BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 04.01.2012 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 graph sheets
4. Total No of Pages.3, No of Questions. 9

PART A

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

$$G(s)H(s) = \frac{20\,s^2}{(1+0.2s)\,(1+0.02s)}$$

and 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) [13M]

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

Draw the polar graph (in the polar graph sheet) and determine (1) Gain margin (2) Phase margin
(Assume the frequencies as 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1 rad/sec) [12M]

3. Draw the root locus (in the graph sheet) for the unity feedback system whose open loop transfer function is $G(s) = \frac{K(s+1)}{(s-1)\,(s+2)\,(s+4)}$. Write the comments/ summary on all the root locus branches. [15M]

PART B

4. (a). G=100, H=0.2; Find the sensitivity of T with respect to G and H. [5M]

4. (b) For the servo mechanisms with open loop transfer function given below explain what type of input signal give rise to a constant steady state error and calculate their values.

$$G(s) = \frac{10}{s^2\,(s+1)\,(s+2)}$$

[5M]

PTO

5. Using block diagram reduction technique find the transfer function C(s)/R(s) for the system shown in Figure 1. [15M]

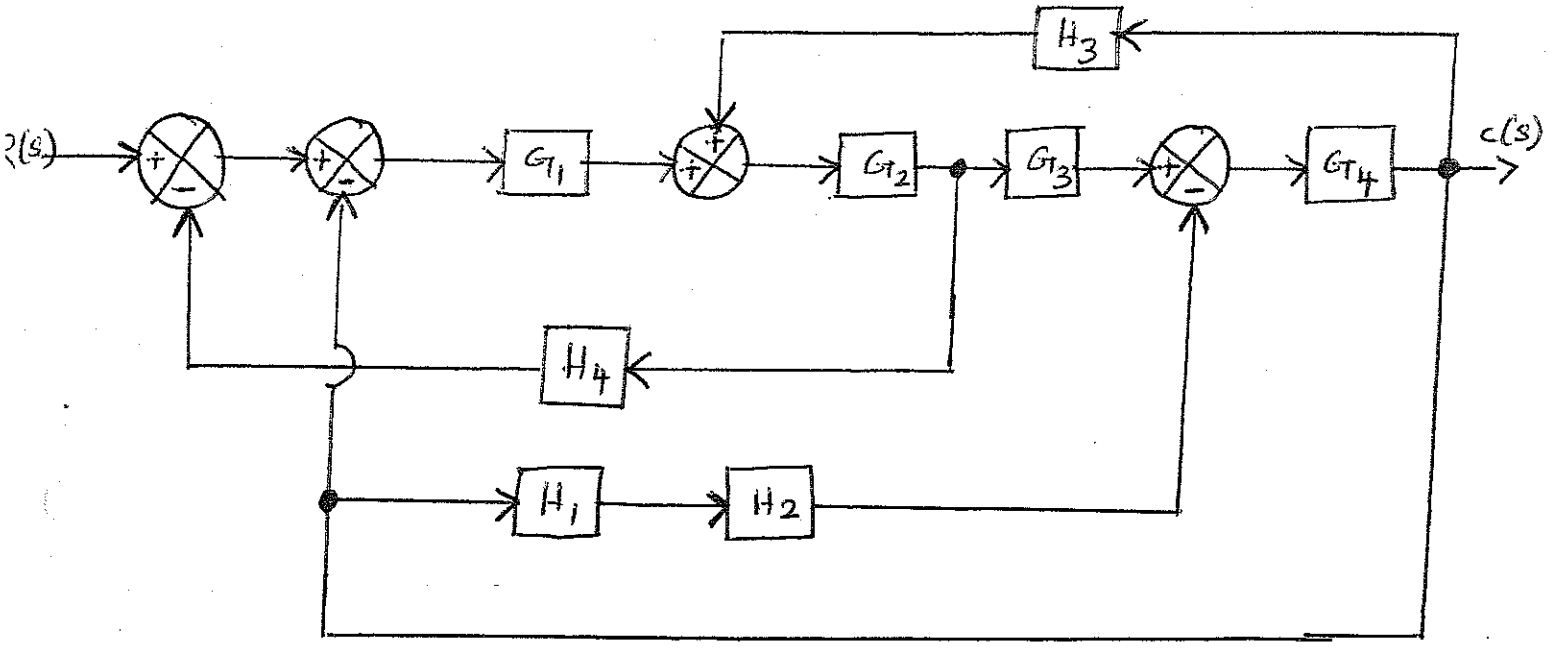

Figure 1

6. Draw the Signal flow graph and using Mason's gain formula evaluate the closed loop transfer function of a system whose block diagram is shown in Figure 2. [15M]

