

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

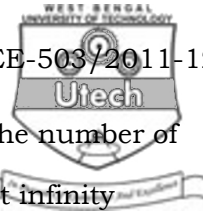
(Multiple Choice Type Questions)

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 type 1, the steady state error for a ramp input is
- a) infinite b) 0
- c) constant d) indeterminate.

- 2



- viii) The type of a transfer function denotes the number of
- poles at origin
 - poles at infinity
 - zeros at origin
 - finite poles.
- ix) Addition of delay to a transfer function can be approximated by addition of
- right half pole
 - right half zero
 - left half zero
 - 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
- 135°
 - 0°
 - 225°
 - -45° .
- xi) When the phase crossover frequency is equal to the gain crossover frequency, the closed-loop system exhibits
- damped oscillatory response
 - sustained oscillation
 - unbounded undamped oscillatory response
 - overdamped response.
- xii) The function $\frac{1}{1+sT}$ has a slope of
- 6 dB/decade
 - 6 dB/decade
 - 20 dB/decade
 - 20 dB/decade.



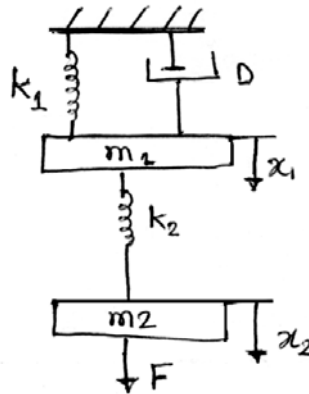
GROUP – B

(Short Answer Type Questions)

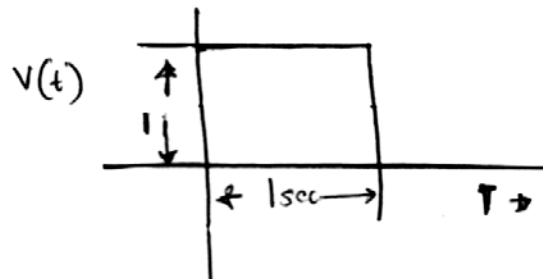
Answer any *three* of the following.

$3 \times 5 = 15$

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

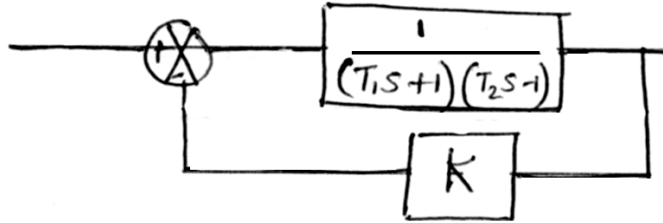


- Write the equations governing x_1 and x_2 considering F as input.
 - Draw the electrical analogous circuit using force voltage analogy.
3. A pulse shown in figure below is applied to a first order system defined by $G(s) = \frac{1}{(0.1s + 1)}$. Sketch the output.





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 $G(s) = \frac{2}{s(0.1s+1)}$ 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_D constant? 2 + 3



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

$3 \times 15 = 45$

7. For an underdamped second order system described by

$$G(s) = \frac{W_n^2}{s^2 + 2\xi W_n s + W_n^2} \quad \text{obtain an expression for peak}$$

overshoot due to a unit step input and hence show that this depends on ξ only. Symbols carry usual significance.

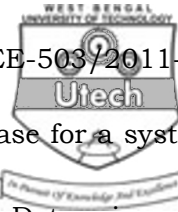
8. A unity feedback system has an open loop transfer function

$$G(s) = \frac{k(s+4)}{s(s+2)}.$$
 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 $G(s) = \frac{10}{s(1+s)(1+0.5s)}$. 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 $G(s) = \frac{10}{s(1+0.5s)(1+0.01s)}$. 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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