$\tilde{K}(1+K_d s)$

Major Test of ME312 : Max Marks 60: Time 2 hours

Instructions: Attempt all questions. All parts of each question must be attempted together.

$K + (K K_d)s$

1(a) Briefly explain the role of proportional, integral and derivative control components in a PID controller. $\omega_n = \sqrt{\frac{K}{I}}$

(b) List the relative merits and demerits of using a hydraulic, pneumatic and electronic controller.

(c) How do gain margin and phase margins determine the stability of a control system? How do you find gain margin and phase margin from Bode plot of system. Explain with a diagram.

(d) In the root locus plots, derive the angle rule and location rule for the asymptotes of the root loci.

(3x4=12)

$\xi = \frac{2 + (K K_d)}{2\sqrt{KI}}$

2. (a) For a second order system with frequency of 100 Hz and damping of 0.2. We intend to use a PD control. Find the proportional and derivative gains such that the natural frequency of the system decreases by 20% while the damping increases by 20%. Show the zeros and poles of the resulting system on complex plane. (6)

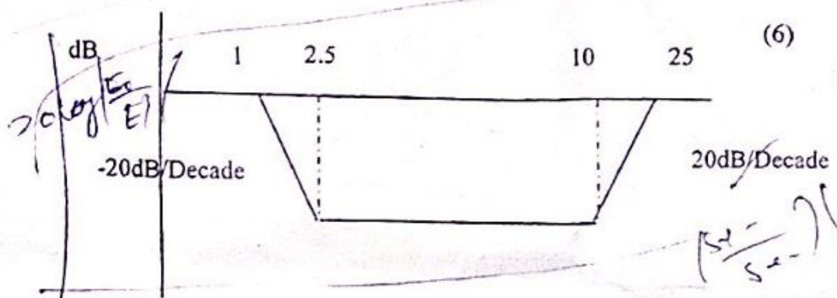
(b) Examine the stability of a system with OLTF, find the gain and phase margins. (6)

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

$(N_p - N_z) = \pm 360$

3. (a) For a lag-lead system whose transfer function is plotted as shown in figure below, give the transfer function.

(6)



$0.2 + .02$

0.24

$\xi = \frac{2}{\sqrt{KI}}$

0.2

$\omega_n = \sqrt{\frac{K}{I}}$ $\quad 10^4 = \frac{K}{I}$

(b) The task is to open the double door of a room. For this a robot should first open the lock using the key. Then open the latch. Thereafter, open the left door and only then can the right door be opened. But all these events should happen in that sequence otherwise the room cannot be opened. Draw the logic diagram after specifying the elements. Also write the logic equations. (6)

4 (a) The system as shown in figure below is being controlled by a PI controller. Prove that the PI controller behaves as a phase lag network. How are the steady state characteristics improved by adding this network when used for a (i) unit step input (ii) unit ramp input

(b) Determine the range of K for which the system is stable. Also construct the root locus of the system with respect to variation of K.

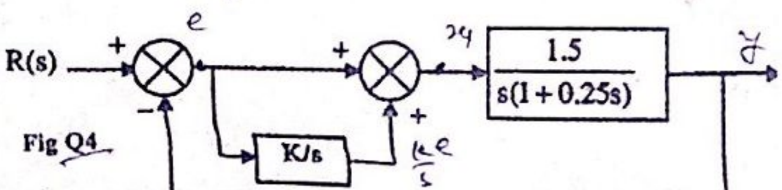


Fig Q4

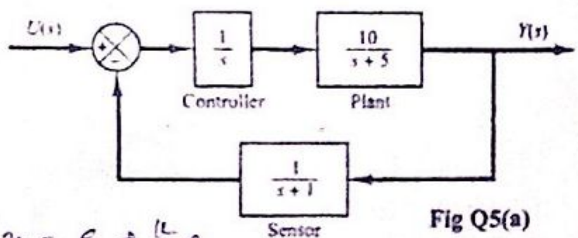


Fig Q5(a)

$y = e + \frac{K}{s} e$

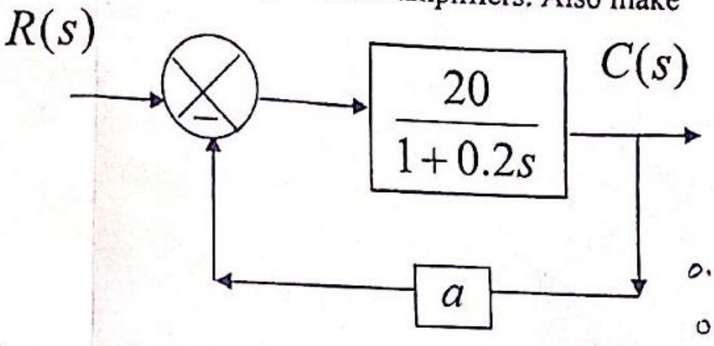
5. (a) From the block diagram given above (right side), obtain a state model for the system (6)

(b) Derive the state equations for the given transfer function using partial fractions. For the state equations find the response to unit step input, with zero initial conditions.

