LAB ASSIGNMENTS

Problem Solving and Program Design Using C

(CSE 3942)

Department of Computer Science & Information Technology
Faculty of Engineering & Technology (ITER)
Siksha 'O' Anusandhan Deemed To Be University
Bhubaneswar, Odisha - 751030

Lab Assignment-1

1. Programming Projects on Overview of C

1.1 Write a program that calculates mileage reimbursement for a salesperson at a rate of $.35 per mile. Your program should interact with the user in this manner: MILEAGE REIMBURSEMENT CALCULATOR
Enter beginning odometer reading=> 13505.2
Enter ending odometer reading=> 13810.6
You traveled 305.4 miles. At $0.35 per mile,
your reimbursement is $106.89.

1.2 Write a program to assist in the design of a hydroelectric dam. Prompt the user for the height of the dam and for the number of cubic meters of water that are projected to flow from the top to the bottom of the dam each second. Predict how many megawatts (1MW = 10^6W) of power will be produced if 90% of the work done on the water by gravity is converted to electrical energy. Note that the mass of one cubic meter of water is 1000 kg. Use 9.80 $meters/second^2$ as the gravitational constant g . Be sure to use meaningful names for both the gravitational constant and the 90% efficiency constant. For one run, use a height of 170 m and flow of 1.30×10^3 m^3/s. The relevant formula (w = work, m = mass, g = gravity, h = height) is: w = mgh.

1.3 Write a program that estimates the temperature in a freezer (in °C) given the elapsed time (hours) since a power failure. Assume this temperature (T) is given by

$$T = \frac{4t^2}{t+2} - 20$$

where t is the time since the power failure. Your program should prompt the user to enter how long it has been since the start of the power failure in whole hours and minutes. Note that you will need to convert the elapsed time into hours. For example, if the user entered 2 30 (2 hours 30 minutes), you would need to convert this to 2.5 hours.

1.4 Write a program to convert a temperature in degrees Fahrenheit to degrees Celsius.

DATA REQUIREMENTS
Problem Input
int fahrenheit /* temperature in degrees Fahrenheit */
Problem Output
double celsius /* temperature in degrees Celsius */
Relevant Formula
celsius = 5/9 (fahrenheit - 32)

1.5 Metro City Planners proposes that a community conserve its water supply by replacing all the community's toilets with low-flush models that use only 2 liters per flush. Assume that there is about 1 toilet for every 3 persons, that existing toilets use an average of 15 liters per flush, that a toilet is flushed on average 14 times per day, and that the cost to install each new toilet is $150. Write a program that would estimate the magnitude (liters/day) and cost of the water saved based on the community's population.

1.6 Write a program that takes the length and width of a rectangular yard and the length and width of a rectangular house situated in the yard. Your program should compute the time required to cut the grass at the rate of two square feet a second.

Lab Assignment-2

2. Programming project on Top-Down Design With Functions

2.1 You have saved $500 to use as a down payment on a car. Before beginning your car shopping, you decide to write a program to help you figure out what your monthly payment will be, given the car's purchase price, the monthly interest rate, and the time period over which you will pay back the loan. The formula for calculating your payment is

$$\text{payment} = \frac{iP}{1-(1+i)^{-n}}$$

where P = principal (the amount you borrow)
i = monthly interest rate $\left(\frac{1}{12}\right.$ of the annual rate)
n = total number of payments

Your program should prompt the user for the purchase price, the down payment, the annual interest rate and the total number of payments (usually 36, 48, or 60). It should then display the amount borrowed and the monthly payment including a dollar sign and two decimal places.

2.2 Four track stars have entered the mile race at the Penn Relays. Write a program that scans in the race time in minutes (minutes) and seconds (seconds) for a runner and computes and displays the speed in feet per second (fps) and in meters per second (mps). (Hints: There are 5,280 feet in one mile, and one kilometer equals 3,282 feet.) Write and call a function that displays instructions to the program user. Run the program for each star's data.

Minutes	Seconds
3	52.83
3	59.83
4	00.03
4	16.22

2.3 In shopping for a new house, you must consider several factors. In this problem the initial cost of the house, the estimated annual fuel costs, and the annual tax rate are available. Write a program that will determine the total cost of a house after a five-year period and run the program for each of the following sets of data.

