BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 29.12.2012 Time: 3Hours M.M = 120 (40%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer each part (Part A, Part B & Part C) in a separate answer sheet.
3. Write the ID No. on all the answer sheets & the graph sheets
4. Total No of Pages.3, No of Questions. 12

PART A

1. Using block diagram reduction technique, find the closed loop transfer function C(s)/R(s) for the system shown in Figure 1. [12M]

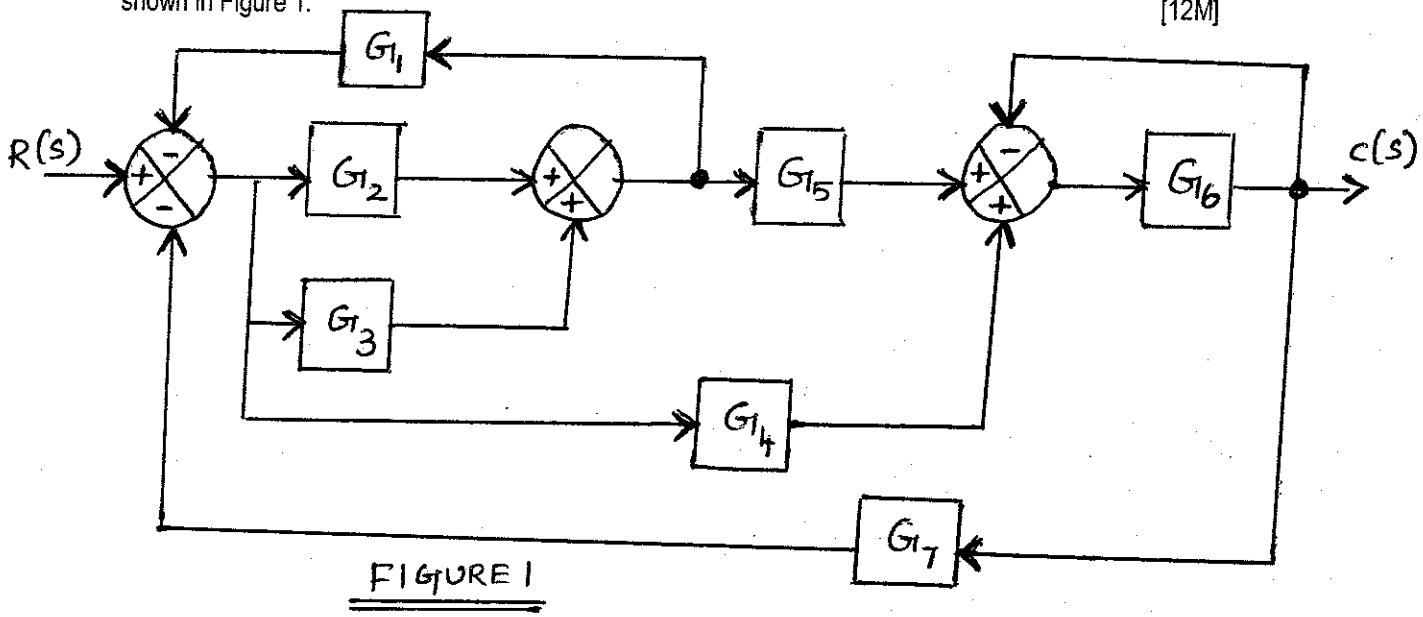

FIGURE 1

2. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{2}{s^2(s+2)(s+1)}$.

Draw the polar graph (in the polar graph sheet) and determine (1) Gain margin (2) Phase margin (Assume the frequencies as 0, 0.2, 0.4, 0.6, 0.8, 1 and 10 rad/sec) [12M]

3. Find the K_p , K_v, K_a for the following system. And also find the steady state error for r(t) = 1+ t

$$G(s) = \frac{100}{s^2(s+2)(s+5)}$$ [8M]

