Homework 3
Due: Saturday, February 27, 11AM, online
Please read "Homework Formatting Instructions.doc" on Blackboard
HW assignments that do not follow the formatting instructions will not be graded.

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1. Benson Motors is a company that builds luxury cars. The company is considering design changes in one of its cars to reduce the car's weight by at least 400 pounds to improve its fuel efficiency. Design engineers have identified 10 changes that could be made in the car to make it lighter. For example, one change could be to use composite body pieces rather than metal. The weight saved by each design change and the estimated costs of implementing each change are below.

	Design Change									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Weight saved (lbs)	50	75	25	150	60	95	200	40	80	30
Cost ($1,000s)	150	350	50	450	90	35	650	75	110	30

Changes 4 and 7 represent alternate ways of modifying the engine block, and so it is not possible to make both of these design changes. Changes 2 and 3 represent the use of a smaller number of cylinder heads and camshafts, respectively, and change 5 represents the use of a turbo-charged in-line engine rather than the current V type engine. So, if change 5 is to be made, then changes 2 and 3 must both be made. Which changes should the company make?

a. Formulate the problem as a binary integer program (i.e. define the variables, and write down the objective function and all constraints in algebraic form).

b. Create a spreadsheet model for this problem and solve it with Solver.

c. What is the optimal solution? What is the optimal value?

2. The emergency center for Orange County wants to locate the county's 2 ambulances to maximize the number of residents that can be reached within 4 minutes in emergency situations. The county is divided into 5 regions, and the average times (in minutes) taken to travel from one region to another are below.

	To Region				
From Region	1	2	3	4	5
1	0	4	6	3	2
2	4	0	2	3	6
3	6	2	0	5	3
4	3	3	5	0	7
5	2	6	3	7	0

The populations in regions 1, 2, 3, 4, and 5 are 45,000, 65,000, 28,000, 54,000, and 43,000, respectively. Determine the best regions for the ambulances to be placed.

a. Formulate the problem as a binary integer program (i.e. define the variables, and write down the objective function and all constraints in algebraic form).

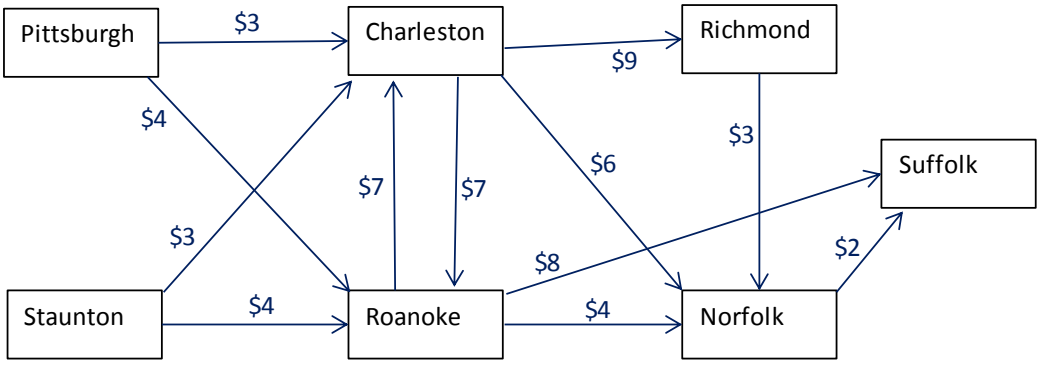
b. Create a spreadsheet model for this problem and solve it with Solver.

c. What is the optimal solution? What is the optimal value?

3. The Natural Disaster Relief Organization (NDRO) wants to find the least costly way to ship food packs and first aid kits from donation centers in Pittsburgh and Staunton to relief centers in Charleston, Roanoke, Richmond, Norfolk, and Suffolk. NDRO contracts with a third-party trucking company to physically ship its emergency supplies. The diagram below illustrates the feasible transportation lanes between city pairs (each lane is one arc) with the unit costs of shipping labeled on each arc. In addition to these variable costs, the trucking company charges a flat fee of $120 for each transportation lane that is used. The trucking company is able to transport up to 200 units of emergency supplies on each transportation lane that is used. Pittsburgh has 60 units of food and 80 units of first aid available, while Staunton has 50 units of food and 60 units of first aid available. The table below lists the number of food and first aid units needed at the relief centers.

	Units Needed	
Relief Center	Food	First Aid
Charleston	10	20
Roanoke	10	10
Richmond	50	30
Norfolk	20	50
Suffolk	15	25

Find the least costly way to distribute the food packs and first aid kits to the centers.



a. Formulate the problem as a mixed integer program (i.e. define the variables, and write down the objective function and all constraints in algebraic form).

b. Create a spreadsheet model for this problem and solve it with Solver.

c. What is the optimal solution? What is the optimal value?