Y(s)/U(s) = 12(1-s) / (s+2)(s+5) (6)

Control Engineering MEL 312 Minor 1 Feb 2015 Time 1 hour Max Marks 30

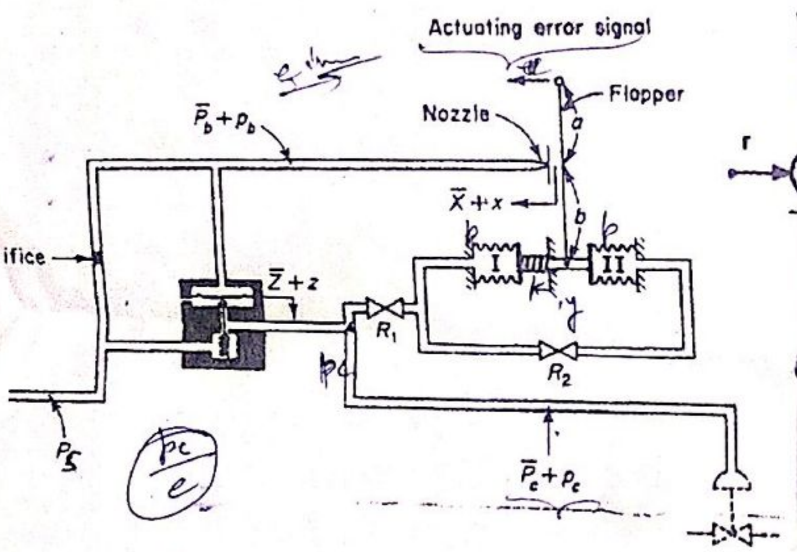
1. Diagram below shows one of the methods of reducing the time constant of a first order system. What should be the value of 'a' so that time constant of 200 ms is reduced to 50 ms. Implement the feedback element and comparator together using Operational amplifiers. Also make an OP amp circuit which is representative of the plant. Give the design parameters (R,L,C) of the op-amp systems (10)



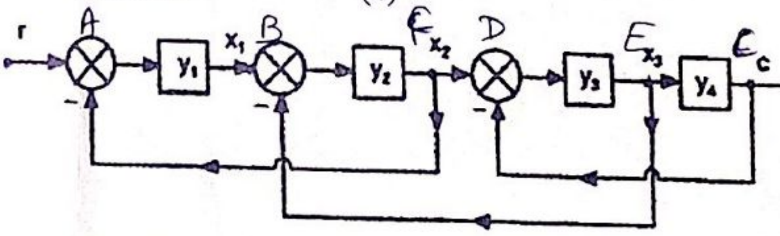
0.2 se

0.2...

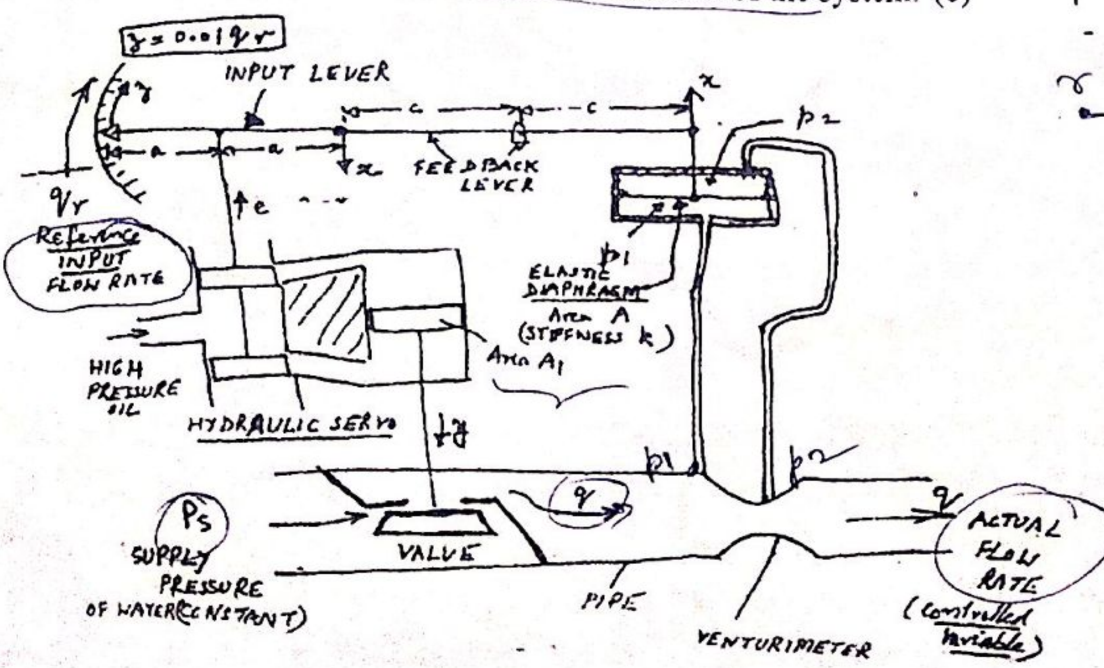
2 (a) The figure below shows a pneumatic controller. It has two bellows each of capacitance C. Also suppose that $R_2 > R_1$. Assuming $p_c = K' p_b$. Draw block diagram and find transfer function between p_c and e. What control action does the system produce? (8)