4. For Figure 2 , derive the transfer function of the field controlled DC motor in terms of motor constants. [8M]

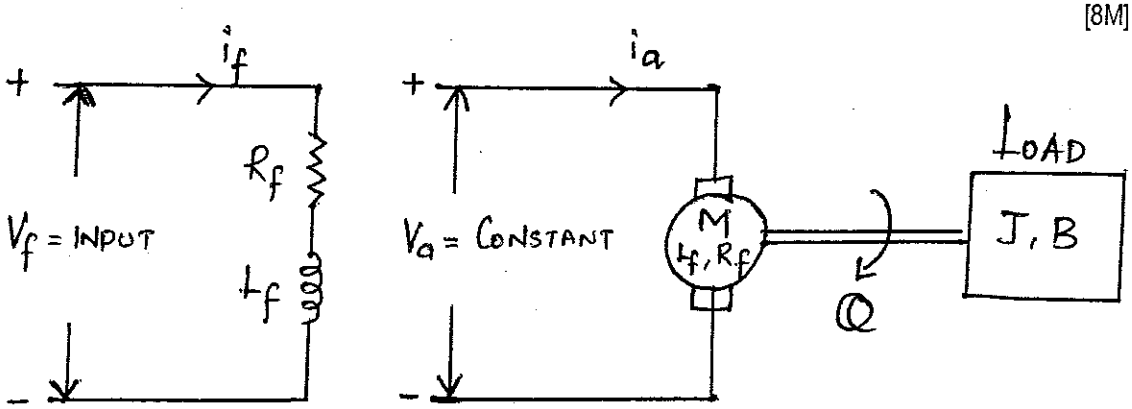

FIGURE 2

PART B

5. Using Mason's gain formula, find the closed loop transfer function of a system shown in Figure 3. [12M]

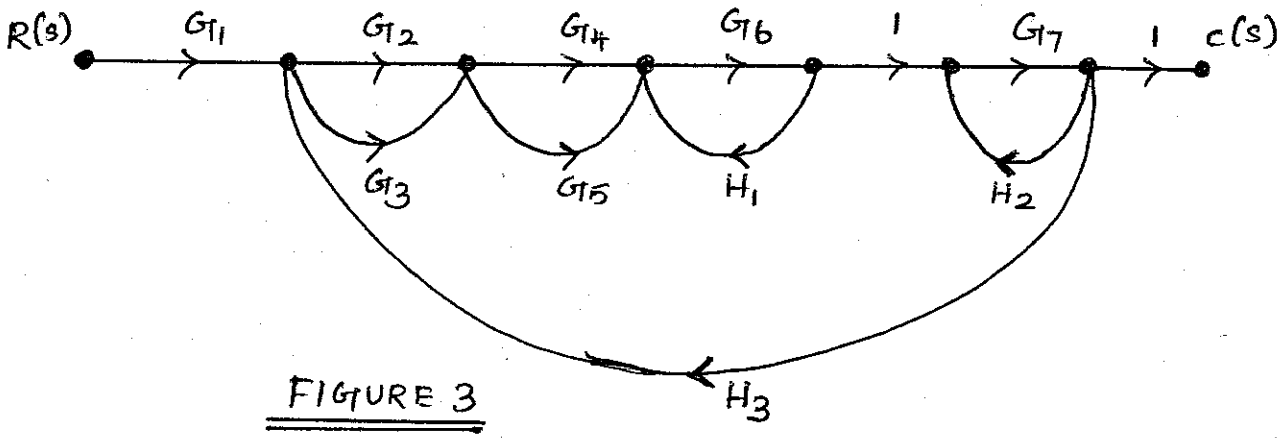

FIGURE 3

6. Draw the Bode plot (in the semi log sheet) for the open loop transfer function

$$G(s) = \frac{100}{s(1+0.2s)(1+0.02s)}.$$

Determine (1) gain cross over frequency (2) phase cross over frequency.
(Assume Lower frequency ω_L = 0.1 rad/ sec; Higher frequency ω_H = 100 rad/sec) [12M]

7. Using Routh's stability criterion, determine the stability of the system represented by the characteristic equation, $s^6+2s^5+8s^4+15s^3+20s^2+16s+16 = 0$. Comment on the location of the roots of the characteristic equation. [6M]

8a. Determine the sensitivity of the closed loop transfer function of the open loop transfer function

G(s) = $\frac{K}{s(s+P)}$ with respect to β where the feedback factor H(s) = (1+ βs).

The values are ; K= 12, P= 3 & β=0.14

8b. Given KK_t = 99; s = j1rad/sec. Find the sensitivity of the closed loop system shown in figure 4 to variation in parameter K. [5M+5M]

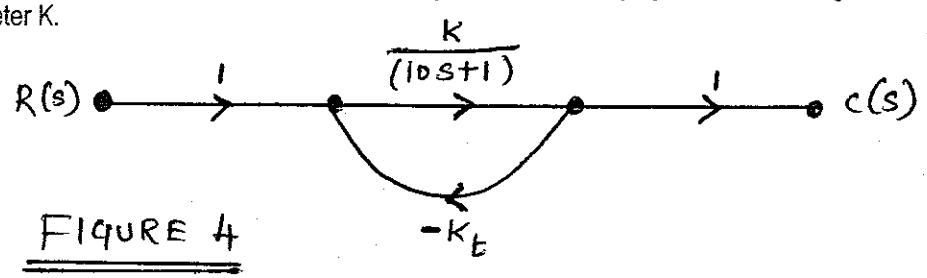

FIGURE 4

PART C

9. Draw the root locus (in the graph sheet) for the unity feedback system whose open loop transfer function is given by

G(s) = $\frac{K}{s(s+1)(s+3)(s+4)}$. Write the comments/ summary on all the root locus branches. [12M]

