



Name :

Roll No. :

Invigilator's Signature :

**CS/B.TECH (ICE)/SEM-4/IC-401/2010
2010**

BASIC CONTROL THEORY

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 :

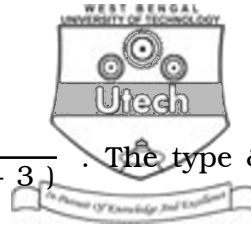
10 × 1 = 10

i) The transfer function for the state variable representation $\frac{dx}{dt} = AX + BU$, $Y = CX + DU$ is given by

- a) $D + C (SI - A)^{-1} B$ b) $B (SI - A)^{-1} C + D$
c) $B (SI - A)^{-1} B + C$ d) $C (SI - A)^{-1} D + B.$

ii) Signal flow graph is used to obtain the

- a) stability of the system
b) transfer function of the system
c) controllability of the system
d) observability of the system.



- iii) Given that $G(s) = \frac{k}{s^2(s+2)(s+3)}$. The type & order of the system is
- a) 3 & 3 b) 2 & 4
c) 3 & 1 d) 3 & 0.
- iv) The transfer function $\frac{1}{1+sT}$ has slope of
- a) - 6 db/decade b) 6 db/decade
c) - 20 db/decade d) 20 db/decade.
- v) A system having 3 zeroes and 4-poles has root locus branches equal to
- a) 3 b) 4
c) 1 d) 7.
- vi) A 2nd order system exhibits 100% overshoot. Its damping coefficient is
- a) equal to 0 b) equal to 1
c) greater than 1 d) less than 1.
- vii) The type of a transfer function denotes the number of
- a) zeros at origin b) poles at infinity
c) poles at origin d) finite poles.
- viii) The electrical resistance is analogous to
- a) viscous damper b) spring
c) mass d) torque.



- ix) The lead lag compensation will improve
- transient response
 - steady state response
 - both (a) and (b)
 - none of these.
- x) When the gain margin is positive and the phase margin is negative, the system is
- stable
 - unstable
 - probabilistic
 - undeterministic.
- xi) Addition of a pole to the closed loop transfer function
- increases rise time
 - decreases rise time
 - increases over shoot
 - has no effect.
- xi) The transfer function of a system is $\frac{10}{1+s}$, when operated as a unity feedback system, the steady state error to a unit step input will be
- zero
 - $1/11$
 - 10
 - infinity.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

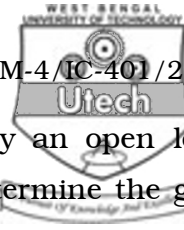
$3 \times 5 = 15$

2. Draw the electrical equivalent circuit diagram for the system shown in figure. Write the system equations.

dia

3. Derive the transfer function of the system shown in figure.

dia



4. A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{k}{s(s+10)}$. Determine the gain k so that the system will have a damping ratio of 0.5. For the values of k , determine rise time, peak time, settling time for a unit step input.
5. Derive the closed loop transfer function of an armature controlled D.C. shunt motor.
6. By means of Routh-Hurwitz's stability criterion, determine the stability of the system represented by the following characteristic equation :

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0.$$

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Derive the transfer function of the network shown below.

dia



- b) The open loop transfer function of a serve system with unity feedback is $G(s) = \frac{500}{s(s+15)}$.

Find the static error constants k_p , k_v and k_a for the system. Also evaluate the dynamic error coefficients.

- c) Obtain the transfer function of the system from the given state model.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} . \quad 5 + 5 + 5$$

8. Draw the Bode plot of the open loop transfer function

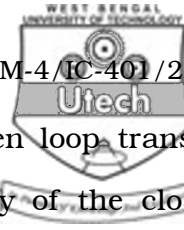
$$G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$$

From the graph determine gain margin, phase margin, gain crossover frequency, phase crossover frequency and the stability of the system.

9. Sketch the root locus for $G(s)H(s) = \frac{k}{s(s+2)(s+4)}$.

Find the value of k at the point when the root loci cross the imaginary axis. Also determine the frequency at this point.

Determine the value of k such that the dominant pair of complex poles of the system has a damping ratio of 0.5.



10. State Nyquist stability criterion. For the open loop transfer function given below determine the stability of the closed loop system using Nyquist criteria :

$$G(s)H(s) = \frac{60}{(s+1)(s+2)(s+5)} .$$

11. a) Explain the principle of operation of lead and lag compensators.
- b) Discuss the design method of PID controllers by analytical method.

8 + 7

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