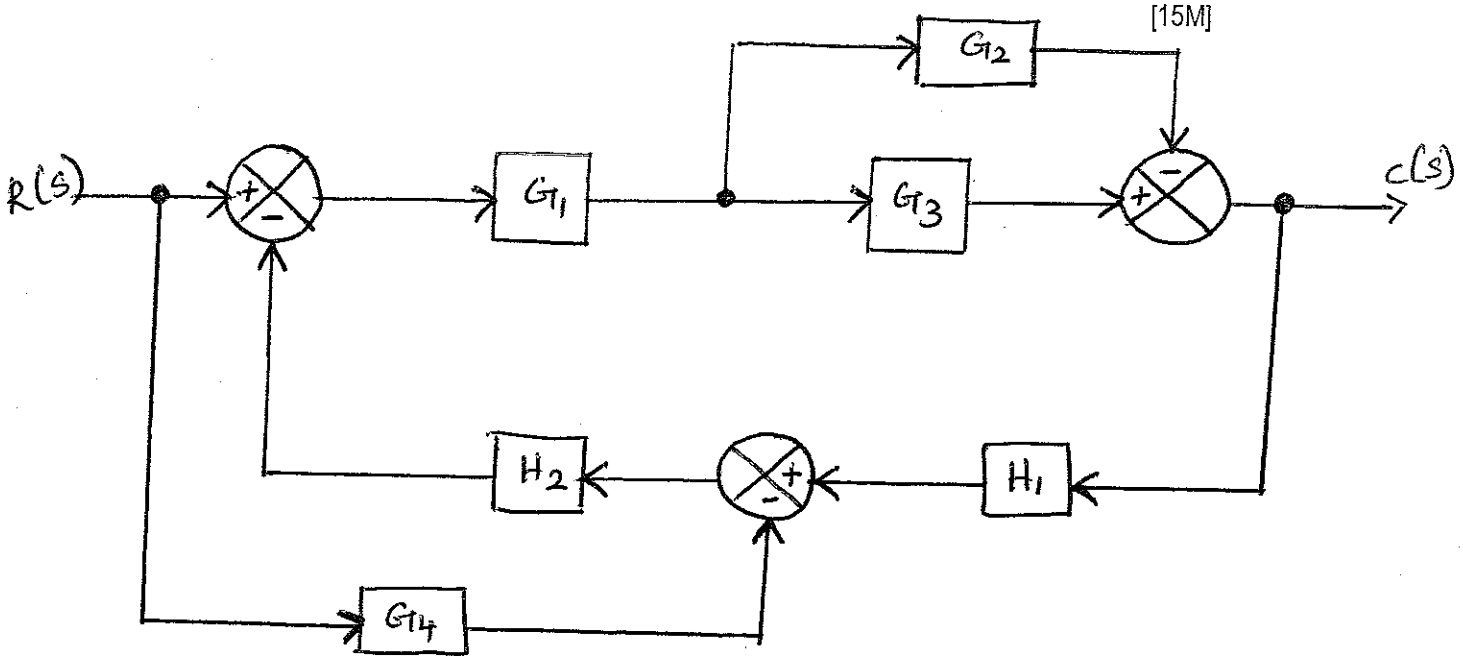

Figure 2

PART C

7. Write the Force balance equations for the linear translational system shown in Figure 3. And also find transfer function $\frac{Y_1(s)}{F(s)}$ and $\frac{Y_2(s)}{F(s)}$ [12M]

