

DO NOT TURN TO THE NEXT PAGE UNTIL YOU ARE INSTRUCTED TO DO SO!

The following exam consists of FIVE problems for a total of 200 points. Please keep three decimal points in all of your computations. To get credits, you are required to provide details such as **providing equations, models, procedures, and explanations** for related questions. You will have 75 minutes to complete the test. The Test 3 will be over at 11:00pm. This means that you have, on average, about 2 minutes for each question.

1. Write down (PRINT) your name in the blank provided on the top right corner on this page.
2. This test is closed book and closed notes. You may bring ONE 8" x 11" note card or equation sheet (One side only). You can write or type anything on the card or sheet. You have to hand it in along with your test paper.
3. Partial credits are available and unsupported answers will not receive any credit even though they may be correct.
4. You are expected to remain in the classroom until you have turned in your test paper. You could not get your test paper back once you turn it in.
5. You must have your own calculator for the test. You cannot use pocket PC, cell phone, PDA, or anything like these for your test. You cannot share calculator with anyone.
6. If you believe that someone sitting near you is cheating, raise your hand and quietly inform a teacher of this. We'll keep an eye peeled, and your anonymity will be respected.
7. If any question seems unclear or ambiguous to you, raise your hand, and your teacher will attempt to clarify it. Or just put it on your test booklet, I will look at it when I grade the test.

Pledge: On my honor as a JMU student, I pledge that I have neither given nor received unauthorized assistance on this examination.

Signature \_\_\_\_\_



- 2 Texas Steakhouse operates with full and part time employees for the Wednesday afternoon shift, which starts at 1:00pm and ends at 11:00pm. The full time employees will work for 8 hours and the part time employees work for 4 hours. The management would like to develop a schedule that will minimize the labor costs and still provide excellent service. The full times are paid \$15 per hours and the part times \$10 per hour. The table below shows the required number of employees during the shift. Employees start to work only at the beginning of each TWO hour period as shown in the Table below.

Time	Total Number of Employees	Time	Total Number of Employees
1:00pm to 3:00pm	5	5:00pm to 7:00pm	12
3:00pm to 5:00pm	11	7:00pm to 9:00pm	8
		9:00pm to 11:00pm	6

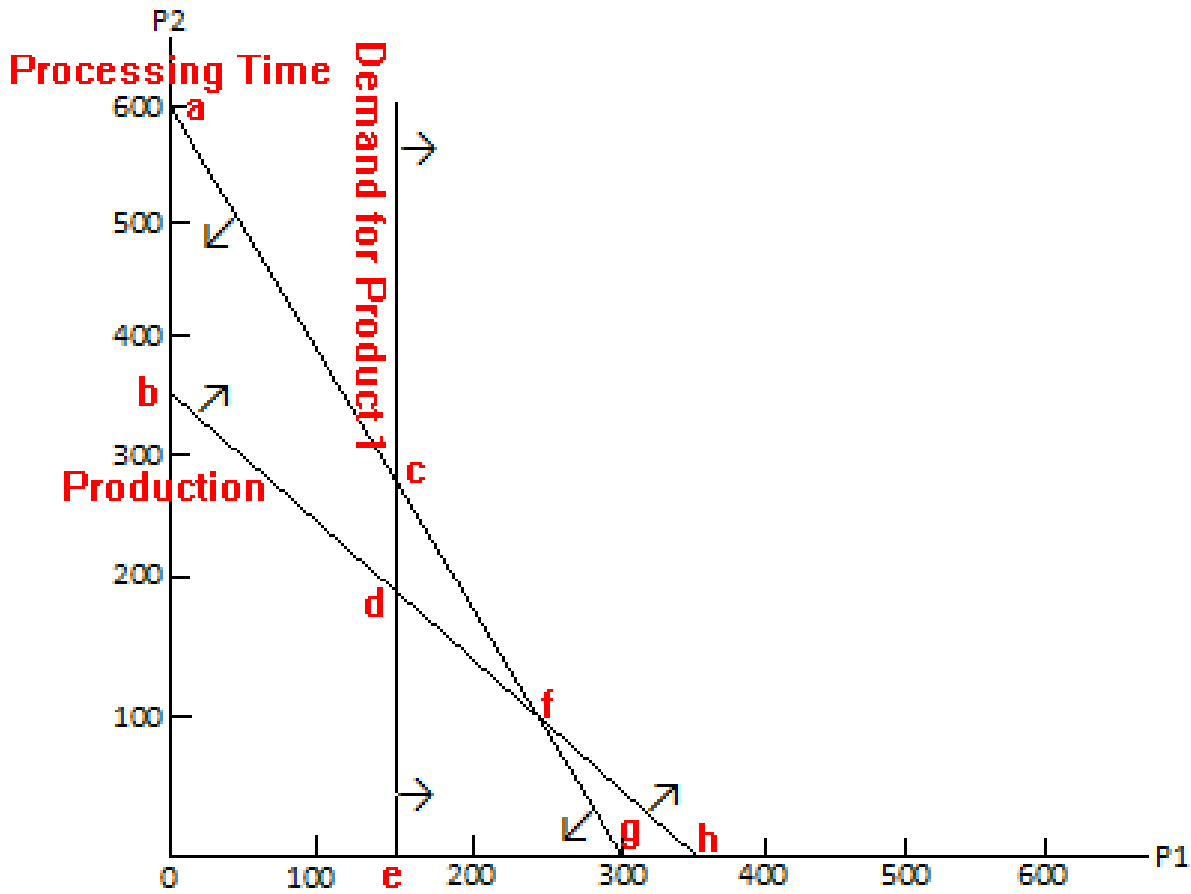
a. (5 pts) Define Decision variables clearly:

