Please complete the problems below in an R Notebook and submit the html file to Canvas. Use R to solve the problems (not the simplex method or Excel as suggested in the text). I recommend starting with pen and paper to set up the problems, rather than coding, to understand the problem.

Problem 1: Dwight and Hattie have run the family farm for over thirty years. They are currently planning the mix of crops to plant on their 120-acre farm for the upcoming season. The table below gives the labor hours and fertilizer required per acre, as well as the total expected profit per acre for each of the potential crops under consideration. Dwight, Hattie, and their children can work at most 6,500 total hours during the upcoming season. They have 200 tons of fertilizer available. What mix of crops should be planted to maximize the family's total profit?

Crop	Labor Required (hours per acre)	Fertilizer Required (tons per acre)	Expected Profit (per acre)
Oats	50	1.5	$500
Wheat	60	2	$600
Corn	105	4	$950

(a) Formulate a linear programming model algebraically
(b) Set up and solve in R.

Problem 2: The kitchen manager for Seattle Academy high school is trying to decide what to feed students. He would like to offer some combination of milk, beans, and oranges, YUM! The goal is to minimize cost, subject to meeting the minimum nutritional requirements imposed by law. The cost and nutritional content of each food, along with the minimum nutritional requirements, are shown below. What diet should be fed to each student? Think carefully how a cost minimum is different than a profit maximum and how the constraints are set up.

	Milk (gallons)	Navy Beans (cups)	Oranges (large Calif. Valencia)	Minimum Daily Requirement
Niacin (mg)	3.2	4.9	0.8	13.0
Thiamin (mg)	1.12	1.3	0.19	1.5
Vitamin C (mg)	32.0	0.0	93.0	45.0
Cost ($)	2.00	0.20	0.25	

(a) Formulate a linear programming model algebraically
(b) Set up and solve in R.

3. Problem 3.4-9, (hint: this is similar to the Personnel Scheduling problem on pages 57 - 60)
4. Problem 3.4-13, use equality constraints (hint: the proportions of the alloys must sum to 1, this is an additional constraint)

5. A farmer is producing Grains and Vegetables with a given set of input mix and water. The input mix includes fertilizer and labor in fixed ratios so they can be treated as one variable, with grains needing 5 units of input and and vegetables needing 50 units of input per acre. Water is also used, grains need 4 units of water and vegetables need 8 units of water per acre. The farmer only has 1,245 units of the input mix and 300 units of water. The profit per acre is $5 for grains and $25 for vegetables. The farmer wants to maximize profits and there is no acreage constraint.

   (a) Formulate a linear programming model algebraically
   (b) Use the graphical method to solve this model (an approximation is fine, you can type the answer in your R Notebook if you're not comfortable graphing)
   (c) Formulate the dual model algebraically
   (d) Use the graphical method to solve the dual model (an approximation is fine, you can type the answer in your R Notebook if you're not comfortable graphing)
   (e) Interpret the dual results

   It is common for the parameters of the model to be uncertain. As such, it is good to be aware of "tipping" points in the model, where small changes in parameters can lead to dramatic changes in the model solution. Using your graph of the primal problem in part (b) above, perform the following sensitivity analysis:

   (f) What changes in the objective function parameters would change the solution in (b)
   (g) What changes in the right hand side constraints would change the solution in (b)
   (h) What changes in the constraint parameters would change the solution in (b)
   (i) Program the problem from above and find the solution
   (j) Find the dual values and interpret them
   (k) Find the sensitivity range and compare to what you found in parts (f) and (g)