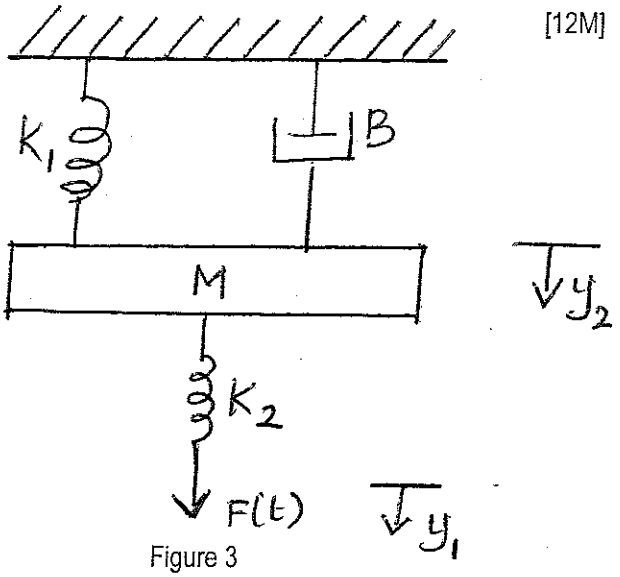

Figure 3

8. The loop transfer function of a single loop feedback control system is given as

$$G(s)H(s) = \frac{K(s+5)}{s(s+2)(1+Ts)}$$

Use Routh's stability criterion and state the conditions for stability.

Represent the parameters K and T in a plane with K as the vertical axis and T as the horizontal axis. Determine the regions in the T-versus-K parameter plane where the closed loop system is asymptotically stable and where it is unstable. Indicate the boundary on which the system is marginally stable.

[15M]

9. A closed loop transfer function is described as

$$\frac{C(s)}{R(s)} = \frac{5}{(s+2+j1)(s+2-j1)}$$

Determine the following, assuming a standard second order system:

i) damped frequency of oscillation ω_d
ii) peak time t_p
iii) rise time t_r
iv) settling time t_s for 2% tolerance band
v) percentage peak overshoot M_p [13M]

