This fourth project will give you experience writing a program that involves branching (if). This project will use the same development process as in Programming Projects #2 & #3, and will be subject to the same rules and grading criteria, with some new criteria added. This specification is less detailed than for previous programming projects. **YOU ARE EXPECTED TO KNOW HOW TO PERFORM BASIC TASKS WITHOUT HAVING TO BE TOLD EXPLICITLY.**

You’ve just opened an Italian restaurant.

Each meal your restaurant serves can consist of an entree, a dessert, and a drink.

Your Italian restaurant serves several entrees (cheese ravioli, beef rigatoni, vegetarian lasagna), several desserts (cheesecake, tiramisu, gelato), and several drinks (coffee, soda, tea).

Your restaurant also has a kiddie menu for children, with two additional entrees (spaghetti, macaroni and cheese), and one additional drink (lemonade).

Each entree has two size options: small and large. (Desserts and drinks come in one size only.)

Each entree price depends on the size choice: for each, the small size is cheaper than the large size. Children can order either from the regular menu or from the kiddie menu, but they can only order the small size of the adult entrees, or one of the kiddie entrees (which only come in one size). Children **CANNOT** order coffee or tea. Adults **CANNOT** order the kiddie entrees or the kiddie drinks.

A customer can order **AT MOST** one item from each category; for example, they can order a large vegetarian lasagna as their entree, cheesecake as their dessert and coffee as their drink. But, they **AREN’T REQUIRED** to order one of each category; for example, they can order no entree or dessert at all, just a cup of coffee.

The prices are:

<table>
<thead>
<tr>
<th>Item</th>
<th>Small Price</th>
<th>Large Price</th>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese Ravioli</td>
<td>$7.25</td>
<td>$9.00</td>
<td>Cheesecake</td>
<td>$4.25</td>
</tr>
<tr>
<td>Beef Rigatoni</td>
<td>$8.75</td>
<td>$10.50</td>
<td>Tiramisu</td>
<td>$5.50</td>
</tr>
<tr>
<td>Vegetarian Lasagna</td>
<td>$9.50</td>
<td>$11.25</td>
<td>Gelato</td>
<td>$3.75</td>
</tr>
<tr>
<td>Spaghetti</td>
<td>$4.50</td>
<td></td>
<td>Coffee</td>
<td>$2.75</td>
</tr>
<tr>
<td>Macaroni &amp; Cheese</td>
<td>$3.75</td>
<td></td>
<td>Soda</td>
<td>$1.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tea</td>
<td>$2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lemonade</td>
<td>$1.75</td>
</tr>
</tbody>
</table>

Your community’s sales tax rate is 8.75%. A tip of 18% is automatically added to every bill.

**NOTE:** You are welcome to substitute other items, as long as you do so consistently and continue to follow the rules. For example, you could change beef rigatoni to eggplant parmigiana, etc, but the number and categories of items, and the prices, **MUST** remain the same.

**IMPORTANT IMPORTANT IMPORTANT IMPORTANT IMPORTANT IMPORTANT!!!**

To get full credit, you **MUST** use *if* blocks properly, including nested *if* blocks.
I. PROJECT DESCRIPTION
Write a program that simulates greeting a customer, taking their order, calculating the bill and producing the check. The computer will be the wait staff, and the user will be the customer.

EXTRA PREPROCESSOR DIRECTIVE
Your program MUST start with the following TWO preprocessor directives, in this order:
#include <stdio.h>
#include <stdlib.h>

II. STRUCTURE OF THE PROGRAM
The program body MUST be broken into four subsections:
1. Greeting subsection: Greet the customer (user).
2. Input subsection: Prompt for and input their order, one item at a time, IDIOTPROOFING EACH VALUE AS SOON AS IT IS INPUT.
3. Calculation subsection: Determine the price of each item, the subtotal, the tax amount, the tip amount, and the grand total.
4. Output subsection: Output their bill in receipt form.

