Reg.No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IV SEMESTER B.TECH (AERONAUTICAL/AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: LINEAR CONTROL THEORY [AAE 2204]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX.MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Write down the governing differential equations of the system shown figure 1 in page 2 and find the transfer function $X_3(s)/X_1(s)$ **(03)**

1B. Using the block diagram reduction technique, find the C/R ratio for the black diagram shown in figure 2 **(05)**

1C. A system is described by the following differential equation: **(02)**

$\frac{d^3y}{dt^3}+3\frac{d^2y}{dt^2}+5\frac{dy}{dt}+y=\frac{d^3x}{dt^3}+4\frac{d^2x}{dt^2}+6\frac{dy}{dt}+8x$. Determine the transfer function Y(s)/X(s).

2A. Convert the block diagram in the figure 2 to signal flow graph and find the transfer function. **(04)**

2B. A unity feedback control system has an open loop transfer function given by, **(02)**

$G(s)=\frac{10}{s(s+2)}$. Find the rise time and percentage overshoot for a step input of 12 units.

2C. The open loop transfer function of a unity feedback control system is given by **(04)**

$G(s)=\frac{100}{s(s+1)(s+2)}$. Find the steady state error when it is subjected to the input, $r(t)=1+2t+1.5t^2$.

3A. Sketch the Bode plot for the following open loop transfer function **(04)**

$$G(s)=\frac{30(1+0.1s)}{s(0.01s+1)(s+1)}$$

3B. Determine the phase margin and gain margin from the plot in 3A. **(02)**

3C. Sketch the polar plot of the following transfer function **(04)**

$$G(s)=\frac{1}{s(s+4)(s+8)}$$

4A. Consider a unity feedback system with open loop transfer function, **(05)**

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

Design a suitable lead compensator so that the system meets the following specifications. I) Percentage overshoot = 9.5%, II) Natural frequency of

oscillation, ω_n= 12 rad/sec and III) velocity error constant $K_v \geq 10$.

4B. The open loop transfer function for a system is given as **(03)**

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

Find the asymptotes, centroid and breakaway and break in points

4C. What is the difference between controller and compensator? **(02)**

5A. What are the critical considerations while selecting state variables? **(02)**

5B. State the advantages of State space model over classic transfer function. **(03)**

5C. Derive the state space representation from the given differential equation for a translational mechanical system given below (Figure 3). **(05)**

$$M_1 \frac{d^2x_1}{dt^2} + D\frac{dx_1}{dt} + Kx_1 - Kx_2 = 0$$

$$-Kx_1 + M_2 \frac{d^2x_2}{dt^2} + Kx_2 = f(t)$$

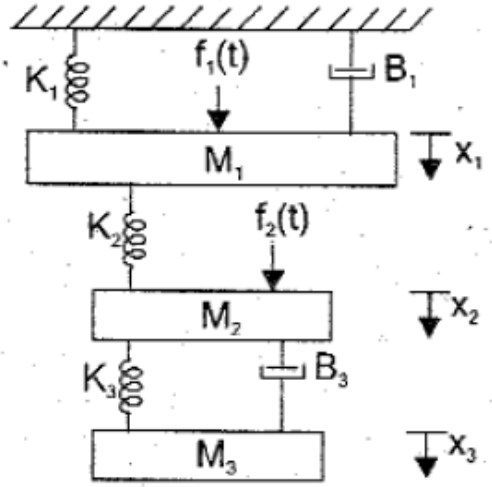

Figure 1

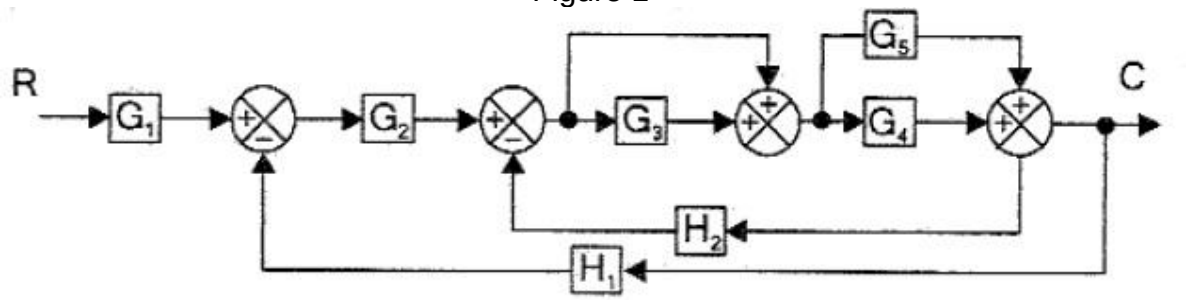

Figure 2

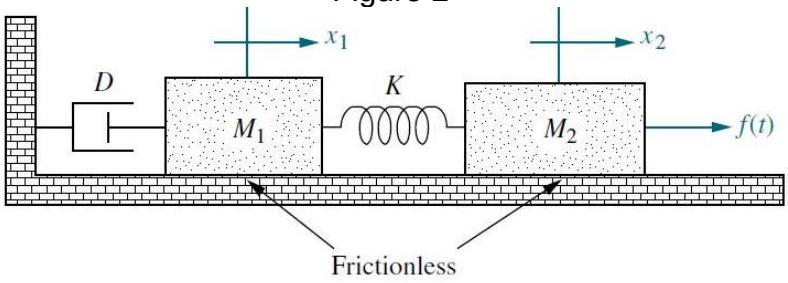

Figure 3