Second Exam
CM 3310
March 28, 2002 7:30-9:30pm
Open Books, Open Notes

Name:____ **Box No.** __________

1. (25 pts) An on-off control was design for a process with output (x) and input (u) and turned on after t>5 mins. The plots of both output and input are shown in Figure 1 to be used for the autotuning method. From these plots determine the PID settings of K_c, τ_I and τ_D. (Note: the process has negative process gain.)

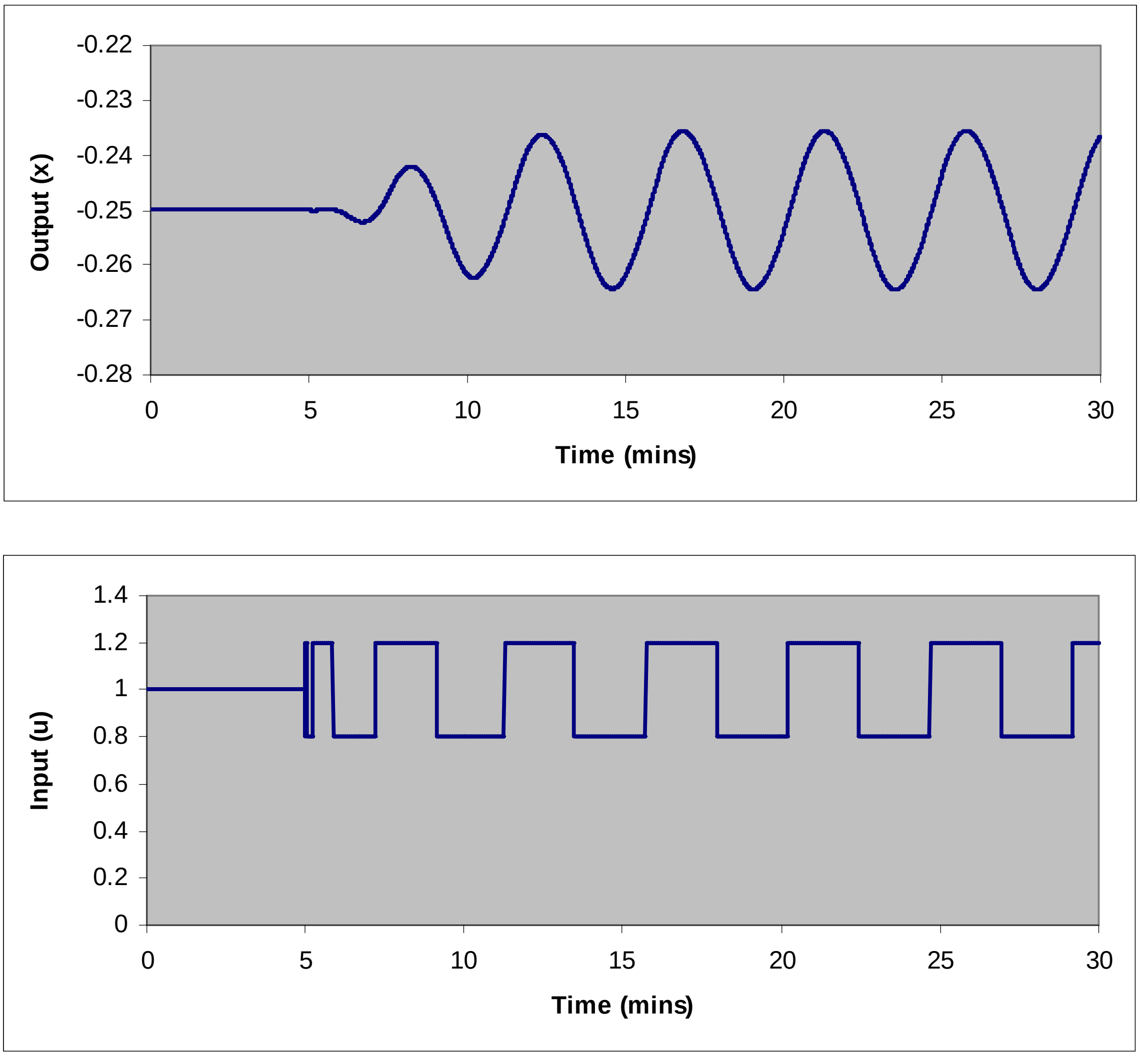

Figure 1.