Please note that you are ABSOLUTELY FORBIDDEN to have:
- ANY executable statements in your declaration section;
- ANY declarations in your execution section (body);
- ANY inputs or calculations in your greeting subsection;
- ANY calculations, or outputs other than prompts and idiotproofing error messages, in your input subsection;
- ANY inputs or outputs in your calculation subsection;
- ANY inputs or calculations in your output subsection.

That is, the subsections MUST BE COMPLETELY SEPARATE, and MUST BE CLEARLY LABELED WITH COMMENTS.

For this programming project, if blocks are not considered to be inputs, nor calculations, nor outputs; that is, in principle you may have an if block in ANY subsection of the program body. However, statements inside the clauses of an if block MUST follow the rules above.

III. IMPLEMENTATION ORDER
Because the program will be complicated, you are STRONGLY advised to IMPLEMENT ONE PART AT A TIME, thoroughly test and debug it, and then go on to the next part. Also, it would probably be best to implement the subsections, NOT in the order in which they appear in the program (as described above), but rather in the following order:

1. Greeting subsection.
2. Input subsection (developed one item at a time). NOTE: If you’re unclear on how to idiotproof, then you can skip the idiotproofing during initial implementation and then develop the idiotproofing code later.
3. Output subsection (developed one item at a time). Note that, at this stage, some or all of your outputs will be garbage, because you haven’t yet written the calculation subsection.
4. Calculation subsection (developed one item at a time).
IV. DETAILS OF THE PROGRAM STRUCTURE

A. Greet the Customer

Welcome the customer to the restaurant.

B. Input the Customer’s Order

1. Ask (prompt) the customer for their age category (child or adult). You can use integer-valued codes to represent the age categories, and you may choose any REASONABLE values for coding these items. So, when the program prompts them for their age category, the OUTPUT might be something like:

Which age category are you?
Please enter:
  1 for adult
  2 for child

2. Input the customer’s age category.

3. IDIOTPROOF the customer’s age category, to ensure that the value that the user has input is one of the values listed in the prompt. (See the Grading Criteria for details.)

4. Ask (prompt) the customer for their entree item choice, giving them a list of entree items to choose from. The list of entree item choices will differ depending on whether the customer is a child or an adult. DON’T LIST ENTREE ITEM CHOICES THAT ARE INAPPROPRIATE FOR THEIR AGE CATEGORY. You can use integer-valued codes to represent the entree items, and you may choose any REASONABLE values for coding these items. So, when the program prompts them for their entree item choice, the OUTPUT might be something like:

What entree item would you like?
Please enter:
  0 for no entree
  1 for cheese ravioli
  2 for beef rigatoni
  3 for vegetarian lasagna

If the customer is a child, the list of entree item choices will be longer.

5. Input the customer’s entree item choice.

6. IDIOTPROOF the entree item choice, to ensure that the value that the user has input is one of the values listed in the prompt. (See the Grading Criteria for details.)

7. If the customer is an adult and chose to purchase an entree, then:

   (a) Ask (prompt) the customer for their entree size choice, giving them a list of sizes to choose from. Again, you can use integer-valued codes to represent the entree sizes, and you may choose any REASONABLE values for coding these sizes. So, when the program prompts them for their entree size, the OUTPUT might be something like:

What entree size would you like?
Please enter:
  1 for small
  2 for large
(b) **Input** the customer’s entree size.

(c) **IDIOTPROOF** the entree size, to ensure that the value that the user has input is one of the values listed in the prompt. (See the Grading Criteria for details.)

(d) **NOTE**: If the customer is a child, then their entree size will be small, so they don’t need to be asked about their entree size.

8. **Ask (prompt) the customer for their dessert item choice**, giving them a list of dessert items to choose from. Again, you can use integer-valued codes to represent the dessert items, and you may choose any **REASONABLE** values for coding these items. So, when the program prompts them for their dessert item choice, the **OUTPUT** might be something like:

   What dessert item would you like?
   Please enter:
   0 for no dessert
   1 for cheesecake
   2 for tiramisu
   3 for gelato

9. **Input** the customer’s dessert item choice.

