BITS, PILANI – DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2010 – 2011
AAOC C321 CONTROL SYSTEMS
COMPREHENSIVE EXAMINATION

MAXIMUM MARKS: 120 WEIGHTAGE: 20%
DATE: 23-12-2010 DURATION: 3 hours

Note:
1. Answer each part (Part A, B & C) in separate answer script.
2. Write the ID No. on all the graph sheets

PART A

1. The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{K(s+2)}{s^2(s^2+2s+2)(s+3)}$. By applying Routh criterion, discuss the stability of the closed loop system as a function of K. [15M]

2. Plot the open loop response on the **polar chart** for a system with unity feedback and an open loop transfer function $G(s) = \frac{20}{(s^2+2s+10)(s+1)}$.

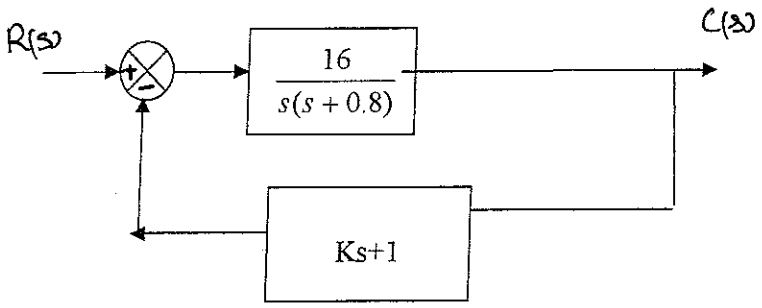
Determine the following:
(i) The phase margin.
(ii) The gain margin in db.
(iii) The gain crossover frequency.
(iv) The phase crossover frequency.
(v) What can you assess about the stability of the system?

Your plot should include the corresponding values for $\omega=0$ and $\omega=\infty$ as well. [15M]

PART –B

3. A positional control system with velocity feedback is shown in figure. What is the response C(t) to the unit step input. The response C(t) should be shown in the standard form (θ should be expressed in radians). Given that $\xi = 0.5$, Calculate rise time, peak time, maximum overshoot and settling times for 5% & 2%.

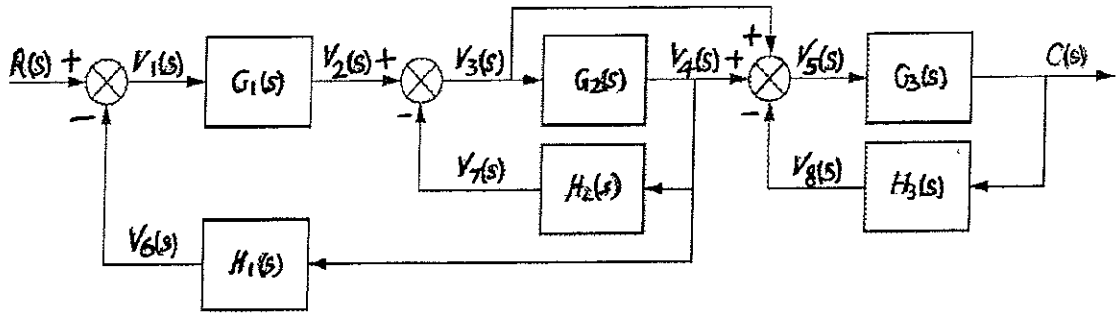
[15 M]



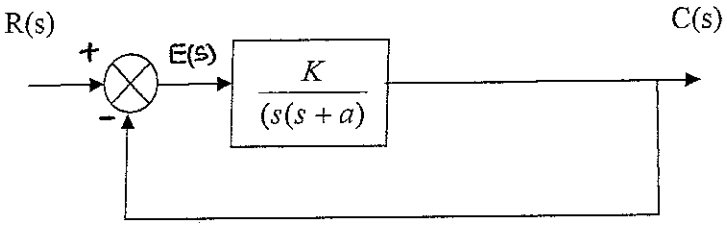
4. Sketch the root locus (**only in the graph sheet provided**) for the unity feedback system whose open loop transfer function is G(S) = K (s+1.5) / s (s+1) (s+ 5) [15M]

