}$ for a given mechanical translational system as shown in fig (a).

1B. Draw the force-voltage and force-current electrical analogous circuits and verify by writing mesh and node equations for the given mechanical system as shown in fig (b) .

1C. For the electrical network shown in fig (c), find the transfer function by considering voltage across R_2 as output.

(8+8+4)

2A. Obtain C(s)/R(s) using block diagram reduction rules as shown in fig (d).

2B. Find the transfer function $\frac{C(s)}{R(s)}$ using Mason's gain formula from the given block diagram as shown in fig (e).

2C. Find the transfer function C(s)/R(s) for a given signal flow graph as shown in fig (f).

(6+8+6)

3A. Obtain the time response C(t), of a unity feedback system whose open-loop transfer function is $G(s) = \frac{3}{s(s+4)}$ for a unit-step input.

3B. Check the stability of the given characteristic equation $S^6 + 2S^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$, using R-H criterion .

3C. Derive the expressions for peak overshoot(M_P) and Settling time(t_s) in terms of ε and w_n for a second order control system.

(4+6+10)

4A. Draw the root locus by a step by step procedure for the closed loop system with the open loop transfer function. $G(s)H(s) = \frac{K(s+2)(s+3)}{s(s+1)}$. Mark all the salient points and comment on the system stability.

4B. Write a note on angle and magnitude condition on root locus.

4C. The open-loop transfer function of a non- unity feedback control system is $G(s) = \frac{K_1}{s^2}$; $H(s) = 1 + K_2 s$. Find the values of K_1 and K_2 . So that M_P = 25 % and T_P = 4sec. Assume step input.

(10+4+6)

5A. An electrical network is shown in fig(g). Select a set of proper state variables & write down a state equation in physical variable form to represent the system.

5B. Define the following terms :

i) State
ii) State variable

5C. The transfer function of a second order system is given by $\frac{C(s)}{R(s)} = \frac{K}{s^2 + 2\zeta w_n s + w_n^2}$ Obtain expressions for : i) Resonant frequency ii) Resonant Peak Magnitude iii) Band width

(6+4+10)

6A. Draw the approximate Bodeplot for the unity feedback system with open loop transfer function $G(s) = \frac{10}{s(s+2)(s+5)}$ and hence find Gain margin & phase margin.

6B. The open loop transfer function of a certain negative unity feedback control system is given by $(s) = \frac{1}{S^2(1+s)}$. Sketch the complete Nyquist plot and comment on the stability.

(10+10)

7A. Sketch the polar plot of the given transfer function $G(s) = \frac{1}{s(1+s)(1+2s)}$. Determine whether these plot cross the real axis. If so, determine the frequency at which the plot cross the real axis and the corresponding magnitude |G(jω)|.

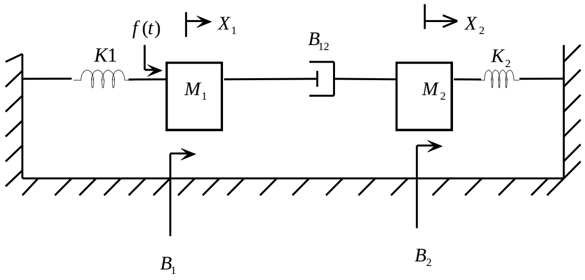
7B. Define the frequency domain specifications : i) Phase cross over frequency ii) Gain cross over frequency iii) Band width iv) Gain Margin v) Phase Margin.

(10+10)

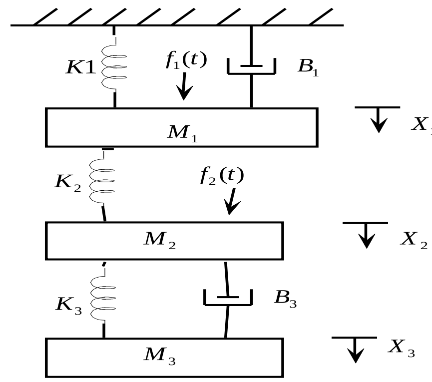
8A. A unit-step response test conducted on a second-order system yielded peak overshoot M_P = 0.14, and peak time t_p = 0.3 sec. Obtain the corresponding frequency response indices resonant peak (M_r), resonant frequency (ω_r), Bandwidth (BW) for the system.

8B.What is the necessity of a compensator to be introduced in a control system. What requirements are met with when a lead compensator, lag compensator, lag-lead compensator is introduced individually in the system and how are they achieved.

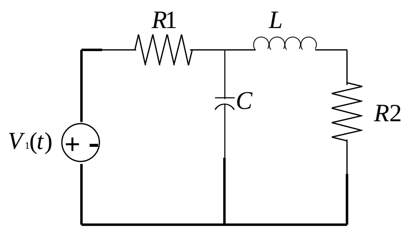
(10+10)



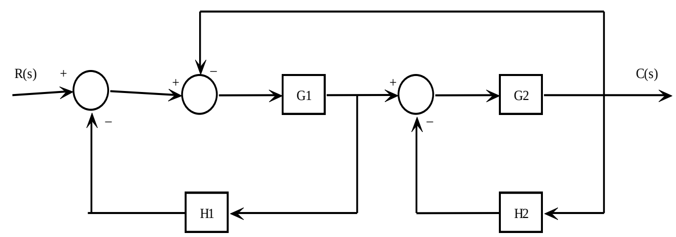
fig(a)



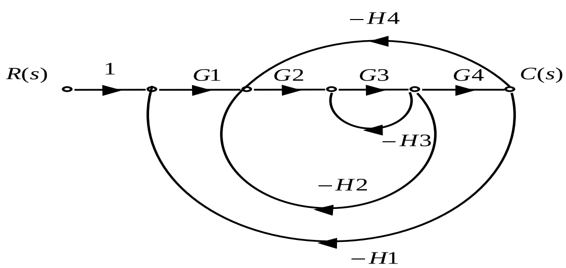
fig(b)



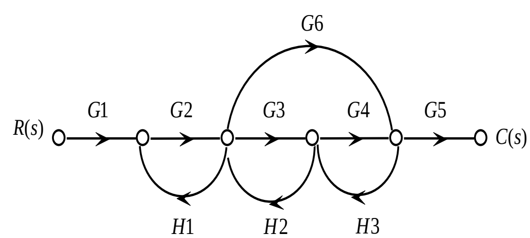
fig(c)



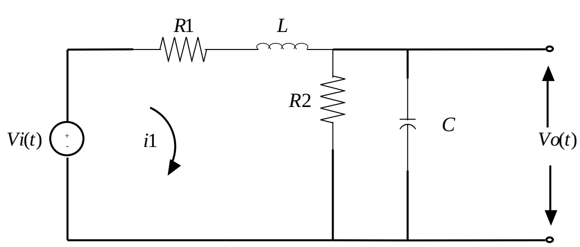
fig(d)



fig(e)



fig(f)



fig(g)