10. **IDIOTPROOF** the dessert item choice, to ensure that the value that the user has input is one of the values listed in the prompt. (See the Grading Criteria for details.)

11. **Ask (prompt) the customer for their drink item choice**. Again, you can use integer-valued codes to represent the drink item choices, and you may choose any **REASONABLE** values for coding these items. The list of drink item choices will differ depending on whether the customer is a child or an adult. **DON’T LIST DRINK ITEM CHOICES THAT ARE INAPPROPRIATE FOR THEIR AGE CATEGORY.**

12. **Input** the customer’s drink item choice.

13. **IDIOTPROOF** the drink item choice, to ensure that the value that the user has input is one of the values listed in the prompt. (See the Grading Criteria for details.)

**NOTE:** YOU MUST FULLY IDIOTPROOF EVERY INPUT THAT NEEDS IDIOTPROOFING. YOU ARE RESPONSIBLE FOR DETERMINING ALL POSSIBLE FORMS OF IDIOCY. Idiotproofing error messages **MUST** be **HELPFUL** and sufficiently detailed that even an idiot could figure out **SPECIFICALLY** what they’ve done wrong.

**IMPORTANT IMPORTANT IMPORTANT IMPORTANT IMPORTANT IMPORTANT!!!**

**ADVICE:** Avoid using ambiguous names for variables and named constants. Specifically, in this project, **DON’T** use names such as `drink` or `coffee`. Instead, use names that **CLEARLY** state the **ROLE** of the variable or named constant, such as `drink_item_code` or `coffee_price`.

**NOTE:** If the customer chooses to buy nothing — no entree, no dessert, no drink — then thank them and **EXIT** the program with a return code of zero (using an appropriate named constant), rather than calculating and printing an empty bill.
C. Calculate the Bill

1. **Entree price:** This value isn’t calculated as such, but is obtained from the entree item choice and the entree size choice. (See VI.B.1.)
2. **Dessert price:** This value isn’t calculated as such, but is obtained from the dessert item choice.
3. **Drink price:** This value isn’t calculated as such, but is obtained from the drink item choice.
4. **Subtotal:** Calculate the subtotal of the food and drink prices.
5. **Tax amount:** Calculate the amount of tax on the subtotal. Both food and drink are taxed at the same tax rate (8.75%).
6. **Tip amount:** The restaurant automatically adds a tip of 18% of the total food and drink bill, **excluding tax** — that is, the tip is calculated based on the sum of the entree price, the dessert price and the drink price, **NOT** on the sum of the entree price, the dessert price, the drink price and the tax amount.
7. **Grand Total:** The grand total bill is the sum of the subtotal, the tax amount, and the tip amount.

D. Print the Bill

1. Present the customer with an itemized bill in receipt form, using the placeholder below. For example:
   
   -----------------------------------------------
   Enrico’s Bistro Bill
   -----------------------------------------------
   Large Vegetarian Lasagna: $11.25
   Tiramisu: $ 5.50
   Coffee: $ 2.75
   -----------------------------------------
   Subtotal: $19.50
   Tax: $ 1.71
   Tip: $ 3.51
   -----------------------------------------
   Grand Total: $24.72
   
   Thank you for visiting Enrico’s Bistro!
   -----------------------------------------------

   (Substitute the name of your restaurant at the top and bottom.)

2. For all of the outputs in the itemized list (from the entree through the grand total), use the `printf` placeholder `%5.2f`, like so:

   ```c
   printf(" Large Vegetarian Lasagna: $%5.2f\n", entree_price);
   ```

   The `conversion format` in the placeholder tells the compiler that the `printf` statement will output some literal text, followed by a floating point number that takes up at least five spaces, two of which are to the right of the decimal point.
3. Item names **MUST** line up on the left side of the bill, dollar signs **MUST** line up, and the `printf` placeholder will cause prices to be flush to the right of the line. For the conversion format to work, **all dollar amounts MUST** be `float`.

