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**CSC121 Python Programming**

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LAB 01 **DESIGNING ALGORITMS FOR COMPUTER PROGRAMS**

# Objectives

In this lab assignment, students will learn:

- How to design steps for getting user input

- How to design steps for processing

- How to design steps for displaying output

- How to execute steps by hand and keep track of value changes in variables

# Goals

In this lab assignment, students will demonstrate the abilities to:

- Design steps for getting user input

- Design steps for processing

- Design steps for displaying output

- Execute steps by hand and keep track of value changes in variables

# Instruction and Problems

In this lab, you need to create algorithms and execute them by hand. Please type and save all your answers in one single Microsoft Word document. Submit the file to Blackboard for credit.

For problem 1 through 4, please design an algorithm for a computer program to solve each problem. All algorithms in this lab should include input steps, processing steps (e.g. steps performing calculations) and output steps. The following is an example.

Problem to solve: *The power of an air conditioner is measured in British Thermal Units (BTU). The higher the BTU, the more heat the air conditioner can bring away. When people buy an air conditioner, they need to know how many BTU they need to keep the room cool. Design a program to estimate how many BTU we need when we install a window air conditioner in a room. This number is determined by the volume of the room. The rule of thumb is that we need 3.5 BTU per cubic foot. The program should ask the user to enter the length, width and height of the room. It should calculate and display the number of BTU needed for the air conditioner.*

Algorithm:

Step 1: Input the length of the room

Step 2: Input the width of the room

Step 3: Input the height of the room

Step 4: Calculate volume = length \* width \* height

Step 5: Calculate BTU needed = volume \* 3.5

Step 6: Display BTU needed

## Problem 1

A hotdog stand sells hotdogs, potato chips and sodas. Hotdogs are $2.50 each. Potato chips are $1.50 per bag. Sodas are $1.25 per cans. Design a program to do the following. Ask the user to enter number of hotdogs, chips and sodas ordered by the customer. The program will calculate and display the total amount due. Submit the algorithm for credit.

Step 1: Input number of hotdogs

Step 2: Input number chips

Step 3: Input number sodas

Step 4: Calculate total cost of hotdogs

Step 5: Calculate total cost of chips

Step 6: Calculate total cost of sodas

Step 7: Add all total costs together

Step 8: Display total cost

## Problem 2

Each student in a course needs to submit 3 lab assignments and take 2 tests. Design a program to do the following. Ask the user to enter 3 lab scores and 2 test scores. Calculate and display the lab average and the test average. Also calculate and display the course grade, which equals 55% of the lab average plus 45% of the test average. Submit the algorithm for credit.

Step 1: Input 3 lab scores

Step 2: Input 2 test scores

Step 3: Calculate lab average = 3 lab scores added together then divide by 3

Step 4: Calculate test average = 2 test scores added together then divide by 2

Step 5: Calculate course grade = lab average \* .55 then test average \* .45

Step 5 (cont.): Then add new lab average and new test average

Step 6: Display grade

## Problem 3

Admission to an aquarium is $14 per person. There is also an IMAX theatre in the building, which charges $8 per ticket for a 3D shark show. Customers have three choices: admission to the aquarium only without watching 3D show, watch 3D show only with no admission to the aquarium, or do both with a 25% discount. Design a program for group orders. Ask the group to enter number of people who want admission only but no 3D show, number of people who want 3D show only but no admission to the aquarium, and number of people who want both. Calculate and display the total amount due from the group. Submit the algorithm for credit.

Step 1: Input how many people don’t want a show

Step 2: Input how many people want a show but no aquarium

Step 3: Input how many people want both

Step 4: Calculate total cost of admission but no show

Step 5: Calculate total cost of show ticket but no aquarium

Step 6: Calculate total cost of both

Step 7: Calculate total cost of every option

Step 8: Display total

## Problem 4

The jackpot of a lottery is paid in 20 annual installments. There is also a cash option, which pays the winner 65% of the jackpot instantly. In either case 30% of the winnings will be withheld for tax. Suppose the jackpot is $100. If installments are chosen, the winner will receive $5 each year before tax, and $3.5 each year after tax (because 30% of $5 is withheld for tax). If cash option is chosen, the winner will receive $65 instantly before tax, and $45.5 instantly after tax (because 30% of $65 is withheld for tax). Design a program to do the following. Ask the user to enter the jackpot amount. Calculate and display how much money the winner will receive annually before tax and after tax if annual installments is chosen. Also calculate and display how much money the winner will receive instantly before and after tax if cash option is chosen. Submit the algorithm for credit.

Step 1: Input jackpot amount

Step 2: Calculate annual installments

Step 3: Calculate annual installments after tax (jackpot \* .3)

Step 4: Display annual installments plan

Step 5: Calculate instant cash

Step 6: Calculate instant cash after tax (Jackpot \* .65)

Step 7: Input which plan is chosen

Step 8: Display Chosen plan

For problem 5 through 8, please execute the algorithm you created earlier and use a table to show value changes of the variables with the test case provided. Submit the variable tables for credit.

