PRINCE OF SONGKLA UNIVERSITY

DEPARTMENT OF CHEMICAL ENGINEERING, FACULTY OF ENGINEERING

Examination paper: Midterm Exam | Semester: 1/2008

Date: July 28, 2008 | Time: 9.00 – 12.00

Subject: 230-425 Process dynamics and control | Room: R 300

ทุจริตในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริต
และพักการเรียน 1 ภาคการศึกษา

ข้อสอบมีทั้งหมด 4 ข้อ 8 หน้า ให้นักศึกษาตรวจสอบความเรียบร้อย เขียนชื่อและรหัสนักศึกษาบนข้อสอบทุกหน้า**ก่อน**ลงมือทำข้อสอบ

- การสอบเป็นแบบเปิดหนังสือ (Open book) อนุญาตให้นำหนังสือและเอกสารการสอนเข้าห้องสอบได้
- อนุญาตให้นำเครื่องคำนวณและ E-dictionary เข้าห้องสอบได้
- อนุญาตให้ทำข้อสอบด้วยดินสอ (2B ขึ้นไป) ได้
- อนุญาตให้เขียนคำตอบด้านหลังกระดาษได้ กรณีกระดาษคำตอบไม่เพียงพอ
- **ไม่อนุญาตให้หยิบยืมเอกสารและเครื่องคำนวณจากผู้อื่น**
- **ไม่อนุญาตให้นำข้อสอบออกจากห้องสอบ**

ข้อสอบข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	35	
2	25	
3	20	
4	20	
รวม	100	

ดร.สินินาฏ จงคง

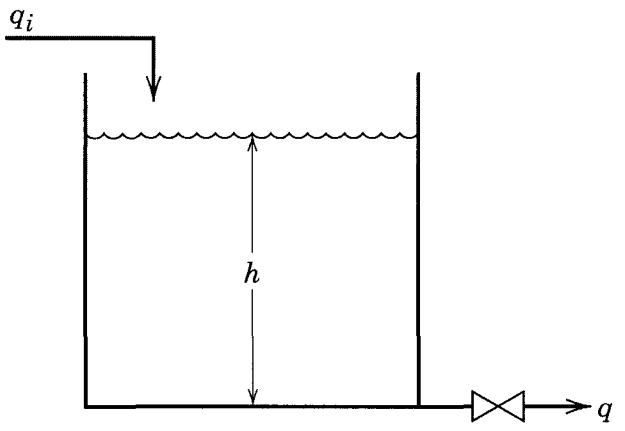
ผู้ออกข้อสอบ

1. A simple surge tank with fixed valve on the outflow line is shown in figure below. If the outflow rate is proportional to the square root of the liquid height, an unsteady-state model for the level in the tank is given by

$$A\frac{dh}{dt} = q_i - C_v h^{\frac{1}{2}}$$

As usual, you can assume that the process initially is at steady state

$$\bar{q}_i = \bar{q} = C_v \bar{h}^{\frac{1}{2}}$$



(a) Find the transfer function $H'(s)/Q_i'(s)$. Put the transfer function in standard gain/time constant form. (10 points)

(b) Find the transfer function $Q'(s)/Q_i'(s)$. Put the transfer function in standard form. (10 points)

(c) If the algebraic function for the outflow rate is linear instead of square root, the level transfer function can be put into a first order form,

$$\frac{H'(s)}{Q_i'(s)} = \frac{K^*}{\tau^* s + 1}$$

with $K^* = \bar{h}/\bar{q}_i$, $\tau^* = \bar{V}/\bar{q}_i$, *and* $\bar{V} = A\bar{h}$ is the initial steady state volume.

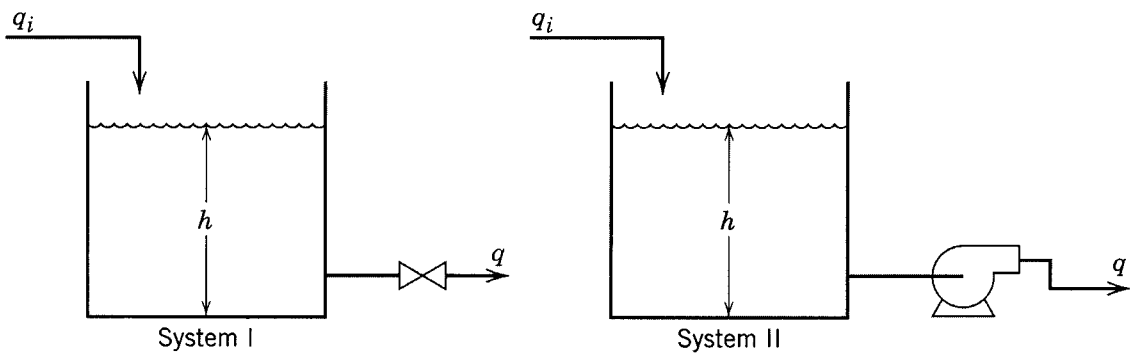
When written this way, τ^* is easy interpreted as the liquid residence time at the nominal operating conditions. What are equivalent expressions for K and τ in the part (a) level transfer function, that is, for the square root outflow relation? (15 points)

2. Two liquid storage systems are shown in figure below. For system I, the valve acts as a linear resistance with transfer function $\frac{H'(s)}{Q_i'(s)} = \frac{0.12}{11.28s+1}$. For system II, variation in liquid level h do not affect exit flow rate q with transfer function $\frac{H'(s)}{Q_i'(s)} = \frac{0.011}{s}$. Suppose that each system is initially at steady state with $\bar{h} = 6$ ft and at time $t = 0$ the inlet flow rate suddenly changes from 50 to 70 gal/min. For each system, determine the following information:

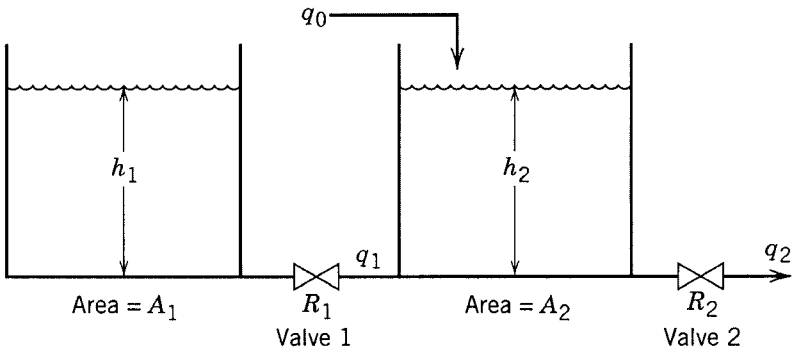
   (a) The transient response *h(t)*. (10 points)

   (b) The new steady state levels. (5 points)

   (c) If each tank is 8 ft tall, which tank overflows first? When? (10 points)



3. An open liquid surge system (ρ = constant) is designed with a side tank that normally is isolated from the following material as shown in figure below.



(a) What do you know about the form of the transfer function $Q_2'(s)/Q_0'(s)$ for Valve 1 partially open? Discuss but do not derive. (10 points)

(b) Is the response to changes in q_0 faster or slower for Case I (Valve 1 is closed) compared to Case II (Valve 1 is opened partially)? Explain why but do not derive the response. (10 points)

4. If the input Y_m to a PI controller changes stepwise ($Y_m(s) = 2/s$) and the controller output change initially as in figure below, what are the value of the controller gain and integral time? (20 points)