Code No. : 5215/S

FACULTY OF ENGINEERING
B.E. 4/4 (Prod.) I Semester (Suppl.) Examination, June 2012
CONTROL SYSTEM THEORY

Time: 3 Hours] [Max. Marks: 75

*Note : Answer **all** questions from Part **A**. Answer **any five** questions from Part **B**.*

PART – A (25 Marks)

1. Draw a block diagram for a system representing the control of human temperature by the way of sweating and indicate the location of following components. 3
   a) The process output signal
   b) The input
   c) The sensor

2. A non-linear device is represented by a function $y = f(x) = x^{1/2}$ where the operating point for the input x is $x_0 = 1/2$. Determine the linear approximation value. 4

3. If $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$, find state transition matrix $\phi(t)$. 4

4. Find the steady state gain and time constant for a first order system given as $G(S) = \dfrac{1}{2 + 0.1S}$. 2

5. List out the advantages of Frequency response techniques over time domain techniques. 2

6. The unit step response test conducted on a second order system yielded $M_p = 0.2$ and $t_p = 0.3$ ms. Obtain the corresponding frequency response indices (M_r, W_r, W_b) for the system. 5

7. What is the basis for the selection of a particular compensator. 3

8. What is the major objective of adding a derivative signal in a feedback system ? 2

PART – B **(50 Marks)**

9. Find the transfer function $\frac{X_3(s)}{F(s)}$ for the given translational mechanical system given in fig (1). **10**

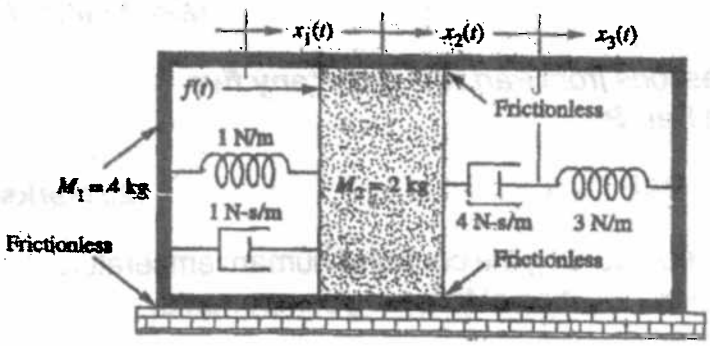

Fig. (1)

10. Using Mason's rule, find the transfer function $T(s) = \frac{C(s)}{R(s)}$ for the system represented by fig. (2). **10**

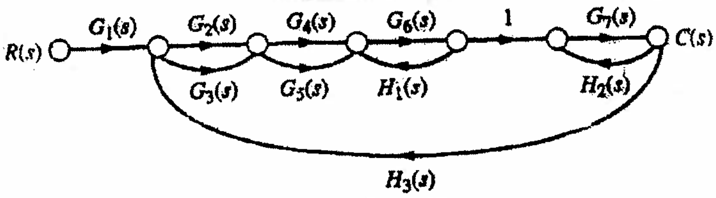

Fig. (2)

11. Consider the translational mechanical system given in fig (3). Find K and M such that the response is characterised by a 2-second settling time and a 1 sec peak time. Also, find what is the resulting percent overshoot. **10**

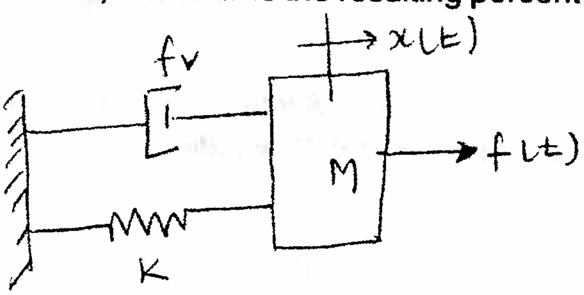

Fig. (3)

12. Consider a unit feedback control system with the given feedforward transfer function. **10**

$$G(s) = \frac{K}{S(S^2 + 4S + 8)}$$

Plot the root loci for the system. If the value of gain 'k' is set equal to 2 where are the closed loop poles located.

13. Draw a Nyquist plot for the unity feedback control system with the open loop transfer function.

$$G(s) = \frac{K(1-S)}{S+1}$$

Using the Nyquist stability criterion, determine the stability of the closed loop system. **10**

14. Consider the system given by $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$ **10**

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Find whether the system is completely state controllable and completely observable. Also check whether the system is completely output controllable.

15. Write short notes on : **10**
    a) Dynamic characteristics of a PI controller
    b) Importance of Laplace transforms
    c) Specifications of a 2^{nd} order system.