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Question # 1.

Part (a).

*) What is control system? Why we use the control system.

" A control system is a system of devices, that manages, commands, directs or regulates the behaviour of other devices or systems to achieved desired results. As the human civilization is being modernized day by day the demand for automation is increasing accordingly

⇒ Why we use control system:-

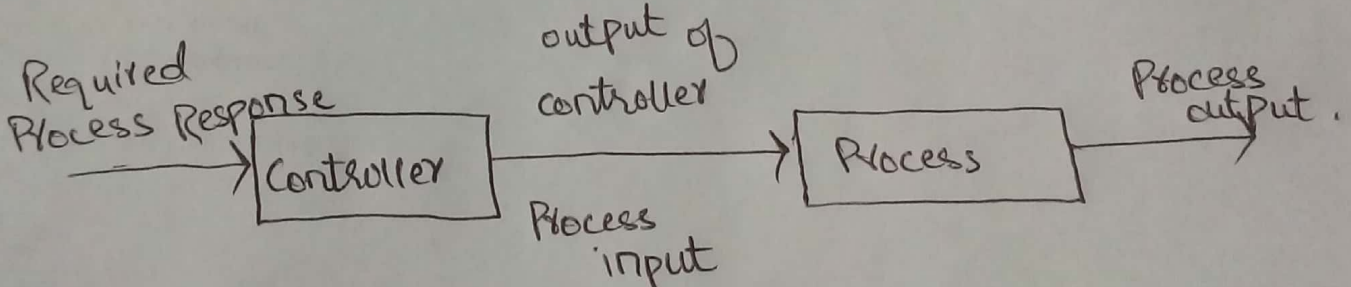
- Modern control theory is based on time-domain analysis of differential equation system.
- Modern control theory made the design of control systems simpler because the theory is based on a model of an actual control system.
- The system stability is sensitive to the error b/w the actual system and its model.
- When the designed controller based on a model is applied to the actual system, the system may not be stable to avoid this situation, we designed control system by first

setting up the range of possible errors & then designing the controller in such a way that, if the error of the system stays within the assumed range, the designed control system will stay stable.

Question # 1
Part (b).

*) **Open Loop control System:?**

In this kind of control system, the output doesn't change the action of the control system otherwise; the working of the system which depends on time is also called open loop control system. It doesn't have any feedback. It is very simple need low maintainance, quick operation, & cost effective. The accuracy of this system is low & less dependable

