

BITS, PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY
III Year EIE – II Semester 2012-13
Comprehensive Examination
Industrial Instrumentation & Control - INSTR C312

Date: 5.6.2013

Max.Marks:40

Time: 3Hrs

Weightage: 40%

Answer ALL Questions

1. (a) Discuss the action of a proportional controller with an example. Show the effect of increasing gain or decreasing the proportional band.
(b) An integral controller is used for speed control with a set point of 12 rpm within a range of 10 to 15 rpm. The controller output is 22% initially. The constant $K_i = -0.15\%$ controller output per second per % error. If the speed jumps to 13.5 rpm, calculate the controller output after 2S for a constant e_p .
2. Design an electronic proportional integral controller with a proportional band of 25% and an integration gain of $0.2\%/\text{sec}$. The 4 to 20mA input converts to a 0.4 to 2V signal and the output is 0-10V. Calculate values of G_p , G_i , R_2 , R_1 and C respectively.
3. (a) What is cascade control Explain with an example.
(b) Name the three basic types of control valves. Explain in detail.
4. Prepare a ladder diagram for control problem with the objective to heat a liquid to a specified temperature and keep it there for 30 min. The event sequence is
 - (i) Fill the tank
 - (ii) Heat and stir the liquid for 30 min
 - (iii) Empty the tank
 - (iv) Repeat from step 1.

Normally open (NO) and normally closed (NC) are available for the limit switches.

5-6-13

SOLUTIONS

(1)

INDUSTRIAL INSTRUMENTATION & CONTROLCompre Exam.

1.a

In a proportional control there is a continuous linear relation between the value of the control variable and the correction applied. The applied correction is changed by the same amount for each unit of deviation.

The input - output relation

$$\varphi_i = \frac{100}{PB} \cdot e + \varphi_0$$

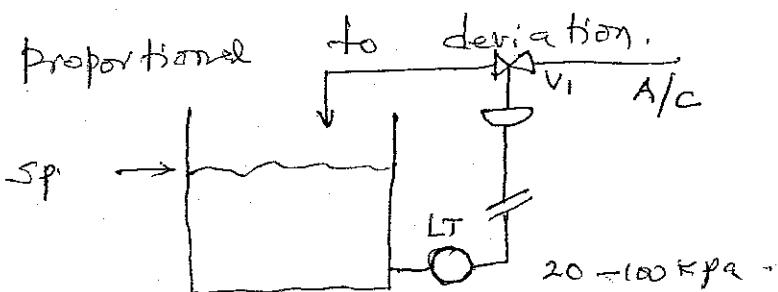
$$\varphi_i = K_p e + \varphi_0$$

φ_i - output at any given time, φ_0 - output when $e=0$,
 e - error signal, PB - proportional band

PB is defined as % of full scale change in input required to change the output from 0 to 100%.

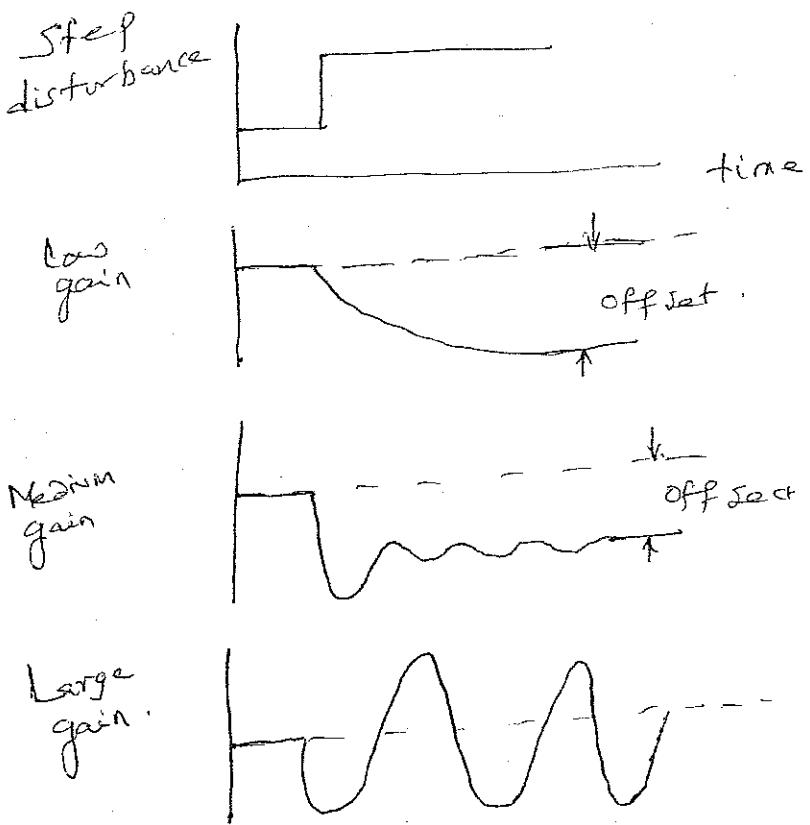
$$\text{Proportional gain} = \frac{100}{\text{Proportional band}}$$

In proportional controllers when the control variable deviates from the set value due to momentary disturbance, the controller gives a correction which is



(2)

The effect of increasing the gain:



The proportional band J should be set such that the response has $\frac{1}{4}$ decay.

(1b)

$$\text{Setpt} = 12 \text{ rpm}$$

Range varies from 10 to 15 rpm.

Need speed = 13.5 rpm.

$$e_p = \frac{12 - 13.5}{15 - 10} \times 100$$

$$e_p = -30\%$$

The rate of controller output change is then

$$\frac{dp}{dt} = K_I e_p = (-0.15 s^{-1}) (-30\%)$$

$$= 4.5\% / s.$$

3

The controller output for const. error can be found from

$$p = K_I \int_0^t e_p dt + p(0).$$

Since e_p is constant

$$p = K_I e_p t + p(0).$$

After 2s we have

$$\begin{aligned} p &= (0.15)(30\%) (2) + 22 \\ &= 31\%. \end{aligned}$$

2. A proportional band of 25% means that when the input changes by 25% of range or 0.4V, the output must change by 100% or 10V. This gives a gain of

$$G_P = \frac{R_2}{R_1} = \frac{10V}{0.4V} = 25$$

K_I of 0.2s. (%-s) says 1% error for 1s should produce an output change of 0.2%. One percent of 1.64 is 0.016V and 0.2% of 10V is 0.02V.

$$\therefore G_I = \frac{1}{R_2 C} = \frac{0.02}{0.016} = 1.25 \text{ s}^{-1}$$

$$\therefore R_2 C = 0.8 \text{ s.}$$

(4)