PART -C

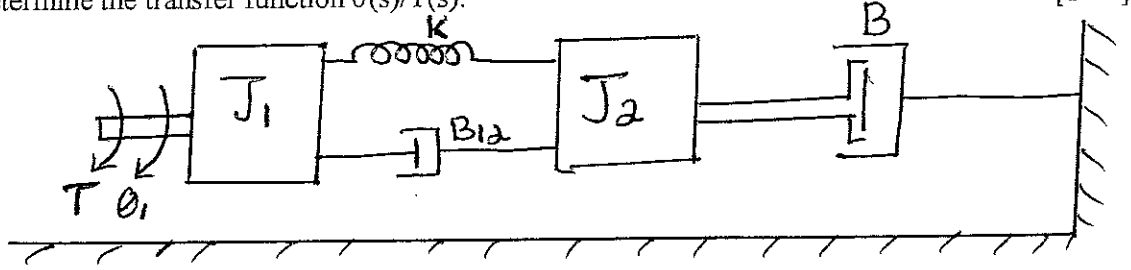
5. Obtain the overall transfer function C/R [15M]



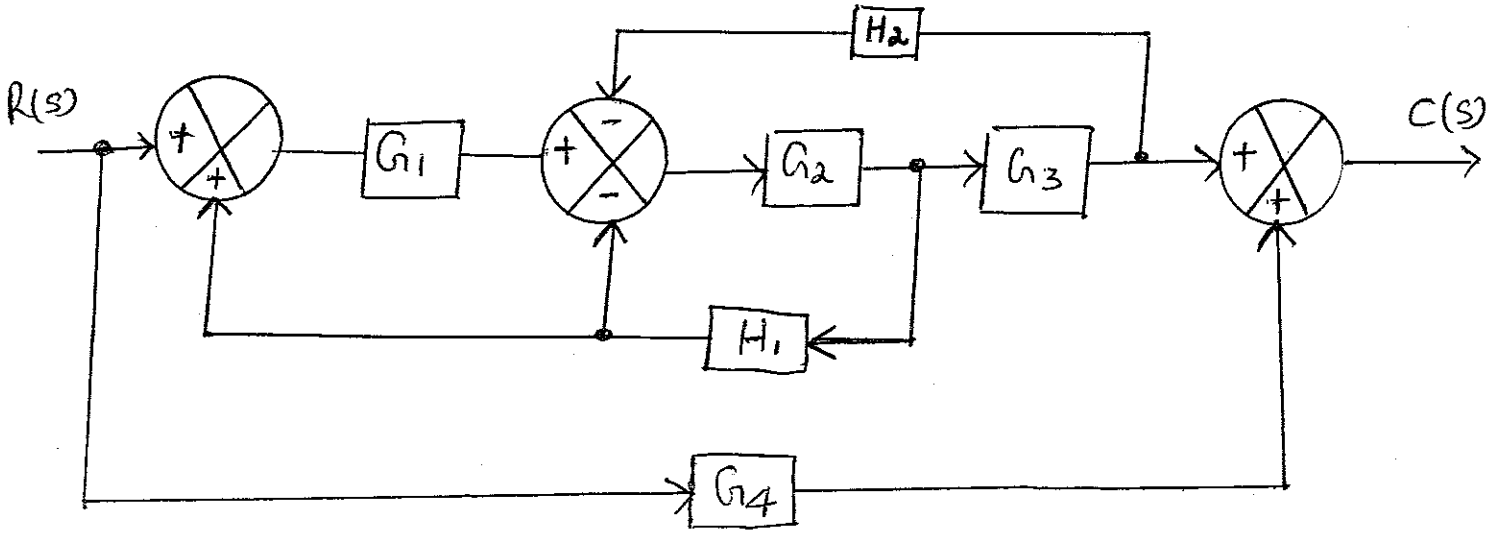
6. Find the Sensitivity of the closed loop Transfer Function to changes in parameter ''a''. How would you reduce the sensitivity? Also find the sensitivity of the steady state error to changes in parameter "K" and Parameter "a" with ramp input. [15M]



7. Write the differential equations governing the mechanical rotational system shown below and determine the transfer function θ(s)/T(s). [15M]



8. Using Masons Gain Formula find the transfer function of the following system. [15M]



BITS, PILANI – DUBAI
FIRST SEMESTER 2010 – 2011
AAOC C321 CONTROL SYSTEMS
Test -II (OPEN BOOK)

MAXIMUM MARKS: 20 WEIGHTAGE: 20%
DATE: 11-11-2010 DURATION: 50 minutes

Answer all Questions

1. The system (Figure 1) shown below is subjected to the following inputs.
   1. 5 u(t),
   2. 5 t u(t) and
   3. 5 t^2 u(t) .

