CONTROL SYSTEM
(ELEC 3103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The transfer function of a system is $G(s) = \frac{K}{s^2(s^2+s+1)}$. The order and type of the system are
(a) 4 and 4 (b) 4 and 2 (c) 2 and 4 (d) 2 and 3

(ii) The characteristics equation of a system is given by $s^2 + 4s + 4 = 0$, the values of natural frequency of oscillation and damping ratio is
(a) 0.5rad/sec and 2 (b) 2 rad/sec and 0.5
(c) 2 rad/sec and 4 (d) 2 rad/sec and 1

(iii) The first column of Routh table containing the following integers 1, 5, -4, 6, 3. The system has _____ number of poles on right half of s-plane.
(a) 2 (b) 5 (c) 1 (d) 0

(iv) A control system is stable when
(a) Zeros of the system have negative real part
(b) Impulse response approaches to zero when time tends to infinity
(c) Impulse response approaches to infinity when time tends to infinity
(d) Roots of the characteristic equation have positive real part

(v) The steady state error of a type-1 system due to unit ramp input is
(a) zero (b) ∞ (c) constant (d) -∞

(vi) If the system has multiple poles on origin of s plane the system is
(a) stable (b) unstable
(c) marginally stable (d) nonlinear

(vii) For a system, the open loop transfer function is given by $G(s)\mathrm{H(s)} = \frac{\mathrm{k}}{(\mathrm{s}^2+4\mathrm{s}+13)}$. The angle of departure from the complex poles are
(a) 0° (b) $\pm 90^\circ$ (c) $\pm 180^\circ$ (d) $\pm 45^\circ$

(viii) A system having a transfer function $G(s) = \frac{(1+2s)}{(1+20s)}$ is a

(a) lag compensator (b) lead compensator
(c) lag-lead compensator (d) lead-lag compensator

(ix) By the use of PD control to the second order system overshoot

(a) increases (b) decreases
(c) remains unaltered (d) can't be determined

(x) If a system is described by, $A = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ then

(a) system is controllable (b) system is uncontrollable
(c) system is undefined (d) couldn't comment on controllability.

Group- B

2. (a)

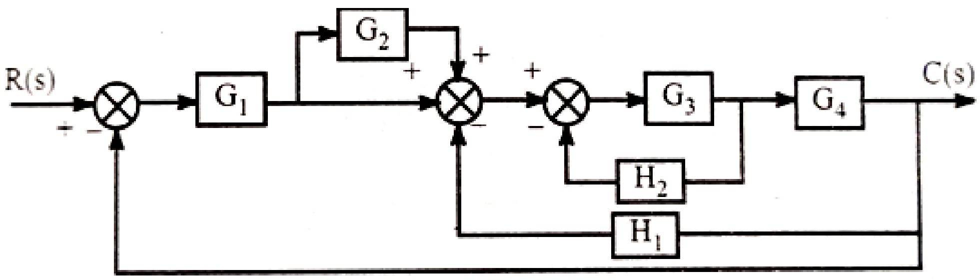

Figure: 1

Solve the block diagram shown in figure: 1 by block diagram reduction technique and determine the overall transfer function (C(s)/R(s)).

[(CO1) (Analyse/IOCQ)]

(b) Sketch the signal flow graph of the above block diagram. From the signal flow graph identify the transfer function C(s)/R(s) using Masson's gain formula.

[(CO1) (Analyse/IOCQ)]

6 + (2 + 4) = 12

3. Describe any of the following three as short notes: **(4 × 3) = 12**

(i) Potentiometer
(ii) Tacho generator
(iii) Synchro
(iv) Gyroscope. [(CO1) (Remember/LOCQ)]

Group – C

4. (a) Define peak time and rise time of a system. [(CO2) (Remember/LOCQ)]

(b) A unity negative feedback heat treatment system has open loop transfer function$G(s) = \frac{10000}{(1+s)(1+0.5s)+(1+0.2s)}$.

The output set point is 400°C. Find out the steady state temperature?

[(CO2) (Remember /LOCQ)]

(c) The open loop transfer function of a negative unity feedback control system is given by $G(s)H(s) = \frac{K}{s(s+1)(s+2)(s+3)}$. Determine (i) the range of K (K>0) for which the system is stable, (ii) the value of K for which system is marginally stable, (iii) frequency of sustained oscillation. [(CO2) (Evaluate /HOCQ)]

3 + 3 + 6 = 12

5. (a) What is 'Break away point' and how to find it. [(CO2) (Understand/LOCQ)]

(b) Sketch the root locus diagram of a negative unity feedback system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+1)(s+4)(s+7)}$. Identify (i) the range of K for which system is stable, (ii) the intersection points between root locus and jω axis, (iii) break away points if any. [(CO2)(Analyze/IOCQ)]

2 + (4 + 6) = 12

Group – D

6. (a) What is 'Principle of Argument'? [(CO3) (Remember/LOCQ)]

(b) State Nyquist Stability Criterion. [(CO3) (Remember/LOCQ)]

(c) The open loop transfer function of a unity feedback system is given by $G(s)H(s) = \frac{5}{1-0.5s}$. Draw the Nyquist plots and evaluates the stability of the closed loop system. [(CO3) (Evaluate /HOCQ)]

2 + 2 + 8 = 12

7. The open loop transfer function of a unity feedback system is given by $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$. Determine the value of K such that (a) Gain margin=20 db and (b) phase margin=60°. [(CO3) (Analyze/IOCQ)]

(6 + 6) = 12

Group - E

8. (a) Classify different types of compensators. How compensators improve frequency domain performance of the closed loop system? [(CO4) (Remember/LOCQ)]

(b) Determine the controllable canonical form of the system whose transfer function is given by,

$$G(s) = \frac{s^3 + 4s^2 + 3s + 6}{s^4 + 2s^3 + 5s^2 + 6s + 4}$$

Hence draw the signal flow graph of the system realized in controllable canonical form. [(CO4) (Analyse /IOCQ)]

4 + (6 + 2) = 12

9. (a) Consider a system having state and output equation as follows.

$$\dot{X} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -4 & 2 \\ 0 & 0 & -10 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix} u$$

and $y = [1 \quad 0 \quad 1]X$

Examine whether the system is state controllable or not.

[(CO4) (Analyse /IOCQ)]

(b) A system is described by,

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

and $y = [1 \quad 0 \quad 0]X$

Using state feedback control place the pole of the close loop system to a desired location $s = -2 \pm j4$ and $s = -10$. Develop the state feedback gain matrix.

[(CO4)(Evaluate/HOCQ)]

4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17%	47.91%	22.91%

Course Outcome (CO):

After the completion of the course students will be able to

CO1. Know the fundamental concepts of Control systems and mathematical modelling of the system

CO2. Analyze time response of a system and understand the concept of stability

CO3. Investigate frequency response of the system and examine the relative stability by various approach

CO4. Design and realize control systems using classical methods and state variable modelling technique

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
EE	https://classroom.google.com/c/MTIxOTk2MTM4MTk3/a/NDYzMDI0MTUxMzA5/details