Initial House Cost	Annual Fuel Cost	Tax Rate
67,000	2,300	0.025
62,000	2,500	0.025
75,000	1,850	0.020

To calculate the house cost, add the initial cost to the fuel cost for five years, then add the taxes for five years. Taxes for one year are computed by multiplying the tax rate by the initial cost. Write and call a function that displays instructions to the program user.

2.4 A cyclist coasting on a level road slows from a speed of 10 mi/hr to 2.5 mi/hr in one minute. Write a computer program that calculates the cyclist's constant rate of acceleration and determines how long the cyclist will take to come to rest, given an initial speed of 10 mi/hr. (Hint: Use the equation

$$a = \frac{v_f - v_t}{t}$$

where a is acceleration, t is time interval, v_1 is initial velocity, and v_f is final velocity.) Write and call a function that displays instructions to the program user and a function that computes a, given t, v_f, and v_r.

2.5 A manufacturer wishes to determine the cost of producing an open-top cylindrical container. The surface area of the container is the sum of the area of the circular base plus the area of the outside (the circumference of the base times the height of the container). Write a program to take the radius of the base, the height of the container, the cost per square centimeter of the material (cost), and the number of containers to be produced (quantity). Calculate the cost of each container and the total cost of producing all the containers. Write and call a function that displays instructions to the user and a function that computes surface area.

2.6 Write a program to take a depth (in kilometers) inside the earth as input data; compute and display the temperature at this depth in degrees Celsius and degrees Fahrenheit. The relevant formulas are

Celsius = 10 (depth) + 20 (Celsius temperature at depth in km)
Fahrenheit = 1.8 (Celsius) + 32

Include two functions in your program. Function *celsius_at_depth* should compute and return the Celsius temperature at a depth measured in kilometers. Function *fahrenheit* should convert a Celsius temperature to Fahrenheit.

Lab Assignment-3

3. Programming project on Selection Structures: if and switch statements

---

3.1 Keith's Sheet Music needs a program to implement its music teacher's discount policy. The program is to prompt the user to enter the purchase total and to indicate whether the purchaser is a teacher. The store plans to give each customer a printed receipt, so your program is to create a nicely formatted file called receipt.txt. Music teachers receive a 10% discount on their sheet music purchases unless the purchase total is $100 or higher. In that case, the discount is 12%. The discount calculation occurs before addition of the 5% sales tax. Here are two sample output files—one for a teacher and one for a nonteacher.

Total purchases	$122.00
Teacher's discount(12%)	14.64
Discounted total	107.36
Sales tax (5%)	5.37
Total	$112.73

Total purchases	$24.90
Sales tax (5%)	1.25
Total	$26.15

Note: to display a % sign, place two % signs in the format string:
printf("%d%%", SALES_TAX);

3.2 Write a program that calculates the user's body mass index (BMI) and categorizes it as underweight, normal, overweight, or obese, based on the following table from the United States Centers for Disease Control:

BMI	Weight Status
Below 18.5	Underweight
$18.5 - 24.9$	Normal
$25.0 - 29.9$	Overweight
30.0 and above	Obese

To calculate BMI based on weight in pounds (wt_lb) and height in inches (ht_in), use this formula (rounded to tenths):

$$\frac{703 \times wt\_lb}{ht\_in^2}$$

Prompt the user to enter weight in pounds and height in inches.

3.3 While spending the summer as a surveyor's assistant, you decide to write a program that transforms compass headings in degrees (0 to 360) to compass bearings. A compass bearing consists of three items: the direction you face (north or south), an angle between 0 and 90 degrees, and the direction you turn before walking (east or west). For example, to get the bearing for a compass heading of 110.0 degrees, you would first face due south (180 degrees) and then turn 70.0 degrees east (180.0 - 70.0 = 110.0). Therefore, the bearing is South 70.0 degrees East. Be sure to check the input for invalid compass headings.

3.4 Write a program that reports the contents of a compressed-gas cylinder based on the first letter of the cylinder's color. The program input is a character representing the observed color of the

cylinder: 'Y' or 'y' for yellow, 'O' or 'o' for orange, and so on. Cylinder colors and associated contents are as follows:

orange	ammonia
brown	carbon monoxide
yellow	hydrogen
green	oxygen

Your program should respond to input of a letter other than the first letters of the given colors with the message, Contents unknown .