   Find the steady-state errors of the system where u(t) is a step input. (6M)

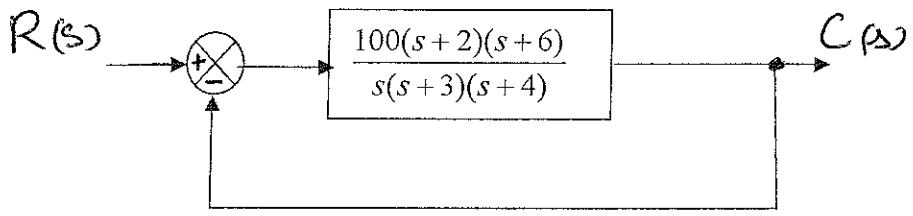


Figure 1

2. A closed loop system has two complex conjugate poles at S_1, $S_2 = -2 \pm j1$. Determine the form of transfer function and find the values of Natural frequency (ω_n), Peak time(Tp), Rise time (Tr) , Settling time for 2% tolerance (Ts) and Peak overshoot (Mp) assuming standard second order system. (7 M)

3. For the following figure (figure-2),find Y/U using Mason's gain formula with value of R=1 ohm, L=1 H and C=1F

(7 M)

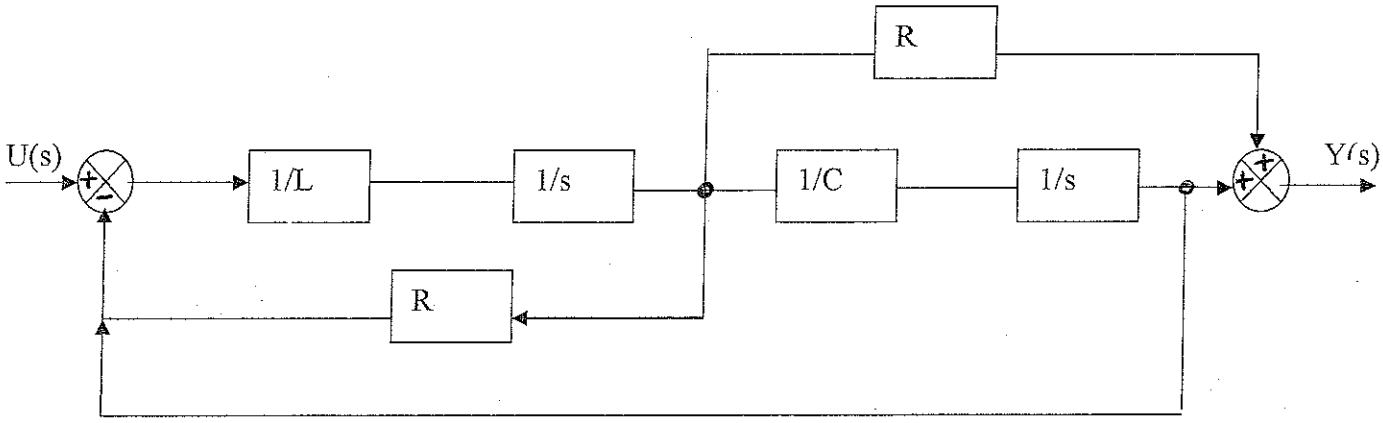
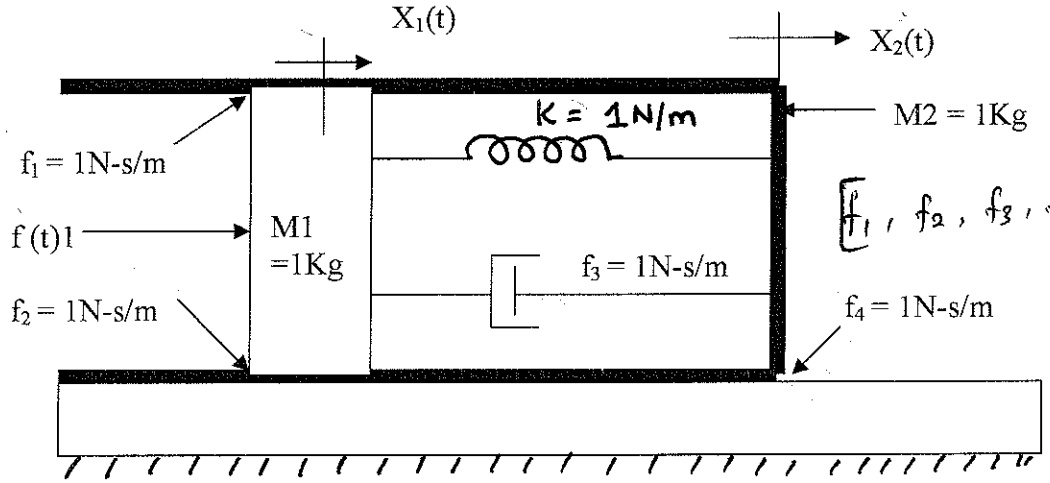