10. The open loop transfer function of a unity feedback control system is given by G(s) = $\frac{K}{s(1+Ts)}$.

(i) By what factor 'K' should be multiplied to increase the damping ratio from 0.2 to 0.8
(ii) By what factor 'K' should be multiplied to reduce the overshoot from 60% to 20% [12M]

11. A step input of ' 3 ' is applied to a unity feedback system with G(s) = $\frac{6}{s(s+5)}$. Find the response of the system. [8M]

12. A step of ' 2 ' is applied to a unity feedback of the system is given in figure 5.
Find (i) A and K so that the damping ratio is 0.6 and damped frequency of oscillation is 8 rad/sec.
(ii) What is the peak value of the response? [8M]

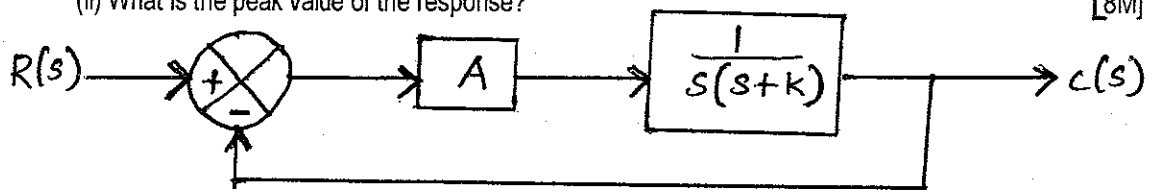

FIGURE 5

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Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
TEST II (OPEN BOOK)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 11.11.2012 Time: 50 Minutes M.M = 60(20%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Total no of questions 3.
4. Text book and handwritten class notes are allowed.

1.For figure1using block diagram reduction technique, find the transfer function from each input to the output C. (When one input is acting the other input is zero) **[20M]**

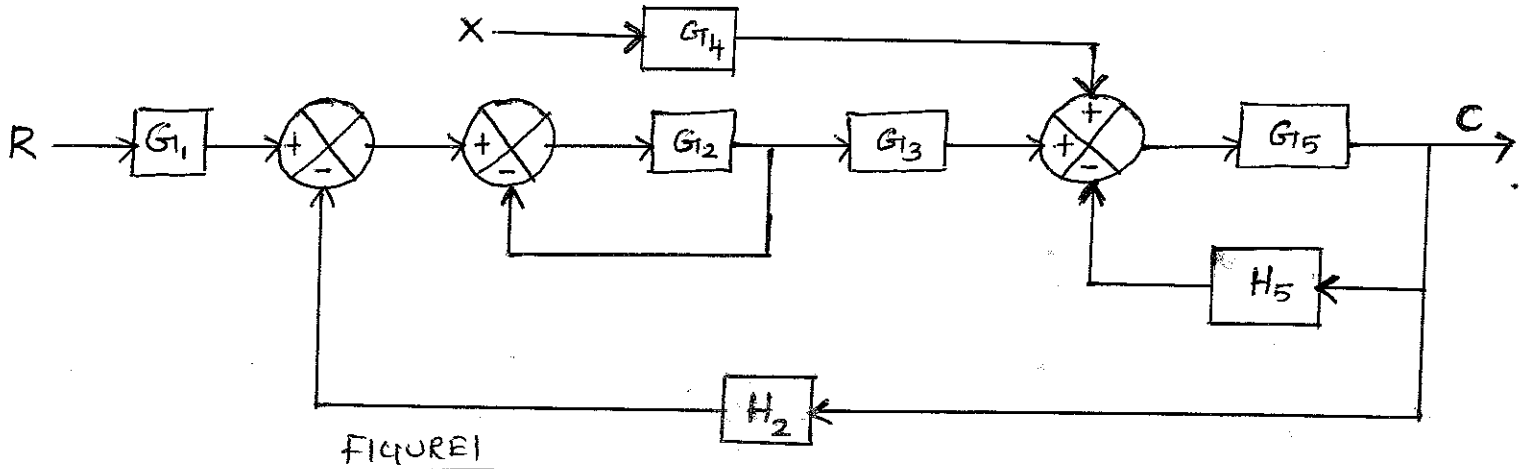

FIGURE1

2A For a system with $G(s) = \frac{K_1}{s^2}$ and $H(s) = 1 + K_2 s$. Find K_1 and K_2 so that peak overshoot is 0.25 and peak time is 2 sec when step input is applied. **[10M]**

