BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 12.01.2012 Time: 3Hours M.M = 80 (40%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Write the ID No. on all the graph sheets
3. Total No of Pages.3, No of Questions.8
4. Answer all the questions.

1. Draw the Bode plot (in the graph sheet) for the open loop transfer function with the following dynamic components:

$$G_p(s) = \frac{50}{s(1+0.2s)(1+0.1s)} \quad ; \quad G_f(s) = 1$$

and determine (1) gain cross over frequency (2) phase cross over frequency.
(Assume Lower frequency = 0.1 rad/ sec, Higher frequency = 20 rad/sec) [10M]

2. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{1}{s(1+s)(1+4s)}$

Draw the polar graph (in the graph sheet) and determine (1) Gain margin (2) Phase margin
(Assume the frequencies as 0, 0.2, 0.25, 0.4, 0.6, 0.8, 1.0, 10 rad/sec) [10M]

3. A system is shown in Figure1.
(i) In absence of derivative feedback (a=0), find ξ and w_n.
(ii) Find a to increase ξ to 0.7.
(iii) Find M_p in both cases. [10M]

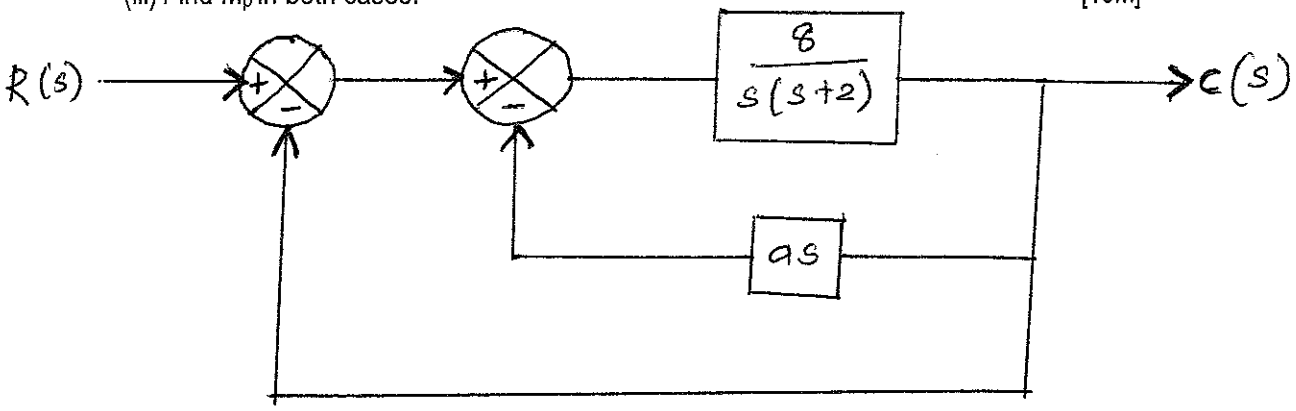


Figure1

4. The characteristics equation of the feedback control system is $s^3 + 3k\ s^2 + (k+2)s + 4 = 0$, Using Routh criterion method;

(i) Find the range of the proportional gain K, that produce stable (if it is possible).
(ii) Determine the value of K so the system is marginally stable.
(iii) Find the frequency of the sustained oscillation [10M]

