Code No.: 6346

FACULTY OF ENGINEERING

B.E. III/IV (Mech) II Semester (Main) Examination, June 2010

CONTROL SYSTEM THEORY

Time : 3 Hours] [Max. Marks : 75

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

Part A – (Marks : 25)

1. (a) The forward transfer function of a control system has three poles at –1, –2, –3. What is the system type and order? 2

(b) Find for the given response function, whether 2^{nd} order approximation is valid or not. 2

$$C(s) = \frac{(s+2.1)}{s(s+2)(s^2+s+5)}$$

(c) Linearise the non-linear equation $z = xy$ in the region $5 \le x \le 7$, $10 \le y \le 12$. Find the error if the linearised equation is used to calculate the value of 'z' when $x = 5$ and $y = 10$. 4

(d) Compare ac and dc servomotors. 3

(e) What information is contained in the specification $K_P = 10{,}000$? 2

(f) The forward path transfer function of a unity feedback control system is

$$G(S) = \frac{5}{S(s+6.54)}$$

find the resonance peak (M_r), resonance frequency (W_r) and Bandwidth (BW) of the closed system. 4

(g) State the properties of state transition matrix. 3

(h) State whether the given statements are true or false : 5

(i) The general effect of adding zero to the forward path transfer function is to increase the bandwidth of the closed loop system.

(ii) By applying a sinusoidal signal of frequency w_0 to a linear system, the steady state output of the system will be of same frequency.

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(iii) A bode plot can be used for stability analysis of both minimum and non-minimum phase transfer function systems.

(iv) A traffic signal is an example of closed loop system.

(v) The characteristic equation $s^3 + 5s^2 + 4 = 0$ represents a continues data system which is stable.

Part B – (Marks : 50)

2. For the given mechanical systems in fig. (1) :

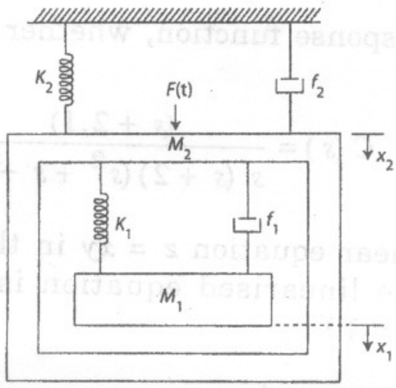

Fig. 1

(i) Find the transfer function 6

(ii) Find the analogous electrical systems using force voltage (or) force current analogy. 4

3. For the given unit step response in fig. 2 find the transfer function.

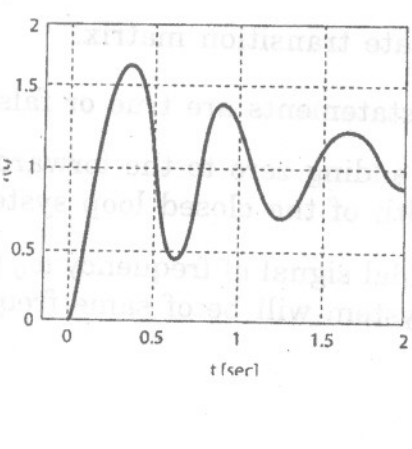

Fig. 2

4. Plot the root locus for the closed loop system with $G(s) = \dfrac{K(s+9)}{s(s^2+4s+11)}$, $H(s) = 1$.

Locate the closed loop poles on the root loci such that the dominant closed loop poles have a damping ratio equal to 0.5. Determine the corresponding value of K. 10

5. Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency w_C to be 10 rad/S. Comment on the stability of the system for $K = 1$. 10

$$G(s) = \frac{KS^2}{(1+s)(1+0.1s)(1+0'01s)}.$$

6. Sketch the Nyquist plot and assess the stability of the closed loop system where open loop transfer function is 10

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

7. The transfer function of a control system is given by $\dfrac{C(s)}{R(s)} = \dfrac{s+2}{(s^3+5s^2+9s+6)}$.

Obtain the state equations and determine whether the system is controllable and observable. 10

8. Answer any **three** questions from the following :

(a) Solution of homogenous state equations

(b) Lag compensation technique

(c) Mason's Gain formula

(d) Performance Indices.

(e) Routh's criteria.