Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION - APRIL / MAY 2017

SUBJECT: CONTROL SYSTEMS (EE 241)

(BRANCH: CE / E&C/ E&E)

Tuesday, 2 May 2017

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

✓ **Answer ANY FIVE full questions.**

1A. Write the differential equations governing the mechanical system shown in *fig (a)* and determine the transfer function.

1B. Write the differential equations governing the mechanical system shown in *fig(b)*. Draw the force- voltage and force-current analogous circuits and verify by writing mesh and node equations.

1C. Compare the differences between open loop and closed loop control system.

(6+10+4)

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

2B. Find the transfer function $\frac{V_0(s)}{V_1(s)}$ using Mason's gain formula from the given block diagram as shown in *fig(d)*.

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

(6+8+6)

3A. The open-loop transfer function of a unity feedback system is $G(s) = \frac{4}{s(s+1)}$. Determine the nature of response of the closed-loop system for a unit-step input. Also determine the rise time, peak time, peak overshoot.

3B. The characteristic equation of a feedback control system is $S^5+s^4+2s^3+2s^2+3s+15=0$. Using R-H criterion, comment on the stability of the system.

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

(4+8+8)

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

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

4C. A system is given by differential equation, $\frac{d^2y}{dt^2}+4\frac{dy}{dt}+8y=8x$, where y = output, & x =input. Determine all time domain specifications for unit step input. **(4+10+6)**

5A. Express the electrical network shown in *fig (f)* in state model physical variable form.

5B. What are the advantages of state variable method of analysis of system ?

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 Peak Magnitude ii) Cut-off frequency iii) Resonant frequency

(6+4+10)

6A. Draw the approximate Bode plot for the unity feedback system with open loop transfer function $G(s)=\frac{100}{s(s+10)}$ and hence find Gain margin & phase margin.

6B. The open loop transfer function of a feedback control system is $G(s)H(s)=\frac{5}{s(s+1)(s+2)}$

Sketch the complete Nyquist plot and comment on the stability.

(10+10)

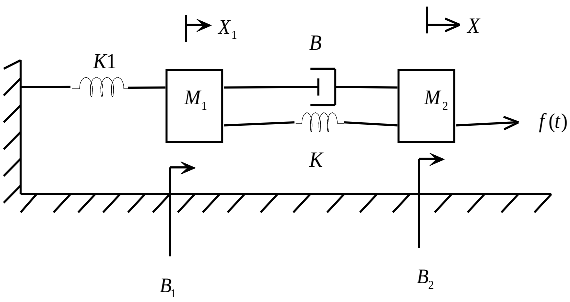
7A. Sketch the polar plot of the given transfer function $G(s)=\frac{1}{(1+s)(1+2s)}$. Determine whether these plot cross the real axis. If so, determine the frequency at which the plot cross the real axis and the corresponding magnitude $|G(j\omega)|$.

7B. Define the frequency domain specifications : (i) Gain Margin (ii) Phase Margin (iii) Phase cross over frequency (iv) Gain cross over frequency (v) Band width **(10+10)**

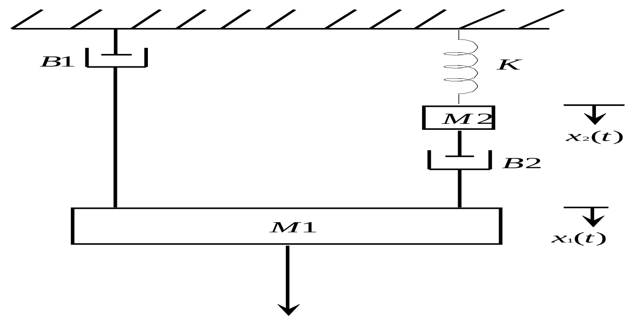
8A. What is the necessity of a compensator to be introduced in a control system. What requirements are met with when a lead compensator, lag compensator, lag-lead compensator is introduced individually in the system and how are they achieved.

8B. A unit-step response test conducted on a second-order system yielded peak overshoot M_P = 0.12, and peak time t_p = 0.2 sec. Obtain the corresponding frequency response indices resonant peak (M_r), resonant frequency (ω_r), Bandwidth (BW) for the system, settling time(t_s).

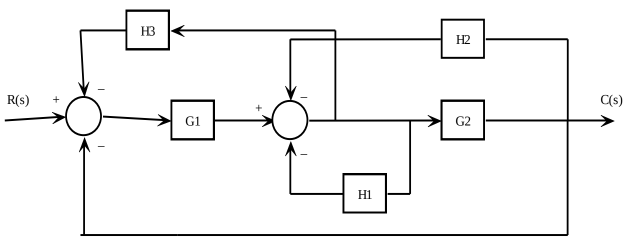
(10+10)



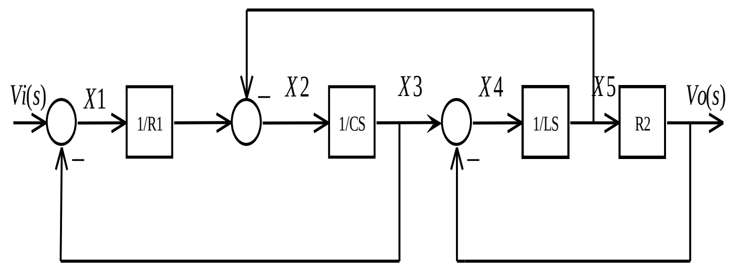
$fig(a)$



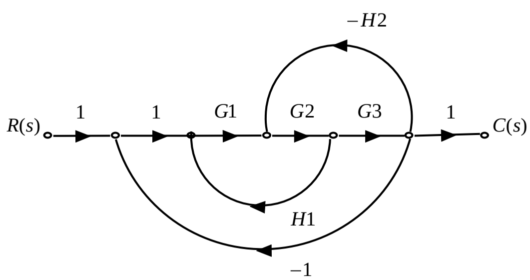
$fig(b)$



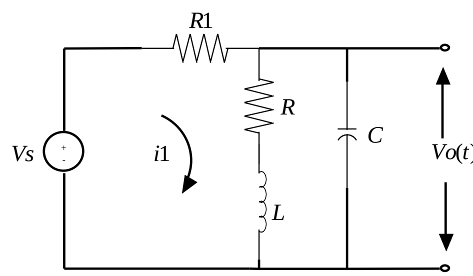
$fig(c)$



$fig(d)$



$fig(e)$



$fig(f)$