5. Develop the mathematical model and find the degrees of freedom for the stirred tank heater shown in Figure 2. [10M]

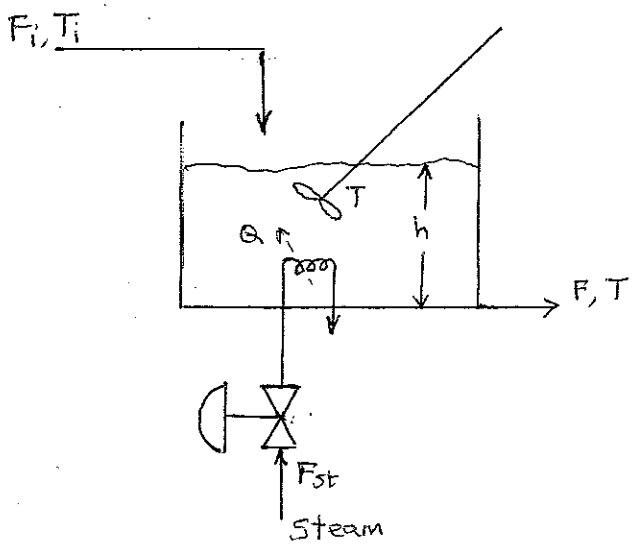


Figure 2

6. Determine the overall transfer function for the system shown in Figure 3. [10M]

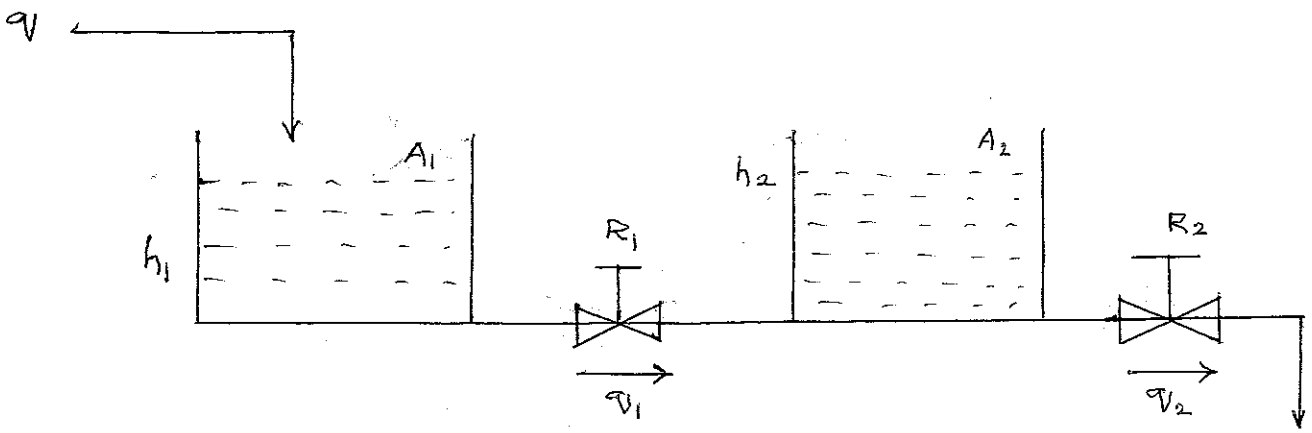


Figure 3

7. Find the total no of variables, total no of equations & the degrees of freedom for the binary distillation column shown in Figure 4. [10M]

