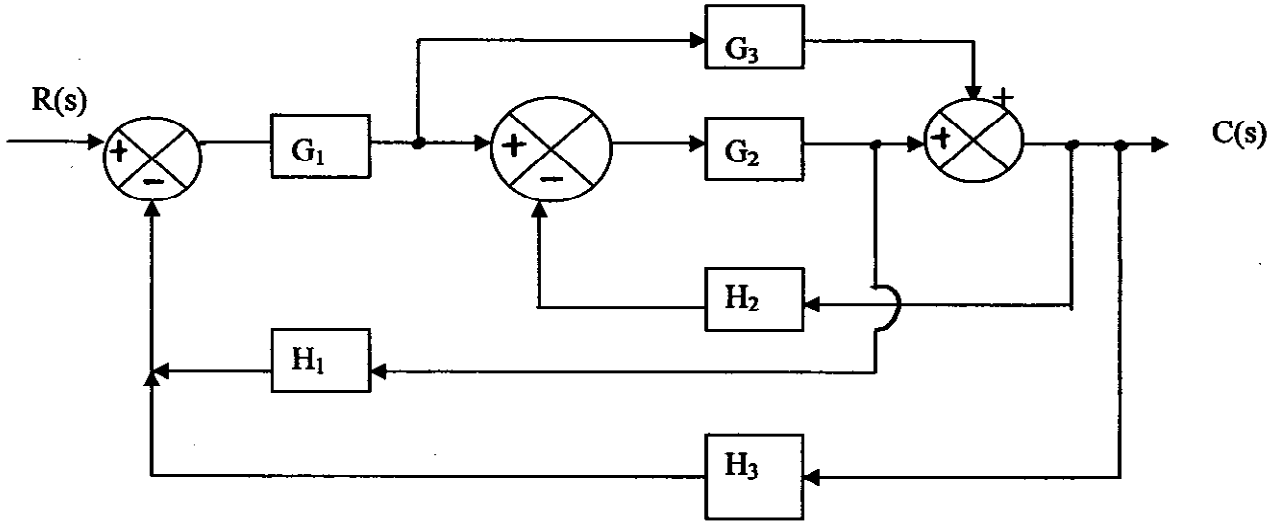
BITS, PILANI-DUBAI
DUBAI INTERNATIONAL CITY
YEAR-III (EEE, EIE, CS, MECH. & CHEM),
SEMESTER I-2007-2008
COMPREHENSIVE EXAMINATION

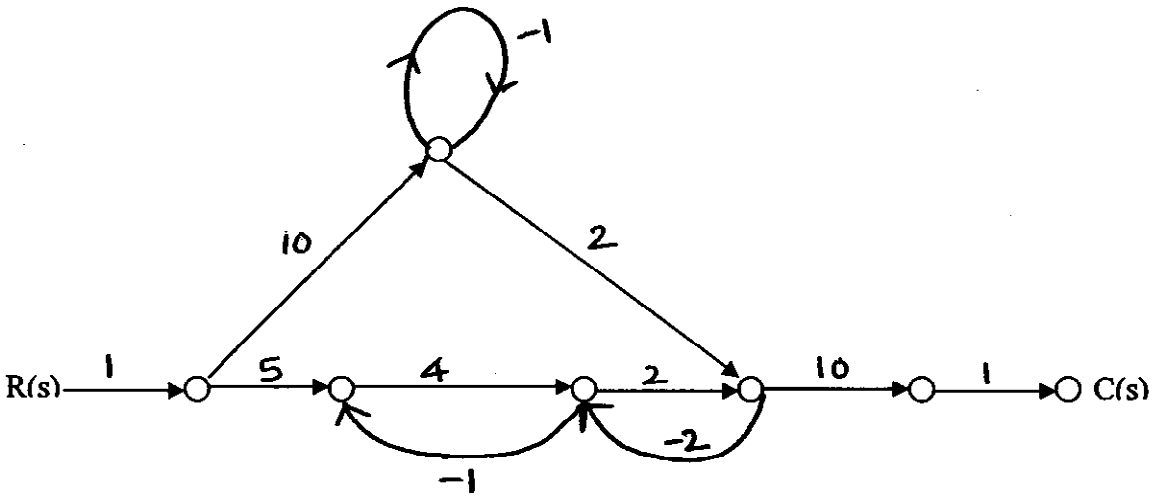
Date: 9-01-2008 Course Number: AAOC UC 321 Course Title: Control Systems
Time: 3 hours Maximum Marks: 80 Weightage : 40%

