

Total number of printed pages – 7

B. Tech
CPEN 5401

Eighth Semester Examination – 2008

PROCESS CONTROL INSTRUMENTATION

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory
and any **five** from the rest.

The figures in the right-hand margin
indicate marks.

1. ✓ Answer the following questions : 2×10
- (a) What is the difference between supervisory control and DDC (Direct Digital Control) ?
 - (b) ✓ A position control system used with a machine tool has an amplifier in series with

P.T.O.

a valve-slider arrangement and a feedback loop with a displacement measurement system transfer function :

Amplifier 20 mA/V

Valve slider arrangement 12 mm/mA

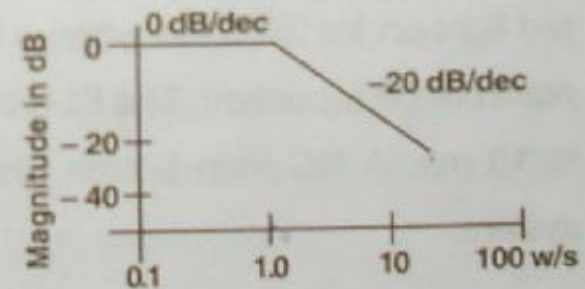
Measurement system 3.0 V/mm

What is the overall transfer function for the system ?

- (c) A system with a transfer function $\frac{k}{\tau s + 1}$ is subjected to a step input. State an equation describing how the output of the system will vary with time.
- (d) What are the different elements are required for Final Control Operation of a control system ? Give example.
- (e) Draw the signal pressure versus gap distance characteristics of a nozzle/flapper system.

- (f) An actuator has a stem movement which is full travel is 30 mm. The minimum flow rate is 2 m³/s and maximum flow rate 24 m³/s. What will be the flow rate when stem movement is 20 mm and it is mounted as (i) Linear valve (ii) Equal percentage valve.

- (g) Draw the characteristics of a two position controller with neutral zone and give one example of it.
- (h) If a step input error is given to a PI controller. What will be the controller output ? Draw it.
- (i) What do you mean by "Tuning of a Controller" ?
- (j) Bode diagram shown in the figure. What will be the transfer function of this system ?



2. (a) What do you mean by action of control valve ? Draw the flow characteristics of different types of control valve. How you will choose the size of a control valve ? 6

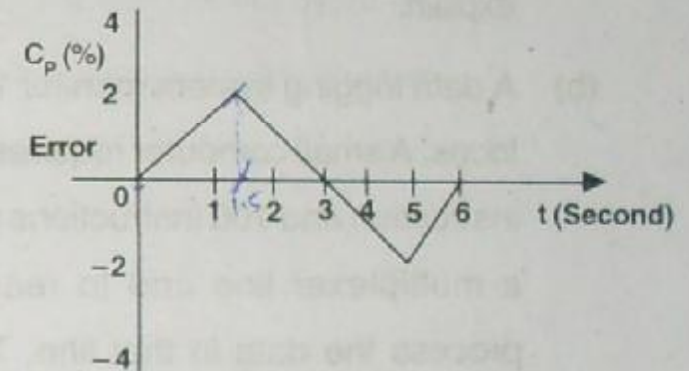
(b) Explain with diagram the operation of Spool valve with hydraulic cylinder. 4

3. (a) A counter is to be used to count objects in the conveyor delivery system. Show how a counter can be set up to count 200 objects and then turn off the conveyor motor. What is the maximum conveyor speed to assure that no object will be missed in the count if the objects are 1 cm apart ? The scan time is 30 ms. 5

(b) Show how a timer can be used to turn a red light on for 2500 ms when a No start push button is pushed. The PLC timer tick is 10 ms. A NC stop button resets the system. 5

4. (a) Write down the describing equation of P, PI and PID controller. What is the proportional Band (PB) of a P-controller ? What is the motivation for addition of Integral Control Mode ? 6

(b) A PI controller has $K_p = 2.0$, $K_i = 2.2 \text{ s}^{-1}$ and $P_1(o) = 40\%$. Plot the output for an error given in figure below : 4



5. (a) Design a three-mode controller using operational amplifiers and which will have a 40% proportional band, $K_i = 0.08 \text{ s}$ and $K_D = 50 \text{ sec}$. Input and output are equally scaled voltages. 6

- (b) An integral control system will have a measurement range of 0.4 to 2.0 V and an output range of 0 to 6.8 V. Design an op-amp integral controller to implement a gain of $K_i = 4\%/(\% \cdot \text{min})$. Specify the values of G_i , R and C. (G_i – Integration Gain). 4
6. (a) Draw the block diagram representation of a data-logging system using computer and explain. 6
- (b) A data logging system monitor 12 analog loops. A small computer requires $4 \mu\text{s}$ per instruction and 100 instructions to address a multiplexer line and to read in and process the data in that line. The ADC performs the conversion in $30 \mu\text{s}$. The multiplexer requires $20 \mu\text{s}$ to select and capture the value of an input line. Calculate the maximum sampling rate of a particular line. 4

7. (a) What are the different tuning rules followed for getting best performance of a control system? Explain any one of them. 6
- (b) In Ziegler-Nichols tuning method, a process begins oscillation with a 30% proportional band in an 11.5 min period. Find the nominal three mode controller setting. 4
8. Write short notes on : 5x2
- (a) Cascade Control System
- (b) Feed Back Control System.