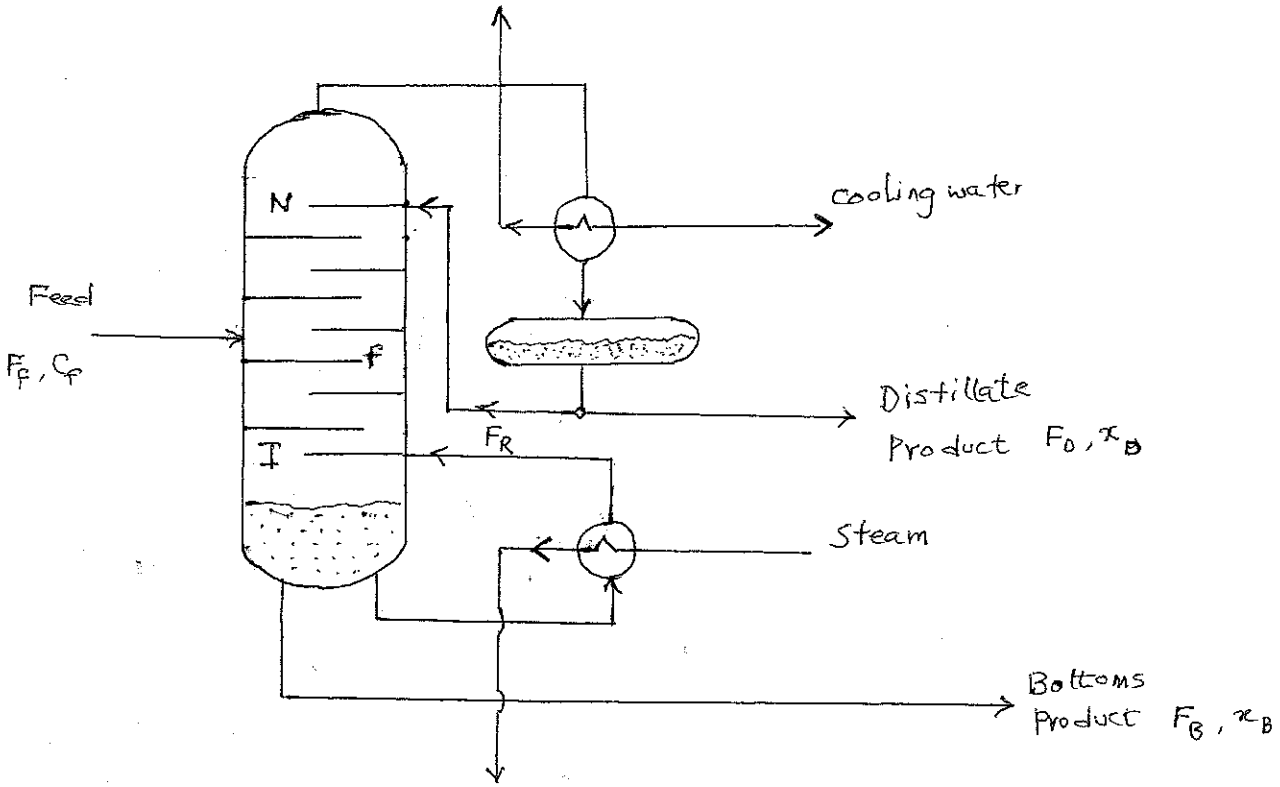


Figure 4

8. (a). What do you mean by derivative kick and proportional kick in PID controller? How do you eliminate it? [5M]

(b). What is ratio control system and explain the different configurations. [5M]

ALL THE BEST

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
TEST II / (Open Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 22.12.2011 Time: 50 Minutes M.M = 20 (20%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.
3. Text book and hand written class notes are allowed.

1. Inflow to a tank having area A is m,(manipulated variable) and outflow q_0 is through a resistance R. Load is downstream head u. Design a feedforward – feedback control configuration for this system. The measuring elements have first order transfer functions with charactering parameters as unity; final control element has unity transfer function. A proportional controller having gain K is in place to provide feedback. Draw the block diagram, and express height in tank in terms of set point and disturbance. [6M]

2. Sketch the polar plots for the given transfer functions: [2+2M]

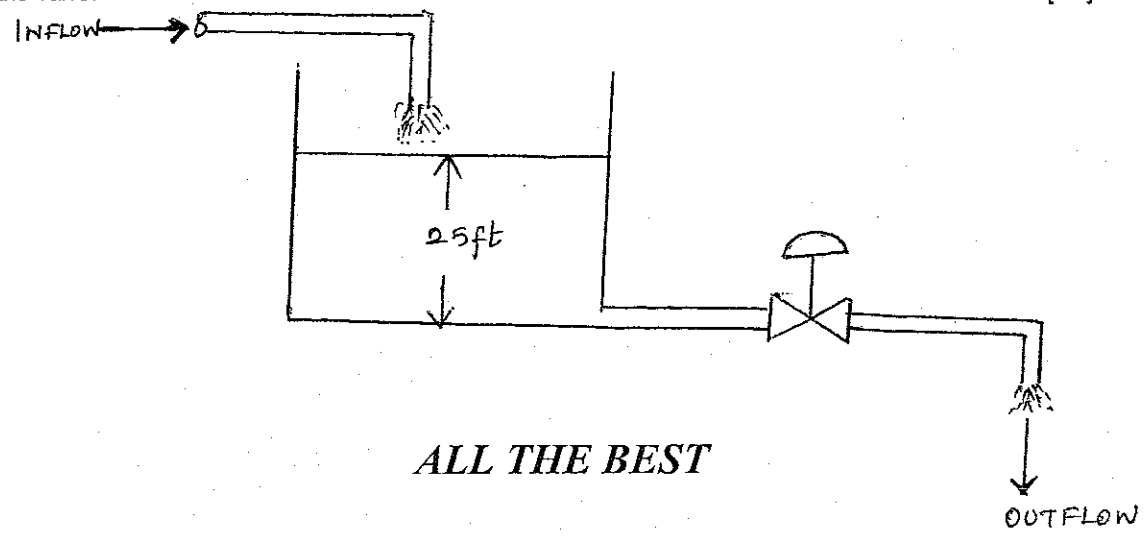
(a) $G(s) = \dfrac{1}{s^2(1+sT_1)(1+sT_2)(1+sT_3)}$ (b) $G(s) = 1+sT$