4. List the bill entries in the order shown, using the name of each menu choice (table, page 1).

5. In some cases, the exact tax amount and/or tip amount will have more than two digits to the right of the decimal point. We will accept results within five cents of the exactly correct bill.

**V. RUNS**

In your script, run the program 8 times, using the following inputs, in the following order:

1. adult, no entree, no dessert, no drink
2. adult, large cheese ravioli, cheesecake, coffee
3. adult, small beef rigatoni, tiramisu, soda
4. adult, large vegetarian lasagna, gelato, tea
5. child, spaghetti, no dessert, soda
6. child, macaroni and cheese, gelato, lemonade
7. child, cheese ravioli, no dessert, soda
8. adult, no entree, no dessert, coffee

In addition, **RUN THE PROGRAM ONCE FOR EACH POSSIBLE CASE OF IDIOCY** that a user might exhibit; that is, you **MUST** have runs that **COMPLETELY TEST EACH AND EVERY IDIOTPROOF CHECK. YOU ARE RESPONSIBLE FOR DETERMINING ALL POSSIBLE FORMS OF IDIOCY.** In your script file, the idiotproof test runs **MUST** occur **AFTER** the runs listed above.

**ADVICE:** Calculate each (non-idiotproof) run’s result by hand, then compare your hand-calculated values to the output of the program, to determine whether the program is running correctly.

**VI. GRADING CRITERIA**

**A. SUBJECTIVE GRADING OF COMMENTS IN THE PROGRAM BODY**

In previous programming projects, one of the grading criteria for comments in the program body has been that **EVERY** statement in the program body had to be preceded by a clear, helpful explanatory comment.

- For PP#4 and beyond, you may choose to write fewer comments than this (though still in the format described in the PP#2 specification), in which case **YOU AGREE TO ACCEPT WITHOUT ARGUMENT** the graders’ **SUBJECTIVE** opinion on whether the amount and nature of your comments is sufficient.
- Alternatively, you may choose to continue to comply with the old criterion, preceding **EVERY** statement in the program body with a clear, helpful explanatory comment, in which case you are guaranteed to get full credit for this aspect of documentation in the program body (assuming that your comments comply with the original grading criteria for comments in the PP#2 specification).
B. NEW GRADING CRITERIA

1. **Format** of if statements, else if statements and else statements:
   For each if statement, the if keyword **MUST** be followed by a blank space and then the open parenthesis that begins the if condition. After the close parenthesis that ends the if condition, there **MUST** be a blank space, followed by the block open, on the same line as the last line of the if condition.
   For each else if statement, the same.
   For each else statement, there **MUST** be a single blank space between the else keyword and the block open, which **MUST** be on the same line as the else keyword. For example:

   ```c
   if (entree_item_code == no_item_code) {
       entree_price = no_item_price;
   } /* if (entree_item_code == no_item_code) */
   else if (entree_item_code == cheese_ravioli_item_code) {
       if (entree_size_code == small_size_code) {
           entree_price = small_cheese_ravioli_price;
       } /* if (entree_size_code == small_size_code) */
       else if (entree_size_code == large_size_code) {
           entree_price = large_cheese_ravioli_price;
       } /* if (entree_size_code == large_size_code) */
   } /* if (entree_item_code == cheese_ravioli_item_code) */
   else if (entree_item_code == beef_rigatoni_item_code) {
       if (entree_size_code == small_size_code) {
           entree_price = small_beef_rigatoni_price;
       } /* if (entree_size_code == small_size_code) */
       else if (entree_size_code == large_size_code) {
           entree_price = large_beef_rigatoni_price;
       } /* if (entree_size_code == large_size_code) */
   } /* if (entree_item_code == beef_rigatoni_item_code) */
   else if (entree_item_code == vegetarian_lasagna_item_code) {
       if (entree_size_code == small_size_code) {
           entree_price = small_vegetarian_lasagna_price;
       } /* if (entree_size_code == small_size_code) */
       else if (entree_size_code == large_size_code) {
           entree_price = large_vegetarian_lasagna_price;
       } /* if (entree_size_code == large_size_code) */
   } /* if (entree_item_code == vegetarian_lasagna_item_code) */
   else if (entree_item_code == spaghetti_item_code) {
       entree_price = spaghetti_price;
   } /* if (entree_item_code == spaghetti_item_code) */
   else if (entree_item_code == macaroni_and_cheese_item_code) {
       entree_price = macaroni_and_cheese_price;
   } /* if (entree_item_code == macaroni_and_cheese_item_code) */
   ```
2. **Format** of if conditions and else if conditions:

