Experiment # 6

PID- Controller System

➢ Objectives:

1. To investigate the simple closed-loop proportional control
2. To investigate proportional control system response
3. To investigate the integral action controller on system response
4. To investigate the derivative action controller on system response.

➢ Equipment:

PCS 327 DC Power Supply, Function generator , Digital Oscilloscope TDS220, wires, TK 286 and Digital Multimeter.

➢ Introduction:

A closed-loop control system is one in which the output signal has a direct effect upon the control action. Figure (6.1) illustrates the block diagram of a simple closed loop proportional control in which:

$V = k1 * \delta$

Where V is the control signal

K1 is the prop. Control gain

δ is the deviation or error signal

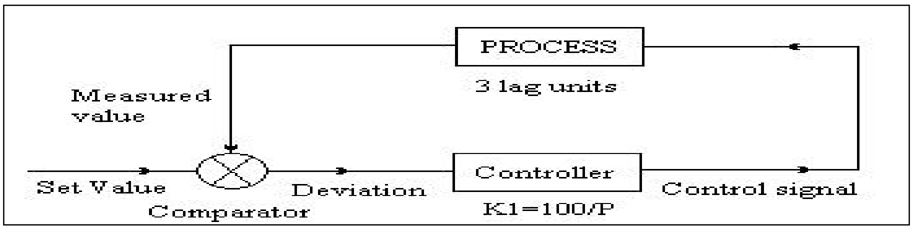

Figure (6.1)

The actuating error signal, which is the difference between the input and the feedback signal, is fed to the controller so as to reduce the error and bring the output of the system to a desired value. In other words feedback can improve the performance of a system by making it faster, more accurate or responsive over a wide range of frequencies. In each case amplification is necessary. For amplification we will use proportional control action which is an amplifier with an adjustable gain. The combination of amplification and feedback my also make the system unstable. The system is unstable if any poles of the overall transfer function are on the (jw) axis or in the right half of the complex frequency plane.

In an ideal system the measured value and the set value should be the same and under steady state condition the deviation should be zero. What is required is an alternative signal to be fed into the main amplifier of sufficient size to provide an output if a steady state deviation exists.

Such signal can be provided by an integrator which gives a constantly increasing output for a steady value input.

By suitable adjustment of the integration section output, the steady state deviation can be reduced to zero. Too much integral term however causes the system to go into oscillation.

- **<u>Procedure:</u>**
- **<u>PART A:Simple Closed Loop Proportional Control:</u>**

1. Connect the elements on the front panel of PCS 327 so that you have a closed loop prop. Control with process of three lag units. The proportional band set to 100% and the non-linear unit set to linear position.

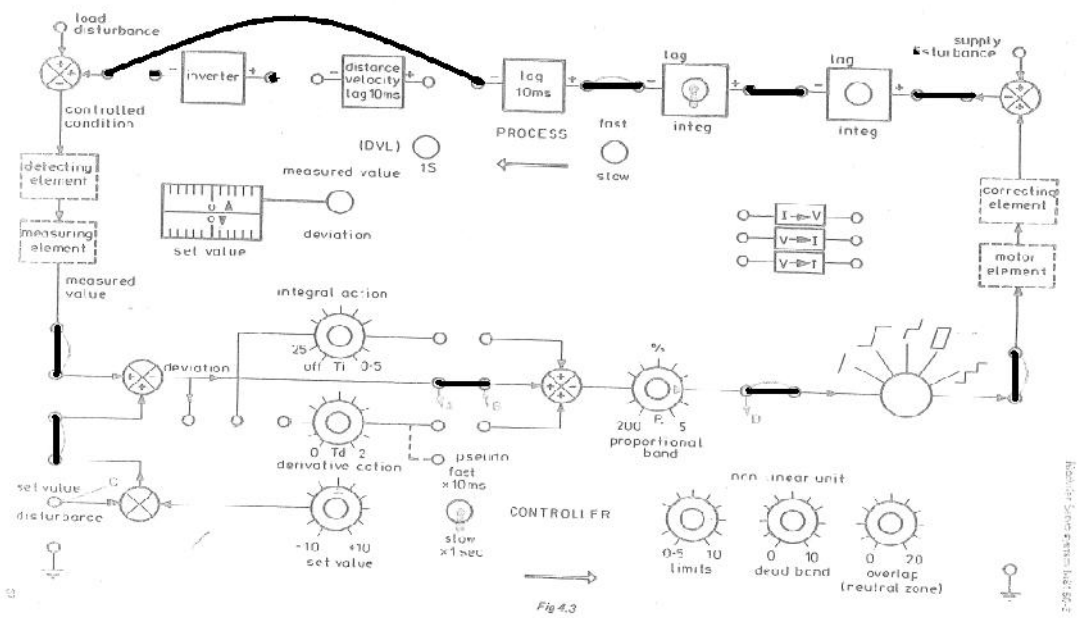

Fig.(6.1)

2. Adjust the set value control potentiometer to give the set values as shown in the table. Read the set values as indicated at the meter. For each of these values read measured and deviation values as indicated at the Measured/Deviation meter by the help of the switch.