To create a variable table, first type the steps of the algorithm in the leftmost column. Execute each step of the algorithm by hand. Whenever a new variable is needed, create a new column to record the value of that variable. The following is an example.

*Execute the BTU algorithm by hand with this test case: room length = 15, room width = 11 and room height =10. Create a table to show how the value of each variable changes during program execution.*

Variable Table:

| Step | Room length | Room width | Room height | Room volume | BTU needed |
| --- | --- | --- | --- | --- | --- |
| Input room length | 15 |  |  |  |  |
| Input room width | 15 | 11 |  |  |  |
| Input room height | 15 | 11 | 10 |  |  |
| Calculate volume = length \* width \* height | 15 | 11 | 10 | 1650 |  |
| Calculate BTU needed = volume \* 3.5 | 15 | 11 | 10 | 1650 | 5775 |
| Display BTU needed | 15 | 11 | 10 | 1650 | 5775 |

## Problem 5

Execute the algorithm you designed in Problem 1. Create a table to show how the values of the variables change during program execution with the following test case: number of hotdogs = 4, number of chips = 2, number of sodas = 3. Submit the variable table for credit.

| Step | Cost of hotdogs  2.50 | Cost of chips  1.50 | Cost of sodas  1.25 | Total cost |
| --- | --- | --- | --- | --- |
| Input hotdogs = 4 | 10 |  |  |  |
| Input chips = 2 | 10 | 3 |  |  |
| Input sodas = 3 | 10 | 3 | 3.75 |  |
| Calculate total cost = Hotdogs + chips + sodas | 10 | 3 | 3.75 | 16.75 |

## Problem 6

Execute the algorithm you designed in Problem 2. Create a table to show how the values of the variables change during program execution with the following test case: Lab 1 score = 95, lab 2 score = 82, lab 3 score = 90, test 1 score = 88, test 2 score = 97. Submit the variable table for credit.

| Step | Lab 1 score | Lab 2 score | Lab 3 score | Test 1 score | Test 2 score | Lab average | Test average | Course grade |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Input Lab 1 = 95 | 95 |  |  |  |  |  |  |  |
| Input Lab 2 = 82 | 95 | 82 |  |  |  |  |  |  |
| Input Lab 3 = 90 | 95 | 82 | 90 |  |  |  |  |  |
| Input Test 1 = 88 | 95 | 82 | 90 | 88 |  |  |  |  |
| Input Test 2 = 97 | 95 | 82 | 90 | 88 | 97 |  |  |  |
| Calculate Lab average = Lab 1 + Lab 2 + Lab 3 then /3 | 95 | 82 | 90 | 88 | 97 | 89 |  |  |
| Calculate test average = Test 1 + test 2 then /2 | 95 | 82 | 90 | 88 | 97 | 89 | 92.5 |  |
| Calculate course grade = lab average \* .55 then test average \* .45 then add together | 95 | 82 | 90 | 88 | 97 | 89 | 92.5 | 90.6 |

## Problem 7

Execute the algorithm you designed in Problem 3. Create a table to show how the values of the variables change during program execution with the following test case: number of people who want admission only but no 3D show = 5, number of people who want 3D show only but no admission = 7, number of people who want both = 8. Submit the variable table for credit.

| Step | Admission only - $14 | 3D show only - $8 | Both – 14+8\*.25 | Total cost |
| --- | --- | --- | --- | --- |
| Input admission only = 5 | 70 |  |  |  |
| Input 3D show only = 7 | 70 | 56 |  |  |
| Input both = 8 | 70 | 56 | 44 |  |
| Calculate total cost = Admission+ 3D show + Both | 70 | 56 | 44 | 170 |

## Problem 8

Execute the algorithm you designed in Problem 4. Create a table to show how the values of the variables change during program execution with the following test case: jackpot amount = 1234000. Submit the variable table for credit.

| Step | Jackpot | Cash option | Cash option after tax | Annual payments | Annual payments after tax |
| --- | --- | --- | --- | --- | --- |
| Input jackpot | 1,234,000 |  |  |  |  |
| Cash option \*.65 | 1,234,000 | 802,100 |  |  |  |
| Cash option after tax \*.30 | 1,234,000 | 802,100 | 240,630 |  |  |
| Annual payments | 1,234,000 | 802,100 | 240,630 | 61,700 |  |
| Annual payments after tax \*.30 | 1,234,000 | 802,100 | 240,630 | 61,700 | 18,510 |

# Grading rubric for Problem 1 - 4

Designing input steps [4 points]

Designing processing steps [9 points]

Designing output steps [4 points]

# Grading rubric for Problem 5 - 8

Showing correct values in variable table [8 points]