Choose $C = 10 \mu F$

$$R = \frac{C \cdot \omega}{10 \mu F}$$

$$= 0.8 \times 10^6$$

$$= 80 \text{ k}\Omega$$

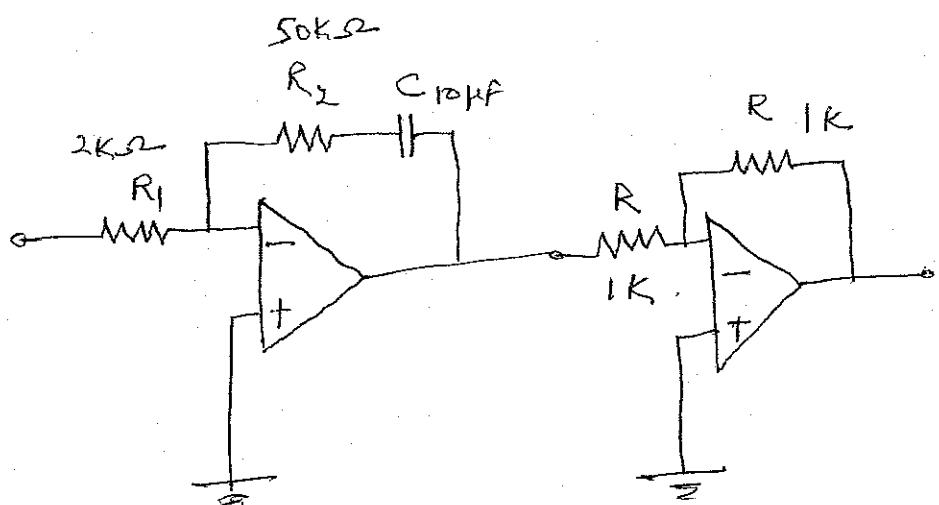
To get the proportional gain, we use

$$\frac{R_2}{R_1} = 25$$

$$\text{choose } R_1 = 2 \text{ k}\Omega$$

$$R_2 = 50 \text{ k}\Omega$$

The circuit is as follows:



3a

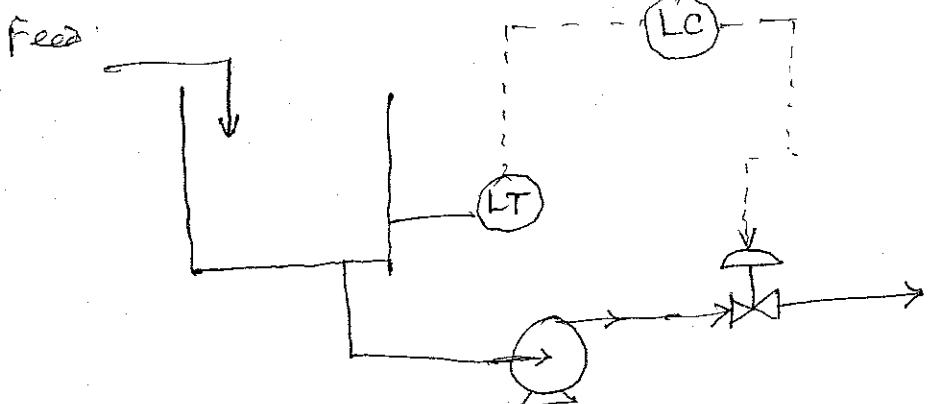
5

In Cascade control we have one manipulated variable and more than one measurement. Cascade control uses the output of primary controller to manipulate the set point of secondary controller. It can improve performance when (i) disturbances affect a measurable secondary process output we wish to control. (ii) The gain of the secondary process including the actuator is non linear.

In the first case a cascade control system can limit the effect of the disturbances entering the secondary variable on the primary output.

In the second case a cascade control system can limit the effect of actuator or secondary process gain variation on the control system performance.

In a cascade control arrangement there are two controllers of which one controller output drives the set point of another controller.



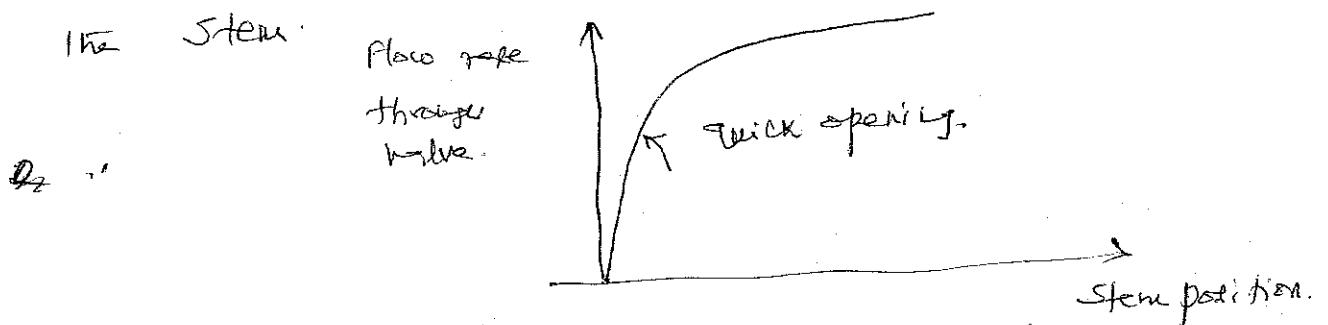
Ex: A level controller driving the set point of a flow controller to keep the level at its set point.

The flow controller in turn drives a control valve to match the flow across the set point. The level controller is requesting.

(6)

3b). There are three basic types of control valves. They are quick opening, linear and Equal percentage. The types are determined by the shape of the plug and seat. As the stem and plug move with respect to the seat, the shape of the plug determines the actual opening of the valve.

1. Quick opening: This type of valve is used predominantly for full on/ full off control applications. The valve characteristic shows that a relatively small motion of the valve stem results in maximum possible flow rate through valve. For ex: This valve may allow 90% of maximum flow rate with only a 30% travel of

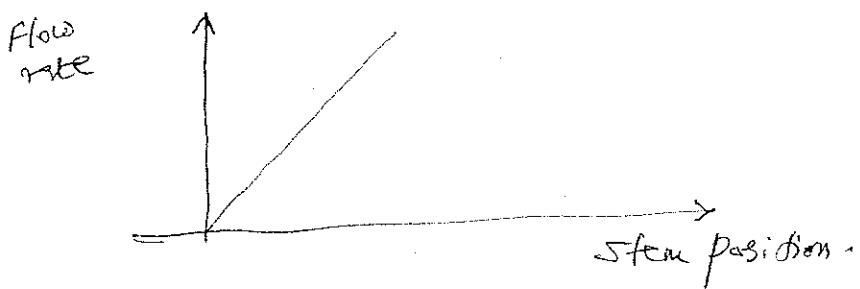


2. Linear: This type of valve has a flow rate that varies linearly with the stem position. It represents the ideal situation where the valve alone determines its pressure drop. The relation is

$$\frac{\Phi}{\Phi_{max}} = \frac{S}{S_{max}}$$

Φ - flow rate (m^3/s) , Φ_{max} - max. flow rate (m^3/s) (7)