Figure 2

BITS, PILANI – DUBAI
FIRST SEMESTER 2010 – 2011
AAOC C321 CONTROL SYSTEM
Test 1 (CLOSED BOOK)

MAXIMUM MARKS: 25 WEIGHTAGE: 25%
DATE: 3-10-2010 DURATION: 50 minutes

1. Find the overall transfer function, X2(s)/F(s) for the mechanical translational system shown in figure 1. Mass 2 is shown in Bold line. [6M]



[f1, f2, f3, f4 – Viscous friction Coefficients]

Fig: 1

2. Derive the torque equation referred to load shaft of a gear train. Mention all the parameters/ symbols and their corresponding descriptions clearly. [6M]

3. For the figure 2, derive the transfer function of the armature controlled DC motor in terms of the motor constants. [6M]

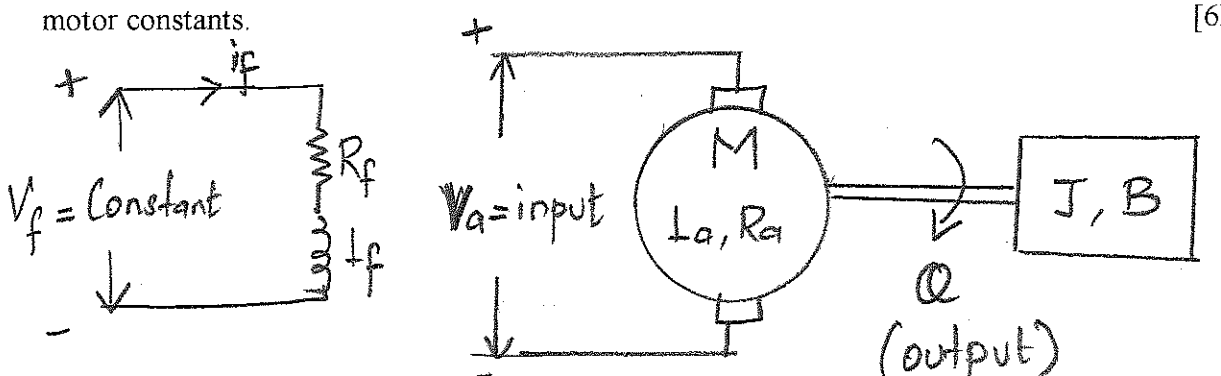


Fig - 2.