   For each if statement and each else if statement, in the condition, any binary operators — including relational operators such as `==` and Boolean operators such as `&&` — **MUST** be surrounded by one or more blank spaces on each side. Unary operators such as `!` **MUSTN'T** be surrounded by blank spaces. For example:

   ```c
   if ((dessert_item_code != no_item_code) &&
       (dessert_item_code != cheesecake_item_code) &&
       (dessert_item_code != tiramisu_item_code) &&
       (dessert_item_code != gelato_item_code)) {
     printf("ERROR: unknown dessert item code %d.\n",
            dessert_item_code);
     exit(program_failure_code);
   } /* if ((dessert_item_code != no_item_code) && ...) */
   ```

3. **Indenting OF if blocks:**

   For a given if block, the if statement, all else if statements (if any), the else statement (if any) and the block closes associated with these statements **MUST** all line up, both with each other and with other statements as appropriate. For example:

   ```c
   if (drink_item_code == no_item_code) {
     drink_price = no_item_price;
   } /* if (drink_item_code == no_item_code) */
   else if (drink_item_code == coffee_item_code) {
     drink_price = coffee_price;
   } /* if (drink_item_code == coffee_item_code) */
   else if (drink_item_code == soda_item_code) {
     drink_price = soda_price;
   } /* if (drink_item_code == soda_item_code) */
   else if (drink_item_code == tea_item_code) {
     drink_price = tea_price;
   } /* if (drink_item_code == tea_item_code) */
   else if (drink_item_code == lemonade_item_code) {
     drink_price = lemonade_price;
   } /* if (drink_item_code == lemonade_item_code) */
   subtotal = entree_price + dessert_price + drink_price;
   ```
4. **Indenting INSIDE if blocks:**

For a given if block, all statements INSIDE any clause of the if block MUST be indented **FOUR SPACES** farther than the associated if statement. This applies especially to if blocks nested inside other if blocks. For example:

```c
if (entree_item_code != no_item_code) {
  if (age_code == child_age_code) {
    entree_size_code = small_size_code;
  } /* if (age_code == child_age_code) */
  else {
    printf("What entree size would you like?\n");
    printf("Please enter:\n");
    printf(" %d for small\n", small_size_code);
    printf(" %d for large\n", large_size_code);
    scanf("%d", &entree_size_code);
    if ((entree_size_code != small_size_code) &&
        (entree_size_code != large_size_code)) {
      printf("ERROR: unknown entree size code %d.\n", entree_size_code);
      exit(program_failure_code);
    } /* if (entree_size_code != small_size_code) */
  } /* if (age_code == child_age_code)...else */
} /* if (entree_item_code != no_item_code) */
```

5. **Commenting if blocks:** You MUST follow all of the rules that are specified in the packet titled “Commenting if Blocks,” which will be posted on the course website soon.

6. **Text on the Same Line After a Block Open:** On any line that has a block open, you are **ABSOLUTELY FORBIDDEN** to have ANY source code text AFTER the block open; that is, the block open MUST be the **FINAL** character on that line.

