Assignment #4 – *due Friday, February 7th, 2020*

1. The Livewright Medical Supplies Company has a total of 12 salespeople it wants to assign to three regions – the South, the East, and the Midwest. A salesperson in the South earns \$600 in profit per month for the company, a salesperson in the East earns \$540, and a salesperson in the Midwest earns \$375. The southern region can have a maximum assignment of five salespeople. The company has a total of \$750 per day available for expenses for all 12 salespeople. A salesperson in the South has average expenses of \$80 per day, a salesperson in the East has average expenses of \$70 per day, and a salesperson in the Midwest has average daily expenses of \$50. The company wants to determine the number of salespeople to assign to each region to maximize profit.

   (a) Formulate an integer programming model for this problem.

   (b) Solve this model by using the computer.

2. Mazy's Department Store has decided to stay open for business on a 24-hour basis. The store manager has divided the 24-hour day into six 4-hour periods and has determined the following minimum personnel requirements for each period:

Time	**Personnel Needed**
Midnight - 4:00 a.m.	90
4:00 - 8:00 a.m.	215
8:00 a.m. - Noon	250
Noon - 4:00 p.m.	65
4:00 - 8:00 p.m.	300
8:00 p.m. - Midnight	125

   Store personnel must report to work at the beginning of one of these time periods and must work for 8 consecutive hours. The store manager wants to know the minimum number of employees to assign to each 4-hour segment to minimize the total number of employees. Formulate and solve this problem.

3. The artisans at Jewelry Junction in Phoenix are preparing to make gold jewelry during a 2-month period for the Christmas season. They can make bracelets, necklaces, and pins. Each bracelet requires 6.3 ounces of gold and 17 hours of labor, each necklace requires 3.9 ounces of gold and 10 hours of labor, and each pin requires 3.1 ounces of gold and 7 hours of labor. Jewelry Junction has available 125 ounces of gold and 320 hours of labor. A bracelet sells for \$1,650, a necklace for \$850, and a pin for \$790. The store wants to know how many of each item to produce to maximize revenue.

   (a) Formulate an integer programming model for this problem.

   (b) Solve this model by using the computer. Compare this solution with the solution with the integer restrictions relaxed and indicate whether the rounded-down solution would have been optimal.

4. Rowntown Cab Company has 70 drivers that it must schedule in six 8-hour shifts. However, the demand for cabs in the metropolitan area varies dramatically according to the time of day. The slowest period is between midnight and 4:00 a.m. The dispatcher receives few calls, and the calls that are received have the smallest fares of the day. Very few people are going to the airport at that time of night or taking other long-distance trips. It is estimated that a driver who starts his/her 8-hour shift at midnight will average \$80 in fares during that period. The largest fares result from the airport runs in the morning. Thus, the drivers who start their 8-hour shift during the period from 4:00 a.m. to 8:00 a.m. average \$500 in total fares, and drivers who start at 8:00 a.m. average \$420. Drivers who start at noon average \$300, and drivers who start at 4:00 p.m. average \$270. Drivers who start at the beginning of the 8:00 p.m. to midnight period earn an average of \$210 in fares during their 8-hour shift. To retain customers and acquire new ones, Rowntown must maintain a high customer service level. To do so, it has determined the minimum number of drivers it needs working during every 4-hour time segment – 10 from midnight to 4:00 a.m., 12 from 4:00 to 8:00 a.m., 20 from 8:00 a.m. to noon, 25 from noon to 4:00 p.m., 32 from 4:00 to 8:00 p.m., and 18 from 8:00 p.m. to midnight.

   (a) Formulate and solve an integer programming model to help Rowntown Cab schedule its drivers and maximize the fares they make.

   (b) If Rowntown has a maximum of only 15 drivers who will work the late shift from midnight to 8:00 a.m., reformulate the model to reflect this complication and solve it.

   (c) All the drivers like to work the day shift from 8:00 a.m. to 4:00 p.m., so the company has decided to limit the number of drivers who work this 8-hour shift to 20. Reformulate the model in (b) to reflect this restriction and solve it.

5. The town of Hillsboro recently purchased a 55-acre tract of farm land, and it has \$550,000 budgeted to develop recreational facilities. The impetus for the purchase was the need for more soccer fields to meet the increasing demand of youth soccer in the area. However, once the land was purchased, a number of other interest groups began to lobby the town council to develop other recreational facilities including rugby, football, softball, and baseball fields, plus walking and running trails, a children's playground, and a dog park. The following table shows the amount of acreage required by each project, the annual expected usage for each facility, and the cost to construct each facility. Also included is a priority designation determined by the town's recreation committee based on several public hearings and their perceptions of the critical need of each facility. Assume that the town will build at most one facility of each type.

Facility	**Annual Usage (people)**	**Acres**	**Cost (\$)**	**Priority**
Rugby fields	4,700	7	75,000	3
Football fields	12,500	12	180,000	2
Soccer fields	32,000	20	350,000	1
Dog park	7,500	6	45,000	3
Playground	41,000	3	120,000	2
Walking/running trails	47,000	25	80,000	1
Softball fields	23,000	5	115,000	2
Baseball fields	16,000	8	210,000	3

(a) Formulate and solve a linear programming model that will maximize annual usage and achieve an average priority level of no more than 1.75.

(b) Reformulate the model such that the objective is to achieve the minimum sum of the priorities while achieving an annual usage of at least 120,000.

(c) What combination of facilities will use the maximum acreage available without exceeding the budget and achieving an average priority level of no more than 1.75? What is the annual usage with these facilities?