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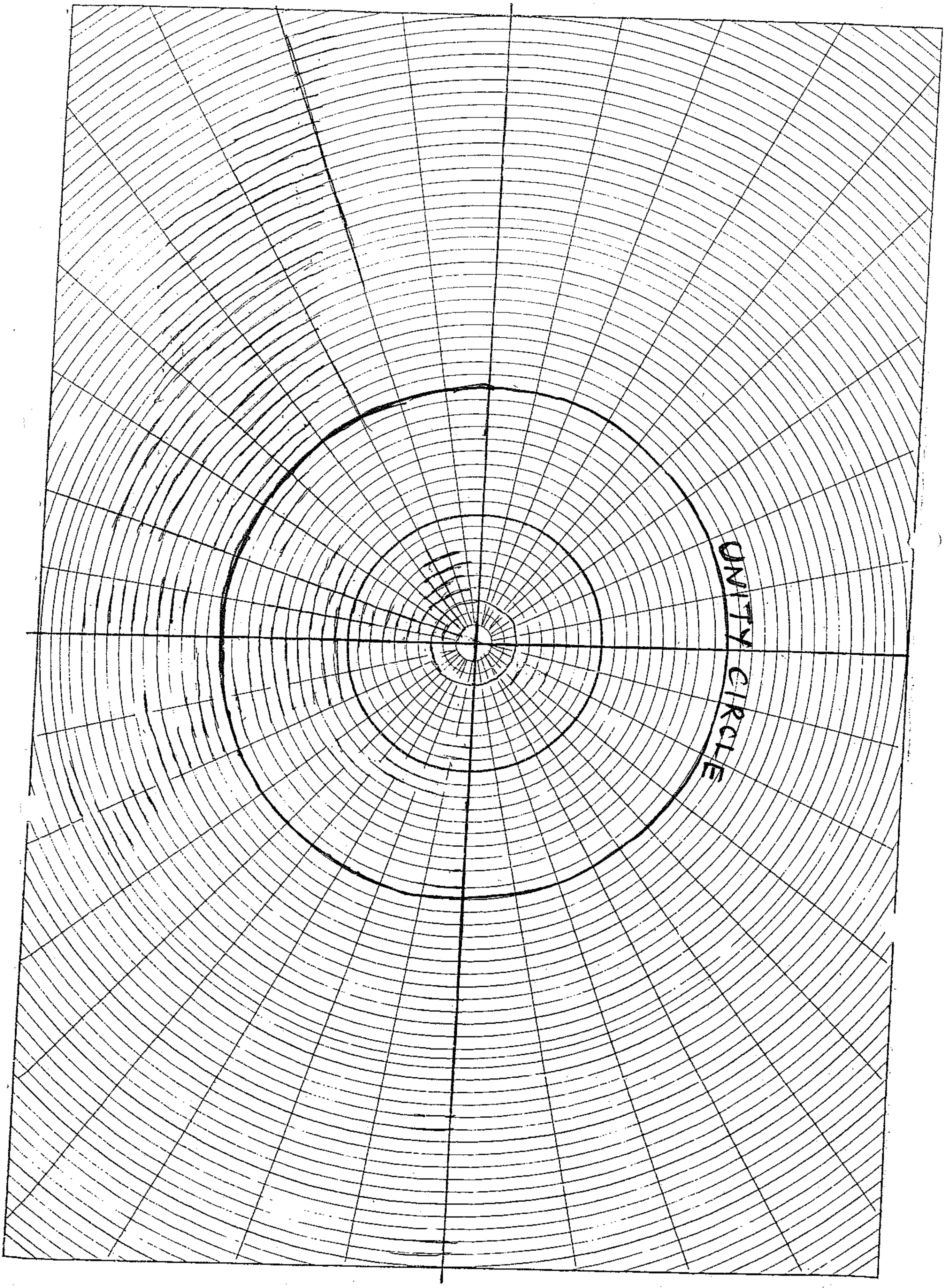
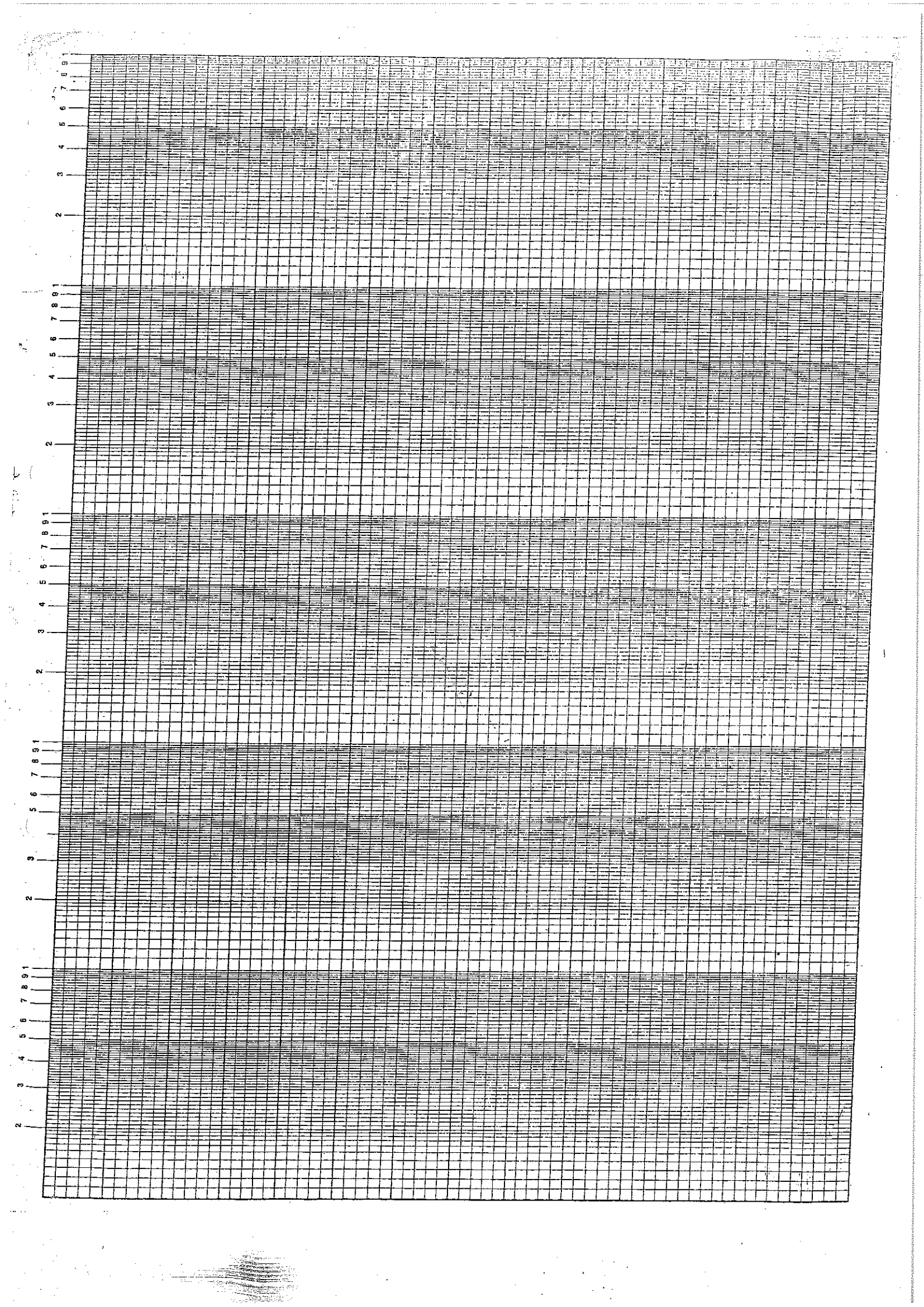

UNITY CIRCLE



BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
TEST II (Open Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 20.11.2011 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. Text book and hand written class notes are allowed.
4. Total No of Pages 2.