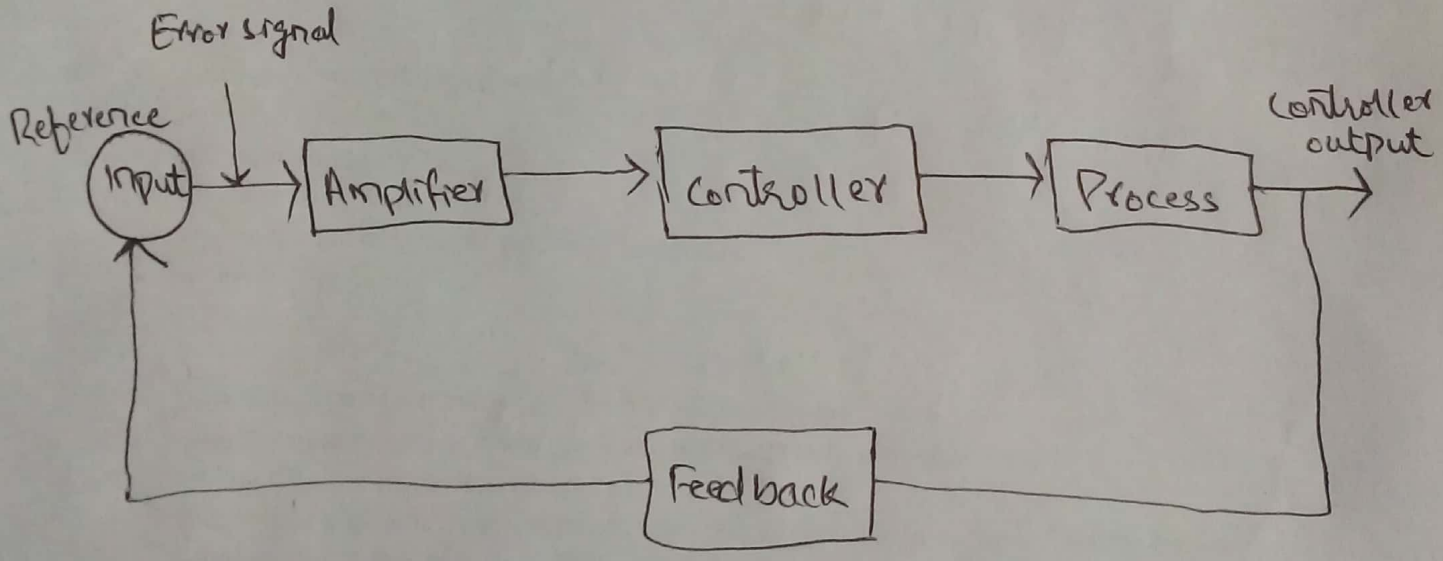


Example:-

The clothes dryer is one of the example of open-loop control system.

*) closed-loop control system:-

The closed-loop control system can be defined as the output of the system that depends on the input of the system. This control system has one or more feedback loops among its input & output. This system provide the required output by evaluating its input. This kind of system produces the error signal and it is the main disparity b/w the output & input of the system.



Example:-

Example of closed-loop control system is AC or air conditioner.

*) Advantages of open loop control system:-

1. Simple in construction & design.
2. Economical.
3. Easy to maintain
4. Generally stable
5. Convenient to use as output is difficult to measure

*) Disadvantages of Open loop control system:-

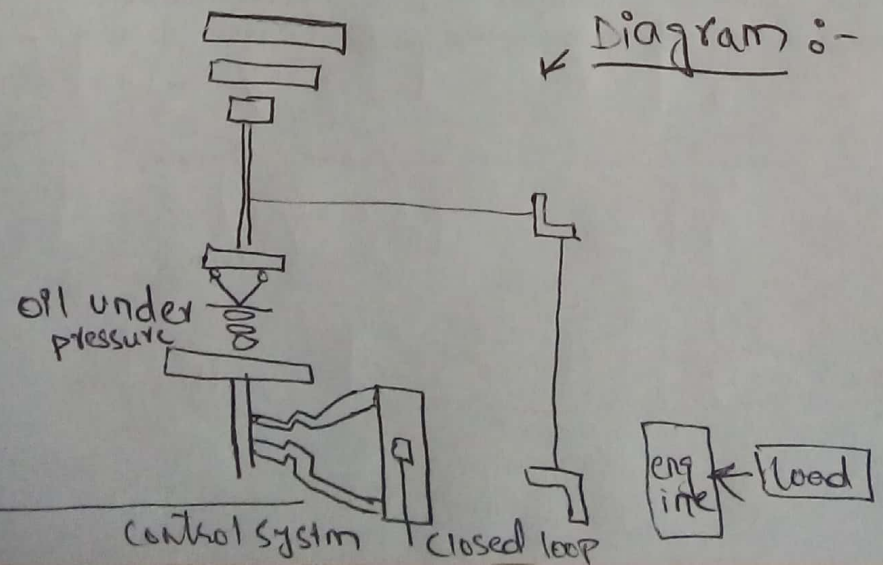
1. They are inaccurate
2. They are unreliable
3. Any change in output cannot be corrected automatically.

Question #03

Answer:-

Speed control system:- The basic principle of watt's governor schematic digram. The amount of fuel admitted to the engine is adjusted according to the difference b/w the desired and the actual engine speeds In this speed control system the plant (controlled system) is the engine and the controlled variable is the speed of the engine. The difference b/w the desired speed & the actual speed is the error signal. The control signal is the actuating signal. The external input to disturb the controlled variable is disturbance. An unexpected change in the load is a disturbance.

