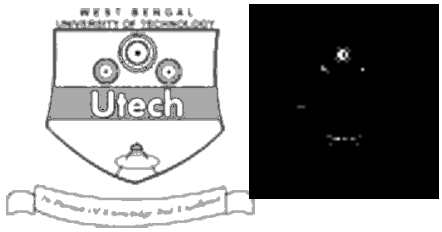
CONTROL SYSTEM - II (SEMESTER - 6)

CS/B.TECH(EE-N)/SEM-6/EE-603/09



1. .....
Signature of Invigilator

2. .....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | |

CS/B.TECH(EE-N)/SEM-6/EE-603/09

ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

CONTROL SYSTEM - II (SEMESTER - 6)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

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FOR OFFICE USE / EVALUATION ONLY

Marks Obtained

	Group – A										Group – B			Group – C				
Question Number																	***Total Marks***	***Examiner's Signature***
Marks Obtained																		

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Head-Examiner/Co-Ordinator/Scrutineer

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ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

CONTROL SYSTEM - II

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Graph sheet is provided on page 31.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) How many state variables are associated with the circuit ?

Dia.

a) 0 b) 1

c) 2 d) 3.

ii) Describing function analysis is based on

a) harmonic linearization

b) system linearisation

c) degree of non-linearity

d) input-output. ratio based on 2nd harmonic.

iii) The state equation of a linear system is given by

$\dot{X} = AX + BV$ where $A = \begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

The state transition matrix of the system is

a) $\begin{bmatrix} e^{2t} & 0 \\ 0 & e^{2t} \end{bmatrix}$ b) $\begin{bmatrix} e^{-2t} & 0 \\ 0 & e^{-2t} \end{bmatrix}$

c) $\begin{bmatrix} \sin 2t & \cos 2t \\ -\cos 2t & \sin 2t \end{bmatrix}$ d) $\begin{bmatrix} \cos 2t & \sin 2t \\ -\sin 2t & \cos 2t \end{bmatrix}$

iv) Lyapunov function is

a) energy function b) work function

c) state function d) output function. ☐

v) Phase plane analysis is generally restricted to

a) second order system b) third order system

c) first order system d) any order system. ☐

vi) If the quadratic form of a matrix is

$10\,x_1^2 + 4x_2^2 + x_3^2 + 2\,x_1 x_2 - 2x_2\,x_3 - 4x_1\,x_3$, then the matrix A is

a) positive definite b) positive semidefinite

c) negative definite d) negative semidefinite. ☐

vii) The input-output characteristics of the control system shown in the figure. The non-linearity is known as

Dia.

a) on-off non-linearity with dead zone

b) on-off non-linearity

c) dead zone with saturation

d) on-off non-linearity with hysteresis. ☐

viii) $Z[\,x(t)\,]$ is given by

a) $\sum_{k=0}^{\infty} x(kT)\,Z^{k}$ b) $\sum_{k=1}^{\infty} x(kT)\,Z^{-k}$

c) $\sum_{k=0}^{\infty} x(kT) Z^{-k}$ d) $\sum_{+\infty}^{-\infty} x(T) e^{-k}$ [ ]

ix) Jump resonance characteristics can be found in

a) Chaotic system

b) Second order nonlinear system

c) higher order nonlinear system

d) linear time varying system. [ ]

x) In discrete time system, the stability is found by

a) Lyapunov function b) Routh-Hurwitz criterion

c) Jury's stability criterion d) Bode plot. [ ]

xi) A 5 × 7 matrix has all entries as – 1. Rank of the system is

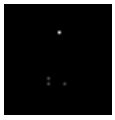
a) 1 b) 7

c) 5 d) 0. [ ]

xii) A matrix A of any state space equations for the transfer function $\frac{C(S)}{R(S)}$ of the system shown in the figure

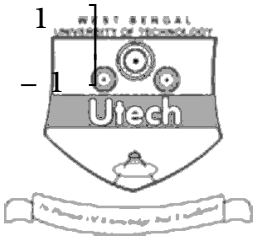
Dia.

is



a) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ b) $\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$

c) $[\,-1\,]$ d) $[\,3\,]$.



GROUP – B

(Short Answer Type Questions)

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

2. a) Consider the network shown in figure. Obtain the state variable formulation.

Dia.

b) Are choice of state variables unique ? 4 + 1

3. Solve the following difference equation using Z - transform method

$x\ (k+2) + 5x\ (k+1) + 6x\ (k) = 0,$

Given $x\ (0) = 0, x\ (1) = 1.$

4. Consider the system given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

check for state controllability.

5. Compute the Z-transform of a sinusoidal function $x\ (t)$ where $x\ (t) = 0$ for $t < 0$

$= \sin \omega t$ for $t \geq 0.$

6. Consider the dynamics of the system represented by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Formulate the Lyapunov function to test asymptotic stability of the system.

GROUP – C

(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. a) Determine the amplitude and frequency of the limit cycle of the non-linearity shown in the given figure.

Fig.

b) Determine the stability of the system shown in the given figure.

Fig. $10 + 5$

8. A system is characterised by the following state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} u, \quad y = [\,1 \;\; 0\,] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

a) Find the transfer function of the system.

b) Draw the block diagram of the above transfer function.

c) Compute the state transition matrix.

d) Obtain the solution to the state equation for a unit step input under zero initial condition. $4 + 3 + 4 + 4$

9. a) Consider the following non-linear differential equation

$$\frac{d^2x}{dt^2} + x^2 + \left(\frac{dx}{dt}\right)^2 - 2x + \frac{dx}{dt} = 0.$$

Determine the points of equilibrium.

b) Determine the type of singular point & draw the phase plane portrait for the van der Pole equation using graphical method.

$$\ddot{x} - (1 - x^2)\dot{x} + x = 0.$$ 5 + 10

10. a) Find the time response of the system shown in figure

Fig.

b) Write a note on Anti-aliasing filter. 10 + 5

11. a) What do you mean in the sense of Lyapunov, asymptotic stability, global stability & local stability ?

b) Determine the stability range for the gain k of the system shown in figure by Lyapunov's method.

Fig. 5 + 10

END