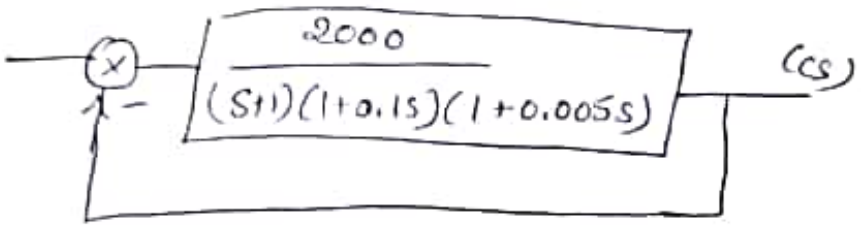
Module - 3

Assignment questions

1) The block diagram shown in figure represents a heat treating oven. The set point (desired temperature) is 1000°c. What is steady state temperature?



2) A mercury in glass thermometer has an overall transfer function as $G(S) = \frac{A}{S+A}$. If the thermometer requires 1 minute to indicate as 95% of its final value for a unit step excitation, determine the value of A.

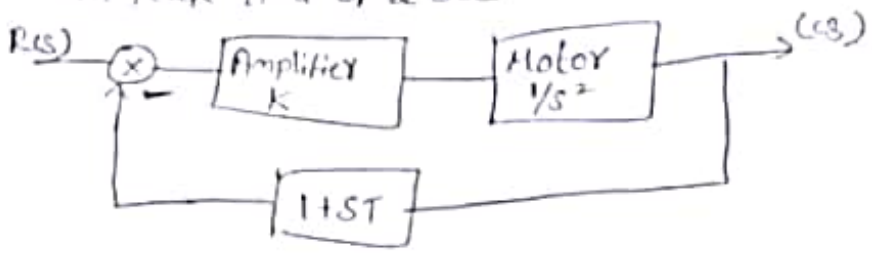
(3) Derive an expression for the time response of a second order system subjected to a unit impulse input for $\xi < 1$, $\xi > 1$, where ξ is a damping ratio.

4) Determine the static error co-efficients for the unity feedback control systems whose open loop transfer functions are

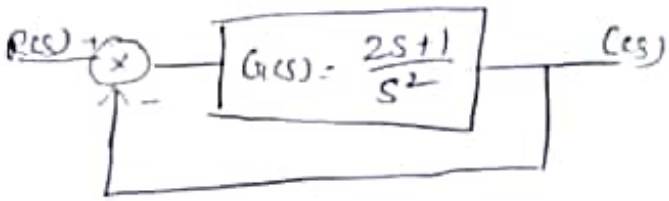
i) $G(S) = \frac{K}{S(S^2+4S+200)}$ ii) $G(S) = \frac{K(1+2S)(1+4S)}{S^2(S^2+2S+10)}$

Find also the error for unit step and unit ramp inputs. Determine 'type' and 'order' of the systems

5) The block diagram of a simple servo system is shown below Compute the values of K and T to give overshoot of 20% and peak time of 2 sec



6) For the system shown in given figure, obtain response to the unit step function.



7) A unity feedback sim is characterized by open-loop transfer function $G(s) = \frac{k}{s(s+10)}$. Find the value of k so that the system will have a damping ratio of 0.5 for this value of k, determine the settling time, peak over shoot for unit step input.

8) Consider unity FBCS (Feedback control system) whose open loop transfer function is given by $G(s) = \frac{0.4s+1}{s(s+0.6)}$ Obtain the response to step i/p for the some calculate rise time, peak overshoot, peak time and settling time.

9). A unity feedback system has $G(s) = \frac{k}{s(s+2)(s^2+2s+5)}$

(i) For a unity ramp i/p, it is desired $e_{ss} \leq 0.2$ Find k

ii) Determine ess if input $r(t) = 2+4t+\frac{t^2}{2}$

10) Find the error constants K_p, K_v and K_a for the unity feedback system represented by the following open loop transfer function. Also determine the steady state error when the input is $r(t) = 1 + t + 2t^2$

$$G(s) = \frac{100}{s^2(s+2)(s+5)}$$

11) The system given in figure is a unity feedback system with minor feedback loop.

i) In the absence of derivative feedback ($a = 0$), determine the damping ratio and undamped natural frequency

ii) Determine the constant 'a' which will increase damping ratio to 0.7

iii) Find the overshoot in both the cases.

