Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(CSE/EEE)/SEM-5/EE-503/2011-12

2011

CONTROL SYSTEMS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) The maximum overshoot for a unity feedback system with open-loop transfer function $G(s) = \frac{1}{s(s+1)}$ for unit step input is

a) 0·14 b) 0·16

c) 0·15 d) 0·17.

ii) For a feedback control system of type1, the steady state error for a ramp input is

a) infinite b) 0

c) constant d) indeterminate.

iii) A control system is defined by the relationship $\frac{d^2x}{dt^2} + \frac{6dx}{dt} + 5x = 12\left(1 - e^{-0\cdot 2t}\right)$. The response of the system as $t \to \infty$ is

a) $x = 6$ b) $x = 2\cdot 4$

c) $x = 2$ d) $x = -2$.

iv) For an underdamped second order system settling time

a) increases with ξ , w_n remaining fixed

b) decreases with ξ , w_n with remaining fixed

c) remains same

d) is indeterminate.

v) A unit ramp is applied to a first order system defined by $G(s) = \frac{k}{Ts+1}$. The output exhibits

a) O offset b) constant offset

c) infinite offset d) overshoot.

vi) The open-loop transfer function of a feedback control system is $G(s) = \frac{1}{(s+1)^3}$. The gain margin of the system is

a) 16 b) 4

c) 8 d) 2.

vii) A linear time invariant system, when subjected to a unit step produces a response $c(t) = te^{-t}$. The transfer function is

a) $\frac{1}{(s+1)^2}$ b) $\frac{1}{s(s+1)^2}$

c) $\frac{s}{(s+1)^2}$ d) none of these.

viii) The type of a transfer function denotes the number of

a) poles at origin b) poles at infinity

c) zeros at origin d) finite poles.

ix) Addition of delay to a transfer function can be approximated by addition of

a) right half pole b) right half zero

c) left half zero d) none of these.

x) A unity feedback system has 3 open-loop poles at $(-2 \pm j2)$ and 0. It has a single zero at $(-4 + j0)$. The angle of departure of the root locus branch starting from pole at $(-2 - j2)$ is

a) 135° b) 0°

c) 225° d) – 45°.

xi) When the phase crossover frequency is equal to the gain crossover frequency, the closed-loop system exhibits

a) damped oscillatory response

b) sustained oscillation

c) unbounded undamped oscillatory response

d) overdamped response.

xii) The function $\frac{1}{1+sT}$ has a slope of

a) – 6 dB/decade b) 6 dB/decade

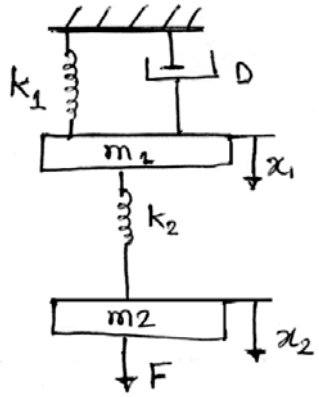
c) – 20 dB/decade d) 20 dB/decade.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

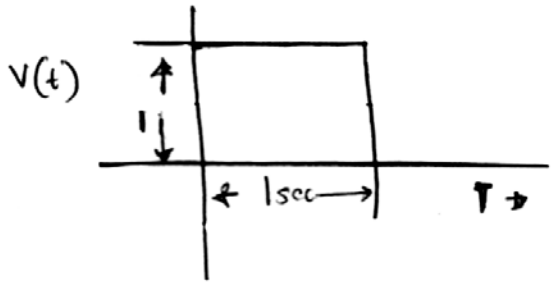
2. For the system shown in figure, a force F is applied as shown.



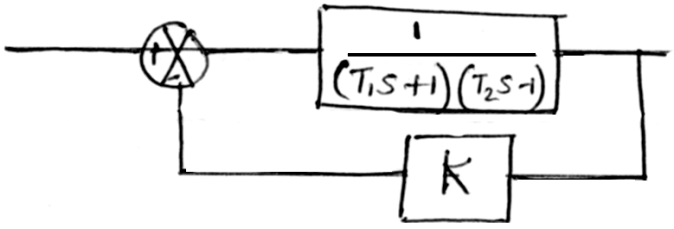
a) Write the equations governing x_1 and x_2 considering F as input.

b) Draw the electrical analogous circuit using force voltage analogy. 3 + 2

3. A pulse shown in figure below is applied to a first order system defined by $G(s) = \frac{1}{(0 \cdot 1s + 1)}$. Sketch the output.



4. For the system shown in figure below find the range of K for the system to be stable.



Assume K, T_1, $T_2 > 0$, $T_1 > T_2$.

5. Define position and velocity error for a system with transfer function $G(s)$. Calculate the steady state error if a system with transfer function $G(s) = \frac{2}{s(0 \cdot 1s + 1)}$ is excited by a function $r(t) = 5U_{-1}(t)$, in unity feedback closed loop configuration. 2 + 3

6. For a PID controller $k_p + \frac{k_i}{s} + sk_D$ define integral time and reset rate. What happens if k_i is increased keeping k_p and k_0 constant ? 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. For an underdamped second order system described by $G(s) = \frac{W_n^2}{s^2 + 2\xi W_n s + W_n^2}$ obtain an expression for peak overshoot due to a unit step input and hence show that this depends on ξ only. Symbols carry usual significance.

8. A unity feedback system has an open loop transfer function $G(s) = \frac{k(s+4)}{s(s+2)}$. Sketch the root locus. Plot with k as the variable parameter. What is the maximum value of k for which both the closed loop poles will be real ? 10 + 5

9. a) State Nyquist Stability Criterion.

   b) An open loop transfer function of a unity feedback system is defined by $G(s) = \frac{10}{s(1+s)(1+0\cdot 5s)}$. Is the open loop system stable ? Using Nyquist stability criterion comment on the stability of the closed loop system.

10. Sketch the Bode plots for magnitude and phase for a system defined by $G(s) = \frac{10}{s(1+0\cdot 5s)(1+0\cdot 01s)}$. Determine the gain cross-over frequency and phase margin. 10 + 5

11. What is a synchro ? Deduce an expression for voltage across rotor of synchro control transformer for a small angular displacement between the rotors of the synchro transmitter and control transformer. 3 + 12

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