Part A

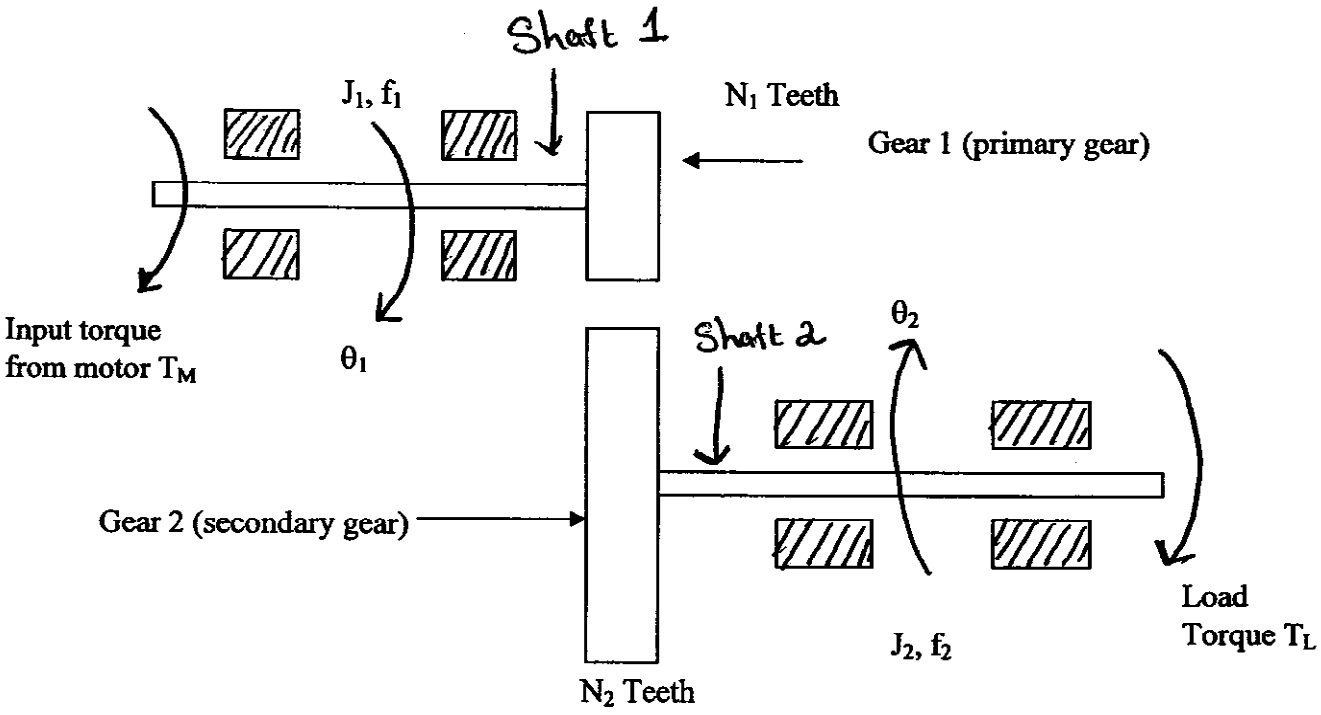
1. Reduce the block diagram and obtain C(s) / R(s) **[8]**



2. Using Masons gain formula, find C(s) / R(s) **[7]**



3. Derive the torque equation of the system shown, referred to Shaft 1 and hence derive the torque equation referred to shaft 2. [10]

