



FACULTY OF ENGINEERING

B.E. 3/4 (Mech.) II Semester (Suppl.) Examination, January 2012

CONTROL SYSTEM THEORY

Time : 3 Hours]

[Max. Marks : 75

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

PART – A

(25 Marks)

1. For each of the following systems argue if in your opinion it is open loop or closed loop. Mention various components of the below systems with proper justification.
 - i) Hair Dryer
 - ii) Traffic Signal
 - iii) Automatic gear train in an automobile. 3
2. State the relative advantages of state space techniques over classical control systems. 2
3. Sketch the polar plot of a system whose $G(S) = \frac{1+3S}{S^2(1+S)}$. 3
4. What is the effect of adding a pole to the forward path transfer function. 2
5. Find the Laplace Transform of $G(S) = \frac{2(S+1)}{S(S^2+S+2)}$. 3
6. What is the effect of PD controller on the rise time and settling time of a control system ? 3
7. A control system is designed to keep the antenna of a tracking radar pointed at a flying target, the system must be able to follow a target traveling in a straight line with a speed of 200 m/s with max permissible error of 0.01° . The shortest distance from the antenna to the target is 250 m. Find the value of error constant K_V in order to satisfy the requirements. 2
8. Find Eigen values of A, if $A = \begin{pmatrix} 1 & 2 \\ 2 & 3 \end{pmatrix}$. 2

9. State whether the given statements below are **True** or **False** :

2

- i) A Mechanical system with mass, spring and damper is an example of closed loop system.
- ii) A closed loop system with pure time delay in the loop is usually less stable than one with a time delay.
- iii) In Root Locus plots, at breakaway points the root sensitivity is Infinite.
- iv) The Design objective of the Phase lead controller is to place the maximum phase lead at the new gain cross over frequency.

10. What is the concept of controllability ?

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PART – B

(50 Marks)

11. For the given mechanical system in fig (1) find the transfer function $G(S) = \frac{X_1(S)}{F(S)}$.

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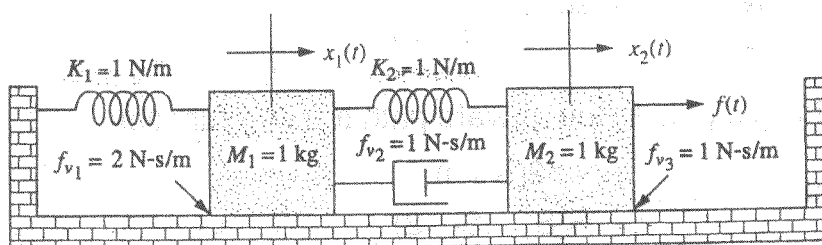


Fig. (1)

12. Sketch the root locus and determine the range of system represented by its characteristic equation $F(S) = S^3 + 2S^2 + 2S + K(S^2 - 1)(S + 2)$.

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13. An armature controlled DC motor is driving a load. The input voltage is 5V. The speed at $t = 2$ seconds is 30 rad/s and the steady speed is 70 rad/s when $t \rightarrow \infty$.

Determine the transfer function $\frac{\omega(s)}{V(s)}$.

10



14. For an automobile moving along the road, the vertical displacements at the tires act as the motion excitation to the automatic suspension system given by a fig(2) where $M = 1 \text{ kg}$, $b = 4 \text{ NM/s}$ and $K = 18 \text{ N/m}$. Sketch the bode plot for the given system.

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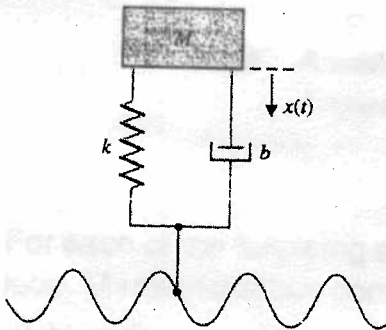


Fig. (2)

15. Sketch the Nyquist plot and determine the stability of a unity feedback system represented by $G(S) = \frac{K}{S(S^2 + 2S + 6)}$.

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16. The transfer function of a control system is given by $\frac{C(S)}{R(S)} = \frac{S + 2}{(S^3 + 5S^2 + 9S + 6)}$. Obtain the state equations and determine whether the system is controllable and observable.

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17. Answer **any 3** of the following :

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- Signal flow graphs
- PID compensation technique
- Performance Indices
- Servomotors
- Frequency response techniques.