COP3530 Practice Exam 1

This exam is worth 100pts and you have 1 hour to complete it. You can implement the solutions in the language of your choice (or pseudocode), but your representation must adequately convey the correct use of pointers, templates and any other relevant constructs. To be safe, you should probably just use C++ or a bastardized version thereof. Do everything as efficiently as possible – you will lose points if your approach is too expensive.

1. You are to implement a Babel fish. This is a leech-like thing you stick in your ear and it allows you to understand any language you hear. We’ll just be looking at the data structures and algorithms involved – you don’t need to worry about the biological aspects of designing a telepathic fish.

You will create a data structure that, for a sequence of words in an unknown language, will return a sequence of equivalent words in a specified language. You may assume that any given word only appears in a single language. Keep in mind that this data structure may be composed of multiple (potentially nested) data structures.

a. Write a class definition for your data structure, including appropriate member variables and methods, as well as for any associated structures. Read the remaining parts of this problem first (25pts).

b. Calculate the space complexity of your approach. Possible characteristic variables include the number of words in your dictionary (n) and the number of languages (L) (5pts).

c. Write a method, ‘insert’, that takes as its parameters a new language/word pair and an existing word in any other language (which may be null), and adds it to the dictionary (20pts).

d. Calculate the time complexity of this method. Possible characteristic variables include the number of words in your dictionary (n) and the number of languages (L) (5pts).

e. Write a method, ‘translate’, that takes as its parameters a string in an unknown language and the label for a target language and returns a string in the target language. If a word doesn’t translate to the target language, leave that word in the source language (25pts).
f. Calculate the time complexity of this translate method. Possible characteristic variables include the number of words in the input string \((m)\), the number of words in your dictionary \((n)\) and the number of languages \((L)\) (5pts).

g. What changes would you need to make to support having the same word in multiple languages (potentially meaning different things)? How would this affect your complexities? (If your answer is ‘none’, how could you change your original implementation to take advantage of the assumption that there are no duplicates and improve the complexities of your methods?) (15pts)