Midterm Practice Problems

1) There are 5 tasks you have been assigned to work on each week at your job. You work 40 hours per week. Each task must receive at least 4 hours of your time. No one task can occupy 2 times the amount of time of any other task. The total combined time spent on tasks 1 and 3 must be at least 15 hours. The total combined time spent on task 4 and 5 cannot exceed 15 hours. The revenue to your company for each hour spent on each of the 5 tasks are (100, 200, 150, 250, 225) dollars per hour. You need not work on tasks an integer number of hours. How should you spend your time? You get paid $150 per hour, are you profitable to the company? If you work more than 40 hours per week you get paid time and a half. Should the company ask you to work more hours?

2) This is a variation of question 1, but it's not the same as question 1. It includes a slack variable!

   There are 5 tasks you have been assigned to work on each week at your job. You work 40 hours per week. Each task must receive at least 4 hours of your time. No one task can occupy 2 times the amount of time of any other task. The total combined time spent on tasks 1 and 3 must be at least 12 hours. The total combined time spent on task 4 and 5 cannot exceed 15 hours. In addition, you hate jobs 1 and 3. You have an agreement with your manager that every extra hour you work on tasks 1 or 3, in excess of the required 12 hours, you will get a bonus of $100/hour on top of your usual pay. But also, every extra hour you work on jobs 1 and 3 (in excess of the required 12) reduces the maximum required hours on jobs 4 and 5. So if you work 13 hours on jobs 1 and 3 (1 hour over the required 12), now you can't work more than 14 hours on jobs 4 and 5. The revenue to your company for each hour spent on each of the 5 tasks are (100, 200, 150, 250, 225) dollars per hour. You need not work on tasks an integer number of hours. How should you spend your time to maximize the revenue to the company minus your bonus payment?

3) Ferrari is planning to design a new car. They have 3 engines to choose from to put in the car, engine 1, 2 or 3. Engine 1 makes 450 horsepower (hp) and costs $50000, engine 2 makes 600 hp and costs $55000, and engine 3 makes 750 hp and costs $65000. Ferrari can also add a turbo charger to engines 1 or 2 if they want to, but not to engine 3. A turbo charger would add 200 horsepower to engine 1 or 150 hp to engine 2, and costs $5000 on either engine. Ferrari must also choose between 2 sets of breaks, beaks 1 or 2. Breaks 1 cost $5000 and breaks 2 cost $7000. If a turbo charger is added to the engine, then Ferrari must use breaks 2. They also have 2 interior options, interior 1 or 2. Interior 1 costs $15000 and interior 2 costs $20000. Ferrari knows that they can only sell cars with interior 1 if the car uses engine 3 or a has a turbo charger. The car must pick exactly 1 engine, exactly 1 set of breaks and exactly 1 interior. The car may or

may not have a turbo charger; if it has a turbo charger it can only have 1. Ferrari wants to design the least expensive car that has at least 600 hp.

Let e1, e2, e3 be the binary variables representing which engine to put in the car.

Let t1 and t2 be the binary variables representing whether a turbo charger is installed on engines 1 or 2.

Let b1 and b2 be the binary variables representing which set of breaks get put on the car.

Let i1 and i2 be the binary variables representing which interior is used in the car.

Hint: The way I solved the problem there are 9 constraints

a) You must pick only 1 engine

b) Turbo1 can only be used on engine1

c) Turbo2 can only be used on engine2

d) Only one of the turbos can be used (this might be redundant?)

e) You must pick only 1 set of breaks

f) Breaks2 must be used if you use a turbo

g) You must pick only 1 interior

h) Interior 1 can only be used if you use engine 3 or a turbo

i) The car must have at least 600 hp