b. (5 pts) Write the objective function (with its goal):

c. (25 pts) Identify the constraints by name and write out each of them:

d. (5 pts) Suppose Texas Steakhouse requires that the number of full time employees during 7:00pm to 9:00pm must be at least 60%. Identify the constraint and write it out.

3. M&D Chemicals produces two products. P1 and P2 are defined as the number of gallons of products 1 and 2 respectively. The total demand for product 1, the total gallons of production and total processing times are given as lines 1), 2) and 3) in the figure below, respectively. The production costs are \$2 per gallon for product 1 and \$3 for product 2. M&D's objective is to satisfy the above requirements at a minimum total production cost.



- (5pts) What should be the objective function?
- (15 pts) What are the constraints for the problem?
- (5 pts) Where is the feasible region on the graph?

d. (5 pts) What is the optimal solution? (You should draw the objective function on the graph and show computational details)

e. (5 pts) What is the optimal objective function value?

4 UMA installs high pressurized instruments for small aircrafts. UMA is developing a 3-period production and inventory plan model based on the relevant information in the table below.

Period	Production Cost (\$)	Demand (Units)	Inventory Cost (\$)	Regular Production Capacity
1	3.8	500	1	250
2	3.9	300	1.1	300
3	4.1	400	1.5	300

The beginning inventory for period 1 is 100 units. In addition, UMA would like to have at least 50 units in ending inventory for period 3. The ending inventory (t) = the beginning inventory (t) + production (t) - demand (t) in the same period (t).

4.1 Develop a linear programming model for UMA to minimize its total production and inventory cost:

a. (5 pts) Define Decision variables clearly:

b. (5 pts) Write the objective function (with its goal):

c. (20 pts) Identify the constraints by name and write out each of them:

4.2 (5 pts) The table below shows the selling prices per unit. UMA would like to maximize its total profit. Write out the objective function (with its goal):

Period	Selling Price (\$)
1	15
2	16
3	15.5

4.3 The Table below shows the overtime production capacity and cost of production in overtime. UMA would like to minimize the total production and inventory cost based on the additional information given in the Problem above.

Period	Overtime Production Capacity	Overtime Production Cost (\$)
1	100	6
2	100	6.4
3	125	6.8

a. (5 pts) Define additional decision variables used here?

b. (10 pts) Write out the objective function with its goal:

c. (20 pts) Write out the constraints:

5. Portable Ratio Systems makes radio products for two-way communications. The distribution channels for the new radio are as follows:
- 1). Marine distributors
  - 2). Business equipment distributors
  - 3). National chain of retail stores
  - 4). Mail order

The table below shows the unit profit, advertising cost, and personal sales time data for the firm. Additional facts are that:

- i. The advertising budget should be no more than \$5000.
- ii. There is a maximum of 1800 hours of sales force time available for allocation to the sales effort.
- iii. Exactly 600 units for the current production period is scheduled.
- iv. The national chain of retail stores requires at least 150 units be distributed through this distribution channel.

The firm would like to maximize its profit in distributing the radios. Decisions must be made as to how many units should be allocated to each of the four distribution channels, as well as how to allocate the advertising budget and sales force to each of the four distribution channels.

