IE 413 Engineering OR I
Homework #3 (Make-up)

Note: This homework assignment is to be conducted by an individual student or a team of two students. Each team or student must submit one set of solution with computer input & output.

1. "Mama's Kitchen" serves from 5:30am each morning until 8:30pm in the afternoon. Tables are set and cleared by busers working 5-hour shifts beginning on the hour from 5am (shift #1) through 4pm (shift #12). Most are college students who hate to get up early in the morning, so Mama's pays $13 per hour for the 5am, 6am, 7am and 8am shifts, and $10 per hour for the others. The manager seeks a minimum cost staffing plan that will have at least a minimum number of busers on duty each hour:

	5am	6am	7am	8am	9am	10am	11am	Noon
# required	3	5	6	5	1	2	4	6
	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm
# required	7	1	3	1	4	6	7	11

(a) Formulate a linear programming model (LP) for this problem. *Be sure to define your variables!*
(b) Use LINDO (or LINGO) to find the optimal solution

2. (Modification of *Problem 3.4-11 of Hillier & Lieberman's OR book*) Eddie Smith is the director of the Computer Center for Johnson College. He now needs to schedule the staffing of the center. It is open from 8 A.M. until midnight, Eddie has monitored the usage of the center at various times of the day, and determined that the following number of computer consultants are required:

Time of Day	Minimum Number of Consultants Required to Be on Duty
8 A.M.–noon	5
Noon–4 P.M.	7
4 P.M.–8 P.M.	9
8 P.M.–midnight	7

Two types of computer consultants can be hired: full-time and part-time. The full-time consultants work for 8 consecutive hours in any of the following shifts: morning (8 A.M.–4 P.M.), afternoon (noon–8 P.M.), and evening (4 P.M.–midnight). Full-time consultants are paid $40 per hour. Part-time consultants can be hired to work any of

the four shifts listed in the above table. Part-time consultants are paid $30 per hour. An additional requirement is that during every time period, there must be at least 2 full-time consultants on duty for every part time consultant on duty. Eddie would like to determine how many full-time and how many part-time workers should work each shift to meet the above requirements at the minimum possible cost.

(a) Formulate an integer programming model for this problem. *Be sure to define your decision variables!*
(b) Use LINDO (or LINGO) to find the optimal solution.

3. (Modification of Exercise 3.4-9, page 81, of Hillier & Lieberman text, 9th edition) Ralph Edmund loves steaks and potatoes. Therefore, he has decided to go on a steady diet of only these two foods (plus some liquids and vitamin supplements) for all his meals. Ralph realizes that this isn't the healthiest diet, so he wants to make sure that he eats the right quantities of the two foods to satisfy some key nutritional requirements. He has obtained the nutritional and cost information shown at the top of the next column.

Ingredient	Grams of Ingredient per Serving		Daily Requirement (Grams)
	Steak	Potatoes	
Carbohydrates	5	15	≥ 50
Protein	20	5	≥ 40
Fat	15	2	≤ 60
Cost per serving	$8	$4	

Ralph wishes to determine the number of daily servings (may be fractional) of steak and potatoes that will meet these requirements at a minimum cost.

(a) Formulate a linear programming model for this problem, and use the graphical method to solve this model. *Be sure to define your decision variables!*
(b) Use LINDO (or LINGO) to solve this model.

4. (Exercise 3.4-12, page 82, of Hillier & Lieberman text, 9th edition) The Medequip Company produces precision medical diagnostic equipment at two factories. Three medical centers have placed orders for this month's production output. The table below shows what the cost would be for shipping each unit from each factory to each of these customers. Also shown are the number of units that will be produced at each factory and the number of units ordered by each customer:

From \ To	Unit Shipping Cost			
	Customer 1	Customer 2	Customer 3	Output
Factory 1	$600	$800	$700	400 units
Factory 2	$400	$900	$600	500 units
Order size	320 units	220 units	420 units	

A decision now needs to be made about the shipping plan for how many units to ship from each factory to each customer.

(a) Formulate a linear programming model (LP) for this problem. *Be sure to define your decision variables!*
(b) Use LINDO (or LINGO) to find the optimal solution

5. (Modification of Exercise 3.4-14, page 82, of Hillier & Lieberman text, 9th edition) The Metalco Company desires to blend a new alloy of 40 percent tin, 35 percent zinc, and 25 percent lead from several available alloys having the following properties:

Property	Alloy				
	1	2	3	4	5
Percentage of tin	60	25	45	20	50
Percentage of zinc	10	15	45	50	40
Percentage of lead	30	60	10	30	10
Cost ($/lb)	87	75	78	87	98

The objective is to determine the proportions of these alloys that should be blended to produce the new alloy at a minimum cost.

(a) Formulate a linear programming model (LP) for this problem. *Be sure to define your decision variables!*
(b) Use LINDO (or LINGO) to find the optimal solution