Name : ....

Roll No. : ....

Invigilator's Signature : ....

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2010-11

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.

GROUP – A

(Multiple Choice Type Questions)

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

$$10 \times 1 = 10$$

i) The characteristic equation of a system is $s^2 + 2s + 2 = 0$. The system is

a) critically damped

b) underdamped

c) overdamped

d) unstable.

ii) 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.

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iii) The type of transfer function denotes the number of

a)   zeros at origin   b)   poles at infinity

c)   poles at origin   d)   none of these.

iv) The phase lead compensation is used to

a)   increase rise time & decrease overshoot

b)   decrease both rise time & overshoot

c)   increase both rise time & overshoot

d)   decrease rise time & overshoot.

v) In torque-current analogy, displacement is analogous to

a)   flux   b)   moment of inertia

c)   voltage   d)   current.

vi) Phase margin of a system is used to specify

a)   time response   b)   frequency response

c)   absolute stability   d)   relative stability.

vii) The phase margin of the system $GH(jw) = \dfrac{1}{(1+jw)^3}$ is

a) $-\pi$ b) π

c)   0   d) $\pi/2$.

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viii) The potentiometer converts linear rotational displacement into

    a) current   b) power

    c) voltage   d) torque.

ix) When a human being tries to approach an object, his brain acts as

    a) an error measuring device

    b) a controller

    c) an actuator

    d) an amplifier.

x) An AC servo motor is basically a

    a) universal motor

    b) single phase induction motor

    c) two phase induction motor

    d) three phase induction motor.

xi) A system has a pole at origin. Its impulse response will be

    a) constant   b) ramp

    c) exponential   d) oscillatory.
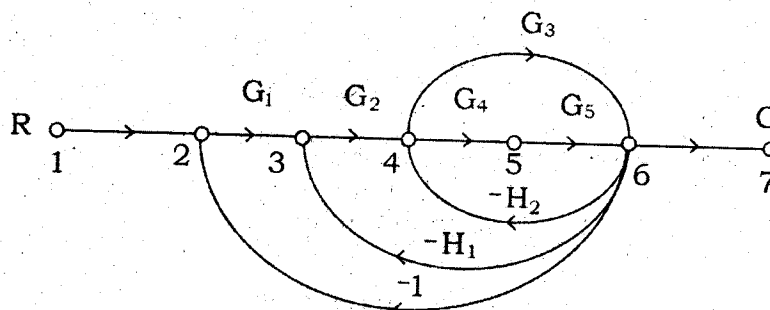
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xii) The natural frequency of oscillation of the output of the

equation $\dfrac{d^2x}{dt^2} + 1 \cdot 5\dfrac{dx}{dt} + 4x = 1$ is

a) 0 rad / sec   b) 1·5 rad / sec

c) 2 rad / sec   d) 4 rad / sec.

GROUP – B

(Short Answer Type Questions)

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

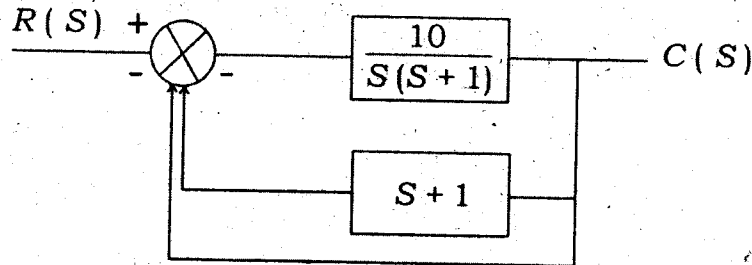2. Find $\dfrac{C}{R}$ of the following signal flow graph using Mason's gain formula :

3. Using Routh criterion, determine the range of values of k for stability for the following system :

$$\frac{C(S)}{R(S)} = \frac{k}{S(S^2 + S + 1)(S + 4) + k}$$

4. For the system shown below

$R(S)$ + ... $-$ ... $-$ ... $\dfrac{10}{S(S+1)}$ ... $C(S)$

$S+1$

a) find K_p, K_v, K_a

b) find steady state error for an input of $5t^2 u(t)$.

c) state the system type number.

5. Derive the transfer function of armature controlled DC motor.

6. The open loop transfer function of a system with unity feedback gain is given as $G(S) = \dfrac{20}{S^2 + 5S + 6}$. Determine the damping ratio, maximum overshoot, rise time & peak time.
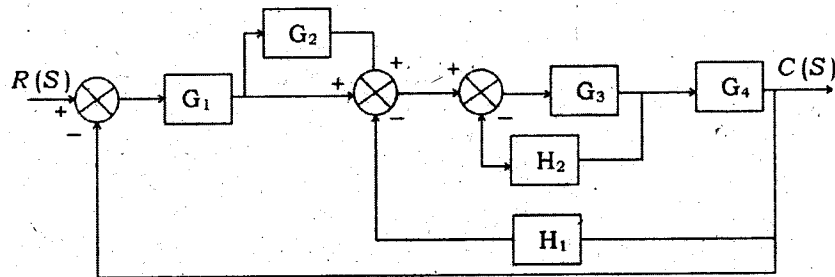
GROUP – C

(Long Answer Type Questions)

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

7. a) Obtain the transfer function of the mechanical system shown below :

K_1 ... $\mapsto X_1$ ... B_{12} ... $\mapsto X$ (output)

M_1 ... M_2 ... $f(+)$

K_2

B_1 ... B_2
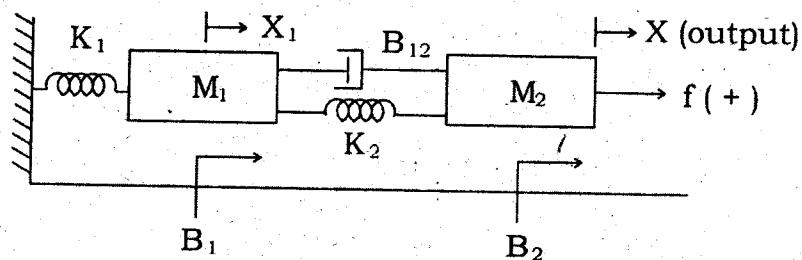
b) Find $\dfrac{C}{R}$ for the block diagram shown below. Use block diagram reduction techniques.

8 + 7

8. Draw the root locus for the unity feedback system whose open loop transfer function is $G(S) = \dfrac{k(S+1)}{(S-1)(S+2)(S+4)}$

Find the range of k for which the system is stable. Show all relevant steps of calculation.

9. Construct the Bode plots for a unity feedback system whose open loop transfer function is given by

$$G(S) = \dfrac{10}{S(1+S)(1+0.02S)}.$$

From the Bode plot determine

a) gain & phase Cross-over frequencies

b) gain & phase margin

c) stability of the closed loop system.

6

10. a) What is compensation ? What is compensated system ? What is compensator ?

b) Write short note on P, PI & PID control. 6 + 9

11. a) State & explain Nyquist stability criterion.

b) Sketch polar plot for the unity feedback system with open loop transfer function $G(S) = \dfrac{1}{S(S+2)}$. 5 + 10

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