Profit, Advertising cost, and Personal sales time data			
Distribution Channel	Profit per Unit Sold	Advertising Cost per Unit Sold	Personal Sales Effort per Unit Sold
Marine distributors	\$90	\$10	2 hours
Business equipment distributors	\$84	\$8	3 hours
National chain of retail stores	\$70	\$9	3 hours
Mail order	\$60	\$15	None

The decision variables M, B, N, and P are defined as the number of units produced for the (M) Marine equipment distribution channel, for the (B) Business equipment distribution channel, for the (N) National chain retail stores distribution channel and for the (P) mail order distribution channel, respectively. The LP formulation for the problem is given as follows:

$$\text{MAX } 90M + 84B + 70N + 60P$$

Subject to:

$$\begin{array}{ll}
 10M + 8B + 9N + 15P & \leq 5000 & \text{Amount of advertising expenditure} \\
 2M + 3B + 3N & \leq 1800 & \text{Sales times} \\
 1M + 1B + 1N + 1P & = 600 & \text{Units made during the current production period} \\
 1N & \geq 150 & \text{Units distributed by National chain retail stores} \\
 M, B, N, P & \geq 0 & 
 \end{array}$$

	A	B	C	D	E	F	G	H	I
1	Portable Radio Systems in Test 3 Fall 2008								
2			M Units for Marine	B Units for Business	N Units for National	P Units for Mail Order			
3			25	425	150	0			
4		Max	90	84	70	60	48450	OFV	
5		Subject To:							
6	Adv. Expenditure		10	8	9	15	5000	<=	5000
7	Sales Times		2	3	3	0	1775	<=	1800
8	Made in Current Period		1	1	1	1	600	=	600
9	Distributed by National Chain		0	0	1	0	150	>=	150

The Answer Report and Sensitivity Report are provided here for reference.

### Answer Report

#### Target Cell (Max)

Cell	Name	Original Value	Final Value
\$G\$4	Max	0	48450

#### Adjustable Cells

Cell	Name	Original Value	Final Value
\$C\$3	M Units for Marine	0	25
\$D\$3	B Units for Business	0	425
\$E\$3	N Units for National	0	150
\$F\$3	P Units for Mail Order	0	0

#### Constraints

Cell	Name	Cell Value	Formula	Status	Slack
\$G\$6	Adv. Expenditure	5000	\$G\$6<=\$I\$6	Binding	0
\$G\$7	Sales Times	1775	\$G\$7<=\$I\$7	Not Binding	25
\$G\$8	Made in Current Period	600	\$G\$8=\$I\$8	Binding	0
\$G\$9	Distributed by National Chain	150	\$G\$9>=\$I\$9	Binding	0

### Sensitivity Report

#### Target Cell (Max)

Cell	Name	Final Value
\$G\$4	Max	48450

#### Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$C\$3	M Units for Marine	25	0	90	1E+30	6
\$D\$3	B Units for Business	425	0	84	6	34
\$E\$3	N Units for National	150	0	70	17	1E+30
\$F\$3	P Units for Mail Order	0		60	45	1E+30

#### Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$G\$6	Adv. Expenditure	5000	3	5000	850	50
\$G\$7	Sales Times	1775		1800	1E+30	25
\$G\$8	Made in Current Period	600	60	600	3.5714	85
\$G\$9	Distributed by National Chain	150	-17	150	50	150



5.3 For the Constraint “\$G\$7 Sales Times”:

5.3.1 (5 pts) What should be the value of the shadow price? (No credit will be given if the item b below is not answered correctly)

5.3.2 (5 pts) How would you interpret the specific meaning of its Shadow Price? (No credit will be given for a general discussion of the meaning of Shadow Price)

5.4 (10 pts) Suppose the Advertising Expenditure increases from \$5,000 to \$5,500. How this change will affect the current optimal solution? If possible, determine the new optimal net profit. If not, explain why not.

Type of ranging (Lower & Upper Limits): \_\_\_\_\_ Range: \_\_\_\_\_

Provide detailed computations here:

5.5 (10 pts) Suppose the units Made in the Current Period decreases from 600 to 550. How this change will affect the current optimal solution? If possible, determine the new optimal net profit. If not, explain why not.

Type of ranging (Lower & Upper Limits): \_\_\_\_\_ Range: \_\_\_\_\_

Provide detailed computations here: