

A process that can be modeled as a First Order with Dead Time (FODT) system is controlled using a PI controller. The control valve and measurement devices have negligible dynamics and steady state gains of 0.5 and 1 respectively. A control engineer designed the PI controller by both Z-N method of continuous cycling and IMC and obtained the following values.

- i) Find the parameter values of the process transfer function.

[Z-N PI relation :  $K_c = 0.45K_u$ ;  $\tau_I = P_u/1.2$ ]

Method	$K_c$	$\tau_I$
Z – N	0.3426	14.2546
IMC-PI	0.2	10.0

- ii) Design a IMC controller for the process for regulatory control.

2. Design a conventional controller for the process  $g(s) = \frac{2.0}{(5s+1)(2s-1)}$  using IMC approach.

3. The transfer function relating process temperature T to Cooling water flow rate  $F_w$  in an open loop unstable chemical reactor is

$$G_p(s) = \frac{-0.7(^{\circ}\text{C} / \text{liter})}{(s+1)(1.5s-1)}$$

where the time constants are in minutes. The

temperature measurement has a dynamic first order lag of 30 seconds.

The range of the analog electronic (4 to 20 mA) temperature

transmitter is 20<sup>0</sup> to 100<sup>0</sup>C. The Air-to-Close control valve on the

cooling water line has linear installed characteristics and passes 500

liter/min when wide open. Design a PID controller for this system. [Z-

N tuning relations :  $K_c = 0.6K_u$  ;  $\tau_I = P_u/2$  ;  $\tau_D = P_u/8$  ;]

4. In a steam-heated exchanger, the steam flow rate is manipulated to control the outlet process fluid temperature. The heat exchanger can be modeled by a 1st order with dead time process having time constant 5 min and dead time 3 min respectively. For each kg/min input of steam flow rate, the process fluid temp is changed to  $4^{\circ}\text{C}$  at steady state. An electronic temperature transmitter (range 0 -  $160^{\circ}\text{C}$ ) is used to measure the process fluid temperature with negligible lag in measurement. The pneumatic linear characteristic control valve in the steam flow line allows 32 kg/min of steam when wide open. An electronic PI controller is used for controlling purpose.

(i) Should the control valve be A-O or A-C? Justify your answer

(ii) What is the direction of controller action(ribose/direct)?

(iii) Draw the block diagram of the process mentioning the input and output signal range and transfer functions for individual block. Include any missing block, if not stated above.

(iv) Find the tuning parameters of the controller using direct synthesis approach in terms of desired closed loop time constant.