1. Using block diagram reduction techniques, find the closed loop transfer function for the block diagram shown in Figure 1. [20M]

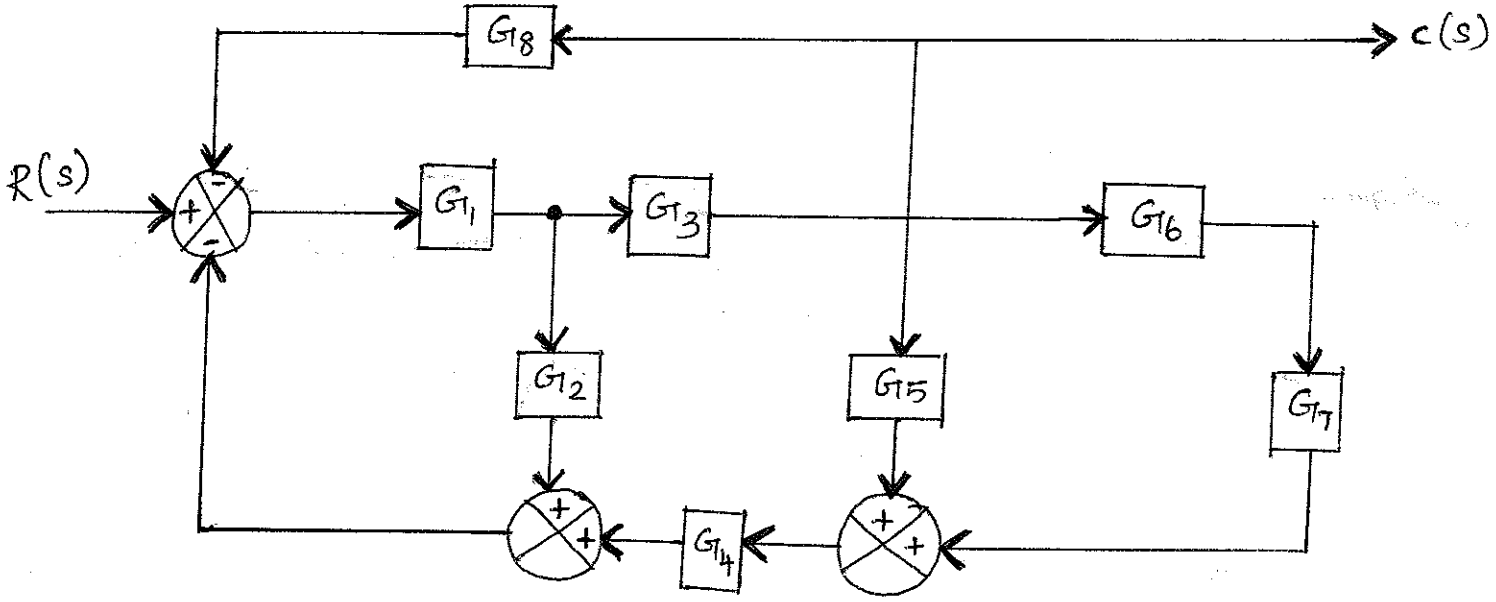


FIGURE 1

2. A unity feedback control system is characterised by the following open loop transfer function

$$G(s) = \frac{(0.4s+1)}{s(s+0.6)}$$

(2A) Determine its transient response for unit step input.
(2B) Evaluate the maximum overshoot and the corresponding peak time.
(2C) Sketch the response. [14+4+2M]

3. The block diagram of a feedback control system is shown in Fig.2.

(3A) Draw an equivalent Signal Flow Graph (SFG) of the system. [5 M]
(3B) Find the following transfer function by applying the gain formula to the SFG. [12M]

$$\frac{Y(s)}{R(s)} \; with \; N(s) = 0$$

(3C) Write the expression for the output Y(s) when R(s) and N(s) are applied simultaneously. [3M]