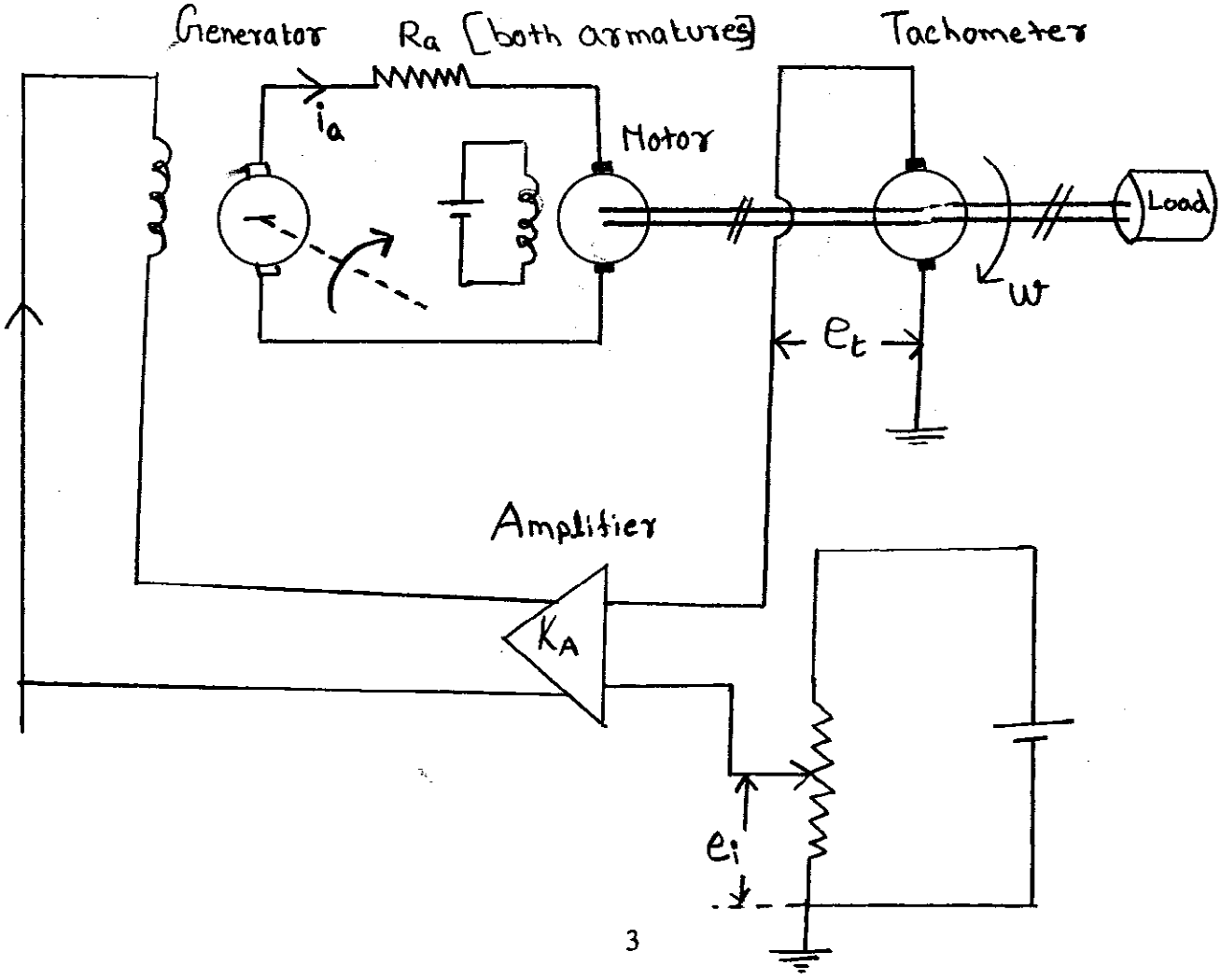


PART B

4. With reference to the following figure of the speed control system of a DC motor, the generator field time constant is negligible. The generator is driven at a constant speed giving a generated voltage of "Kg" Volts / field –amp. The DC motor is separately excited and it maintains a back emf of "K_b" volts per radian/sec. It produces a torque of "K_T" Newton-metre / amp. The combined moment of inertia of motor and load is "J" Kg-m^2 . The friction is negligible. The tachometer has a gain of "K_t" volts per radian/sec and the amplifier gain is "K_A" amperes/ volt. Find out the transfer function $\Omega(s)$ / Ei(s) where $\Omega(s)$ is the Laplace transform of speed ω (t) and Ei(s) is the Laplace transform of $e_i(t)$. Assume negligible load torque ($T_L = 0$).