3. Sketch the bode plot for the given open loop transfer function with the following dynamic components:

$$G_p(s) = \frac{5}{s(1+0.2s)(1+0.02s)} \quad ; \quad G_f(s) = 1$$

And determine (1) Gain cross over frequency (2) Phase cross over frequency.
(Assume Lower frequency = 0.1 rad/ sec; Higher frequency = 100 rad/sec) [7M]

4. A control valve regulates the liquid flow of a tank. The water level is controlled in the tank at a level of 25 feet by regulating the outflow. The measured inflow varies from 0 to 120 gallons per minute. Calculate C_v for the valve. [3M]



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BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
TEST I / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 03.11.2011 Time: 50 Minutes M.M = 25 (25%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1.Develop the mathematical model for the system shown in Figure 1. What are the state variables for this system and what type of balance equations have you used? All the flow rates are volumetric and the cross sectional areas of the three tanks are A_1, A_2 and A_3 (ft^2) respectively. The flow rate F_5 is constant and doesn't depend on h_3, while all other effluent flow rates are proportional to the corresponding hydrostatic liquid pressures that cause the flow. [6M]

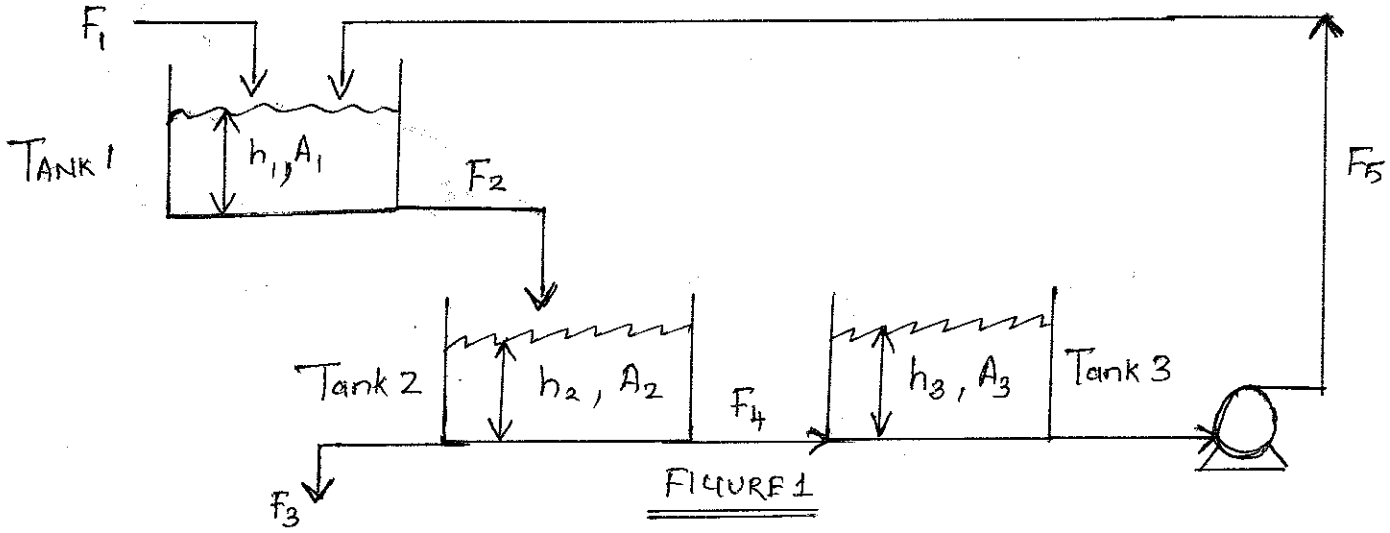

FIGURE 1

2. The open loop transfer function of a unity feedback control system is given by $G(s) = k_c / (s+2)(s+4)(s^2+6s+25)$.By applying the Routh criterion, discuss the stability of the closed loop system as function of k_c .Determine the value of k_c which will cause sustained oscillation in the closed loop system.? [4M]