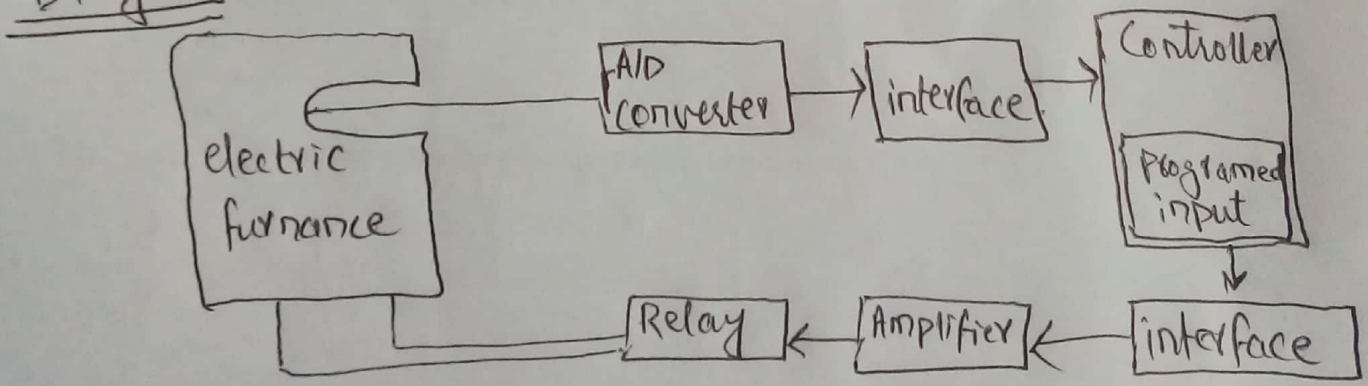
Diagram:-



Temperature control system:-

figure 1-2 shows a schematic diagram of temperature control system of an electric furnance. the temperature in electric furnance is measured by a thermometer which is an analog device. The analog temperature is converted to a digital temperature by an A/D converter. The digital temperature is fed to a controller through an interface. The digital temperature is compared with a programmed input temperature and if there is any discrepancy (error) the controller sends out a signal to a heater, through an interface, amplifier and relay, to bring the furnance temparature to desired value.

Diagram:-



Question # 2.

*) Find laplace transform of :

(i) $f(t) = t^n$

$$\mathcal{L}\{t^n\} = \int_0^\infty e^{-st} t^n \, dt$$

$$= \int_0^\infty e^{-x} \left(\frac{x}{s}\right)^n \frac{dx}{s} \quad = s^n$$

$$= \int_0^\infty \frac{e^{-x} - x^n}{s^{n+1}}$$

$$= \frac{1}{s^{n+1}} \int_0^\infty e^{-x} - x^{n+1-1} \, dx$$

$$= \frac{\sqrt{n+1}}{s^{n+1}} \quad (n > -1)$$

$$L \cdot \{t^n\} = L \frac{n!}{s^{n+1}}$$

(ii)

$f(t) = e^{at}$

$$\mathcal{L}\{e^{at}\} = \int_0^\infty e^{at} e^{-st} \, dt$$

$$= \int_0^\infty e^{-t(s-a)} \, dt$$

$$= \left[\frac{e^{-t(s-a)}}{-(s-a)}\right]_0^\infty$$

$$\frac{-1}{s-a}[0-1] \Rightarrow \boxed{\mathcal{L}\{e^{at}\} = \frac{1}{s-a}}$$