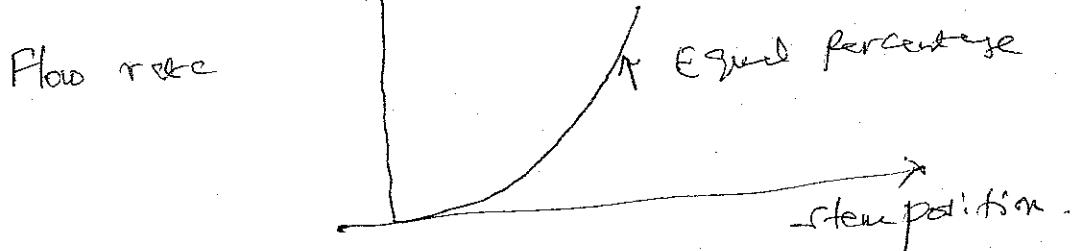
S - stem position , S_{max} - max stem position (m)



3. Equal percentage :

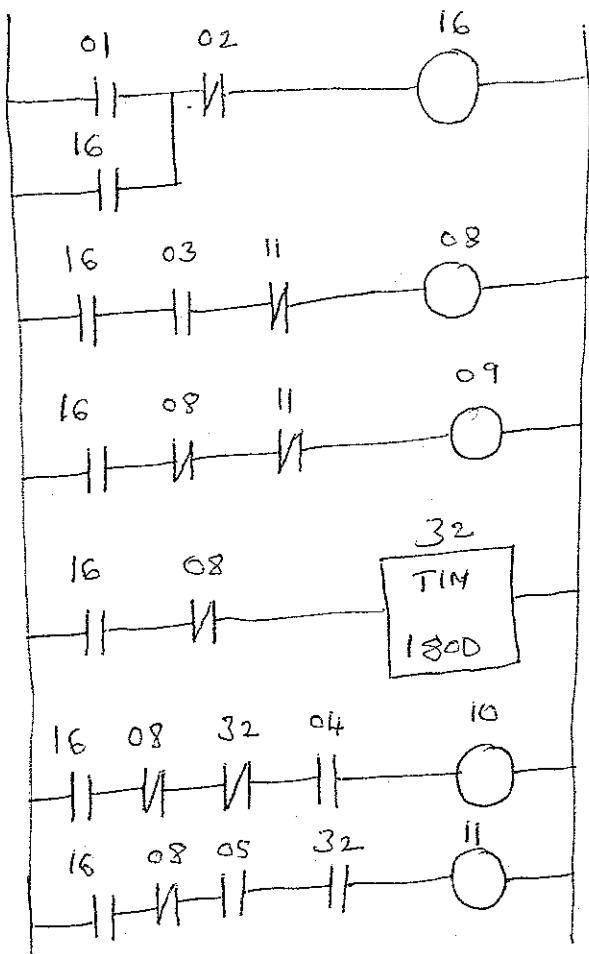
This valve has a characteristic that a given percentage change in stem position produces an equivalent percentage change in flow. That is an equal percentage. Usually this type of valve does not shut off the flow completely in its limit of stem travel. Thus Φ_{min} is the minimum flow when the stem is at one limit of its travel. At the other extreme i.e. at its maximum, open valve allows a flow Φ_{max} at its maximum, open valve flow rate. we define rangeability R as the ratio

$$R = \frac{\Phi_{max}}{\Phi_{min}}$$



The curve shows the increase in flow rate for a given change in valve opening depends on the extent to which the valve is already open. The curve is represented by $\Phi = \Phi_{min} R^{S/S_{max}}$.

4



8

Inputs:

- 01 - Normally open
- 02 - Normally closed
- 03 - Full level switch
(opens on rising level)
- 04 - Temp. switch
(opens on rising temp)
- 05 - Empty switch
(closes on rising level)

outputs:

- 08 - input valve
- 09 - stir motor
- 10 - Heater
- 11 - output valve

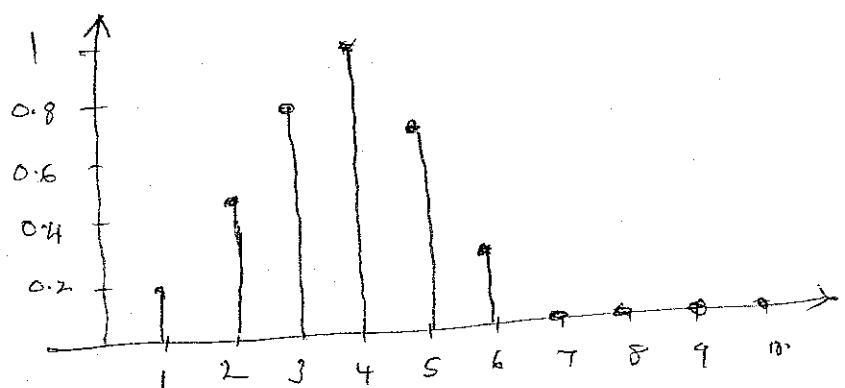
Rung 2 opens the input valve provided the output valve is not open until the full level is reached. When the full level is reached rung 3 turns on the stir, provided the output valve is not open. Rung 4 starts a 30 min timer. The heater is controlled by rung 5. The rung is energized and de-energized as the temp. goes below and above limit. When the timer times out, the rung is de-energized and rung 6 is energized to open the output valve. The output valve remains open until the empty limit switch opens.

5. The fuzzy set " Comfortable type of a house for a 4 person family " may be described using a fuzzy set in the following manner.