3. A positional control system with velocity feedback is shown in Figure 2. What is the response C(t) to the unit step input. And also find c(t) in time domain by constructing right angle triangle. Given that $\xi = 0.5$. Calculate rise time, peak time, maximum overshoot and settling times. [10M]

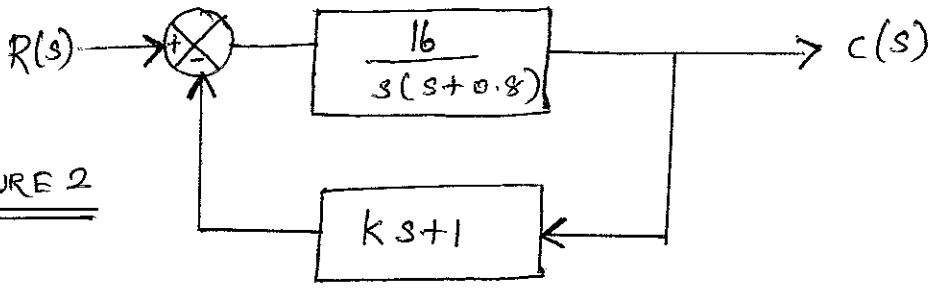

FIGURE 2

4. For the Figure 3, find the transfer function of the process in terms of deviation variable. And also identify what is the order of the given process. [5M]

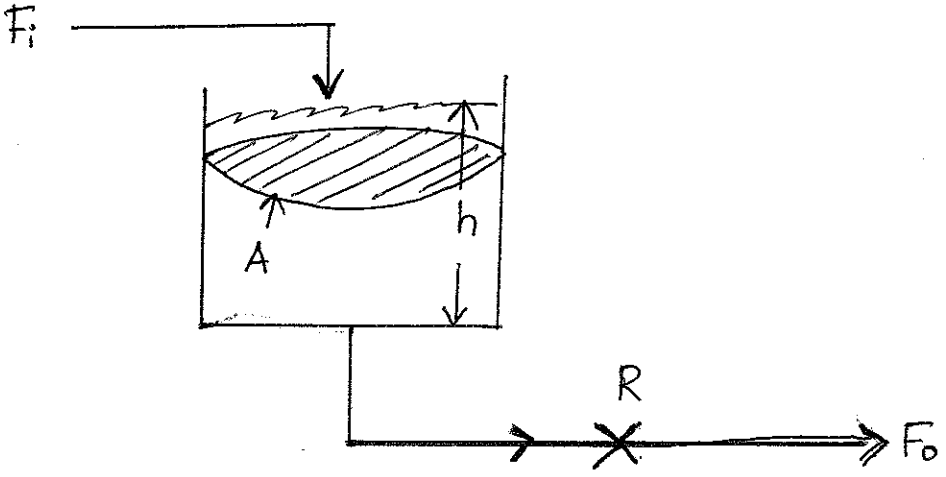

FIGURE 3

ALL THE BEST

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2011-2012
QUIZ II/ (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 12.12.2011 **Time: 20 Minutes** **M.M = 14 (7%)**

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1. Consider the mixing process shown in Figure1. Develop two alternative feedback loops for each of the following cases.
(a) Control the liquid level in the tank
(b) Control the concentration of A in the tank
(c) Control the liquid temperature in the tank. [3M]