(b) For the block diagram shown below. Find the transfer function between c and r. Use Mason's Formula. (4)



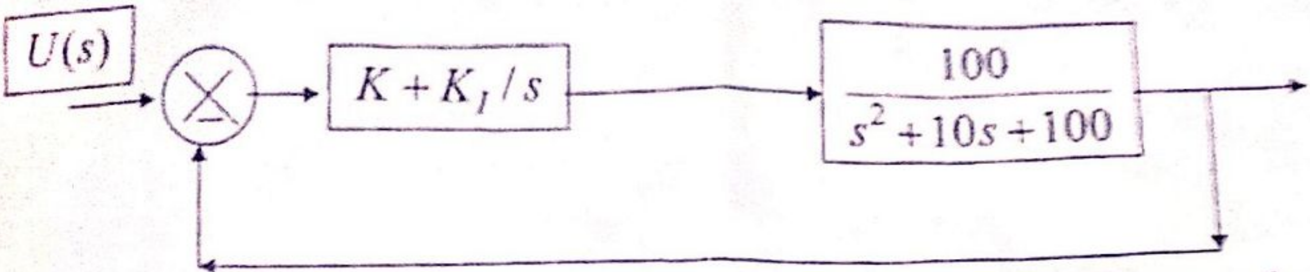
Q3. Figure below shows a flow control system with control variable q(m^3/s). The actual flow is sensed using a venturimeter and $q=0.0001(p_1 - p_2)$ with pressures being in N/m^2. Diaphragm stiffness is 1000N/m and its diameter is 0.06 m. The port constant of hydraulic servo is 0.05 m^2/s. and the area A_1 of the piston is 0.01 m^2. Further flow rate is related to motion y as $Q=300\ y$. Draw the block diagram of the system and find the transfer function of the system. (8)



$q = e A ...$

Minor II MEL 312 : Max Marks 40: Time 1 hour

1. The unity feedback system shown by the block diagram below consists of a proportional plus integral controller and a plant modeled by a second order type transfer function.



(a) Find the value of K_I so that the steady state error due to a unit ramp input is not more than 10%.

(b) For the value of K_I in part (a) find the range of value of K for which maximum value of the real part of the closed loop poles would be <= - 1 (10)

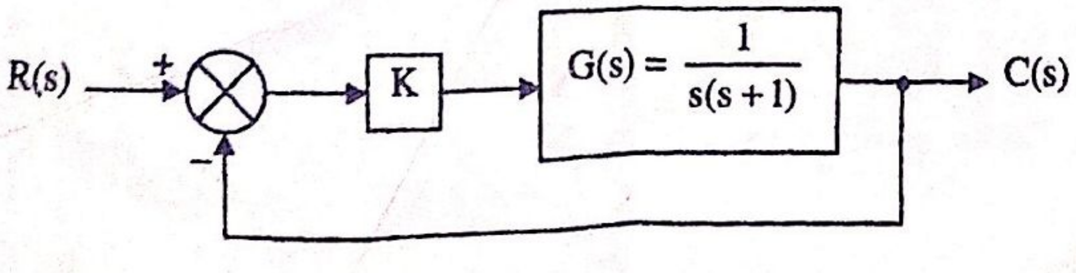
2 (a) What is meant by Equivalent Unity Feedback System? How is this concept useful in designing control systems? (3)

(b) Explain how derivative control can be used to increase the damping of a second order plant. For a second order system with OLTF as $GH = \dfrac{2}{(1+s)(1+2s)}$

we intend to use a PD control ($1 + K_D D$). The system is subjected to step input. Find the derivative gain such that peak overshoot is limited to 20%. (7)

3. (a) Draw the Polar diagram for a first order system $G(s) = 1/s$ controlled by a proportional controller. How will the diagram change if (i) controller gain is increased (ii) if an integral element is also introduced in the controller? (3)

(b) For the control system shown in figure below, find the value of K such that phase margin is 70°. For that value of K what is the gain margin. Use Nichols Chart



(7)