

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. Please do NOT tear out any bluebook pages (other pages tend to fall out); just draw a line through material you want me to ignore.

- (1) [12 points] The spreadsheet below is an overview summary of New York State estimated revenues and expenditures that was used at the beginning of the budget process in the 1990 budget planning year. (You'll note that the budget was in deficit even before several categories such as legislature "member items" were added.) The estimates were projected into the future to give a five-year planning scenario.

NYS REVENUE ESTIMATION: (Annual estimates in \$Millions)					
	1990	(14585)	(14329)	(14073)	(13817)
Pers Inc Tax	\$14000	\$14896	\$15849	\$16864	\$17943
Sales Tax	\$5600	\$5933	\$6286	\$6660	\$7057
User Taxes & Fees	\$2400	\$2424	\$2448	\$2473	\$2497
Business Tax	\$3100	\$3209	\$3321	\$3437	\$3557
Misc Revenue	\$2800	\$2979	\$3170	\$3373	\$3589
One Time Rev	\$0	\$0	\$0	\$0	\$0
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Total projected revenues	\$27900	\$29441	\$31075	\$32806	\$34643
NYS ESTIMATED BUDGET EXPENDITURES (Annual estimates in \$Millions):					
	1990	(14585)	(14329)	(14073)	(13817)
Personal Service	\$6606	\$7087	\$7609	\$8176	\$8794
Nonpersonal Service	\$2112	\$2239	\$2375	\$2521	\$2678
Capital Projects	\$941	\$992	\$1046	\$1163	\$1227
Local Aid	\$8298	\$8721	\$9166	\$9635	\$10129
Aid to Education	\$7823	\$8214	\$8625	\$9056	\$9509
GPLG Aid	\$1000	\$1000	\$1000	\$1000	\$1000
Fringe Benefits	\$1652	\$1772	\$1902	\$2044	\$2198
Member Items	\$0	\$0	\$0	\$0	\$0
Debt Service	\$200	\$200	\$200	\$200	\$200
Deficiencies	\$0	\$0	\$0	\$0	\$0
Program Revisions	\$0	\$0	\$0	\$0	\$0
Productivity enhancements	\$0	\$0	\$0	\$0	\$0
	-----	-----	-----	-----	-----
Total projected expenditures	\$28632	\$30225	\$31923	\$33796	\$35735
Estimated Surplus (deficit)	(\$1)	#N/A!	\$1	\$1	(\$1)

- (a) What formulas would be used in cells B10, B27, and B29?

(b) You have been asked to produce a section of the spreadsheet that will compute the *fractions of total state revenues in each year* that each of the revenue categories represents. You begin as follows:

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Pers Inc Tax	\$14000	\$14896	\$15849	\$16864	\$17943
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Debt Service	\$200	\$200	\$200	\$200	\$200
Deficiencies	\$0	\$0	\$0	\$0	\$0
Program Revisions	\$0	\$0	\$0	\$0	\$0
Productivity enhancements	\$0	\$0	\$0	\$0	\$0
	-----	-----	-----	-----	-----
Total projected expenditures	\$28632	\$30225	\$31923	\$33796	\$35735
Estimated Surplus (deficit)	(\$1)	#N/A!	\$1	\$1	(\$1)
	1990	(14585)	(14329)	(14073)	(13817)
Pers Inc Tax					
Sales Tax					
User Taxes & Fees					
Business Tax					
Misc Revenue					
One Time Rev					

Show the cell formulas (in your bluebook) that you would use in cells B32 through B37 to compute these fractions. (Column B is enough here; don't bother with the others.)

(c) To enter the formulas in cells B32 .. F37 most efficiently, you could enter a particular cell formula into cell B32, fill down to enter the correct computations in column B, and then select cells B32 through B37 and fill right to enter all the cell formulas for rest of the block of cells B32..F37. What cell formula could you write in cell B32 that would, according to this plan, fill all these cells correctly?

(d) You plan to add a row of computations that will compute the *annual fractional increases* in each of the expenditure categories (which you'll probably format as percentages). Assume cell C50 contains the computation for the annual fractional increase in estimated Personal Services from 1990 to 1991. What cell formula would you write in cell C50?

- (2) [12 points] Professors at many universities in the United States accumulate retirement savings in the Teachers Insurance and Annuity Association and its associated College Retirement Equities Fund -- TIAA/CREF. Professors contribute a percentage of their salaries each year and the university contributes a percentage. The annuities and equities also earn investment returns (we'll call it the interest on the accumulation), which further increase a professor's retirement accumulation.

Professor Willy Makit will retire in twenty years and would like to forecast the size of his retirement accumulation when he retires. He earns \$50,000 in 1995. He and the university together contribute a total of 12 percent of his salary into TIAA/CREF. His retirement accumulation at the beginning of 1995 is \$100,000. He assumes that his salary will go up about 3 per cent each year, and his TIAA/CREF accumulation will earn an investment return of about 7 percent each year.

(a) Formulate in your bluebook a spreadsheet like the following, containing these assumptions and designed to carry out the computations for twenty years. Show initial values and cell formulas for just two years (that's columns B and C). [You need not do any arithmetic!]

	1995	-13305	-13049	-12793
Salary				
Retirement contributions				
Retirement accumulation				
Interest on accumulation				

(b) Write the spreadsheet model in (a) as a set of two difference equations, one for S_t , salary in year t , and one for A_t , the retirement accumulation in year t .

- (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 planning for 300 accident victims at site A and 200 at site B. 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):

Victim assignment	(decision variables)			
	To hospital:	1	2	3
From	A	120	30	= ?
accident site:	B	80	90	= ?
Travel times	(data)			
	To hospital:	1	2	3
From	A	?	?	?
accident site:	B	?	?	?
Minimize total travel time:		(objective)	= ?	
Subject to:	(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? (You are not explaining how you set it up; you are explaining what you are going to do with it 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 and 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?

(d) What would the matrix equation in (b) look like if each year the agency hired 80 new staff, 9 new administrators, and 1 new senior manager each year?

(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 $\text{MAX}(0,\text{MIN}(C5,10))$ yield if $C5$ is less than 0? ...greater than 10? ...between 0 and 10?