CE203/SC301 Tutorial 6: Proportional Control

1) A proportional control system is used to regulate the temperature of a chemical solution flowing through a pipe. The output range of the controller can vary between -5V and +5V. The temperature sensor used for sensing the temperature produces a voltage between 2V and 7V, this corresponds to the temperature 0^oc to 50^oc.

(a) If the nominal output of the controller is set at 1V (corresponding to zero controller output), what is the nominal output level (P_o) of the controller.

(b) At this nominal setting, the feedback signal has a value of 4.5V. What is the corresponding nominal temperature?

(c) Because of an increase in the flow rate, the temperature of the solution starts to drop. So the controller has to increase its output voltage in order to maintain the temperature. If the controller output is 2.5V at steady state, find the new controller output in percentage (p).

(d) If the system has a proportional gain constant of K_p = 5% per %, calculate the resultant offset error (e_p) of the system and hence the actual temperature.

(e) If the proportional gain constant is increased to K_p = 10% per %, what is the actual temperature if the controller output is 2.5V?

(f) With K_p = 5% per %, find the proportional band of the system and calculate the maximum error (%) before the controller loses control of the temperature?

2. A digital proportional controller is to be implemented using an 8-bit microcontroller. The requirements are:

K_p = 5
Nominal Setpoint = 122
Maximum Output = 200
Maximum Input Range = 0 to 240
Nominal Output Fraction = 0.45

(a) Develop the discrete control equations required to implement the algorithm.

(b) What is the output (in decimal number) if the feedback input = 100?