(iii) $f(t) = \sin at$

$$\mathcal{L}\{\sin at\} = \int_0^\infty e^{-st} \sin at \, dt$$

$$\therefore \int e^{ax} \sin bx \, dx = \frac{e^{ax}}{a^2+b^2}\left[a \sin bx - b \cos bx\right]$$

$$= \frac{e^{-st}}{(-s)^2+(a)^2}\left[-s \sin at - a \cos at\right]_0^\infty$$

$$= \frac{1}{s^2+a^2}\left[0 - 1\,(0-a)\right]$$

$$\mathcal{L}\{\sin at\} = \frac{a}{s^2+a^2}$$

$$\mathcal{L}\{\cos at\} = \frac{s}{s^2+a^2}$$

$$\mathcal{L} \sinh(at) = \frac{a}{s^2+a^2}$$

$$\mathcal{L} \cosh(at) = \frac{s}{s^2+a^2}$$

$$\mathcal{L}(t^0) = \frac{1}{s}$$

$$\mathcal{L}(t^1) = \frac{1}{s^2}$$

$$\mathcal{L}[t^5] = \frac{\sqrt{s+1}}{s^{s+1}}$$ Ans.

(iv) $f(t) = \cos 3t$

Soln:- $L\{\cos 3t\} = \frac{s}{s^2+3^2} = f'(s)$

By shifting property

$$L\{e^{2t}\cos 3t\} = f'(s-a)$$

$$= \frac{s-2}{(s-2)^2+9}$$

$$= \frac{(s-2)}{s^2-4s+13}$$

$$L\{e^{2t}\cos 3t\} = \frac{s-2}{s^2-4s+13}$$ Ans:-

(v) :- $L\{e^{-5}t^5\}$.

Sol:-

$$L\{t^5\} = \frac{5!}{s^{5+1}} = \frac{120}{s^6} = f'(s)$$

by shifting property.

$$L\{e^{-t}t^5\} = f'(s-(-1))$$

$$= f'(s+1) = \frac{120}{(s+1)^6}$$

$$L\{e^{-t}t^{-5}\} = \frac{120}{(s+1)^6}$$

(vi) $\mathcal{L}\{t \sin 3t\}$

$$\mathcal{L}\{\sin 3t\} = \frac{3}{s^2+9} = f'(s)$$

$$\mathcal{L}\{t \sin 3t\} = \frac{-d}{ds} f'(s)$$

$$= \frac{-d}{ds}\left(\frac{3}{s^2+9}\right)$$

$$= -3(-1) \frac{}{(s^2+9)^2} \times \frac{d}{ds} s^2+9$$

$$= \frac{d}{ds}(s^2+9) = 2\frac{d}{ds} s = 2(1) = 2$$

$$= \frac{6s}{(s^2+9)^2}$$ Ans.

(vii) $\mathcal{L}\left\{\frac{1-\cos t}{t}\right\}$

Sol:- $\mathcal{L}\{1-\cos t\} = t$

$= \mathcal{L}(1) - \mathcal{L}\{\cos t\}$

$= \frac{1}{s} - \frac{s}{s+1}$

$= f'(s)$

By using t property.

$\mathcal{L}\left\{\frac{f(t)}{t}\right\} = \int_0^\infty f'(s)\,ds$

$= \int_0^\infty \left(\frac{1}{s} - \frac{s}{s^2+1}\right) dt$

$= \left[\log s - \frac{1}{2}\log(s^2+1)\right]\Big|_0^\infty$

$= \frac{1}{2}\left[\log s - \log(s^2+1)\right]\Big|_0^\infty$

$= \frac{1}{2}\left[\log \frac{s^2}{s^2+1}\right]\Big|_0^\infty$

$= \frac{1}{2}\left[\lim_{s\to\infty} \log\left(\frac{s^2}{s^2+1}\right) - \log\left(\frac{s^2}{s^2+1}\right)\right]$

$= \frac{1}{2}\left[\lim_{s\to\infty} \log\left(\frac{1}{1+1/s^2}\right) - \log\left(\frac{s^2}{(s^2+1)}\right)\right]$

$= \frac{1}{2}\left[\log 1 - \log\left(\frac{s^2}{s^2+1}\right)\right]$

$= -\frac{1}{2}\log\left(\frac{s^2}{s^2+1}\right)$ Ans.