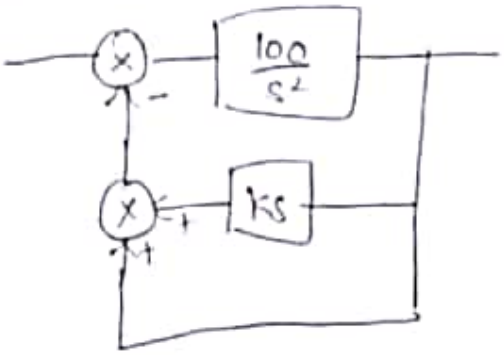
12) A negative feedback sys with unity feedback has a plant $G(s) = \frac{2(s+8)}{s(s+4)}$

i) Find the response of the system for a unit step input

ii) Using the final value theorem, determine the steady-state value of the response for the same step input.

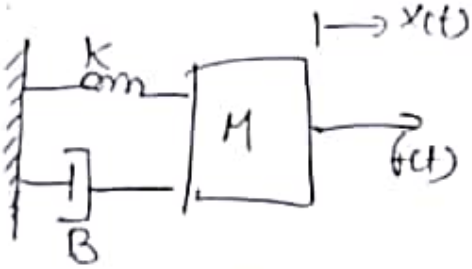
13) A plotter may be represented by the block diagram shown in the fig. (i) Determine the value of the gain K that gives a peak overshoot of 4.32%

ii) for this value of K, determine the steady-state error for a unit ramp input. iii) For what range of K is the 2% settling time less than 1sec



14) Refer the fig find the following,

(i) Transfer function $\frac{X(s)}{F(s)}$ and (ii) ζ, ω_n, %Mp, T_s and T_p



Assume: K = 33N/m, B = 15 N-s/m M = 3 kg

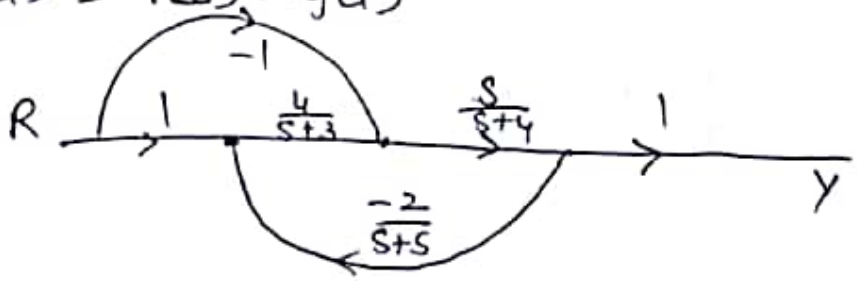
15) For a unity feedback control system with $G(s) = \frac{64}{s(s+9.6)}$ write the output response to a unit step input.

Determine: i) The response at t = 0.1 sec

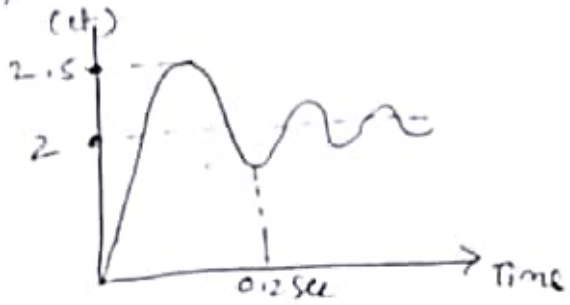
ii) Maximum value of the response and the time at which it occurs (iii) settling time.

