Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE-OLD)/SEM-5/EC-513/2012-13

2012
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) In a phase lead network bandwidth

a) decreases b) increases

c) remains same d) none of these.

ii) State the Type and Order of the following system :

$$G(s)H(s) = 200/(s^2+20s+200)$$

a) Type 0; Order 0 b) Type 1; Order 1

c) Type 0; Order 2 d) Type 1; Order 2.

iii) Velocity error of a system occurs due to

a) Unit step input b) Unit ramp input

c) Unit impulse input d) Unit parabolic input.

iv) A second order system exhibits 100% overshoot. Its damping ratio is

a) equal to 1 b) less than 1

c) equal to 0 d) greater than 1.

v) The forward path transfer function of a unity feedback system is given by G(s) = k/[s(s+4)(s+5)]. The centroid of asymptotes is

a) 0 b) – 1

c) – 2 d) – 3.

vi) If a zero is added to a second order system, the Rise time

a) increases b) decreases

c) remains same d) increases abruptly.

vii) If all the roots of the characteristic equation lie in the right half of the *s*-plane, the system is

a) stable b) unstable

c) marginally stable d) none of these.

viii) The settling time for 2% criterion is (where ξ is the damping factor and ω_n is the natural frequency of oscillation of the system)

a) $1/(\xi\omega_n)$ b) $2/(\xi\omega_n)$

c) $3/(\xi\omega_n)$ d) $4/(\xi\omega_n)$.

ix) A control system with unit damping factor will give

a) Oscillatory response

b) Critically damped response

c) Undamped response

d) No response.

x) Signal flow graph approach is applicable to

a) Linear systems b) Non-linear systems

c) Both (a) & (b) d) None of these.

xi) The speed of response and steady state error can be increased in

a) Lead compensator

b) Lag compensator

c) Lead-Lag compensator

d) None of these.

xii) The state transition matrix $\Phi(t)$ is given by (where (sI–A) is a matrix and L^{-1} denotes Inverse Laplace transformation)

a) (sI-A) b) $(sI–A)^{-1}$

c) L^{-1} (sI–A) d) L^{-1} [sI–A)].

GROUP – B

(Short Answer Type Questions)

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

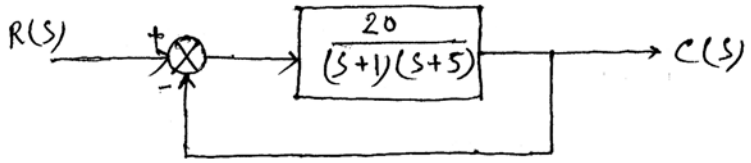
2. For a system with $F(s) = s^4 + 22s^3 + 10s^2 + s + k = 0$, obtain the marginal value of k and the frequency of oscillation for that value of k, using Routh-Hurwitz criterion.

3. The closed loop transfer function of a unity feedback control system is given below :

$$C(s)/R(s) = (Ks + \beta) / (s^2 + \alpha s + \beta)$$

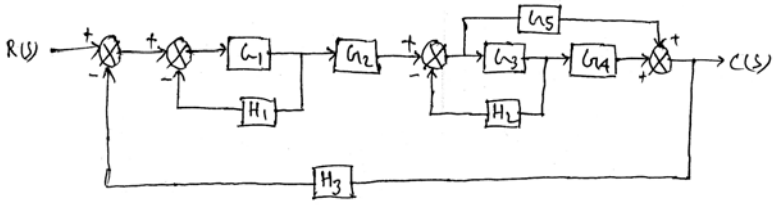
Show that its steady state error for unit ramp input is $(\alpha - K)/\beta$.

4. The block diagram of a unity feedback control system is shown in fig given below :



Determine the characteristic equation of the system, ω_n, ξ, ω_d, t_p, M_p, the time at which the first undershoot occurs, the time period of oscillations and the number of cycles completed before reaching the steady state.

5. Find out the overall transfer function using block diagram reduction technique.



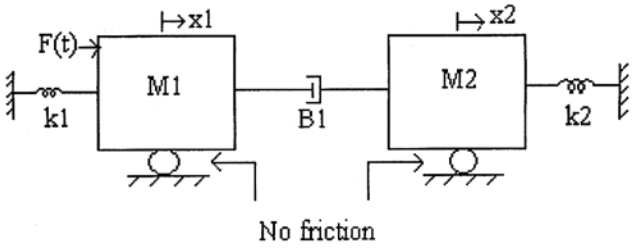
6. A system is described by and $\dot{X} = \begin{bmatrix} 1 & -1 \\ 1 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$ and $Y = [\ 1\ 0\ ]\ X$. Check the controllability and observability of the sysstem.

GROUP – C

(Long Answer Type Questions)

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

7. a) Obtain the differential equation of the mechanical system.

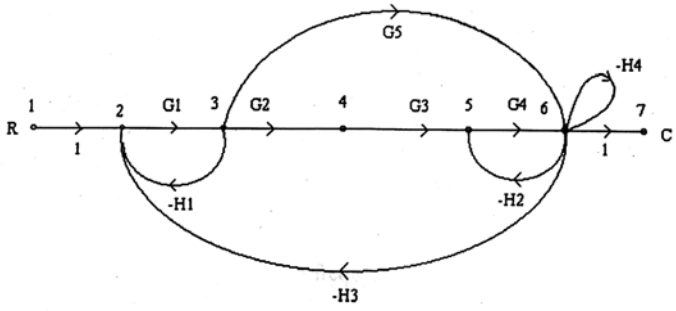


b) Draw the Electrical analogous circuit based on 'force-current' analogy. $7\frac{1}{2} + 7\frac{1}{2}$

8. a) Explain the different 'Signal Flow Graph' terminologies.

b) Compare between 'Block Diagram' and 'Signal Flow Graph' methods.

c) For the given signal flow graph find the C/R ratio.



5 + 2 + 8

9. a) Define the following Time domain specifications :

   i) Rise time

   ii) Peak time

   iii) Max. overshoot

   iv) Settling time

   v) Delay time.

   b) Obtain an expression for settling time (for 5% criterion).

   c) Obtain the Rise time, Peak time, Max. peak overshoot & Settling time for the closed loop system described by $G(s) = 36/(s^2 + 2s + 36)$. 5 + 2 + 8

10. a) Using Routh-Hurwitz criterion for the unity feedback system with transfer function

$$G(s) = k/[s(s + 1)(s + 2)(s + 5)]$$

   i) Find the range of k for stability.

   ii) Find the value of k for marginally stable.

   iii) Find the actual location of the closed loop poles when the system is marginally stable.

   b) For a unity feedback system the open loop transfer function is given by

$$G(s) = k/[s(s + 2)(s^2 + 6s + 25)]$$

   i) Sketch the root locus on a graph paper for $0 \le k \le \infty$

   ii) At what value of 'k' the system becomes unstable ?

   iii) At this point of instability determine the frequency of oscillation of the system. 6 + 9

11. a) What do you mean by 'Resonant frequency' and 'Bandwidth' of a system ?

b) Sketch the Bode plot showing the magnitude in decibels and phase angle in degrees as a function of log frequency for the transfer function given by $G(s) = 1000/[s(s + 10)(5s + 10)]$

c) From the plot determine the Gain margin and Phase margin of the system. 3 + 10 + 2