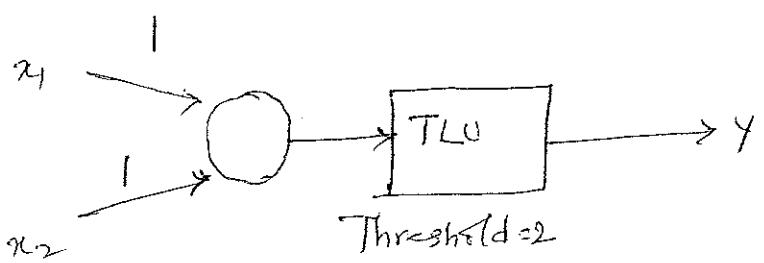
Fuzzy set (no. of bedrooms, comfort factor)

$$\text{House for four} = \text{Fuzzy set} \left[\left\{ (1, 0.2), (2, 0.5), (3, 0.8), (4, 1) \right. \right. \\ \left. \left. (5, 0.7), (6, 0.3) \right\} \right]$$

Membership grade



5b

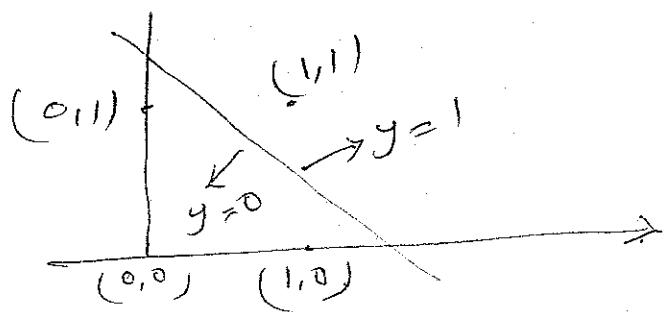


$$\text{Net} = x_1 \cdot 1 + x_2 \cdot 1 = x_1 + x_2$$

$$y = f(\text{net}) = 1 \quad \text{if } \text{net} \geq 2 \\ = 0 \quad \text{if } \text{net} < 2$$

x_1	x_2	Net	y
0	0	0	0
0	1	1	0
1	0	1	0
1	1	2	1

It is a AND gate



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TEST -2 (Open Book)

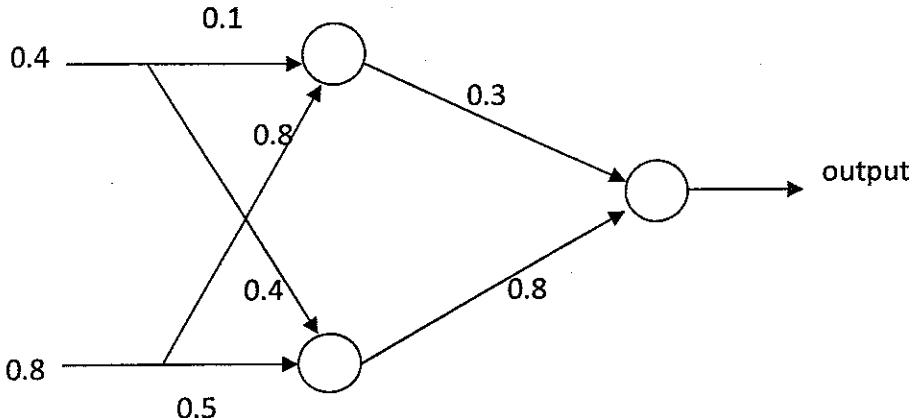
Industrial Instrumentation & Control - INSTR C312

Date: 5.5.2013
Max.Marks:20

Time: 50 Mts
Weightage: 20%

Answer ALL Questions

1. (i) What process data is required to size a control valve.
(ii) Why are control valves noisy.
(iii) What is Trim in a control valve. (3M)
2. Find the proper C_v for a valve that must allow 600 gal/min of a liquid with a maximum pressure difference of 55 psi. The specific gravity of the liquid is 1.3. Find the required valve size. (3M)
3. Two motors are to be controlled as follows :
(i) When the run switch operated both motors run.
(ii) After 4 mins motor 1 must stop.
(iii) Motor 2 continues to run for 2mins and stops.
(iv) At this point lamp is switched on.
(v) After 90 secs the lamp goes off and cycle repeats.
(vi) If Stop is operated any time, the process stops. (6M)
4. Consider the network shown below.



Assume that the neurons have a sigmoid activation function.

- (i) Perform a forward pass on the network
- (ii) Perform reverse pass (training) once (target=0.5). (8M)

SOLUTIONSTEST - 2INDUSTRIAL INSTRUMENTATION & CONTROL

1. (i) The following data is required to size a control valve.
Medium, Pressure, Flow rate and Temperature.

Medium: The liquid flowing through the valve. Its specific gravity, critical pressure, vapor pressure and viscosity are required.

Pressure: The upstream and downstream pressures for each flow rate.

Flow rate: The maximum flow rate is used to select the valve size.

Temperature: The maximum temperature is to be specified.

- (ii) Noise is created by an object vibrating. Valve components tend to vibrate whenever they are subjected to high velocity turbulent flow. Therefore control valves tend to be noisy on high pressure drop applications particularly where flow rates are high. Special low noise valves are designed to drop pressure gradually so their velocities are controlled at low levels.

(2)

(iii) The trim consists of the parts of the valve that affect the flow through the valve. In a standard globe valve the trim could just be the plug and seat. In a special valve the trim could consist of the plug, seat and retainer.

(3)

The valve sizing factor $\Phi = C_D \sqrt{\frac{\Delta P}{SG}}$

$$\text{Then } C_D = \Phi \sqrt{\frac{SG}{\Delta P}}$$

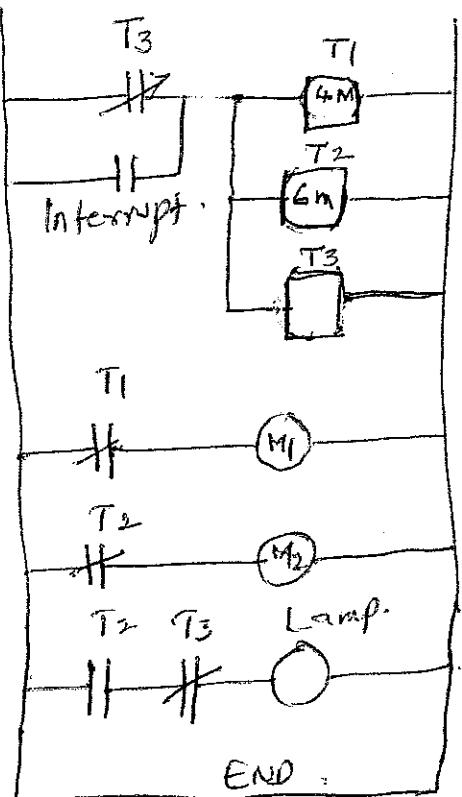
$$= \left(600 \frac{\text{gal}}{\text{min}} \right) \sqrt{\frac{1.03}{55}}$$

$$= 600 \times 0.1537$$

$$= 92.22$$

Accordingly the diameter of valve = 3" = 7.5 cm

(3)



Rung 1: Timers 1 and 2 are set by timer 3 being off.
(ie as soon as rung switch is activated).