16) For the flow graph shown in fig, Mention the type number and order of the system & determine the steady state errors for step and ramp inputs

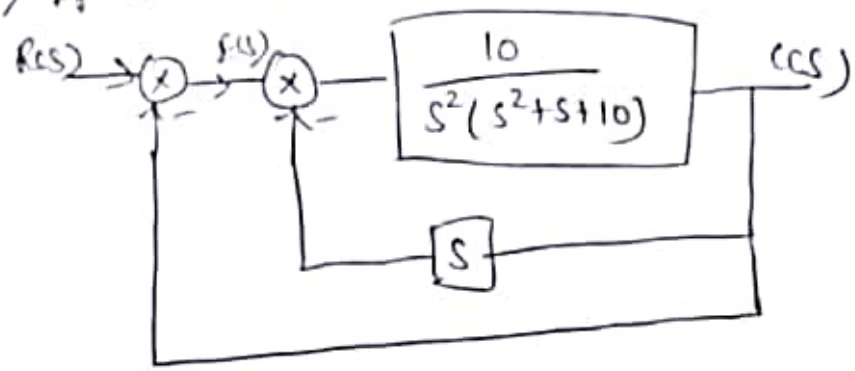
$e(t) = r(t) - y(t)$



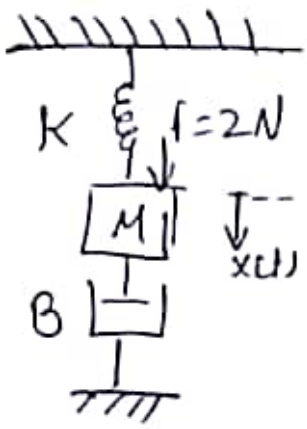
17) Find the open loop transfer function of an equivalent prototype single loop unity feedback sim having second order, whose step response is shown in the fig

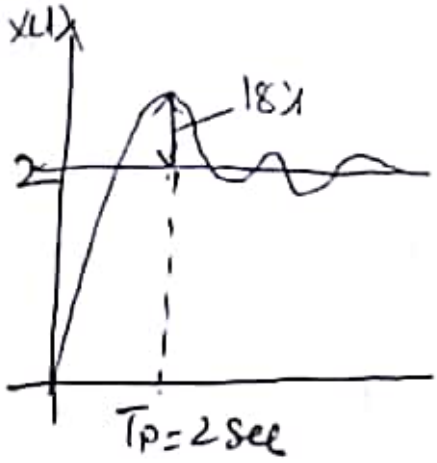


18) for the sim shown in fig (i) Identify the Type of $\frac{C(s)}{E(s)}$ (ii) Find the values of K_p, K_v, K_a.
iii) If $r(t) = 10u(t)$, find the steady state value of the o/p



19) For a spring mass damper sim shown in fig, an experiment was conducted by applying a force of 2 Newtons to the mass. The response x(t) was recorded using an xy plotter and the experimental result is as shown in fig below. Find the value of M, k and B.





20) The open loop transfer function of an unity feedback control sim is given by

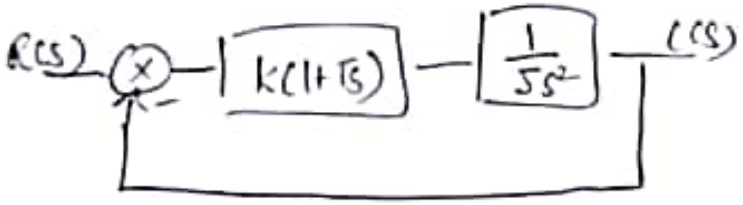
$$G(s) = \frac{K}{s(1+Ts)}.$$

(i) By what factor should the amplifier gain K be multiplied in order that the damping ratio is increased from 0.2 to 0.8

ii) By what factor should K be multiplied so that the system overshoot for unit step excitation is reduced from 60% to 20%

21) Find the position, velocity and acceleration error constant for a control system having open loop transfer function $G(s)H(s) = \frac{4}{s(s+1)(s+2)}$. Also determine its steady state error for a unit step, ramp and parabolic inputs What is the steady state error due to the transform input of $R(s) = \frac{2}{s} - \frac{1}{s^2}$?