With the system orginally at rest, a control voltage, e_i = 100 V is suddenly applied. Determine how the load speed (ω (t))will change with time and hence find the steady state speed (in radians per sec.) .

The given data :
J= 6 Kg-m^2, K_A= 4.0 amperes/ volt , K_T = 1.5 Newton-metre / amp, Kg = 50 Volts / field –amp. Ra =1.0 ohm, K_t =0.2 volts per radian/sec, K_b = K_T in M.K.S Units [10]



5. Sketch the Root locus for $G(s)H(s) = K/ ((s+4)(s^2+4s+25))$. Calculate the angle of asymptotes, coordinates of centroid, angle of departure at poles and points of intersection of the root locus with the imaginary axis. (sketch on graph sheet) [10]

6. After deriving the necessary steps in detail, sketch the polar plot for

$$G(S)= \frac{1}{(s\,(1+sT_1)(1+sT_2)}$$

Also determine the point of intersection of the plot with the real axis. [10]

PART C

7. For a closed loop negative feedback control system with unity feedback,

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

Derive the expression for the response c(t) due to r(t)= t . Hence calculate the steady state response. [10]

8. The negative feedback control system has the forward path transfer function as

$G(s) = 10/ s(s+1)$ While the feedback path transfer function $H(s) = 5$. Determine the sensitivity of Transfer function with respect to G and H at $\omega = 2$ rad/sec. [5]

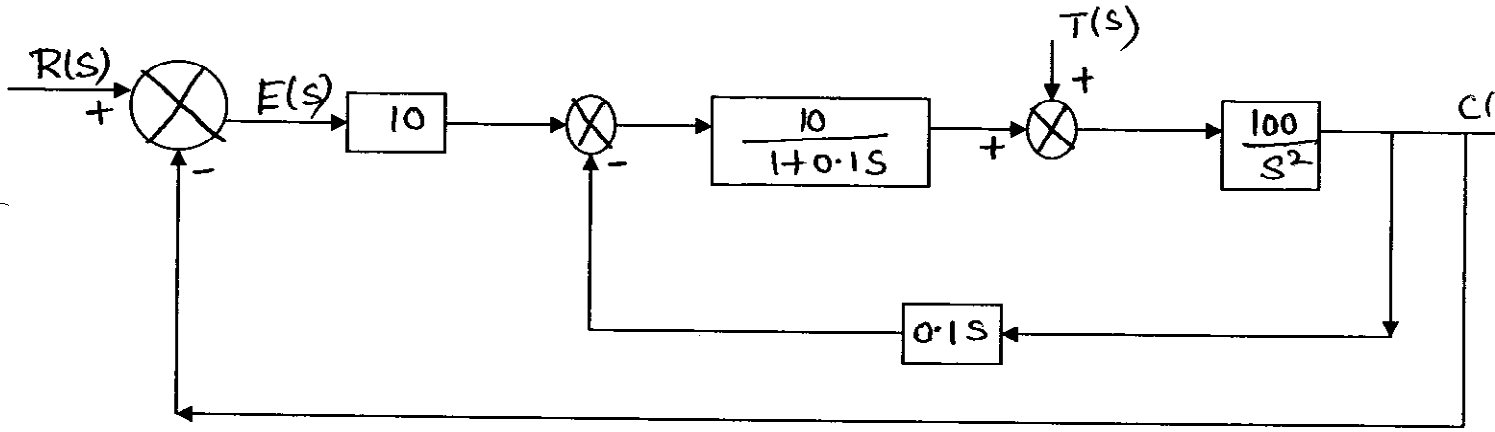
9. By applying Routh stability criterion ,find the range of K for the system to be stable for

$$G(s)H(s) = \frac{K}{s\,(s+5)\,(s^2+5s+20)}$$ [10]

BITS, PILANI- DUBAI
International Academic City,
Test II Open Book
AAOC UC 321
IIIrd Year (EEE,EIE,CS, Mech and Chemical)
1st Semester 2007-2008, 13-12-2007