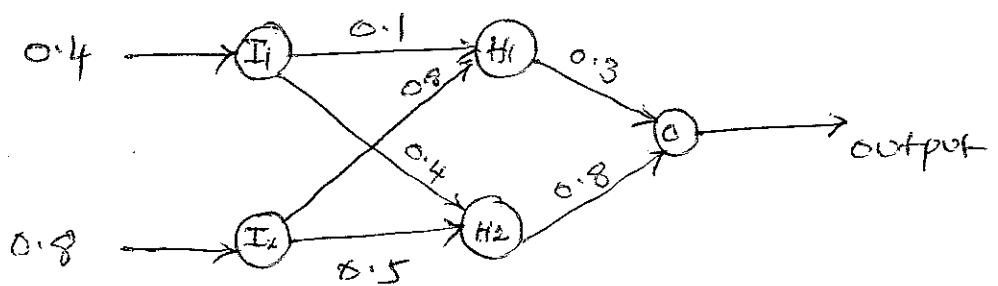
Rung 2: M₁ runs as long as Timer 1 is off. After 4 mins timer 1 comes on M₁ stops.

Rung 3: M₂ runs as long as timer 2 is off. Timer 2 continues running 6 mins from start as M₂ stops.

Rung 4: The lamp is on only if timer 2 is on and timer 3 is off. As soon as M₂ stops and goes off after 70 sec. when timer 3 comes on.

Stop: If the stop switch is on timers 1 and 2 will not reset and cycle stops at the END.

(4)



$$(i) H_1: (0.1 \times 0.4) + (0.8 \times 0.8) = 0.04 + 0.64 = 0.68$$

$$\text{output}_1 = \frac{1}{1+e^{-0.68}} = 0.66$$

$$H_2 = (0.4 \times 0.4) + (0.8 \times 0.5) = 0.16 + 0.4 = 0.56$$

$$\text{output}_2 = 0.63$$

$$\begin{aligned} \text{Input to Output Neuron} &= (0.3 \times 0.66) + (0.8 \times 0.63) = \\ &= 0.198 + 0.504 = 0.702 \end{aligned}$$

$$\text{output} = \frac{1}{1+e^{-0.702}} = 0.66.$$

Forget = 0.5

(A)

$$\begin{aligned}\text{output error} &= \delta = (t-o)(1-o)\alpha \\ &= (0.5 - 0.66)(1 - 0.66)0.66 \\ &= (-0.16)(0.34)(0.66) = -0.0359\end{aligned}$$

New weights for output layer.

$$\begin{aligned}w_1^+ &= w_1 + (\delta \times \text{input}) \\ &= 0.3 + (-0.0359 \times 0.66) = 0.2763\end{aligned}$$

$$\begin{aligned}w_2^+ &= w_2 + (\delta \times \text{input}) \\ &= 0.8 + (-0.0359 \times 0.63) = 0.7773\end{aligned}$$

Error for hidden layers:

$$\begin{aligned}\delta_1 &= \delta \times w_1 = (-0.0359 \times 0.2763) \times (1 - 0.66)(0.16) = -2.225 \times 10^{-3} \\ \delta_2 &= \delta \times w_2 = (-0.0359 \times 0.7773) \times (1 - 0.63)(0.63) = -6.504 \times 10^{-3}\end{aligned}$$

New hidden layer weights:

$$w_3^+ = 0.1 + (-2.225 \times 10^{-3} \times 0.4) = 0.0991$$

$$w_4^+ = 0.8 + (-2.225 \times 10^{-3} \times 0.8) = 0.7982$$

$$w_5^+ = 0.4 + (-6.504 \times 10^{-3} \times 0.4) = 0.4026$$

$$w_6^+ = 0.5 + (-6.504 \times 10^{-3} \times 0.8) = 0.5012$$

With the new weights the output has to be calculated again.

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III Year EIE – II Semester 2012-13
TEST -1(Closed Book)

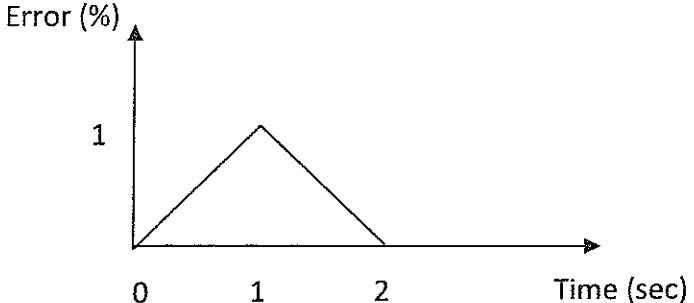
Industrial Instrumentation & Control - INSTR C312

Date: 18.3.2013
Max.Marks:25

Time: 50 Mts
Weightage: 25%

Answer ALL Questions
All questions carry equal marks

-
1. (a) Differentiate between Distributed control system and Hierarchical control system.
(b) Explain the proportional controller action with an example.
 2. Given the error as shown in the figure, plot the output of a proportional integral controller given $K_p=5$, $K_s=1 \text{ S}^{-1}$ and $P_i(0)=20\%$.



3. (a) What are the advantages and disadvantages of hydraulic controllers.
(b) Draw the diagram of a hydraulic proportional controller and derive the expression for the same.
4. An integral control system has a measurement range of 0.5-2.5 V and an output range of 0 to 10 V. Design an electronic integral controller to implement a gain $K_i=4\%(\text{min})$.
5. A proportional pneumatic controller has equal area bellows. If 3 to 15 psi signals are used on input and output, find the ratio of pivot distances that provides a proportional band of 23%.

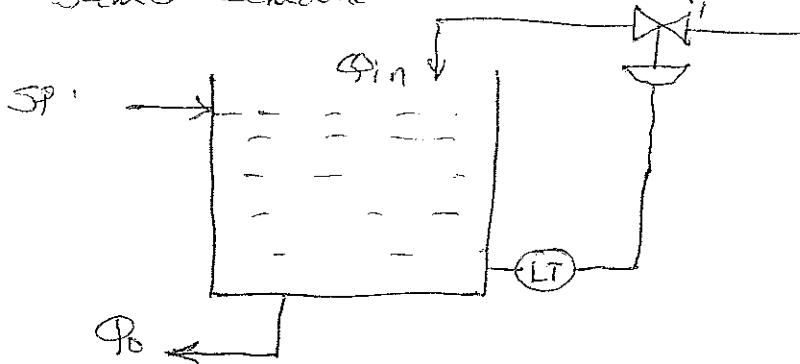
INDUSTRIAL INSTRUMENTATION & CONTROL

TEST 1

1. (a) Distributed control systems: DCS emerged with rapid advances in VLSI and processing capabilities. In this several microcomputers spread all over and assigned with a specific task and mutually linked. Each microcomputer performs its task independently of the other microcomputers in the system. This type of parallel processing provided excellent system response and eliminates the possibility of single point failure crashing the whole system. It has the advantage of upgradation with out disturbing the entire system.

(b) Hierarchical control system: combination of three levels of control namely dedicated digital controllers for process loops, direct digital control for certain process variables and supervisory control constitute a hierarchical system. The upper computers depend upon the lower level devices for process data and lower level systems depend on the higher level systems for more control functions.

