

**PAD 504 - Midterm Test**

Please answer each of the following. Put *everything* you want me to see in the bluebooks provided. Show all significant work and any partial answers for part credit.

- (1) [12 points] You have been asked to help predict the number of students in Schuylerville High School over the next several years.

Data: You are told that in 1992 there were

200 9th-graders,  
170 10th-graders,  
130 11th-graders,  
and 100 12th-graders.

Elementary school enrollments suggest that the number of *new* 9th graders over the next several years will be 180 (1993), 160 (1994), 140 (1995) and 150 (1996). Recent enrollment patterns at Schuylerville suggest that each year about 6 percent of the students at each grade level (including 9th graders) "stay back," i.e., remain at that grade the next year, while about 90 percent of the students in each grade graduate to the next grade.

- (a) Use this information to create a spreadsheet showing the number of students in each grade and the total number of students in the high school. Begin your spreadsheet with the year 1990. Show cell formulas for 1991. [Please make your spreadsheet cells big and your writing clear, and please don't use any absolute cell references (\$'s) because they make your spreadsheet very hard to read.]
- (b) How many students will there be at each grade level in 1991?
- (c) What fraction of 10th-graders leave Schuylerville High School each year? Explain.
- (d) Show the formulas you would add to your spreadsheet to compute the *percent change in the total enrollment from last year to this year* for 1993, '94, '95, and '96.
- (2) [8 points] Write difference equations for the enrollments in grades 10, 11 and 12 in Schuylerville High School, using the information given in problem (1). For consistency, please let  $F_t$  = number of 9th graders at time  $t$ ,  $O_t$  = number of 10th graders at time  $t$ ,  $J_t$  = number of 11th graders at time  $t$ , and  $S_t$  = number of 12th graders at time  $t$ . [F = Freshman, O = sOphomores, J = Juniors, and S = Seniors.]

- (3) [18 points] You have been asked to help draw up a disaster plan for assigning casualties to hospitals in Burtonville. We start simply, just as you did in homework, by assuming that casualties will occur at two points, A and B, and will be transported to three hospitals, 1, 2, and 3. Travel times from A to hospitals 1, 2, and 3 are 25, 15, and 10 minutes, respectively; from point B they are 20, 5, and 15 minutes. You are asked to figure out how many accident victims from A and B to assign to each of the hospitals to *minimize the total travel time* without exceeding the hospital capacities of 250, 150, and 150 emergency patients.

You begin as shown below. (The question marks flag cells you will fill in as requested in parts (a) through (e) of this question):

<b>Victim assignment</b>	(decision variables)			
	To hospital:	1	2	3
From	A	120	30	= ?
accident site:	B	80	90	= ?
<b>Travel times</b>	(data)			
	To hospital:	1	2	3
From	A	?	?	?
accident site:	B	?	?	?
<b>Minimize total travel time:</b>		(objective)	= ?	
<b>Subject to:</b>	(constraints)			
	Victims totals		Constraints	Slack
Hospital 1 capacity	= ?		250	= ?
Hospital 2 capacity	= ?		150	= ?
Hospital 3 capacity	= ?		150	= ?

- (a) Cells in the array C3:E4 contain values of the decision variables. They show that the user of this spreadsheet has tried values of 120, 30, 80, and 90 in four of the six cells. Cells E3 and E4 should contain *cell formulas* for the number of victims remaining to transport from sites A and B to hospital 3. What cell formulas would you put in E3 and E4?
- (b) Cells in the array C8:E9 contain data about travel times. What values go in cells C8, C9, D8, D9, E8, and E9?
- (c) The objective function goes in cell D11. What cell formula would you put in D11?
- (d) Cells B15, B16, and B17 contain cell formulas for the total number of victims sent to hospitals 1, 2, and 3. What cell formulas would you put in B15, B16, and B17?
- (e) What cell formulas would you put in cells E15, E16, and E17?
- (f) After filling in all these cells, how would you use this spreadsheet to solve Burtonville's problem? (Write your answer as if explaining, briefly but clearly, to your boss or an interested coworker who doesn't understand what you're planning to do and why.)

(4) [12 points]

(a) Consider this description of the movement of people in an out of a mental health facility: From one year to the next, 84 percent of the residents stay in the facility, while 16 percent leave as outpatients. 23 percent of the outpatients return each year to the facility for more treatment; the other 77 percent remain outpatients.

Copy the matrix equation below, replacing the question marks with the numbers necessary to represent this story as a matrix product:

$$\begin{bmatrix} \text{Residents} & t \\ \text{Outpatients} & t \end{bmatrix} = \begin{bmatrix} ? & ? \\ ? & ? \end{bmatrix} * \begin{bmatrix} \text{Residents} & t-1 \\ \text{Outpatients} & t-1 \end{bmatrix}$$

(b) The following is a difference equation model for transfer patterns among jobs levels in a agency, expressed in matrix form:

$$\begin{bmatrix} S_t \\ A_t \\ M_t \end{bmatrix} = \begin{bmatrix} .87 & .13 & 0 \\ .10 & .74 & .10 \\ 0 & .09 & .80 \end{bmatrix} * \begin{bmatrix} S_{t-1} \\ A_{t-1} \\ M_{t-1} \end{bmatrix}$$

where

$S_t$  = number of staff at time  $t$ ,

$A_t$  = number of middle-level administrators at time  $t$ ,

$M_t$  = number of senior managers at time  $t$ .

Assuming  $S_0 = 1000$ ,  $A_0 = 100$ , and  $M_0 = 10$ , compute  $S_1$ ,  $A_1$ , and  $M_1$ .

(c) Is the model in (b) a Markov model? How do you know?

(5) [8 points] Spreadsheet quickies:

(a) What does  $\text{IF}(C3>10,D5,E5)$  mean?

(b) What would  $\text{SUM}(B3:B10,E3:E10)$  do? [Lotus or Enable users would see  $\text{@SUM}(B3..B10,E3..E10)$ .]

(c) What is wrong with  $\text{SUM}(B1+B2+B3+B4)$ ? [Lotus or Enable users would see  $\text{@SUM}(B1+B2+B3+B4)$ .]

(d) What would  $\text{MAX}(0,\text{MIN}(C5,10))$  do?