Table (6.1)

Set Value (V)	Measured Value (V)	Deviation (V)
2		
4		
6		
-2		
-4		
-6		

3. Apply to the load disturbance socket voltage of 1.5V dc and repeat the above procedures.
4. Leave the circuit connected for the following part (B).

Questions:

1. Do the set and measured values appear at the same time? Why?
2. Why is the measured value less than the set value?
3. Describe briefly what happens to the signal through the elements of the closed loop system.
4. What happens immediately to the set disturbance signal at the summing element?
5. Compare the position of the set value potentiometer and the set value on the meter with and without the dc disturbance value?

➢ PART B: Proportional Control System Response:

1. Apply to the set value disturbance socket a square wave signal 5Vp-p at 2HZ. Compare the reading of the measured and set value meters.
2. Connect the measured value to the oscilloscope, draw the measured value, with both process and controller switches once at Fast and the second at Low for P.B at 100%.
3. Repeat step (2) for the deviation.
4. Change the P.B gain once to 50% and then to 30% and repeat steps (2, 3).

Questions:

In view of the above experiment and what you have seen in the control courses, what can you say about proportional control, its advantages and disadvantages?

➢ PART C: Proportional + Integral Control:

1. Connect the front panel of the PCS327 using 2 lag units.

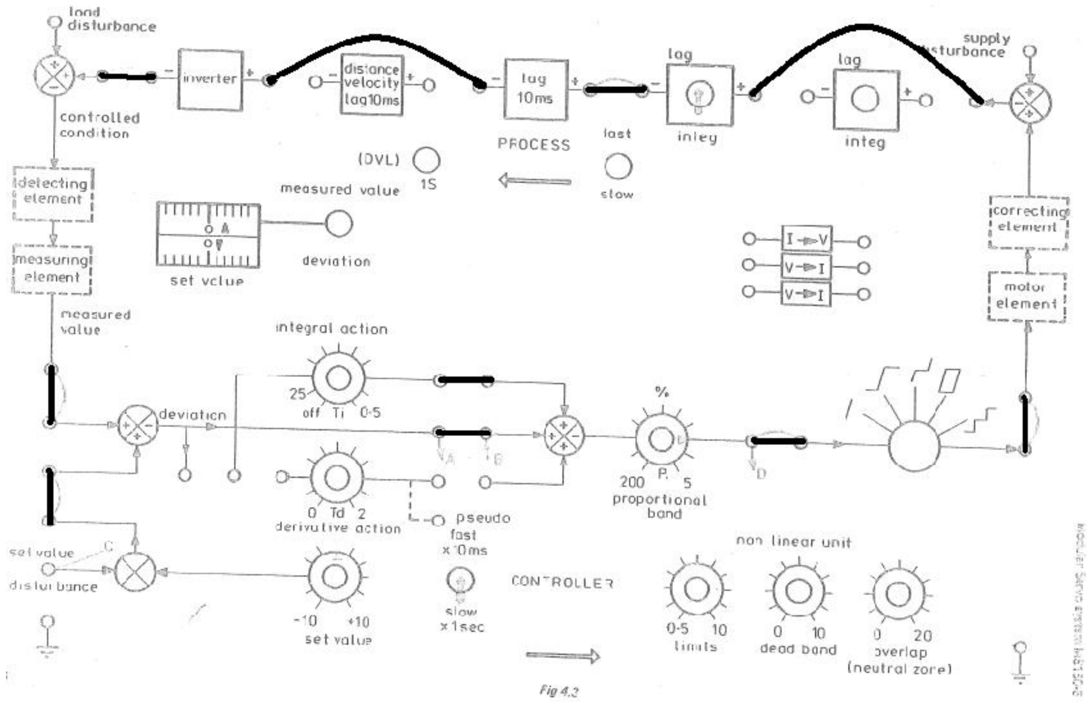

Fig.(6.2)

2. Apply to the set value disturbance socket a square wave of 5Vp-p at 2HZ.
3. Adjust the proportional band control to 50% or until the system settles without overshoots.
4. Monitor deviation socket. And slowly reduce the setting on integral action control unit until deviation falls to zero.
5. Note the effect of the integrator on the system, note also the difference the measured and the set values.
6. Reduce integral action control to 10 and note the response of the system, repeat for Ti of 15.
7. For each integral action control set, compare between mathematical results and experimental results.
8. Repeat the above procedure for 3 lag units.

➢ PART D: Proportional + Derivation Control:

1. Replace the integral action unit for part c by the derivative action unit.
2. Repeat all the procedure of part c and notice the effect of the derivative action unit.
3. Compare between your experimental and theoretical results.