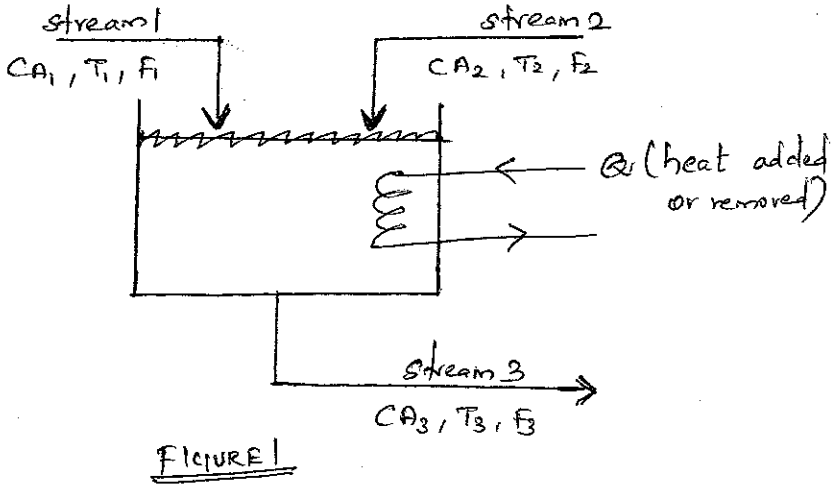

FIGURE 1

2. Mention the second order Pade approximation for exponential term. [1M]

3. Why the processes with dead time are difficult to control? [1M]

4. Inverse response otherwise called as..... [1M]

5. What is the transfer function of parallel PID controller with proportional and derivative mode weighing? [2M]

6. An integral controller is used for temperature control in a range of 0 to 250 °C with a set point of 150°C. At zero error, the controller output is 20%. Rest rate is -0.1%/ sec per %error. If temperature jumps to 180 °C, calculate the controller output after 5 seconds. [3M]

7. Calculate C_v of the valve for the system shown below. The measured inflow varies from 0 to 120 gallons per minute. [3M]

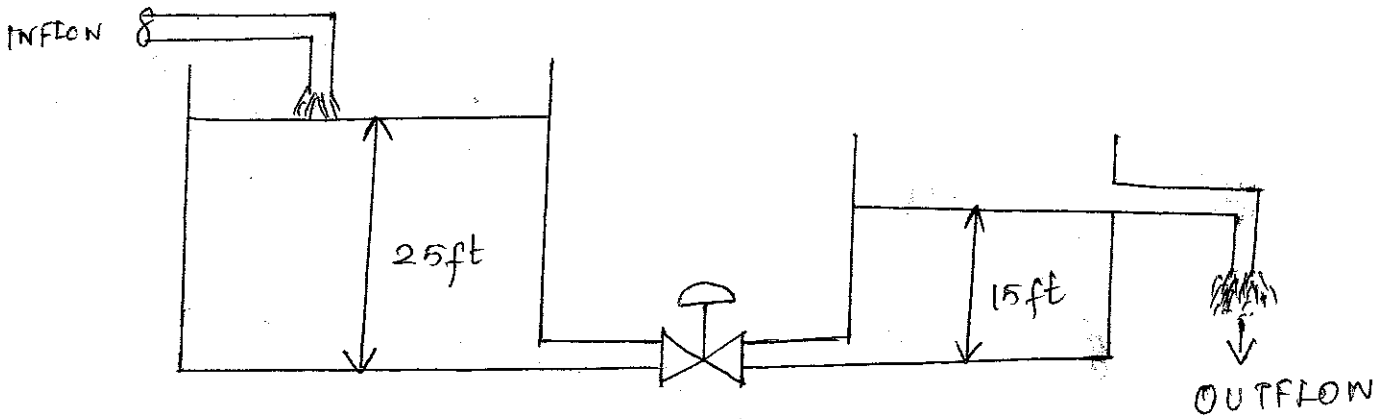

FIGURE 2

Name: ID No:

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Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 03.10.2011 Time: 20 Minutes M.M = 16 (8%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1. A steam turbine drives a compressor (Fig.1) whose load can change with time. Small variations in the shaft speed of the turbine are controlled through the use of a fly ball speed governor. For this system: (a) Identify all the external disturbances. [8 M]
(b) Identify all the available manipulated variable.
(c) Determine the basic control objective
(d) Suggest a feedback control system that can be used to satisfy the control objective.

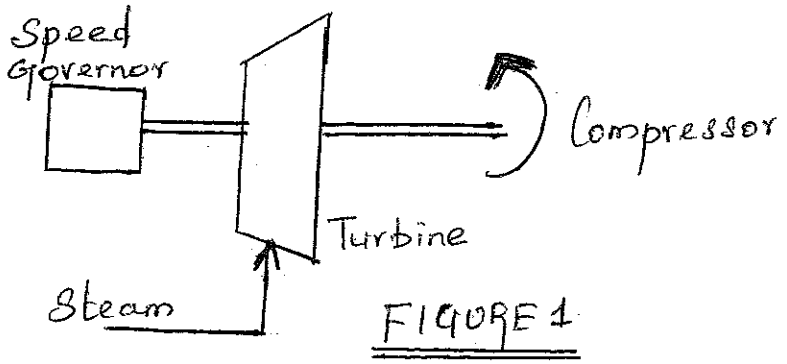

FIGURE 1

2. In Fig.2 the distillation configuration for the separation of benzene from toluene is given. The feed to the distillation comes from the reactor, where toluene has been hydro dealkylated to produce benzene.

Toluene $+H_2$ ..... Benzene $+CH_4$

after the excess H_2 and the produced CH_4 have been removed in a flash unit. For the distillation system,

(a) Identify all the control objectives(make sure that you have included all the operational objectives)
(b) Identify all the external disturbances.
(c) Identify all the available measurements.
(d) Identify all the manipulated variables. [8M]

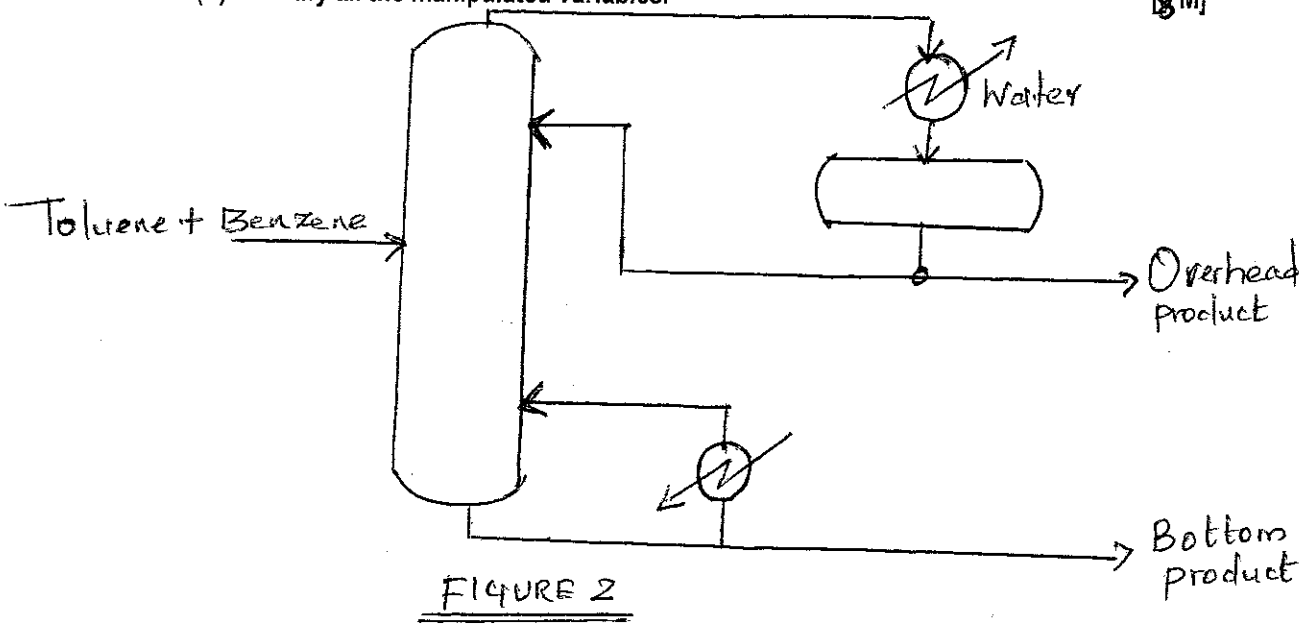

FIGURE 2