2. (25 pts) After linearization and letting P denote perturbation variables around the initial steady state, the model for the pressures in the two pressure vessels in series (see Figure 2) are given by

$$\frac{dP_1}{dt} = \alpha_1 (P_0 - P_1) - \alpha_2 (P_1 - P_2)$$
$$\frac{dP_2}{dt} = \alpha_2 (P_1 - P_2) - \alpha_3 (P_2 - P_{atm}) + \beta u$$

where u is the valve opening to be treated as manipulated variable while P_0 is the pressures upstream of vessel 1 and P_{atm} is the atmospheric pressure.

Let α_1=2, α_2=1, α_3=2 and β=3. Assuming all initial conditions to be zero, obtain the transfer functions: G_p (from u to P_1), G_{d1} (from P_0 to P_1) and G_{d2} (from P_{atm} to P_1), i.e.

$$\hat{P}_1 = G_p \hat{u} + G_{d1} \hat{P}_0 + G_{d2} \hat{P}_{atm}$$

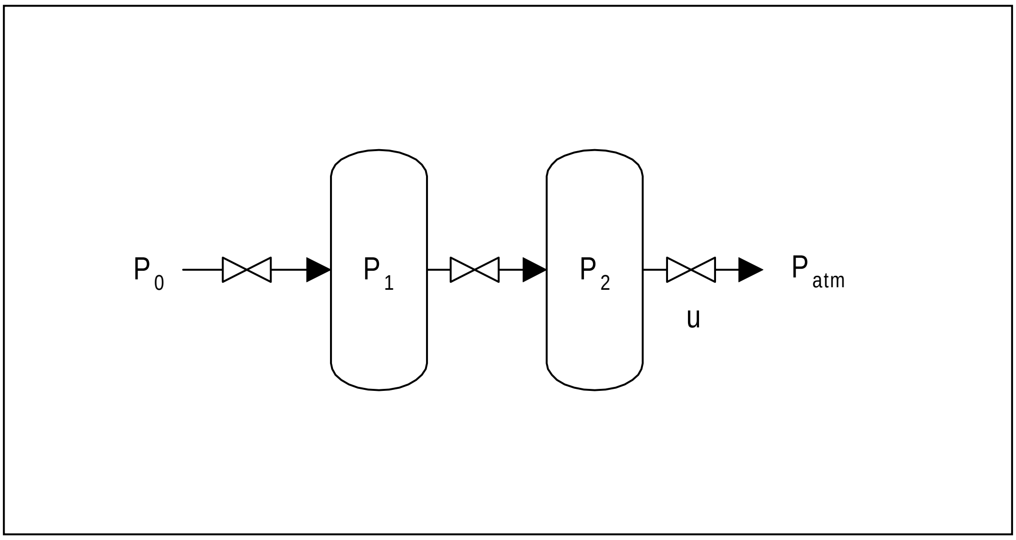

Figure 2.

3. (25 pts) Reduce the transfer function block diagram given in Figure 3 to the one shown in Figure 4, i.e. obtain G_p and G_d in terms of transfer functions A, B, etc.

