FACULTY OF APPLIED SCIENCE AND ENGINEERING
DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING
Final Examination - April 2000
MIE 365 S - Operational Research II - Type C
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TOTAL POINTS: 76

Question 1	17
Question 2	11
Question 3	12
Question 4	10
Question 5	12
Question 6	14

This exam has 4 pages.

QUESTION 1 - Recursive Copies [17 points]

A copy machine repairman has four pieces of test equipment for which he estimates 25%, 30%, 55%, and 15% chances of using them at his next stop. However, the devices weigh 20, 30, 40, and 20 pounds respectively, and he can carry no more than 60 pounds. The repairman seeks a maximum "utility" feasible collection of devices to carry with him.

a) Write a recursion formula to solve this problem. Define the stages and states you used in your formulation, as well as any variables introduced. Explain the decision making criterion you used to select the preferred alternative in each step. [6 points]

b) Draw a network to represent the dynamic program structure in part a), indicating the stages and states, and possible transitions among them. [4 points]

c) What is the starting point of the first stage? [1 point]

d) Solve the dynamic programming problem. [6 points]

QUESTION 2 – Heuristic vs Algorithm [11 points]

Kristin's Cookie Co. predicts orders of 30, 25, 10 and 35 batches in the next 4 months. Each month in which Kristin bakes cookies requires spending $1000 to rent kitchen facilities. One batch of cookies costs $30 to produce. Batches can be held in inventory and stored frozen at a cost of $20 per batch per month for rental of freezer space.

a) Solve this problem using the Wagner-Whitin Algorithm. [5 points]

b) Solve this problem using the Silver-Meal Heuristic. [3 points]

c) Which solution approach do you recommend (Wagner-Whitin, Silver-Meal, or some other approach)? Why? [3 points]

QUESTION 3 – New Product Development [12 points]

The Research and Development Division of Tyler Industries has been developing 4 new possible product lines. Management must now decide which of these 4 products will actually be produced and at what levels. A substantial cost is associated with beginning the production of any product, as is given by the first row of the following table:

	Product 1	2	3	4
Startup cost	$50,000	$40,000	$70,000	$60,000
Marginal revenue	70	60	90	80

Management has imposed the following policy constraints on production:

1) no more than 2 of the products can be produced
2) either product 3 or 4 can be produced only if either product 1 or 2 is produced
3) one of 2 alternative factory setups can be used, where production requirements (in hours per unit) are:

	Product 1	2	3	4
Setup 1	5	3	6	4
Setup 2	4	6	3	5

4) total production time can not exceed an available 6,000 hours.

Formulate the problem as a mixed integer linear programming problem. Define any variables you use.

QUESTION 4 – Delivery Decisions [10 points]

Speedy Delivery provides 2-day delivery service of large parcels across North America. Each morning at each collection center, the parcels that have arrived overnight are loaded onto several trucks for delivery throughout the area. Parcels are divided among the trucks according to their geographical destinations to minimize the average time needed to make the deliveries. A decision support system software package is used to generate a number of attractive possible routes for individual delivery trucks.

This morning, there are 9 parcels to be delivered by a staff of 3 drivers at Tyger Forest Collection Center. The decision support system has produced the following possible

routes, where the numbers in each column indicate the order of the deliveries, along with the estimated time required to traverse the route:

	Attractive Possible Routes									
Delivery Location	1	2	3	4	5	6	7	8	9	10
A	1				1				1	
B		2		1		2			2	2
C			3	3			3		3	
D	2					1		1		
E			2	2		3				
F		1			2					
G	3						1	2		3
H			1		3					1
I		3		4			2			
Time (hours)	6	4	7	5	4	6	5	3	7	6

Using the above information, formulate a mixed integer linear programming model to solve this problem. Define any variables you use in your formulation.

QUESTION 5 – Wise Investing [12 points]

Warren Buffy has been offered 3 major investments and he would like to choose one. The first is a *conservative* investment that would perform very well in an improving economy and only suffer a loss in a worsening economy. The second is a *speculative* investment that would perform extremely well in an improving economy but would do very badly in a worsening economy. The third is a *counter-cyclical* investment that would lose some money in an improving economy but would perform well in a worsening economy.

Warren believes there are 3 possible scenarios over the lives of these potential investments: (1) an improving economy, (2) a stable economy, and (3) a worsening economy. He is pessimistic about where the economy is headed, and so has assigned prior probabilities of 0.1, 0.5 and 0.4, respectively, to these 3 scenarios. He also estimates that his profits under these respective scenarios are given by the following table:

	Improving Economy	Stable Economy	Worsening Economy
Conservative	$30 million	$5 million	-$10 million
Speculative	$40 million	$10 million	-$30 million
Counter-cyclical	-$10 million	$0	$15 million

a) Which investment should Warren make if he is a risk neutral decision maker? Draw a decision tree to support your computations. [6 points]

In light of new economic information, Warren has reconsidered his prior probabilities. He believes that 0.1 is just about right as the prior probability of an improving economy, but is quite uncertain about how to split the remaining probabilities between a stable economy and a worsening economy.

b) What advice can you give Warren about what to do (in terms of the probabilities of stable and worsening economies)? Hint: a graph may be helpful. [4 points]

c) Warren is an enormously wealthy investor who has built his fortune through his legendary investing acumen. What risk attitude would you recommend to Warren? Why? [2 points]

QUESTION 6 – Barbershop Queue [14 points]

Newell and Jeff are the two barbers in a barbershop. They provide 2 chairs for customers who are waiting to begin a haircut, so the number of customers in the shop varies between 0 and 4. The probability of each number of customers in the shop, p(n) is: p(0) = 1/16, p(1) = 4/16, p(2) = 6/16, p(3) = 4/16, and p(4) = 1/16.

a) Compute L. How would you describe the meaning of your result to Newell and Jeff? [3 points]

b) For each of the possible values of the number of customers in the queuing system, specify how many customers are in the queue. Compute Lq. How would you describe the meaning of your result to Newell and Jeff? [4 points]

c) Given that an average of 4 customers per hour arrive and stay to receive a haircut, determine W and Wq. Describe the meaning of these results to Newell and Jeff. [4 points]

d) Given that Newell and Jeff are equally fast in giving haircuts, what is the average duration of a haircut? [3 points]