2B The parameters of a mechanical system of figure 2 are M= 100Kg; B= 1000N/m/ sec ; K= 10000N/m. A step force of 100 Newton is applied to the mass at t=0.From the physical parameters of the system, obtain the transfer function, damping ratio (ξ), undamped natural frequency (ω_n) and damped frequency of oscillation (ω_d). Also obtain the response for the given input. **[10M]**

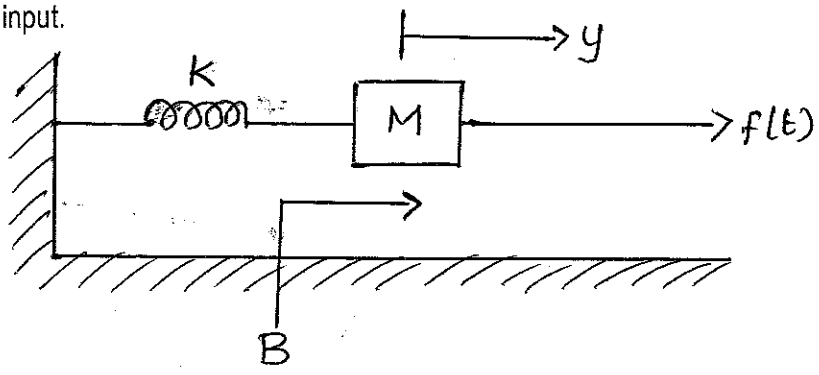

FIGURE 2

PTO

3A Determine the sensitivity with respect to G and H of the overall transfer function for the system shown in figure 3. **[4M]**

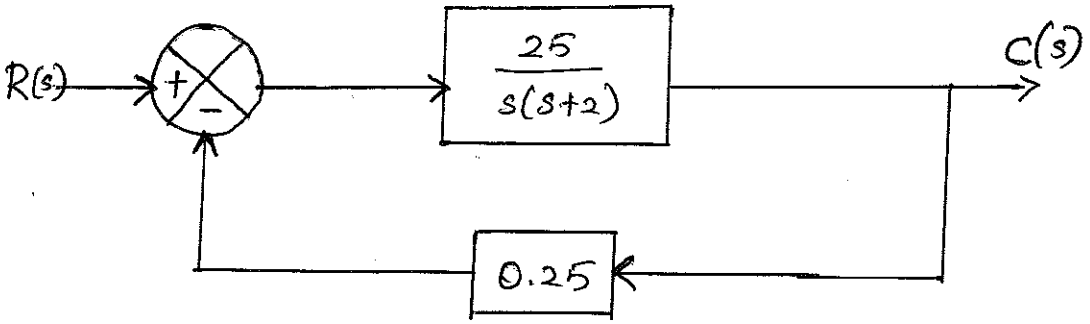

FIGURE 3

3B Find the closed loop transfer function for the figure 4 using Mason's gain formula. **[16M]**

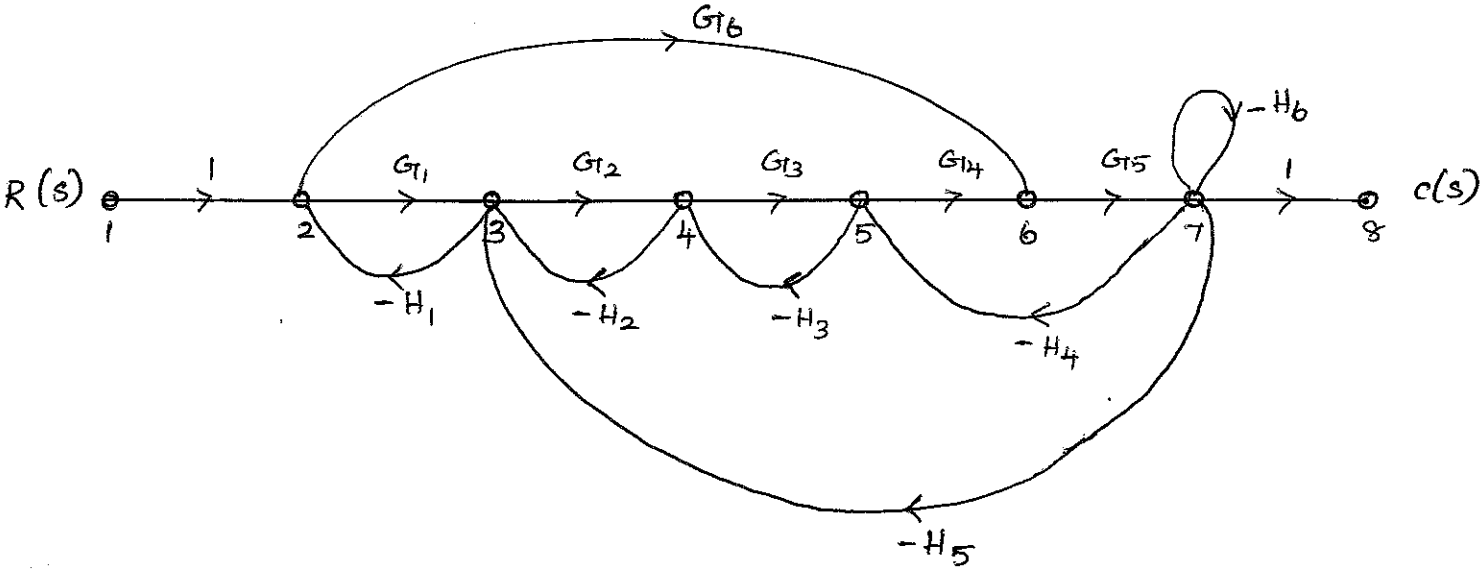

FIGURE 4

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Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
TEST I (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 23.09.2012 Time: 50 Minutes M.M = 75(25%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Total no of questions 3.

1a. Write the differential equations governing the mechanical rotational system shown in Fig1 and determine the transfer function $\theta_2(s)/ T(s)$. [22 M]

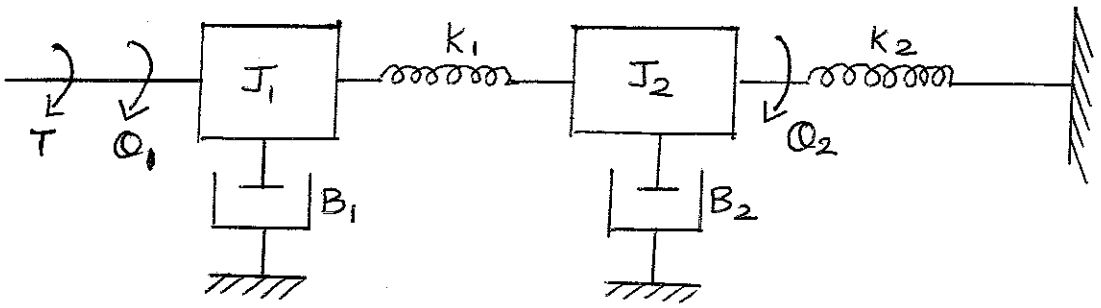

FIG1. MECHANICAL ROTATIONAL SYSTEM

1b. Write the differential equation for the RLC series circuit. [3M]

2a.Derive the transfer function of the armature controlled DC motor in terms of motor constants for Fig 2. [22 M]

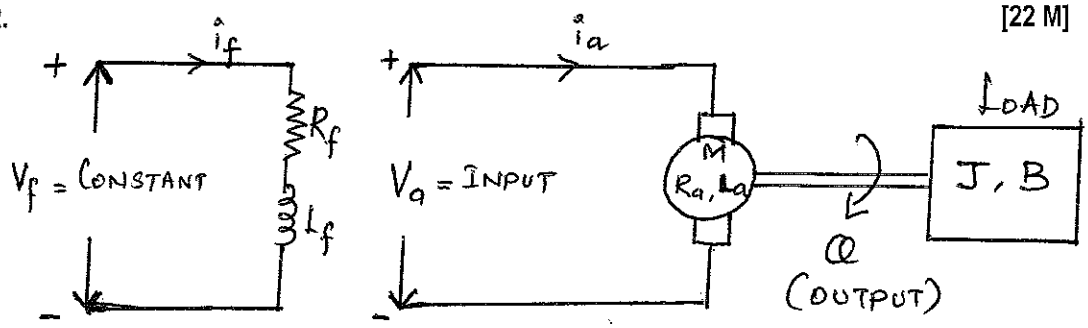

FIG2. ARMATURE CONTROLLED DC MOTOR

2b. Consider the torsional spring in a mechanical rotational system. Its analogous element in torque – voltage analog is..... and torque – current analog is .....
[3M]

PTO

3a. Write the differential equations governing the mechanical translational system shown in Fig 3. [23M]

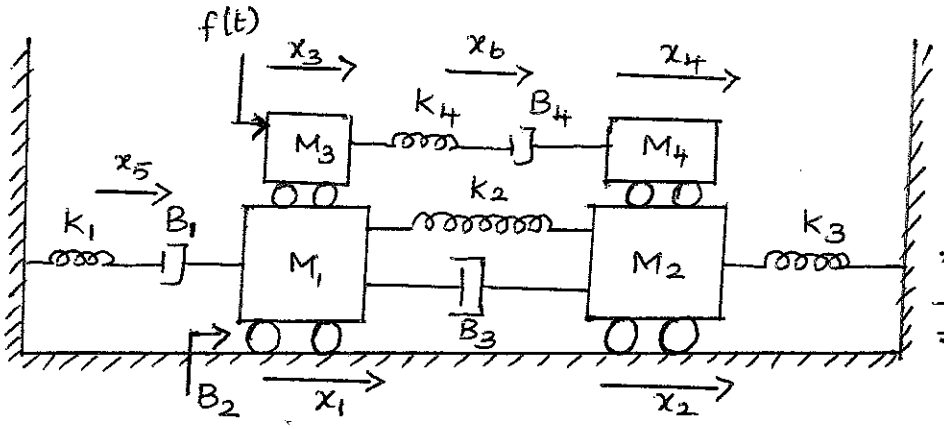

FIG.3. MECHANICAL TRANSLATIONAL SYSTEM

3b. Mention the relationship between the torque, angular displacement and number of teeth for gear train system. [2M]

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Semester I 2012-2013
QUIZ II (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 05.12.2012 Time: 20 Minutes M.M = 21 (7%)

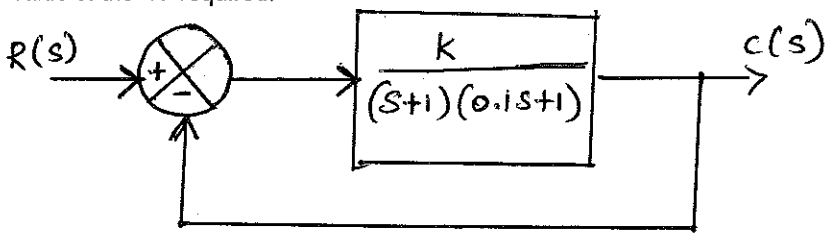
NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Total No of Pages.3

1. The open loop transfer function of a unity feedback control system $G(s)H(s) = \frac{30}{s(s+1)(s+T)}$ where " 'T " is a variable parameter. The closed loop system will be stable for which values of " T". [5M]

2. Find the response of first order system when subjected to a unit impulse signal. [2M]

3. A second order system has a damping ratio of 0.6 and natural frequency of oscillation of 10 rad/sec. Determine the damped frequency of oscillation. [2M]

4. The system shown in figure 1 has a unit step input. In order that the steady state error is 0.1, find the value of the "K" required. [2M]



5. The damping ratio of a system is 0.75 and the natural frequency of oscillation is 12 rad/sec. Determine the peak overshoot and the peak time. [2M]

6. The closed loop transfer function of certain second order unity feedback control systems are given below. Determine the type of the damping in the system. [2M]

(a) $\frac{C(s)}{R(s)} = \frac{2}{s^2+4s+2}$

(b) $\frac{C(s)}{R(s)} = \frac{2}{s^2+4}$

7. Consider a unity feedback system with a closed loop transfer function. [3M]

$$\frac{C(s)}{R(s)} = \frac{ks + b}{s^2+as+b}$$

Determine,

(a) The open loop transfer function

(b) Velocity error constant

(c) Steady state error for a unit ramp input

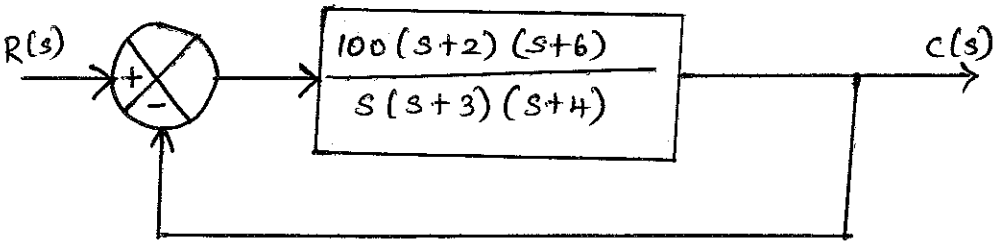
8. The system shown below (figure 2) is subjected to the following inputs.