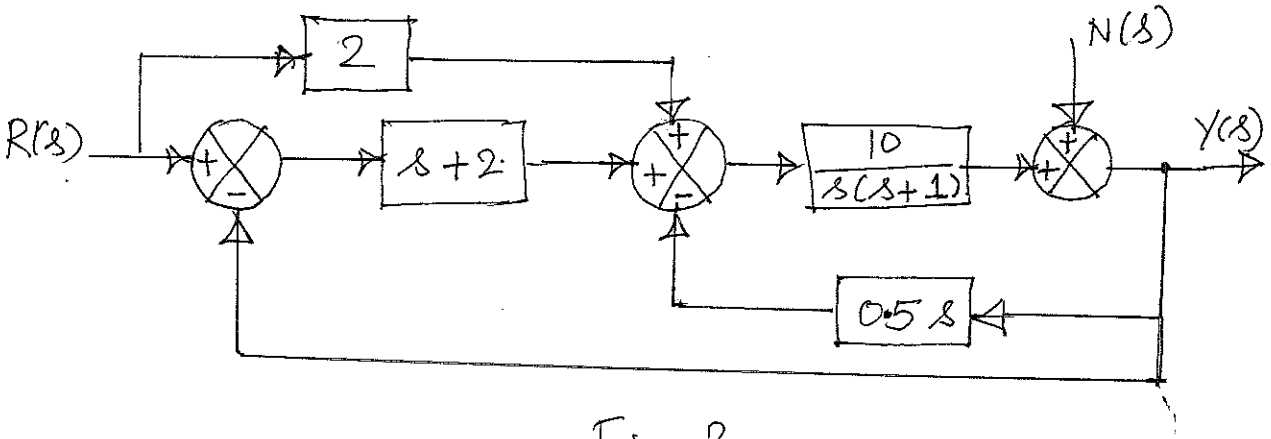


Fig. 2

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
TEST I (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 02.10.2011 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.

1. Write the differential equations governing the mechanical rotational system shown in Fig1 and determine the transfer function θ(s)/ T(s). [25 M]

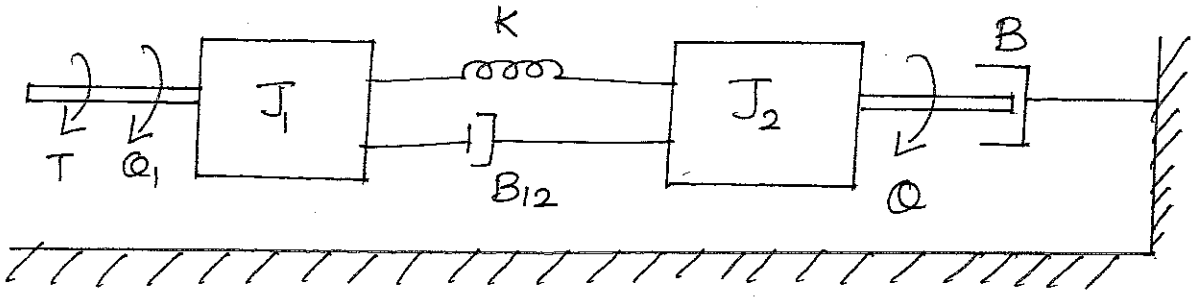

FIG 1. MECHANICAL ROTATIONAL SYSTEM

2. Derive the transfer function of the field controlled DC motor in terms of motor constants for Fig 2. [25 M].

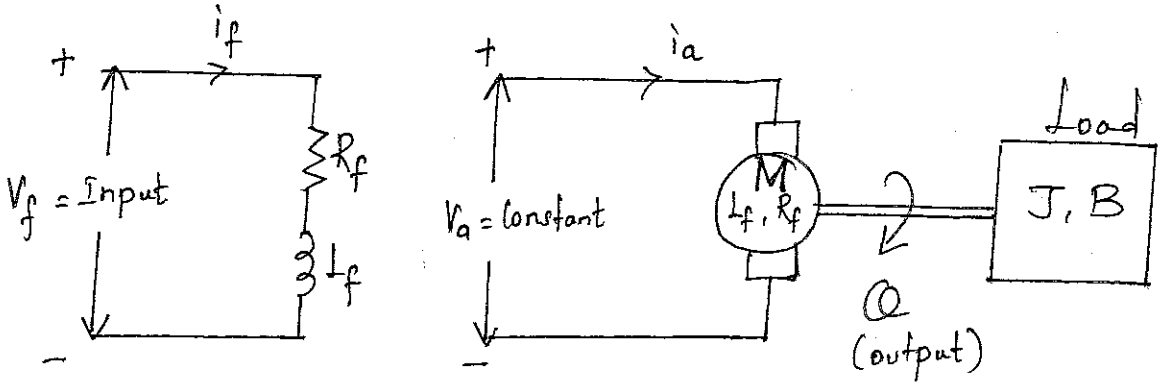

FIG 2. FIELD CONTROLLED DC MOTOR

PTO

3. A gear train consisting of two gears is used to drive a load. One gear-1 consists of 20 teeth and the gear - 2 has 10 teeth.

(a) What is the ratio of the diameters of the gear?

(b) If gear- 1 is rotated by an angle of 40^{o}, then what will be the angular displacement of gear -2 ?

(c) If the angular speed of gear- 1 is 30 rad/sec then what is the value of angular speed of gear- 2 ?

(d) If the angular acceleration of gear -2 is 4 rad/ sec^{2} then find the angular acceleration of gear- 1.

(e) If the torque acting on gear- 1 is 5 N-m then find the torque on gear- 2.

(f) Write the equation for equivalent moment of inertia referred to motor shaft (shaft 1) [25 M]

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VERSION A

Name: ID No:

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
QUIZ 1 (Closed Book) quiz-2
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 19.10.2011 Time: 20 Minutes M.M = 24 (8%)

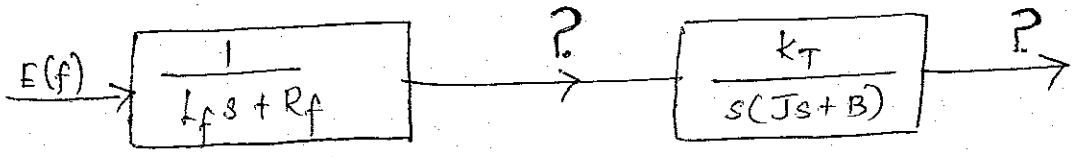
NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Total No of Pages.3

1. Inertia and friction parameters are referred from one shaft of the gear train to the other in the direct ratio of..... [1M]

2. Define coulomb friction force. [1M]

3. What is the status of the gain by the use of negative feedback? [1M]

4. In the following block diagram of the field controlled DC motor, identify the missing quantities. [2M]



5. Write the analogous quantities for displacement and velocity in force- voltage analogy. [2M]

6. Write the force balance equation of ideal dashpot. [1 M]

7. Draw the standard parabolic signal and represent in time domain equations. [2M]

8. Integral of Ramp signal is _____ signal. [1M]

9. Draw the unit impulse signal response and represent in time domain equations. [2M]

10. For large values of GH, the sensitivity of feedback control system with respect to sensor H is _____ and so it is important to use _____elements which do not vary with environmental changes. [2M]

11. Label the components of the basic control loop shown in Fig 1. [2M]

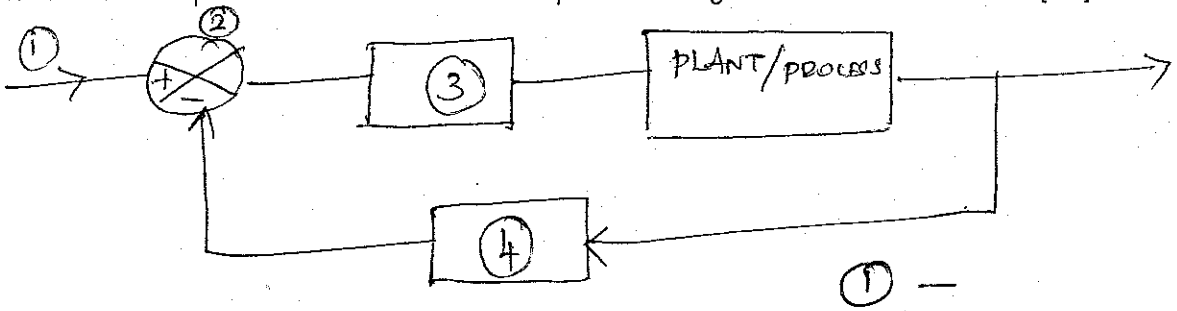


Fig 1

1 —
2 —
3 —
4 —

12. Apply the gain formula to the SFG shown in Fig.2 and find the transfer function. [4M]

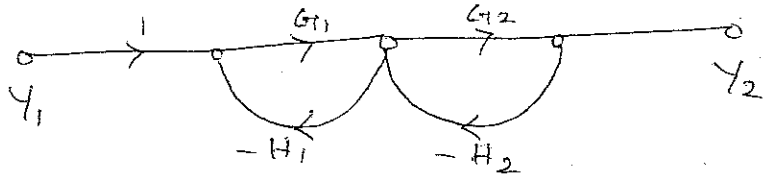
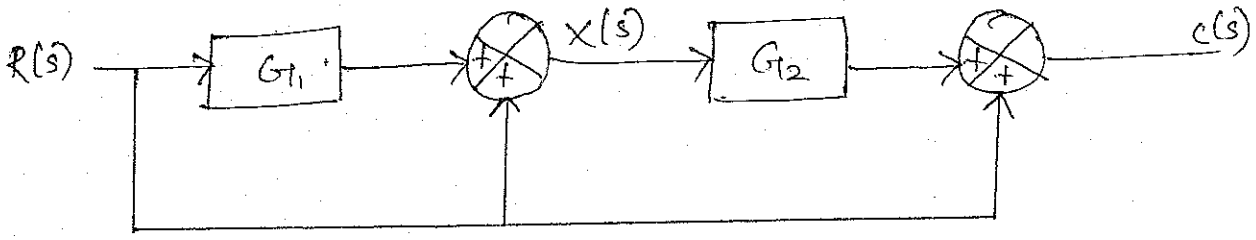


Fig 2

$\frac{Y2}{Y1}$ =

13. The overall transfer function C(s)/ R(s) of the following block diagram will be.....[3M]



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VERSION A

Name: ID No:

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
QUIZ I (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 15.12.2011 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.2, No of Questions. 6

1. The characteristics equation of the feedback control system is $s^3+3ks^2+(k+2)s+4 = 0$. Find the following;

(A). The value of K for which the system is stable.....

(B). The frequency of sustained oscillation is ..... [4+ 3 M]

2. For a transfer function G(s)H(s) = $\frac{K(s+8)}{s(s+5)(s+6)}$, find the following ;

A) The number of root locus branch (es) that will terminate at infinite zeroes is/are_____.

B) The angle(s) of asymptotes is/are_____

C) The asymptotes intersect (centroid) at _____

D) The characteristic equation is _____s^3+_____s^2+_____s+_____= 0

[1+2+2+2M]

3. For the following transfer function of the system, the type is ..... and the order is .....

$$G(s)\,H(s) = \frac{K}{s^3(s^2+2s+1)}$$ [2M]

4. The steady state error for a type 1 system, with unit ramp input signal is ..... [1M]

5. A Unity feedback system has an open loop transfer function of $G(s) = \frac{20(s+5)}{s^2(s+0.1)(s+3)}$

The steady state error for unit parabolic input is..... [2M]

6. The open loop transfer function of a servo mechanism with unity feedback is

$G(s) = \frac{10}{s(0.1s+1)}$. The position error constant is ..... [2M]

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VERSION B

Name: ID No:

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
QUIZ I (Closed Book)
BE (Hons) III year

Course No : AAOC C321
Course Title : CONTROL SYSTEMS
Date : 15.12.2011 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.2, No of Questions. 6

1. For a transfer function $G(s)H(s) = \frac{K(s+8)}{s(s+5)(s+6)}$, find the following:

A) The number of root locus branch (es) that will terminate at infinite zeroes is/are_____.

B) The angle(s) of asymptotes is/are_____

C) The asymptotes intersect (centroid) at _____

D) The characteristic equation is _____s^3+_____s^2+_____s+_____= 0

[1+2+2+2M]

2. For the following transfer function of a system, the type is ..... and the order is .....

$$G(s)\,H(s) = \frac{K}{s^3(s^2+2s+1)}$$

[2M]

3. The steady state error for a type 1 system with unit ramp input signal is ..... [1M]

4. A Unity feedback system has an open loop transfer function of $G(s) = \frac{20(s+5)}{s^2(s+0.1)(s+3)}$

The steady state error for unit parabolic input is ..... [2M]

5. The open loop transfer function of a servo mechanism with unity feedback is

$G(s) = \frac{10}{s(0.1s+1)}$. The position error constant is ..... [2M]

6. The characteristics equation of the feedback control system is $s^3+3ks^2+(k+2)s+4 = 0$, find the following.

(A). The value of K for which the system is stable.....

(B). The frequency of sustained oscillation is ..... [4+ 3 M]

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