22) Assuming the time constant T of the controller to be 3 Sec and the ratio of torque to inertia K/J to be 3 rad^2/sec^2, find the damping ratio, rise time, peak time and maximum overshoot (M_p) of the sim shown in fig



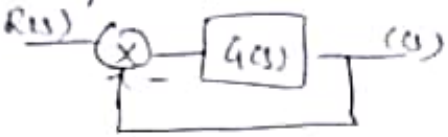
23) The step response of a unity feedback control system is given by $c(t) = 1 - 1.66e^{-8t}\sin(6t + 37^\circ)$

(i) Find the closed loop transfer function.

(ii) What is the corresponding open loop transfer function?

iii) Determine the complete output response for a unit step input, when the system is operated on open loop.

24) The unity f/b s/m shown in fig $G(s) = \frac{K(s+\alpha)}{(s+\beta)^2}$ is to be designed to meet the following specifications. steady state error for a unit step input = 0.1, damping ratio, natural frequency = $\sqrt{10}$ rad/sec, find K, α & β



25) A unity f/b control system is characterized by an open loop. T.F $G(s) = \frac{K}{s(s+\alpha)}$, where K and α are positive constants

i) By what factor the amplifier gain K should be reduced so that the peak overshoot of the unit step response reduces from 75% to 25%?

ii) Find the values of K and α so that, damping ratio is 0.6 and frequency of damped oscillations is 8 rads/sec Also find the peak value of the response, when the system is excited by a step of 2V

iii) If the above loop TF G(s) is multiplied with a factor $(s+\beta)$, and the closed loop poles are located at $-1 \pm j1$ find the values of K, α and β so that the steady state error for a ramp i/p equals 1/10.

26) The forward path transfer function of a certain unity negative f/b c/s is G(s). The system is subjected to unit step input. From the transient response curves, it is observed that the system peak overshoot is 15%. and the time at which it occurs is 1.8 sec. Determine the closed loop transfer function of the system

27) A signal is represented by equation $\frac{d^2\theta}{dt^2} + 10\frac{d\theta}{dt} = 150e$. where $e = (r - \theta)$ is the actuating sig. Calculate the value of damping ratio, undamped and damped frequency of oscillation. Also draw the block diagram of the sim. and find its closed loop transfer function

28) The block diagram of a

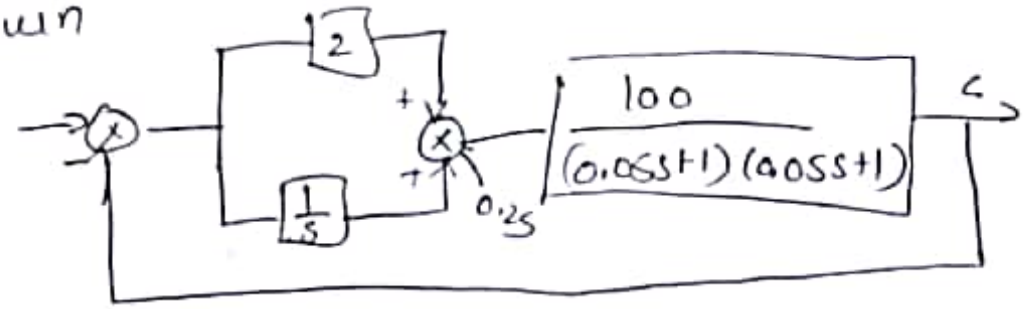
28) The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{K}{s(sT+1)}$

(i) By what factor the amplifier gain K should be multiplied so that the damping ratio is increased from 0.2 to 0.8.

ii) By what factor the time constant T should be multiplied so that the damping ratio is reduced from 0.6 to 0.3

iii) For the system overshoot of the unit step response to reduce from 60% to 20%. Show that $\frac{TK_1 - 1}{TK_2 - 1} = 43.22$ where K_1 and K_2 are the values of K for 60% and 20%.

29) Given



What is the steady state error

30) Find the error co-efficients for a sim having $G(s) = \frac{10}{s(1+s)}$ and steady state error if Input to the system is

$a_0 + a_1 t + a_2 t^2$