(a) 5 u(t)

(b) 5 t u(t)

(c) 5 t^2 u(t)

Find the steady state errors of the system where u(t) is a step input. [3M]



(a)

(b)

(c)

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BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
QUIZ I (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 17.10.2012 Time: 20 Minutes M.M = 24 (8%)

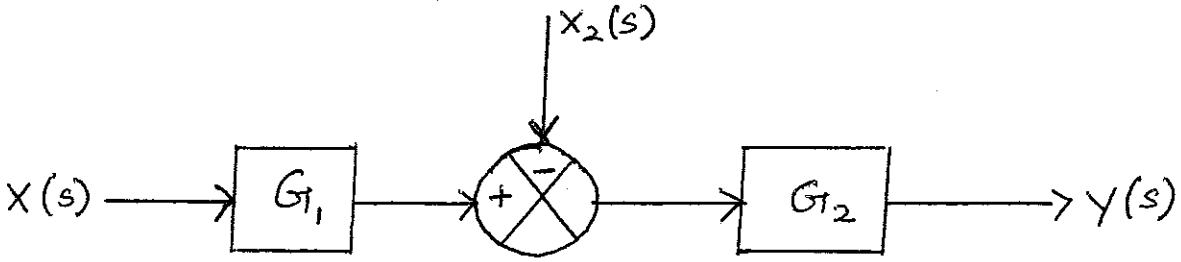
NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Total No of Pages.3 ; No. of Questions. 8 .

1. Regenerative feedback means the output is feedback with..... [1M]

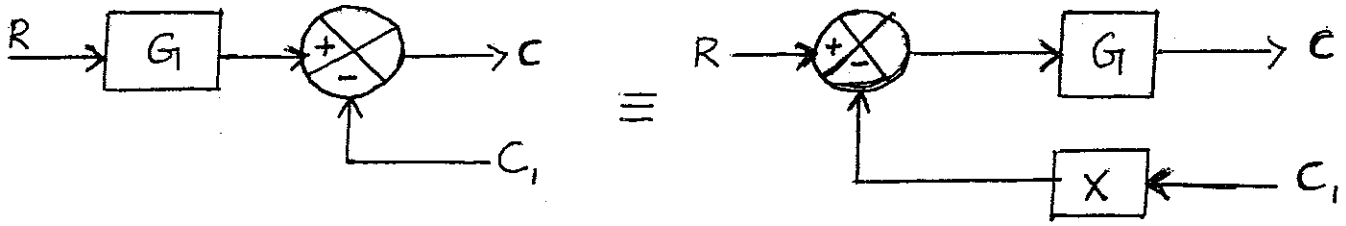
2. ..... loops are loops which do not posses any common node. [1M]

3. Three blocks with the gains of 4, 6 and 8 are connected in parallel. The total gain of the arrangement is ..... [2M]

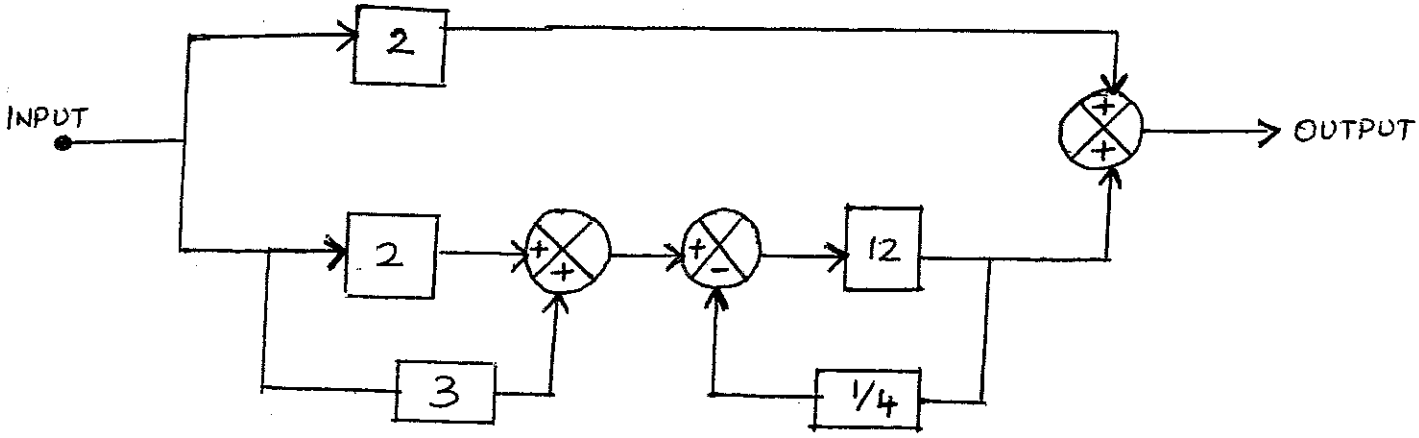
4. Find the output for the block diagram shown below. [2M]



