Questions and Exercises to work out and turn in:

Grading Guidelines:

* A right answer will get full credit when:

1. It is right (worth 25%)
2. It is right **AND** neatly presented making it easy and pleasant to read. (worth an **extra** 15%)
3. There is an **obvious and clear link** between 1) the information provided in the exercise and in class and 2) the final answer. A clear link is built by properly writing, justifying, and documenting an answer (worth an **extra** 60%).
4. Calculation mistakes will be minimally penalized (2 to 5% of full credit) while errors on units will be more heavily penalized.

You are welcome/encouraged to discuss exercises with other students or the instructor. But, ultimately, **personal** writing is expected.

* USE THIS FILE AS THE STARTING DOCUMENT YOU WILL TURN IN. **DO NOT DELETE ANYTHING FROM THIS FILE:** JUST **INSERT** YOUR ANSWERS.
* IF USING HAND WRITING (STRONGLY DISCOURAGED), **USE THIS FILE** BY CREATING SUFFICIENT SPACE AND WRITE IN YOUR ANSWERS.
* FAILING TO FOLLOW TURN IN DIRECTIONS /GUIDELINES WILL COST **A 30% PENALTY.**

Objectives of this assignment:

* to use and manipulate the concepts presented in this module
* to propose and write algorithms in pseudocode
* to analyze the time complexity of algorithms
* to analyze the space complexity of algorithms
* to learn autonomously new concepts

What you need to do:

Answer the questions and/or solve the exercises described below.

Problem (100 points)

The objective is to determine whether the Knapsack problem is NP-complete.

1. (5 points) Research the *Knapsack* problem and **state** it formally
   1. Given a knapsack of weight capacity and items, each item with a weight and a value Determine the number of each item to include in the collection so that the total weight and the value is as large as possible.
2. (10 points) **Which** NP-complete problem among the ones presented in Chapter 34 is the closest to Knapsack (**Hint**: see the map of NP-complete problems shown on the slides and in the textbook). Let us call this problem ***Problem B***.
   1. If **Problem A** is the Knapsack problem listed above, then the closest **Problem B** would be the SUBSET-SUM problem.
   2. The SUBSET-SUM problem is discussed on page 1097 of the textbook and is stated:
3. (5 points) **Describe** an instance for the Knapsack problem.
   1. A set of items with non-negative weights, a maximum weight values , and minimum total value .
4. (5 points) **Cast** the Knapsack problem as a decision problem.
   1. Does there exists a subset of weights with total weight , such that the total value .
5. (5 points) **Describe** an instance for *Problem B*
   1. A set of non-negative integers and total sum
6. (5 points) **Cast** *Problem B* as a decision problem.
   1. Does there exists a subset of numbers where the total sum of
7. (15 points) Propose a **reduction algorithm** to reduce *Problem B* to the Knapsack problem. Ensure that the reduction algorithm runs in proportional time
   1. http://cgm.cs.mcgill.ca/~avis/courses/360/2003/assignments/sol4.pdf
8. (10 points) Show that the Knapsack problem is in NP
9. (30 points) Show that the answers for both problems are the same
10. (10 points) Is the Knapsack problem NP-complete?

What you need to turn in:

* Electronic copy of this file (including your answers) (standalone). Submit the file as a Microsoft Word or PDF file.
* Recall that answers must be well written, documented, justified, and presented to get full credit.
* How this assignment will be graded:
* A right answer will get full credit when:
* It is right (worth 25%)
* It is right AND neatly presented making it easy and pleasant to read. (worth 15%)
* There is an obvious and clear link between 1) the information provided in the exercise and in class and 2) the final answer. A clear link is built by properly writing, justifying, and documenting an answer (worth 60%).
* Calculation mistakes will be minimally penalized (2 to 5% of full credit) while errors on units will be more heavily penalized.
* You are welcome/encouraged to discuss exercises with other students or the instructor. But, ultimately, personal writing is expected.