Instructions

1. Open book test
2. Exam time: 45 min [Extra time: 15 min]
3. Keep your video ON
4. Answer all questions
5. Need to submit handwritten answer script (scanned)
6. Send answer script to: sonadhulo@gmail.com

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Test 2

Course No.: CH 31011 **Max. Time**: 45 min (Extra: 15 min)

Course Title: Instrumentation and Process Control **Total Marks**: 25

Q1. The bottoms temperature of a distillation column, in ^{0}C (represented as y in deviation variables) is controlled by manipulating the steam flow rate to the reboiler, in lb/hr (represented as u_1 in deviation variables). This purely feedback control strategy is shown in Figure 2. An approximate transfer function model for this process is given as:

$$\bar{y}(s) = \frac{0.25}{(10s+1)}\bar{u}_1(s)$$ **[3+(3+5+2)+(3+4+5) = 25]**

However, the steam flow rate itself depends on the percent valve opening (represented as u_2 in deviation variables), and the steam supply pressure, in psi (represented as d_1 in deviation variables) which is known to fluctuate in an unpredictable, but measurable, fashion. These process variables are related according to the following approximate model:

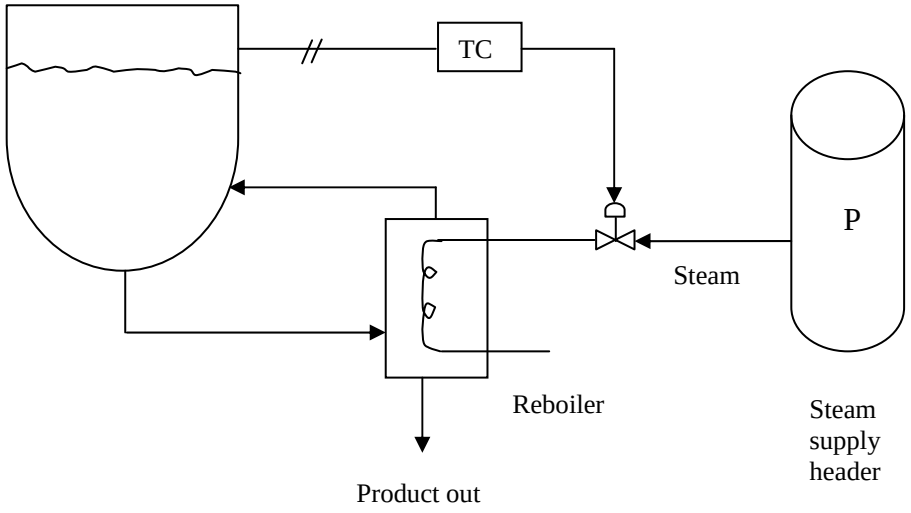

Figure 2: Feedback control of a distillation column's bottom temperature.

$$\bar{u}_1(s) = \frac{2.2}{(2s+1)}\bar{u}_2(s) + \frac{1.5}{(0.5s+1)}\bar{d}_1(s)$$

(a) Develop the block diagram for the feedback controlled process exactly shown in Figure 2.

(b) Cascade control is a popular strategy for dealing with the control problems related to such steam pressure fluctuations. Draw a block diagram for this process under such a cascade control strategy; include all the transfer functions (and the suitable controllers), and label all the signals.

(c) Because the steam supply pressure is measured, it is also possible to configure this process for feedforward-feedback control instead of cascade control. Reconfigure the process for this new control structure, draw a block diagram showing all transfer functions, and obtain the expression(s) for the feedforward controller to be implemented.