4. Find C(s)/ R(s) for the system shown in figure 3. [7M]

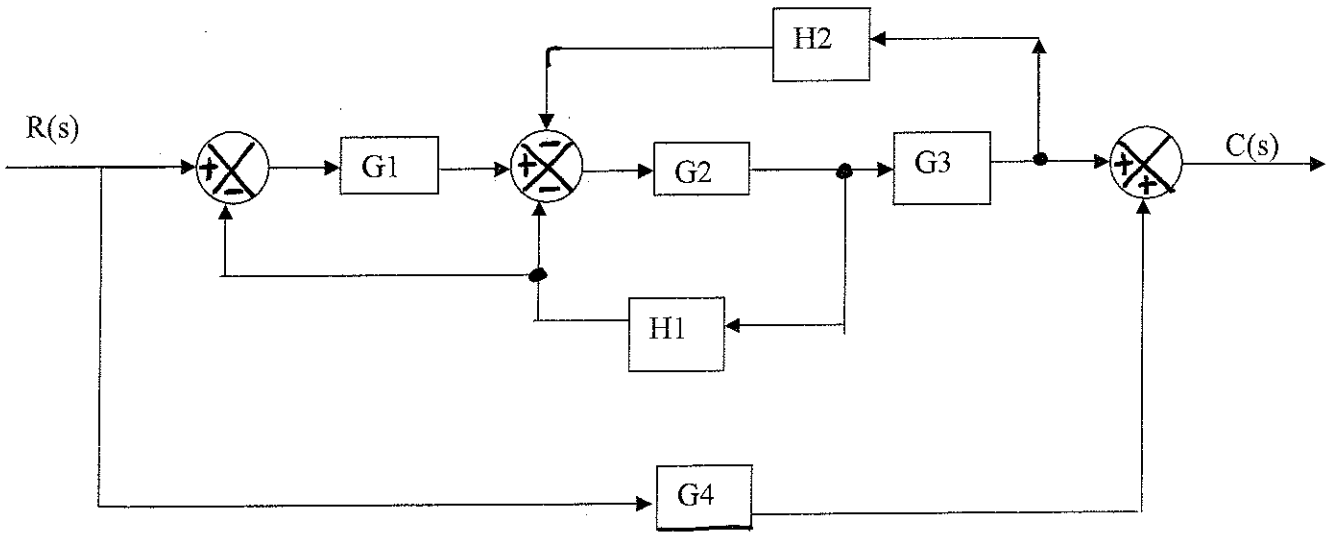


Fig: 3

BITS, PILANI – DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2010 – 2011
AAOC C321 CONTROL SYSTEM
Quiz -II (CLOSED BOOK)

MAXIMUM MARKS: 21 **WEIGHTAGE: 7%**
DATE: 8-12-2010 **DURATION: 20 minutes**

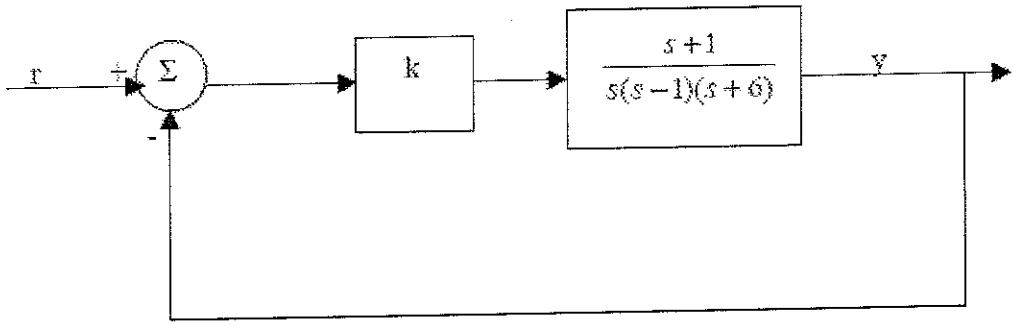
Attention: Transfer the answers to the box shown below.
Overwritten/Rewritten answers will not be evaluated
No step marks
Steps to the final answers has to be shown

1. For a unity feedback control system with

$G(s) = \dfrac{K}{s(s+2)(s+6)}$. The root locus plot has break away point at s=_____. The intersection of root locus with imaginary axis occurs at s= _____ for a K value of _____.

2. Determine the stability and the roots on the imaginary axis of the following polynomial
a(s)= $S^5+5S^4+11S^3+23S^2+28S+12$ [7 marks]

3. Consider the system shown below. The stability properties of the system are a function of the proportional feedback gain "k". Determine the range of "k" over which the system is marginally stable. [7 Marks]



1. Answer
Breakaway points
_____
Point of intersection.
s= k=

2. Answer
Comment on Stability
_____
_____
Roots on Imaginary axis
_____

3. Answer
Range of "k"
_____

A

BITS, PILANI – DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2010 – 2011
AAOC C321 CONTROL SYSTEM
Quiz -I (CLOSED BOOK)

MAXIMUM MARKS: 24 WEIGHTAGE: 8%
DATE: 27-10-2010 DURATION: 20 minutes

Attention: Transfer the best answers (a,b,c,d) to the box shown against.
Overwritten answers will not be evaluated

