

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (IT)/SEM-4/EE-411/2010
2010
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) If a closed loop control system operates at a point on JW axis, the system is
 - a) overdamped b) underdamped
 - c) marginally stable d) unstable.
- 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) Addition of a pole to the closed loop transfer function
- a) increases rise time b) decreases rise time
 - c) increases overshoot d) has no effect.
- iv) The state transition matrix is given by
- a) $[SI - A]$ b) $\{(SI - A)^{-1}\}$
 - c) $L\{(SI - A)^{-1}\}$ d) $L^{-1}\{(SI - A)^{-1}\}$.
- v) An a.c. servomotor is basically a
- a) universal motor
 - b) single phase induction motor
 - c) two phase induction motor
 - d) three phase induction motor.
- vi) A potentiometer converts linear/rotational displacement into
- a) current b) power
 - c) voltage d) torque.
- vii) State variable approach converts an n th order system into
- a) n second order differential equations
 - b) two differential equations
 - c) n first order differential equations
 - d) a higher order system.



viii) In control system, we have the following methods for system analysis :

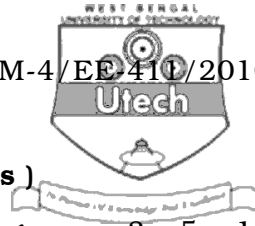
- i) Nyquist criterion
- ii) Bode plot
- iii) Root locus
- iv) Routh-Hurwitz criterion

Which of the above are in time domain ?

- a) (i) and (ii) b) (ii) and (iii)
 - c) (i) and (iii) d) (iii) and (iv).
- ix) The forward path gain of a control is 2.5 and the pole-zero configuration of the overall transfer function is shown in Fig. The following overall transfer function is

Fig.

- a) $\frac{2 \cdot 5(s+1)}{s(s+2)(s+3)}$ b) $\frac{2 \cdot 5(s+2)}{s(s+1)(s+3)}$
- c) $\frac{2 \cdot 5(s+3)}{s(s+1)(s+3)}$ d) none of these.



GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Derive the closed loop transfer function of an armature controlled DC shunt motor.
3. Determine the transfer function C/R for the system given below.

Fig.

4. Find the condition for stability for the system whose characteristic equation is given below :

$$s^3 + (k+0.5)s^2 + 4ks + 50 = 0$$

5. The forward path transfer function of a unity feedback system is given by :

$$G(s) = \frac{5(s^2 + 2s + 100)}{s^2(s+5)(s^2 + 3s + 10)}$$

Determine step, ramp & parabolic error co-efficients. Also determine the type of the system.

6. Obtain the state transition matrix of the following system :

$$\frac{dx_1}{dt} = x_1 + u$$

$$\frac{dx_2}{dt} = x_1 + x_2 + u.$$



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

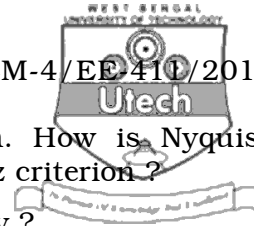
7. A unity feedback control system has a open loop transfer function $G(s) = \frac{k}{s(s+3)(s^2+2s+2)}$. Sketch the root locus of the

system by determining the following :

- a) Centroid, number & angle of asymptotes.
- b) Angle of departure of root loci from the poles.
- c) Break-away point.
- d) The value of k & the frequency at which the root locus crosses JW axis.

8. Construct the Bode plot for a unity feedback control system having $G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$. From the plot obtain the gain

margin, phase margin, gain cross-over frequency & phase cross-over frequency. Comment on the stability of the system.



9. a) State the Nyquist stability criterion. How is Nyquist criterion different from Routh-Hurwitz criterion ?
 b) What do you mean by relative stability ?
 c) The open loop transfer function of a unity feedback control system is given by :

$$G(s) = \frac{s + 0.25}{s^2(s+1)(s+0.5)}$$

Determine the closed loop stability by applying Nyquist criterion. (3 + 2) + 3 + 7

10. a) Obtain the transfer function of the system from the given state model :

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

$$Y = [1, 2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

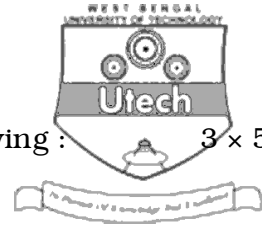
- b) Find z-transform of the following function $F(s) = \frac{1}{s(s+a)}$.
 c) Determine the pulse transfer function of the sampled data control system shown below. The sampling time is $T = 0.5$ second.

Fig.

5 + 3 + 7

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11. Write short notes on any *three* of the following :



3 × 5

- a) PID controller.
 - b) Sample & Hold circuits.
 - c) Tachometer.
 - d) Transient response of a 2nd order system.
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