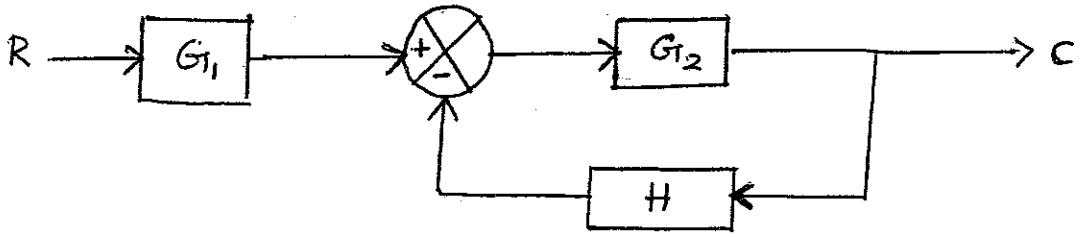
5. What is the value of 'X' for which the two block diagrams are equal? [2M]



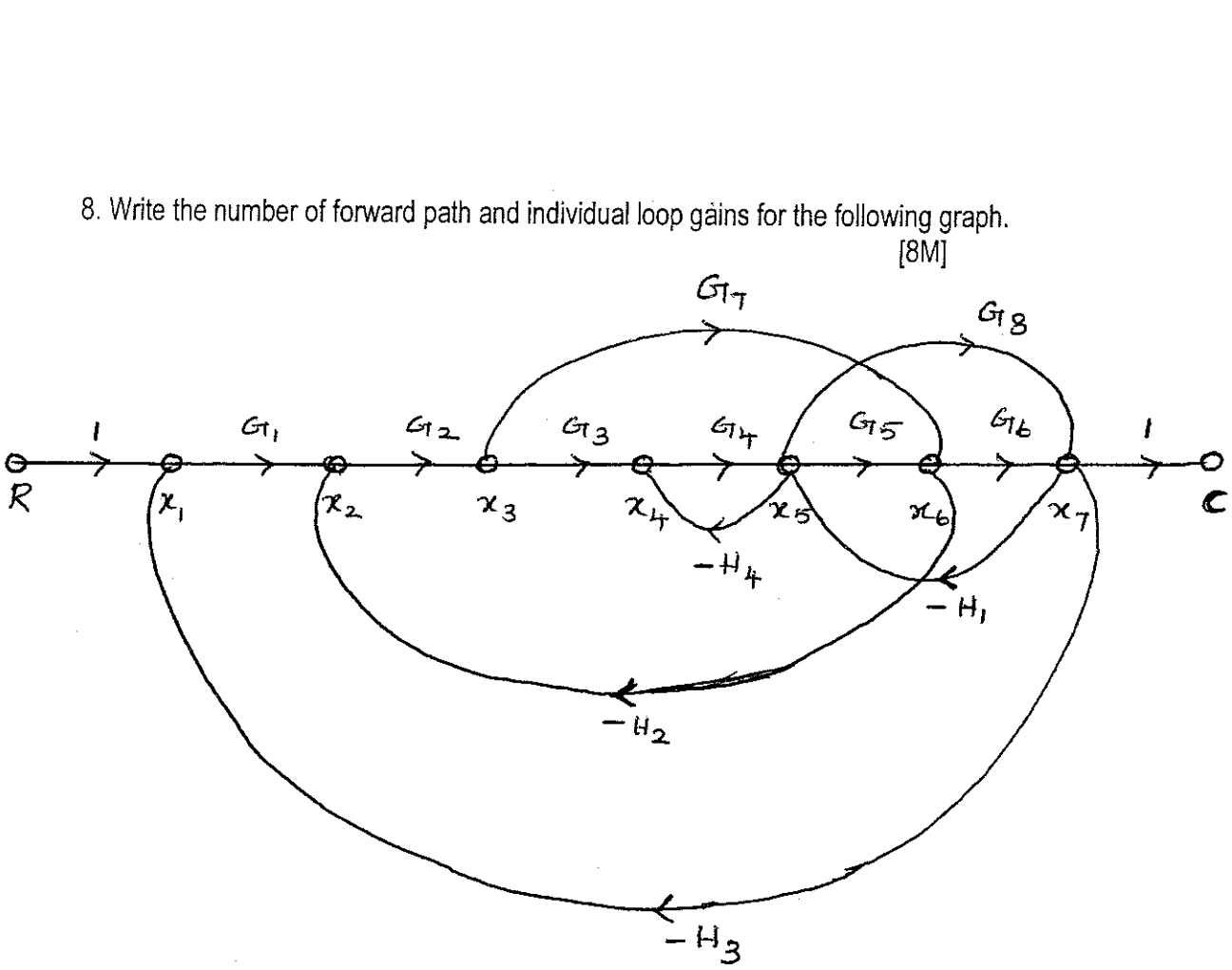
6. What is the gain of the system, whose block diagram shown below? [3M]



7. Find the sensitivity of T with respect to $G_1\left(S_{G_1}^{T}\right)$ and $G_2\left(S_{G_2}^{T}\right)$ [5M]



8. Write the number of forward path and individual loop gains for the following graph. [8M]



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