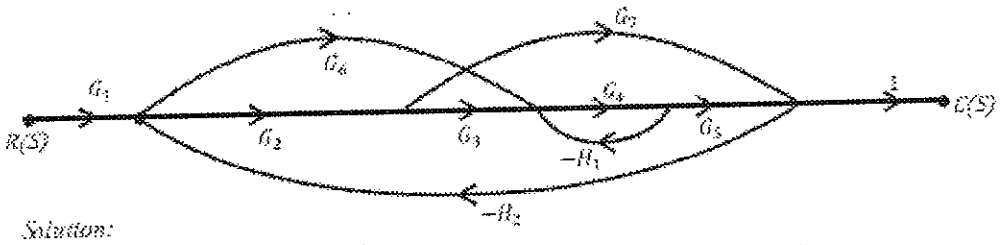
1. $S_G^T + S_H^T$ for a closed loop system will be [2M] | 1.

a) $(1-(GH)^2) / (1+GH)^2$ b) $2/(1+GH)$ c) $1/(1+GH)^2$ d) $H/(1+GH)$

2. The sensitivity of the open loop system is [2M] | 2.

a) One b) Zero c) Infinite d) $\pi/2$

3. The number of individual loops in the following graph [2M] | 3.



Solution:

a) Three b) two c) four d) five

4. The loop gain of a regenerative feedback loop with Forward path gain as "G" and feedback path gain as "H" is [2M] | 4.

a) G H b)-GH c) G/(1-GH) d) G/(1+GH)

5. In a series RLC circuit, the transfer function of the output voltage across the capacitor in terms of supply voltage is [2M] | 5.

a) sC / R+sL b) sC/ s^2+sR+1
c) $sC/ s^2+sR+1/LC$ d)$1/ s^2 LC+sRC+1$

6. The superposition principle is applicable to [2M] | 6.

a) non linear systems b) linear and non linear systems
c) non linear discrete systems d) linear systems

7. In gear train, the ratio of θ_1/ θ_2 is equal to [2M] | 7.

a) N_1/N_2 b) N_2/N_1
c) 1 d) $[N_1/N_2]^2$

8. Transfer function of a system is the ratio of Laplace transform of the output to the Laplace transform of input at ---------- [2M]

8.

a) Internal state conditions b) Final state conditions
c) Zero initial conditions d) External state conditions

9. The differential equation corresponding to the Transfer function [4M]

9.

$$G(s)=\frac{2s+1}{s^2+6s+2} \text{ is } \_\_\_\_\_$$

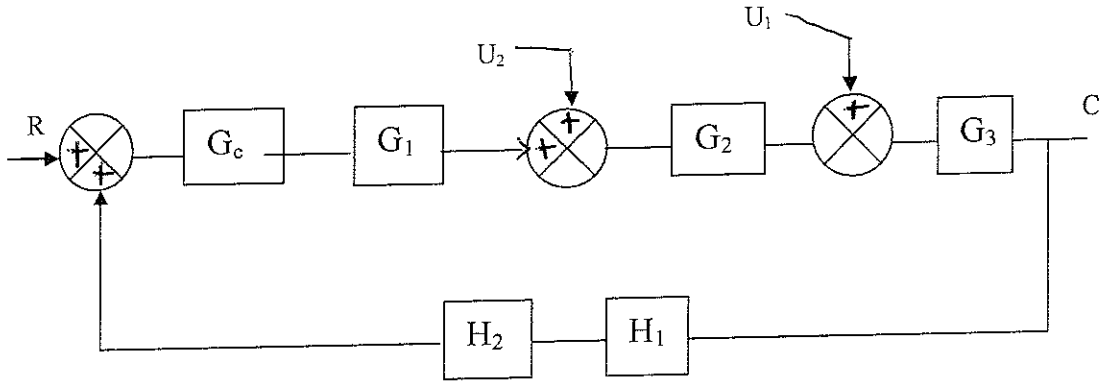
a) $\frac{d^2c}{dt^2}+6\frac{dc}{dt}+2c=2\frac{dr}{dt}+r$

b) $6\frac{d^2c}{dt^2}+\frac{dc}{dt}+c=2\frac{dr}{dt}+2r$

c) $6\frac{d^2c}{dt^2}+\frac{dc}{dt}+6c=\frac{dr}{dt}+2r$

10. The C/U_1 for the block diagram below with $U_2=0$ is ____ [4M]

10.



a) $\frac{G_3G_2}{1-H_2H_1G_3G_2G_1}$

b) $\frac{G_3G_2}{1+H_2H_1G_3G_2G_1}$

c) $\frac{G_3G_2}{1+H_2H_1G_cG_3G_2G_1}$

d) $\frac{G_3G_2}{1-H_2H_1G_cG_3G_2G_1}$