A Diet Problem

John Morgan loves steaks and potatoes. He has, therefore, decided to go on a diet consisting entirely of these two foods (plus some liquids). John wants to make sure that his diet satisfies basic nutritional requirements. The nutritional and cost information John has obtained is given in the following table:

Ingredient	**Content** (g per serving) **Steak**	**Potato**	**Daily Requirement**
Carbohydrates	0	60	≥ 150
Protein	50	4	≥ 160
Fat	16	1	≤ 96
Cost per serving	£3.50	£1.50	

John wishes to determine the number of daily servings (which may be fractional) of steak and potatoes that will meet the requirements at a minimum cost.

1. Formulate an LP model for this problem.
2. Solve the problem using the simplex method. Use dual pivoting rather than the first-stage procedure to deal with the infeasible initial tableau. State the optimal solution and the minimum-cost diet programme for John.
3. After falling ill several times this autumn, John has realised he may need to watch his vitamin C intake. A serving of steak provides 1% of the recommended daily amount of vitamin C, whereas a serving of potatoes provides 30%. Formulate an additional constraint that will ensure that John receives at least 100% of the recommended daily amount of vitamin C.

   Add this constraint to the final tableau obtained in part 2.; perform the necessary additional pivots to get the new optimal solution.
4. Unhappy about the amount of potatoes he had to consume every day, John has decided to introduce tomatoes into his diet. A serving of tomatoes contains 8g of carbohydrates, 5g of proteins, no fat and covers 43% of the recommended daily amount of vitamin C. The cost of a tomato serving is £1. How is John's diet going to change?

   Add a new decision variable to the final tableau obtained in part 3.; perform the necessary additional pivots to get the new optimal solution.

Submission and marking

The solution must be submitted via Moodle. You should submit the following file(s):

1. A mathematical formulation of the problem (with decision variables and their interpretation, objective, constraints). The solution itself. The solution after implementing parts 3. and 4.

   Note – You can use a word processor or LaTeX to produce this file, or you can submit hand-written text scanned into PDF on a "multi-function printer". **Mobile-phone photographed solutions will *not* be accepted.**

2. A file containing the simplex tableaux if you have used Excel (or other spreadsheet software) for the pivoting.

Check Moodle for the marking scheme, as well as office hours of relevant staff.

Part 1. LP formulation of problem	. *0 points*	. *1 points*	. *2 points*	1 point per: 1. decision variables, 2. objective, 3. constraints *3 points*
Part 2. Pivoting	Incorrect or major errors *0 points*	Minor errors *1 points*	Correct *2 points*	
Part 2. Optimal solution	Incorrect *0 points*	Correct including interpretation *1 points*		
Part 3. Additional constraint	Incorrect *0 points*	Minor errors *1 points*	Added correctly *2 points*	
Part 3. Dual pivoting	Incorrect or major errors *0 points*	Minor errors *1 points*	Correct, including statement of new solution *2 points*	
Part 4. Additional decision variable	Incorrect *0 points*	Minor error *1 points*	Added correctly *2 points*	
Part 4. Pivoting	Incorrect *0 points*	Correct, including statement of new solution *1 points*		