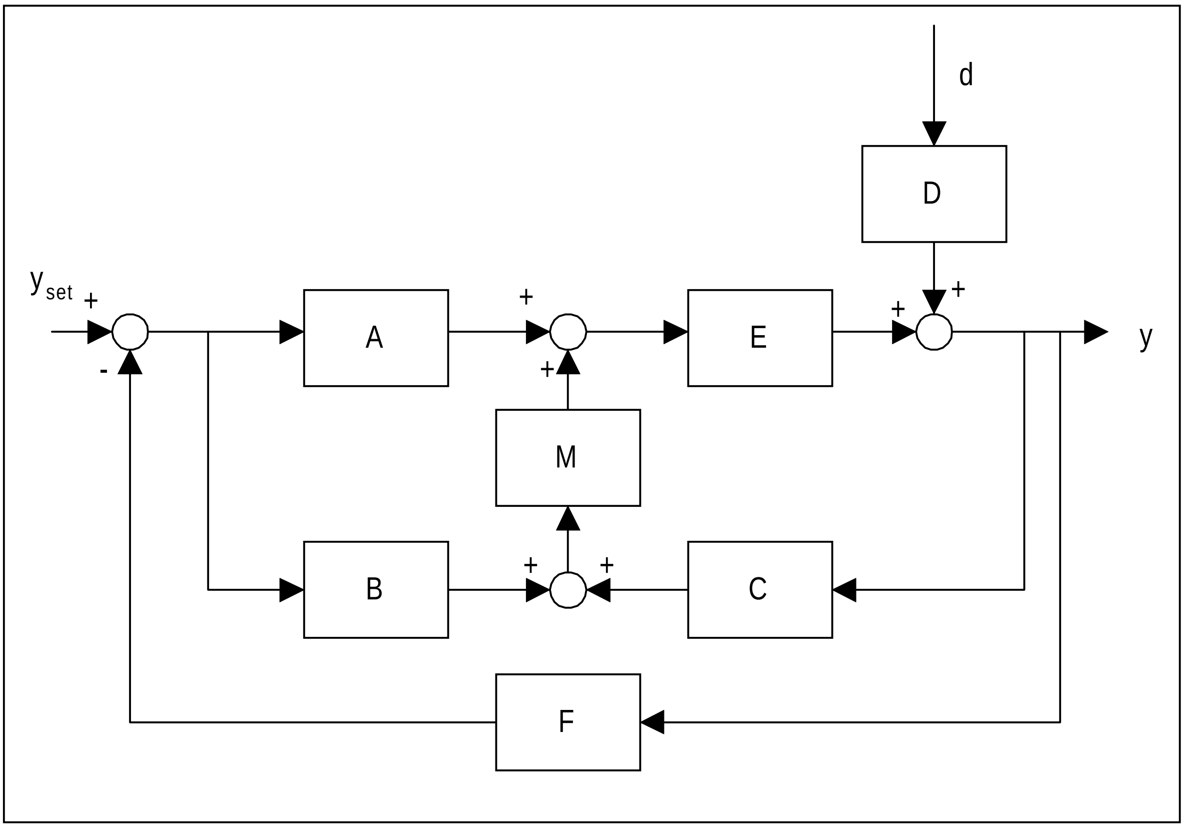

Figure 3.

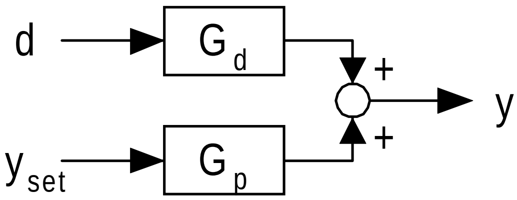

Figure 4.

4. (25 pts) Use the Routh-Hurwitz method to determine the range of K_c that would stabilize the feedback controlled process shown in Figure 5.

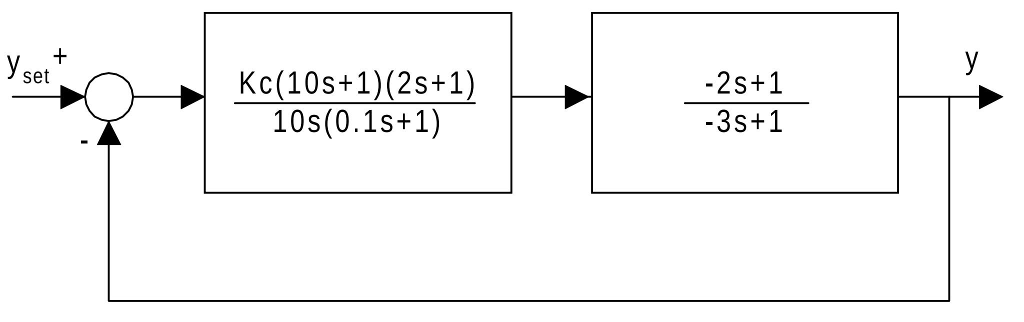

Figure 5.

5. (Bonus: 10 pts) Find the Laplace transform of $f(t)$ given

$$f(t) = 2t\sin(-3t)$$