3.5 Write a program that determines the day number (1 to 366) in a year for a date that is provided as input data. As an example, January 1, 1994, is day 1. December 31, 1993, is day 365. December 31, 1996, is day 366, since 1996 is a leap year. A year is a leap year if it is divisible by four, except that any year divisible by 100 is a leap year only if it is divisible by 400. Your program should accept the month, day, and year as integers. Include a function leap that returns 1 if called with a leap year, 0 otherwise.

3.6 Write a program to control a bread machine. Allow the user to input the type of bread as W for White and S for Sweet. Ask the user if the loaf size is double and if the baking is manual. The following table details the time chart for the machine for each bread type. Display a statement for each step. If the loaf size is double, increase the baking time by 50 percent. If baking is manual, stop after the loaf-shaping cycle and instruct the user to remove the dough for manual baking. Use functions to display instructions to the user and to compute the baking time.

Operation	White Bread	Sweet Bread
Primary kneading	15 mins	20 mins
Primary rising	60 mins	60 mins
Secondary kneading	18 mins	33 mins
Secondary rising	20 mins	30 mins
Loaf shaping	2 seconds	2 seconds
Final rising	75 mins	75 mins
Baking	45 mins	35 mins
Cooling	30 mins	30 mins

Lab Assignment-4

4. Programming project on Repetition and Looping Statements

4.1 a. Write a program that will find the smallest, largest, and average values in a collection of N numbers. Get the value of N before scanning each value in the collection of N numbers.

b. Modify your program to compute and display both the range of values in the data collection and the standard deviation of the data collection. To compute the standard deviation, accumulate the sum of the squares of the data values (sum_squares) in the main loop. After loop exit, use the formula

$$standard\ deviation = \sqrt{\frac{sum\_squares}{N} - average^2}$$

4.2 a. Write a program to process a collection of daily high temperatures. Your program should count and print the number of hot days (high temperature 85 or higher), the number of pleasant days (high temperature 60–84), and the number of cold days (high temperatures less than 60). It should also display the category of each temperature. Test your program on the following data:

55 62 68 74 59 45 41 58 60 67 65 78 82 88 91 92 90
93 87 80 78 79 72 68 61 59

b. Modify your program to display the average temperature (a real number) at the end of the run.

4.3 Write a program to process weekly employee time cards for all employees of an organization. Each employee will have three data items: an identification number, the hourly wage rate, and the number of hours worked during a given week. Each employee is to be paid time and a half for all hours worked over 40. A tax amount of 3.625% of gross salary will be deducted. The program output should show the employee's number and net pay. Display the total payroll and the average amount paid at the end of the run.

4.4 Suppose you own a beer distributorship that sells Piels (ID number 1), Coors (ID number 2), Bud (ID number 3), and Iron City (ID number 4) by the case. Write a program to

a. Get the case inventory for each brand for the start of the week.

b. Process all weekly sales and purchase records for each brand.

c. Display out the final inventory.

Each transaction will consist of two data items. The first item will be the brand ID number (an integer). The second will be the amount purchased (a positive integer value) or the amount sold (a negative integer value). For now you may assume that you always have sufficient foresight to prevent depletion of your inventory for any brand. (Hint: Your data entry should begin with four values representing the case inventory, followed by the transaction values.)

4.5 Assume that United States consumers put $51 billion in fast food charges on their credit and debit cards in 2006, up from $33.2 billion in 2005. Based on this model of the billions of fast food charges,

$$F(t) = 33.2 + 16.8t$$

where t is years since 2005, write a program that repeatedly prompts the user to enter a year after 2005 and then predicts the billions of dollars of fast food charges U.S. consumers will

make in that year. Define and call a function $fast\_food\_billions$ that takes the year as its input argument and returns the prediction as its result. Tell the user that entry of a year before 2005 will cause the program to stop.

4.6 The rate of decay of a radioactive isotope is given in terms of its half-life H, the time lapse required for the isotope to decay to one-half of its original mass. The isotope cobalt-60 (^{60}Co) has a half-life of 5.272 years. Compute and print in table form the amount of this isotope that remains after each year for 5 years, given the initial presence of an amount in grams. The value of amount should be provided interactively. The amount of ^{60}Co remaining can be computed by using the following formula:

$$r = amount \times C^{y/H}$$

where amount is the initial amount in grams, C is expressed as $e^{-0.693}$ (e = 2.71828), y is the number of years elapsed, and H is the half-life of the isotope in years.