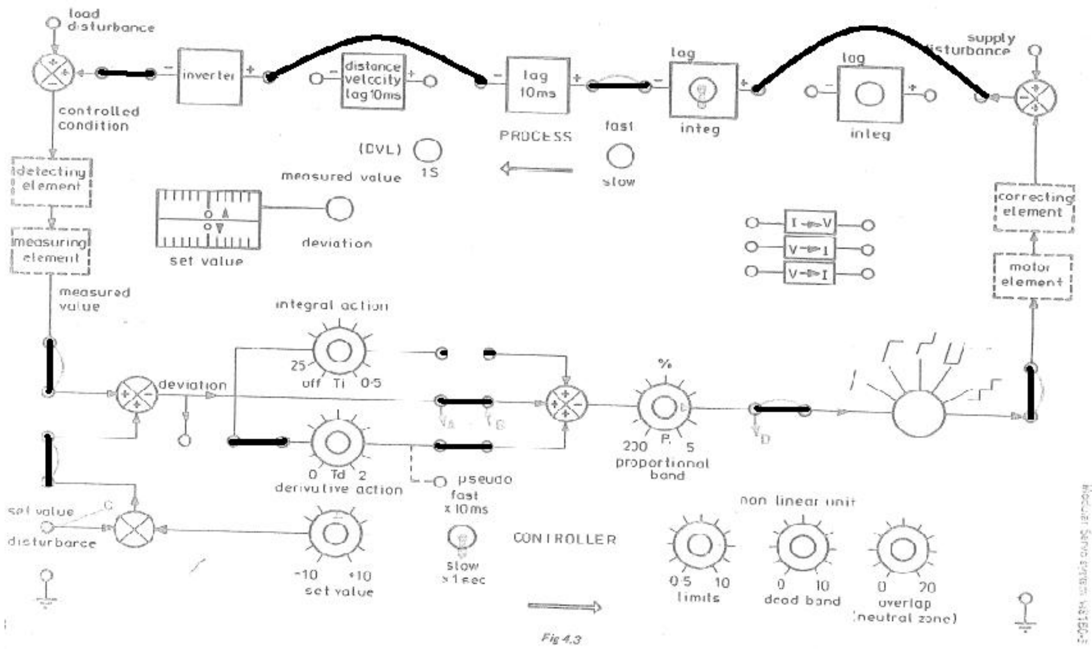

Fig.(6.3)

➢ PART E: Three-Term Controller (P+I+D) :

1. For the same circuit of the above part connect the integral and derivative action units with 3 lag units.

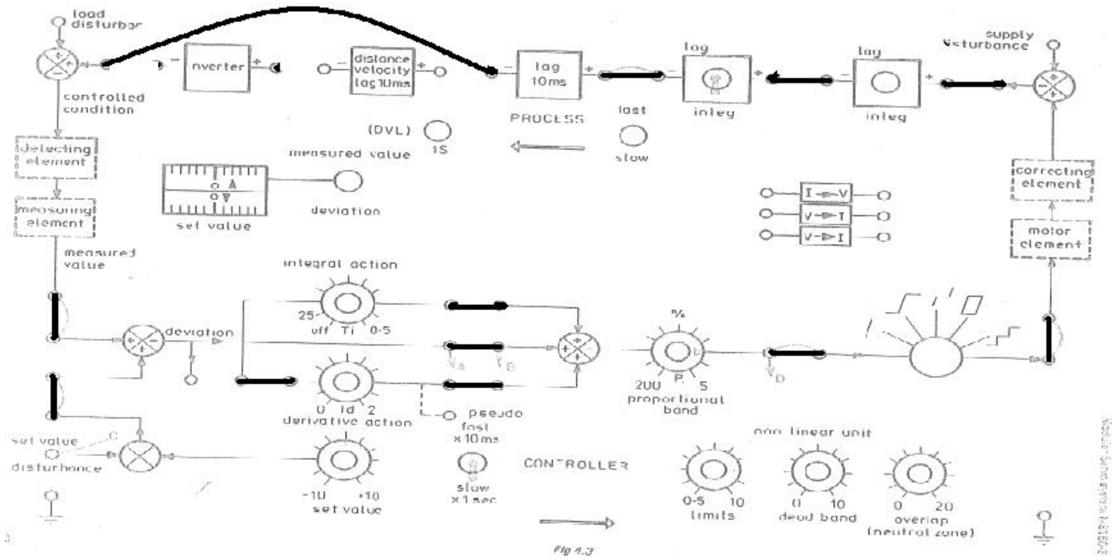

Fig.(6.4)

2. Adjust integral action until steady state deviation is zero.
3. After a disturbance note the steady state deviation and number of overshoots before the system settles.
4. Slowly increase the derivation action control and note the effect this has upon the system response, also check if this has any effect upon the steady state deviation.
5. Change one controller action keeping the two others constants and see the effect upon the over shoot, settling time and steady state error.

Questions:

From your results, what does the effect of the derivative action upon:

a. Steady state error.
b. Settling time.
c. Number of oscillations.