7. **Text on the Same Line After a Block Close:** On any line that has a block close, you are **ABSOLUTELY FORBIDDEN** to have ANY source code text AFTER the block close **EXCEPT** the comment that labels that block close (see grading criterion #5).
8. Idiotproofing

(a) **ALL** inputs **MUST** include idiotproofing checks. Here’s a typical idiotproofing check:

```c
if (age_code == adult_age_code) {
    if ($(drink_item_code != no_item_code) && (drink_item_code != coffee_item_code) && (drink_item_code != soda_item_code) &&
      (drink_item_code != tea_item_code)) {
        printf("ERROR: unknown drink item code %d.\n",
               drink_item_code);
        exit(program_failure_code);
    } /* if ($(drink_item_code != no_item_code) && ...) */
} /* if (age_code == adult_age_code) */
else {
    if ($(drink_item_code != no_item_code) && (drink_item_code != soda_item_code) &&
      (drink_item_code != lemonade_item_code)) {
        printf("ERROR: unknown drink item code %d.\n",
               drink_item_code);
        exit(program_failure_code);
    } /* if ($(drink_item_code != no_item_code) && ...) */
} /* if (age_code == adult_age_code)...else */
```

Notice the `exit` statement, which causes the program to immediately terminate. **ALL** idiotproofing checks **MUST** include an `exit` statement. Notice that the `exit` statement is **INSIDE** the `if` block, and should be indented appropriately (see above). Also, your program **MUST** have a named constant `program_failure_code` whose value is `-1`.

(b) Each idiotproofing check **MUST** occur **IMMEDIATELY** after the associated `scanf` statement. **ALL IDIOPROOFING MUST BE COMPLETED BEFORE ANY CALCULATIONS ARE PERFORMED**; that is, idiotproofing belongs in the input subsection.

(c) Idiotproof error messages **MUST CLEARLY AND UNAMBIGUOUSLY** state the nature of the error. Thus, no two error messages should be the same.

(d) You **DON’T** have to idiotproof the data type. For example, when inputting the entree item code, you **DON’T** have to check whether the user input something like 2.73. Idiotproofing the data type is far beyond the scope of material covered in this course. In fact, you’d probably have to be in at least the second programming course for CS majors before you’d have covered that kind of material.

**VII. WHAT TO SUBMIT**
Submit cover, summary essay, script and extra credit bonus form (if any) in the usual style, format and order, and upload your source file and script file to Canvas in the usual way.
VIII. EXTRA CREDIT

You can receive an extra credit bonus of as much as 5% of the total value of Programming Project #4 by doing the following:

1. Attend at least one CS1313 help session for at least 30 minutes, through Wed March 28.
2. During the help session that you attend, work on CS1313 assignments (ideally PP#4, but any CS1313 assignment is acceptable). **YOU CANNOT GET EXTRA CREDIT IF YOU DON’T WORK ON CS1313 ASSIGNMENTS DURING THE HELP SESSION.**
3. Before you leave the help session, fill out **BOTH** halves of the form on the last page of this project specification and have the help session leader (instructor or TA) sign **BOTH** halves. **THE FORM CANNOT BE SIGNED UNTIL BOTH HALVES ARE COMPLETELY FILLED OUT.**
4. Attach the bottom half of the form to your PP#4 script printout, **AFTER** the script itself, and keep the top half for your own records.

**BONUS VALUE NOTICE:** Through Wed March 7, the extra credit bonus will be worth 5% of the total value of PP#4; from Mon March 12 through Wed March 14, the extra credit bonus will be worth **only 2.5%** of the total value of PP#4; from Mon March 26 through Wed March 28, the extra credit bonus will be worth **only 1.25%** of the total value of PP#4. That is, **YOU’LL GET TWICE AS MUCH EXTRA CREDIT DURING THE FIRST WEEK AS THE SECOND WEEK, AND TWICE AS MUCH EXTRA CREDIT DURING THE SECOND WEEK AS THE LAST WEEK.**

**NOTE:** This extra credit bonus **WON’T** be available on any other programming project unless explicitly stated so in the project’s specification.
CS1313 PROGRAMMING PROJECT #4 BONUS REQUEST FORM

Name ____________________________________________ Lab ___________
Help Session Date ________________
Help Session Time (Arrive) _____________ Help Session Time (Depart) _____________

Instructor Signature ________________________________________________

Keep this copy for your records.

Submit this copy.
In your submission, attach this copy AFTER your script file printout.
If you put this in the wrong place in your submission, then you WON’T get the extra credit.