(1b) In this there is a continuous linear relation between the value of the control variable and the correction applied. The applied correction is changed by the same amount for each unit of deviation.



The input output relation

$$\Phi_i = \frac{100}{PB} \cdot e + \Phi_0$$

Φ_i — output at any given time

Φ_0 — output when $e=0$

e — error signal i.e. Set point value — Measured Value

P_B — Proportional band in percentage.

In proportional controllers when the control variable deviates from the set value due to momentary disturbance, the controller gives a correction which is proportional to deviation.

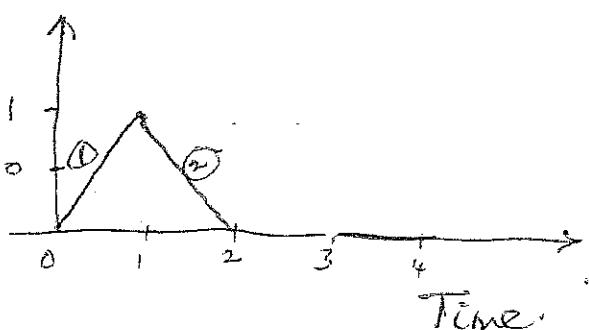
This correction forces the controlled variable towards the set value reducing the error.

Proportional band is defined as % of full scale change in input required to change the output from 0 to 100%.

$$\text{Proportional Gain} = \frac{100}{\text{Proportional Band}}$$

proportional controller produces residual error in (3).
 Controlled variable when a change in load occurs.
 This error is offset. It can be minimized by a
 larger constant K_p which also reduces proportional
 band.

Error %.



$$K_p = 5$$

$$K_I = 1 \text{ s}^{-1}$$

$$P_2(0) = 20\%$$

2.

The solution is obtained from the eqn.

$$P = K_p E_p + K_p K_I \int e_p dt + P_2(0).$$

The error can be expressed as:

$$E_p = t \quad 0 \leq t \leq 1$$

$$= -t+2. \quad 1 \leq t \leq 3.$$

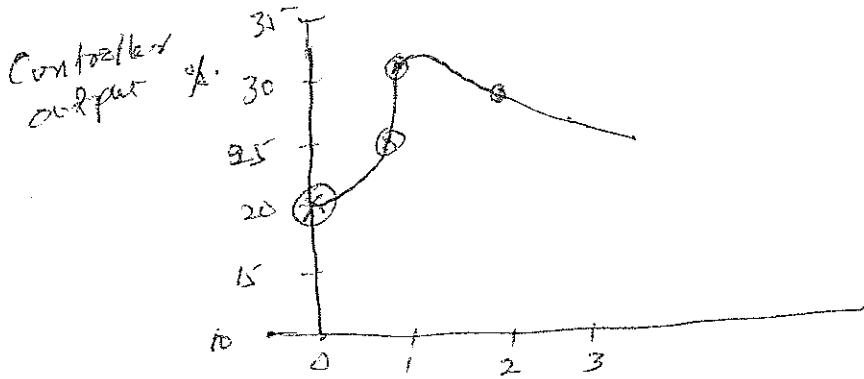
For $0 \leq t \leq 1$.

$$\begin{aligned} P_1 &= K_p E_p + K_p K_I \int_0^t e_p dt + P_2(0) \\ &= 5t + 5 \int_0^t (-t+2) dt + 20 \\ &= 5t + \frac{5t^2}{2} + 20 \end{aligned}$$

$$\begin{aligned} P_2 &= 5(t+2) + 5 \int_0^t (-t+2) dt + 20 \\ &= -5t + 10 - \frac{5t^2}{2} + 10t + 20 = \frac{-5t^2}{2} + 5t + 30. \end{aligned}$$

(4)

t	0	1	2
$P_1 = \frac{5t^2}{2} + 5t + 20$	20	25	-
$P_2 = -\frac{5t^2}{2} + 5t + 30$	-	32.5	30



(3 a)

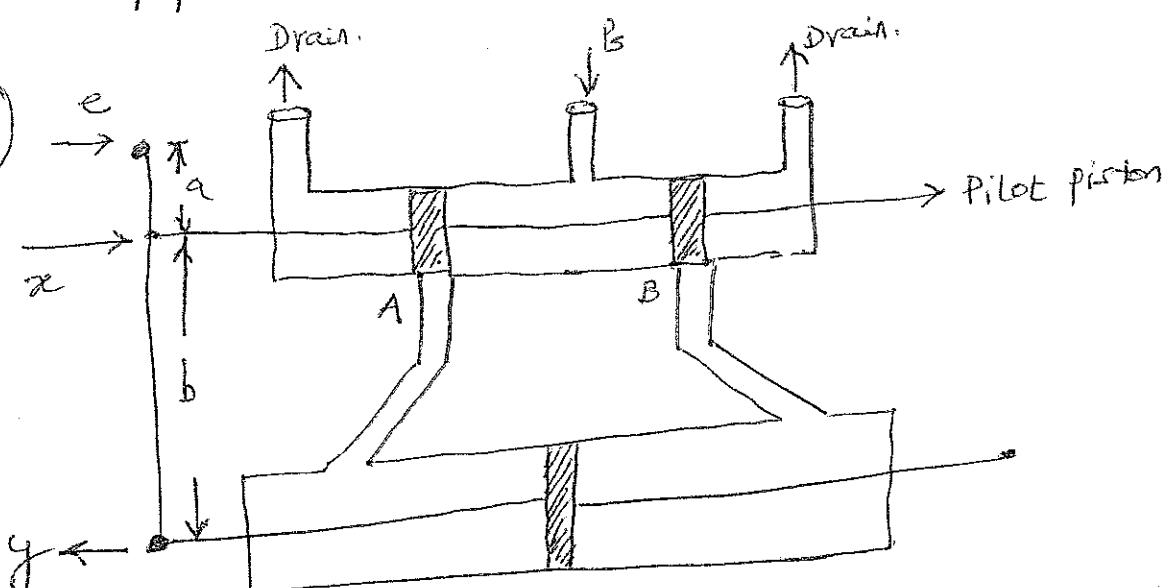
Advantages :

- High range of operating pressures ,
- High speed response
- Power gain is high
- Self lubricating property resulting in better performance and life .
- High concentration of power with in a small dimension .
- Availability of both linear and rotary actuators .
- Can be operated under continuous , intermittent reversing conditions with out any damage .
- Small sized hydraulic actuators can develop large forces or torques .

Limitations:

- Care should be taken to ensure leak free operation.
- It is costly.
- Fire and explosion hazards exist unless fire resistant fluids are used.
- Contamination of oil may disrupt the functioning of the system, so filtering is required.
- Non linear characteristics make the design more complicated.
- Hydraulic systems have poor damping characteristics.
- Improper system may render the system unstable.

