Assignment 1

Instruction:
Please form <u>a team of up to **two**</u> for this assignment. Failure to adhere to the following instruction may cost you some points.

1. Your team need to (1) submit a hard-copy answer for formulations *in class* and (2) an Excel file on Blackboard for the problems you need to solve in Excel. Please have <u>only one</u> of your team members to submit the Excel file on Blackboard. The Excel file must have the solver set up properly to justify your answer. A spreadsheet that simply displays your answer without proper solver setup will receive zero credit.
2. ***Late submission will be taken 20% of points off***.
3. In the Excel file, please highlight **decision** and **objective value** cells in <mark>yellow</mark>. Label any table in the model clearly. Readability of your model is part of the grade. You will be taken points off if your models are not clearly labeled or hard to read even if your answers are correct.
4. Format monetary values with '$' such as "$100". Make sure "," is used in numbers such as "10,000" and "12,000,000".
5. Include the ***last names*** of team members in the Excel file name so I can tell who is on your team.

Problem 1

A trust officer at a bank needs to determine how to invest $100,000 in the following collection of bonds to maximize the annual return.

Bond	Annual Return	Maturity	Risk	Tax-Free
A	9.5%	Long	High	Yes
B	8.0%	Short	Low	Yes
C	9.0%	Long	Low	No
D	9.0%	Long	High	Yes
E	9.0%	Short	High	No

The officer wants to invest at least $50,000 of the money in short-term bonds. Also, no more than $60,000 should be invested in high risk bonds. Also, the total investment in tax-free bonds should be at least 1.5 times of the total investment in non-tax-free bonds.

Please do the following:

1. Formulate this problem as an optimization problem by defining decision variables, the objective function and constraints.
2. Create a spreadsheet model for this problem and solve it using Solver. What is the optimal decision and the firm's profit?

Problem 2

A furniture manufacturer produces three types of tables (A, B, C) using three types of machines. The machine time required (hours per table) to produce the tables, retail price and the material cost of each table is given below.

Machine	A	B	C	Total machine time available per week
Router	1.5	2.0	1.7	1,000
Sander	3.0	4.2	3.5	2,000
Polisher	2.5	1.5	2.0	1,500
Retail price per table	$300	$350	$400	
Material cost per table	$100	$120	$130	

The company has a capital limit so it cannot spend more than $10,000 in the material per week. The company wants to make sure at least 20% of the tables produced should be table A. Also tables B and C should account for no more than 70% of the tables produced. How many of each table should be produced per week to maximize the company's profit? Please formulate this problem as an optimization problem by defining decision variables, the objective function and constraints. You do NOT need to solve this problem.

Problem 3

The Molokai Nut Company (MNC) makes 4 different products from macadamia nuts: Whole, Cluster, Crunch and Roasted nuts. To meet marketing demands for the coming week, MNC needs to produce at least 1,000 pounds of the Whole nut, between 400 and 500 pounds of the Cluster nut, no more than 150 pounds of the Crunch nut, and no more than 200 pounds of the Roasted nut. Each pound of the Whole, Cluster, Crunch, and Roasted nut contains, respectively, 60%, 40%, 20% and 100% macadamia nuts with the remaining weight made up of chocolate coating. The company has 1,100 pounds of nuts and 800 pounds of chocolate available for use in the next week. The various products are made using 4 different machines that hull the nuts, roast the nuts, coat the nuts in chocolate (if needed), and package the products. The following table summarizes the time required by each product on each machine. Each machine has 60 hours of time available in the coming week.

Machine	Minutes Required per Pound			
	Whole	Cluster	Crunch	Roasted
Hulling	1.00	1.00	1.00	1.00
Roasting	2.00	1.50	1.00	1.75
Coating	1.00	0.70	0.20	0.00
Packaging	2.50	1.60	1.25	1.00

The selling price and variable cost associated with each pound of product is summarized in the following table.

	Per Pound Revenue and Costs			
	Whole	Cluster	Crunch	Roasted
Selling price	$5.00	$4.00	$3.20	$4.50
Variable cost	$3.15	$2.60	$2.16	$3.10

Please formulate this problem as an optimization problem by defining decision variables, the objective function and constraints. You do NOT need to solve this problem.

Problem 4
JL Foods has $2 million in advertising budget this year for three products: JL Ketchup, JL Spaghetti Sauce and JL Taco Sauce. JL Taco Sauce is a new product introduced this year. In the past, JL Foods advertised $0.7 million on JL Ketchup and it also advertised $0.7 million on JL Spaghetti Sauce.

From past experience, the marketing department estimates that each dollar spent advertising only ketchup increases ketchup sales by 4 bottles and each dollar spent advertising only spaghetti sauce increases its sales by 3.2 bottles. Since JL makes $0.30 in profit per bottle of ketchup and $0.35 per bottle of spaghetti sauce sold (excluding the sunk cost of the given advertising budget), this amounts to a profit of $1.20 (=4*$0.30) per advertising dollar on ketchup and $1.12 (=3.2*$0.35) per advertising dollar on spaghetti sauce.

Because taco sauce is a new product, its initial profit is projected to be only $0.10 per bottle. But each advertising dollar spent solely on taco sauce is estimated to increase sales by 11 bottles. The company also projects that sales of each product would increase by 1.4 bottles for each dollar spent on a joint advertise that advertises all of the three products together. For example, if it spends $3 advertising only ketchup, $4 advertising only spaghetti, $0 advertising only taco sauce, $2 on a joint advertisement, then it will have the following sales:

	Ketchup	Spaghetti	Taco Sauce
# of bottles sold	(4)(3)+(1.4)(2)	(3.2)(4)+(1.4)(2)	(1.4)(2)

JL wishes to maximize its profit this year from advertising while also adhering to the following guidelines:
1. A maximum of $2 million total advertising
2. At most $400,000 on joint advertising
3. At least $100,000 on joint advertising
4. At least $1 million promoting taco sauce, either individually or through joint advertising
5. At least $250,000 promoting ketchup only
6. At least $250,000 promoting spaghetti sauce only
7. At least $750,000 promoting taco sauce only
8. Total expenditure for promoting ketchup individually and joint advertising should not exceed $700,000.

9.   Total expenditure for promoting spaghetti individually and joint advertising should not exceed $700,000.
10.   At least 7.5 million total bottles of product sold (assuming sales are solely driven by advertising)

Please do the following:
1. Formulate this problem as an optimization problem by defining decision variables, the objective function and constraints.
2. Create a spreadsheet model for this problem and solve it using Solver. What is the optimal decision and the firm's profit?