Duration 50 minutes **Max. Marks: 20**

1. **Find the steady state Error E , if T is unit step input and R=0.** **[8]**



2. **The open loop transfer function of unity feedback system is** $G(s) = \frac{K}{S[1+TS]}$

For this, overshoot reduces from 0.6 to 0.2 due to change in "K" only. Show that $(TK_1 - 1) / (TK_2 - 1) = 43.33$ **where** K_1 **and** K_2 **are values of K for 0.6 and 0.2 overshoot respectively.** **[6]**

3. **For a system with the following characteristic equation, examine stability [6]**

$$F(S) = S^6 + 3S^5 + 4S^4 + 6S^3 + 5S^2 + 3S + 2 = 0$$

BITS,Pilani – DUBAI
III Year (EEE,CS,EIE,MECH,CHEM)
IIIrd Year, 1st Semester, 2007-08

TEST 1

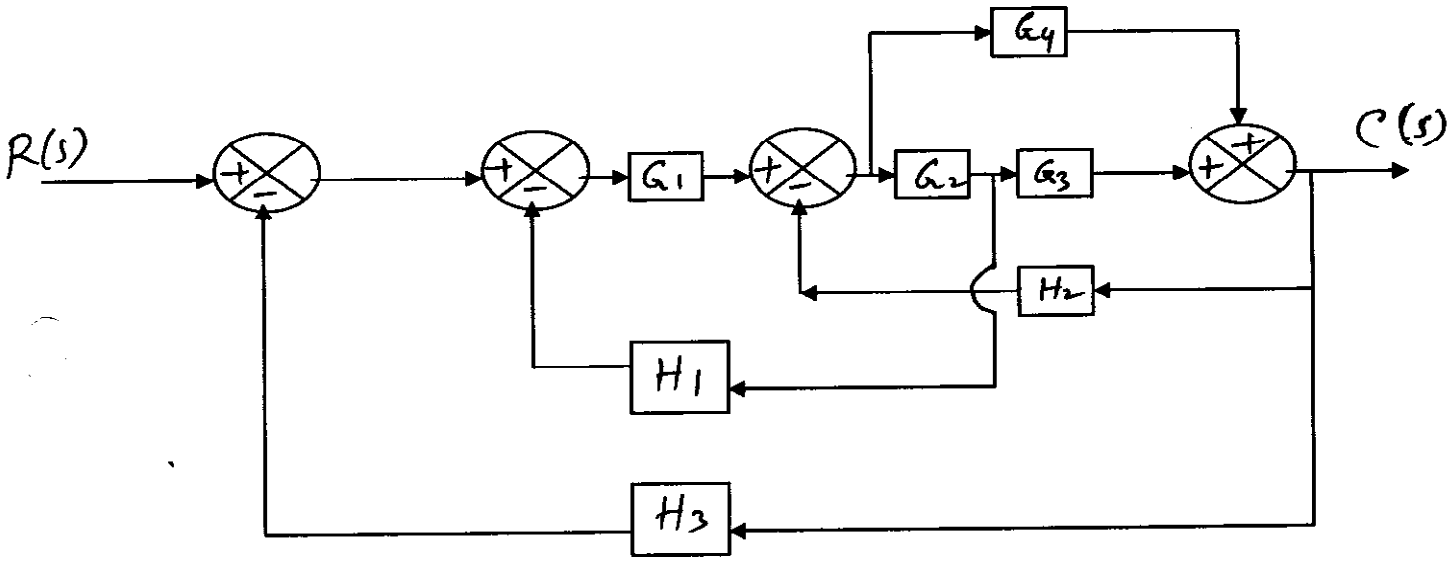
Course No.: AAOC UC321 **Max. Marks: 25**

Course Title: Control Systems **Duration: 50 minutes**

Answer All Questions

1. Derive from the fundamentals the Transfer Function of Armature controlled DC Servo motor.(separately excited) [9]

2. Derive the Transfer Function of the following figure using the Block diagram reduction technique [8]



3. Derive the Transfer Function of the figure of question 2 using Signal Flow Graph and Mason's Gain formula. [8]