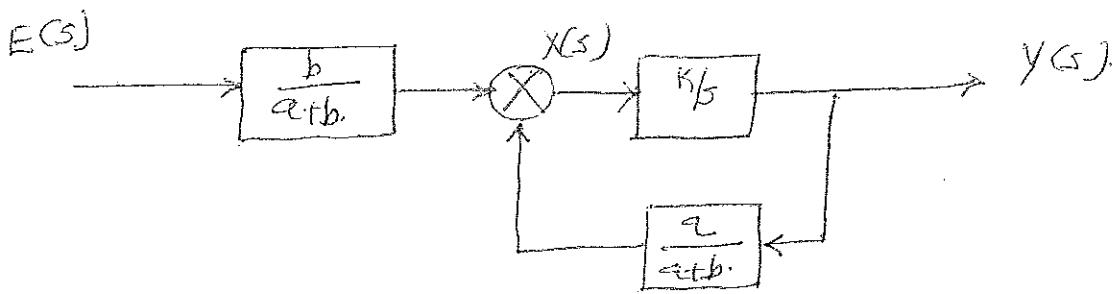
3b



The basic unit of hydraulic system acting as an integral controller can be modified using feedback to convert to proportional controller.

If x moves to the right, valve B is uncovered and the master piston moves to the left. This action continues till pilot piston again covers both A and port B.

(6)



Transfer function

$$= \frac{b}{b+a} \cdot \frac{\frac{K/s}{s}}{1 + K_b \left(\frac{a}{a+b} \right)}$$

$$= \left[\frac{b}{a+b} \right] \left[\frac{K}{1+GH} \right]$$

under normal operating conditions $GH > 1$

$$\frac{Y(s)}{E(s)} = \frac{b}{a} = K_p$$

This is a proportional controller.

(4) The input range = $2.5 - 0.5 = 2V$

output range = $10 - 0 = 10V$

K_I to be converted to seconds.

$$4\% (\% - \text{min}) \left(\frac{1 \text{ min}}{60 \text{ s}} \right) = 0.0667\% (\%-\text{s})$$

$$1\% \text{ of the input for } 1s = (0.01)(2V)(1s) = 0.02V.s$$

$$0.0667\% \text{ of the output} = \left(\frac{0.0667}{100} \right)(10V) = 0.00667V$$

Thus $G_I = \frac{0.00667V}{0.02V.s} = 0.3335 \text{ s}^{-1}$

$$G_I = \frac{1}{RC} = 0.3335 \text{ s}^{-1}$$

$$\therefore RC = 2.9998 \text{ s.}$$

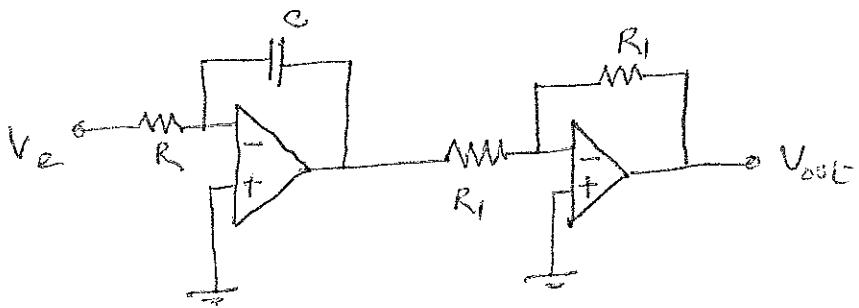
(7)

$$C = 100 \text{ pF}$$

$$R = 29.998 \text{ k}\Omega$$

or $30 \text{ k}\Omega$.

The analog controller circuit



$$\therefore R = 30 \text{ k}\Omega \quad C = 100 \text{ pF}$$

$$R_1 = 1 \text{ k}\Omega$$

(5) Below we have agreed areas.

$$K_p = \left(\frac{x_1}{x_2} \right) \left(\frac{A_1}{A_2} \right)$$

Since $A_1 = A_2$

$$K_p = \frac{x_1}{x_2} \rightarrow \text{Ratio of pivot distances.}$$

$$PB = 23\%$$

$$PB = \frac{100}{K_p}$$

$$K_p = \frac{100}{PB} = \frac{100}{23} = 4.35$$

$$K_p = \frac{x_1}{x_2} = 4.35$$

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III Year EIE – I Semester 2012-13

Industrial Instrumentation & Control - INSTR C312

Date: 10.4.2013

Max.Marks:7

Time: 20mts

Weightage: 7 %

Answer ALL Questions

1. Why is tuning of a controller required.
 2. If process reaction time $T=4.5\text{mins}$, lag= 2.5mins and $\Delta C_p=4$, find K_p for PI controller method for $\Delta P=9\%$.
 3. A process begins oscillations with a 30% proportional band. Find K_p for proportional controller.

4. Show Bode plot and mark Gain margin and Phase margin.

5. Give three disadvantages of cascade control.

6. What is feed-forward control.

7. Draw the diagram to show the ratio control configuration.

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III Year EIE – I Semester 2012-13
QUIZ -2

Industrial Instrumentation & Control - INSTR C312

Date: 10.4.2013

Max.Marks:7

Time: 20mts

Weightage: 7 %

Answer ALL Questions

1. Why is tuning of a controller required.

Tuning is required to achieve :

- Keep the maximum deviation (error) as small as possible.
- Achieve short settling times.
- Minimize the integral of errors until the process has settled to its desired set point.

2. If process reaction time $T=4.5\text{mins}$, lag=2.5mins and $\Delta C_p=4$, find K_p for PI controller method for $\Delta P=9\%$.

$$\text{Reaction rate } N = \frac{\Delta C_p}{T} = \frac{4}{4.5} = 0.89\%/\text{min}$$

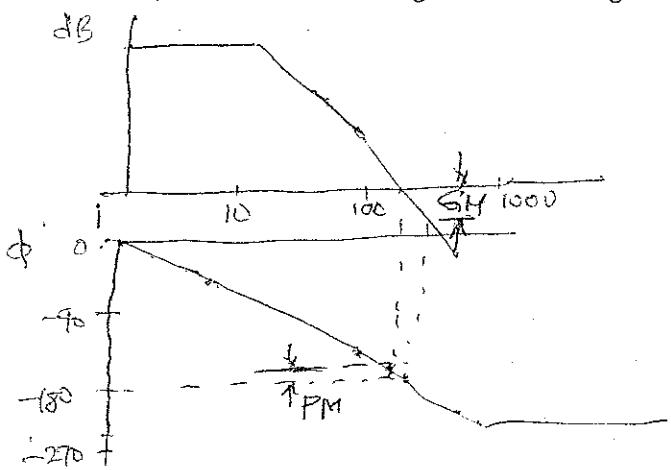
$$\text{For Zeigler Nichols method } K_p = \frac{0.9 \Delta P}{NL} = \frac{0.9 \times 9\%}{0.89 \times 2.5} = 3.64$$

