	Utech
Name:	
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Invigilator's Signature :	

CONTROL SYSTEM - I

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.

Graph sheet(s) & semi-log paper(s) will be provided by the institution.

GROUP - A

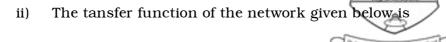
(Multiple Choice Type Questions)

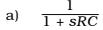
1. Choose the correct alternatives for any *ten* of the following :

 $10 \times 1 = 10$

- i) Human system is
 - a) a multivariable feedback control system
 - b) an open loop control system
 - c) a single variable control system
 - d) a complex control system.

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b)
$$\frac{sRC}{1 + sRC}$$

c)
$$\frac{RC}{1 + sRC}$$

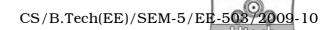
d)
$$\frac{1 + sRC}{1 - sRC}$$

- iii) Single flow graph is
 - a) topological representation of a set of differential equations
 - b) Bode plot
 - c) polar plot
 - d) locus of roots.
- iv) The unit impulse response of a linear time invariant second order system is

$$g(t) = 100 e^{-8t} \sin 6t (t \ge 0)$$

The natural frequency and damping fraction of the system are respectively

- a) 10 rad/sec & 0.6
- b) 10 rad/sec & 0.8
- c) 6 rad/sec & 0.6
- d) 6 rad/sec & 0.8

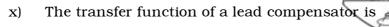


- The characteristic equation of a unity feedback system v) is given by $s^3 + s^2 + 4s + 4 = 0$. The system
 - a) has one pole in the RH s plane
 - b) has no poles in the RH s plane
 - exhibits oscillatory nature c)
 - d) both (b) and (c).
- If the gain (k) of a system becomes zero, the roots will vi)
 - a) move away from zero b) move away from poles
 - coincide with the zero d) coincide with poles. c)
- vii) For $\zeta = 0$, w_r is equal to
 - a)

- c) $\frac{w_n}{\sqrt{1-2\zeta^2}}$
- d) $w_n \sqrt{1-3\zeta^2}$.
- viii) For a type-3 system, the asymptote at a lower frequency will have a slope of
 - - -6 dB / octave b) -12 dB / octave
 - 24 dB / octave c)
- d) 40 dB / octave.
- Gain margin is the reciprocal of the gain at the ix) frequency at which the phase angle is
 - 90° a)

180° b)

c) -180° d) 0°.



$$G_C(S) = \frac{1 + 0.12 \text{ s}}{1 + 0.04 \text{ s}}$$

The maximum phase shift that can be obtained from this compensator is

a) 60°

b) 45°

c) 30°

d) 15°.

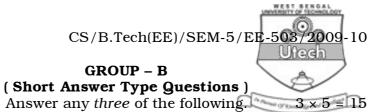
xi) The disadvantage(s) of polar plot is (are)

- a) the calculations are time consuming for exact plot
- b) it is very difficult to calculate gain & phase margin
- c) plot is crammed at high frequencies
- d) all of these.

xii) The characteristic equation of an armature controlled dc motor is of

- a) first order equation
- b) second order equation
- c) zero order equation
- d) third order equation.

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2. For a rotational system shown in figure below, draw electrical analogous circuit based on *T-i* analogy.

3. Find the simplified block diagram of figure shown.

4. Find the range of k of the system shown in figure to be stable.

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5. A unity feedback system has

$$G(S) = \frac{180}{s(s+6)} & r(t) = 4t$$



Determine:

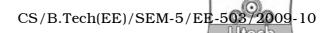
- a) the steady state error
- b) the value of k to reduce the error by 6%.
- 6. Determine time respone specification for a unit step input to a unit feedback system having $G(S) = \frac{144}{s(s+12)}$.

GROUP - C

(Long Answer Type Questions) Answer any *three* of the following. $3 \times 15 = 45$

- 7. a) What do you mean by root locus?
 - b) Draw the root locus diagram for the control system shown below and calculate gain at break-away points.
 Comment on the stability of the system.

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- 8. a) Define (i) Bode plot (ii) minimum phase function (iii) all pass function.
 - b) Sketch the Bode plot for the system having open loop transfer function.

$$G(S) = \frac{16(1+0.1s)}{s^2(s+1)(s+0.5s)}$$

From the plot determine (i) phase margin (ii) gain margin (iii) stability of the system. 3+12

- 9. a) What do you mean by Nyquist criterion?
 - b) For the system with open loop transfer function

$$G(S)H(S) = \frac{40}{(s+4)(s^2+2s+1)}$$

obtain gain margin, phase margin and stability of the system using Nyquist plot. 3+12

- 10. a) Obtain mathematical model of armature controlled DC motor and then determine the transfer function of the stystem.
 - b) What are (i) synchros (ii) position encoder (iii) resolvers?

9 + 6

- 11. Write notes on any three of the following:
- 3×5

- a) PID controller
- b) Lead-lag compensator
- c) Polar plots
- d) AC tacho generator.