3. A process begins oscillations with a 30% proportional band. Find K_p for proportional controller.

$$30\% \text{ of Proportional band means } K_c = \frac{100}{30} = 3.33$$

$$\begin{aligned} K_p &= 0.5 K_c \\ &= 0.5 \times 3.33 \\ &= 1.65 \end{aligned}$$

4. Show Bode plot and mark Gain margin and Phase margin.



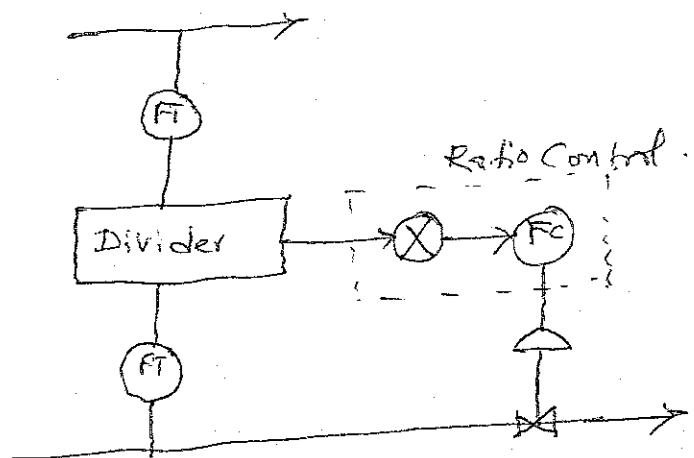
5. Give three disadvantages of cascade control.

- (i) It requires additional measurement to work
- (ii) There is an additional controller to be tuned
- (iii) Control strategy is more complex.

6. What is feed-forward control.

Feed forward control configuration measures the disturbance directly and takes control action to eliminate its impact on the process output.

7. Draw the diagram to show the ratio control configuration.



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III Year EIE – I Semester 2012-13
QUIZ 1

Industrial Instrumentation & Control - INSTR C312

Date: 27.2.2013

Max. Marks:8

Time: 20mts

Weightage: 8 %

Answer ALL Questions

1. State FOUR demands of a control system.
 2. Draw the general process control loop block diagram. Show all the variables.
 3. What is a distributed control system.
 4. Explain any TWO characteristics responsible for time lag.

5. Define proportional band. Give the relation between proportional band and proportional gain.

6. Show the proportional controller response curve for step disturbance in the load.

7. Give the equations for Integral controller and derivative controller.

8. Show the PID control response for step load change.

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QUIZ -1

Industrial Instrumentation & Control - INSTR C312

Date: 27.2.2013

Max. Marks: 8

Time: 20mts

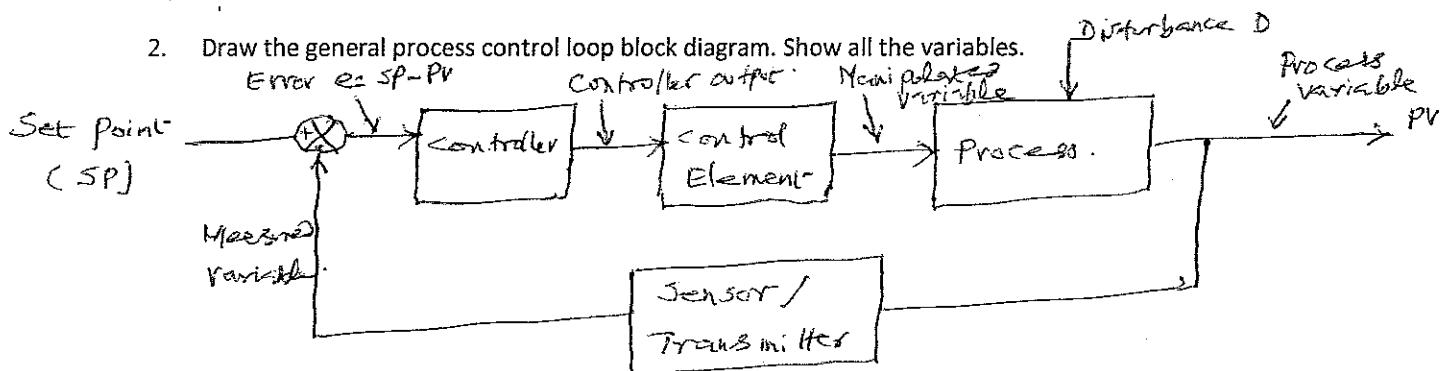
Weightage: 8 %

Answer ALL Questions

- State FOUR demands of a control system.

High reliability and ability, Fast trouble shooting, Easy configuration, Simple operation, High accuracy and reproducibility of variables, flexibility regards to modification and extensions required by the process.

- Draw the general process control loop block diagram. Show all the variables.



- What is a distributed control system.

In this several microcomputers spread over all over and assigned a specific task and mutually linked. Each microcomputer performs its task independently of the other microcomputers in the system. This type of parallel processing provides excellent system response time and eliminates the possibility of single point failure crashing the whole system.

- Explain any TWO characteristics responsible for time lag.

Characteristics responsible for time lag are: Capacitance, Resistance and Dead time.

Capacitance of the process is ability to store energy.
Resistance of the process is ability to resist the transfer of energy.

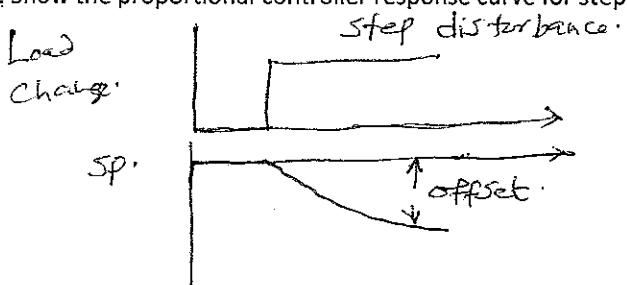
Dead time is the time during which no change takes place.

5. Define proportional band. Give the relation between proportional band and proportional gain.

Proportional band is defined as 1% of full scale change in input required to change the output from 0 to 100%

$$\text{Proportional Gain} = \frac{100}{PB}$$

6. Show the proportional controller response curve for step disturbance in the load.



7. Give the equations for Integral controller and derivative controller.

$$\text{Integral control } P = K_I \int e dt + P_0$$

$$\text{Derivative control } P = K_D \frac{de}{dt} + P_0$$

8. Show the PID control response for step load change.

