OVERVIEW

This document is aimed at instructing students while they are undertaking their lab work.

This lab work is presenting an introduction to the **python programming language**.

A **computer program** is a sequence of instructions that control the behaviour of a computer.

The instructions tell the computer when to perform tasks like reading input and displaying results, and how to transform and manipulate values to achieve a desired outcome.

An **algorithm** must be translated into a computer program before a computer can be used to solve a problem.

The translation process is called **programming** and the person who performs the translation is referred to as a **programmer**.

Students should use the concepts taught in the class to perform the basic programming questions in python.

A QUICK RECAP OF INTRO TO PYTHON PROGRAMMING

```python
# variable 'x' is having value 10
x = 10

# multiple assignments
s , t = 11, 12  # here s value is 11 and t value is 12

# we use print() to display the value
print(x,s,t)
```

```
10 11 12
```

```python
# print() has two arguments sep ( by default space)
# and end (by default is newline)
a,b,c,d = 11, 12, 13, 14
print(a,b,c, sep = "@", end = "#")
print(c)
print(d)
```

```
11@12@13#13
14
```

```python
# mathematical operators
print(a+b*c-d**a/c+c//2+d%a)

# augmented assignment operators
a,b,c,d = 11, 12, 13, 14
a += 2
b -= 1
c *= 1
d /= a
b %= 2
print(a,b,c,d)

# strings
h = "hello"
m = "to myself"
print(h + " " + m + "!!!") # + is concatenation operator
```

```
32.87533839323956
13 1 13 1.0769230769230769
hello to myself!!!
```

```python
# to take input from the user
s = input("Enter a string (set of characters): ")
n = int(input("Enter a integer number: "))
f = float(input("Enter a decimal number: "))

# str() use to convert into string type to perform concatenation
print("String: " + s + " Integer Number: " + str(n) \
      + " Decimal Number: " + str(f))
```

```
Enter a string (set of characters): GDGPSS
Enter a integer number: 2023
Enter a decimal number: 06.09
String: GDGPSS Integer Number: 2023 Decimal Number: 6.09
```

```python
# math module
# first import the library in your current session
import math

x = 9
z = math.sqrt(x) # calculate the square root of x
y = math.pow(x,2) # calculate the square of x
c = math.pi  # constant pi
d = math.fabs(y) # absolute value of y
e = math.log(2,3) # finds log 2 with base 3
f = math.log2(16) # value of log2 of 16
g = math.log10(10000) # value of log 10 of 10000
h = math.sin(c/6) # value of sin at pi/6
i = math.tan(c/6) # value of tan at pi/6
j = math.ceil(2.3) # least integer function
k = math.floor(2.3) # greatest integer function
# print all the values
print(x,y,z,c,d,e,sep=" --> ")
print(f,g,h,i,j,k,sep=" --> ")
```

```
9 --> 81.0 --> 3.0 --> 3.141592653589793 --> 81.0 --> 0.6309297535714574
4.0 --> 4.0 --> 0.49999999999999994 --> 0.5773502691896257 --> 3 --> 2
```

Let’s apply all of these concepts in interesting programming questions.

EXERCISES

The exercises in this lab will allow you to put the concepts discussed previously into practice.

Solving these exercises is an important step toward the creation of larger programs that solve more interesting problems.

Exercise 1: Mailing Address

Create a program that displays your name and complete mailing address. The address should be printed in the format that is normally used in the area where you live. Your program does not need to read any input from the user.

Exercise 2: Hello

Write a program that asks the user to enter his or her name. The program should respond with a message that says hello to the user, using his or her name.

Exercise 3: Area of a Room

Write a program that asks the user to enter the width and length of a room.

Once these values have been read, your program should compute and display the area of
the room.

The length and the width will be entered as floating-point numbers.

Include units in your prompt and output message; either feet or metres, depending on which
unit you are more comfortable working with.

Exercise 4: Area of a Field

Create a program that reads the length and width of a farmer's field from the user in feet. Display the area of the field in acres.

Hint: There are 43,560 square feet in an acre.

Exercise 5: Bottle Deposits

In many jurisdictions a small deposit is added to drink containers to encourage people to recycle them. In one particular jurisdiction, drink containers holding one litre or less have a ₹8 deposit, and drink containers holding more than one litre have a ₹20 deposit.

Write a program that reads the number of containers of each size from the user.Your program should continue by computing and displaying the refund that will be received for returning those containers.

Format the output so that it includes a rupee sign and two digits to the right of the decimal point.

Exercise 6: Tax and Tip

The program that you create for this exercise will begin by reading the cost of a meal ordered at a restaurant from the user.

Then your program will compute the tax and tip for the meal.

Use your local tax rate when computing the amount of tax owing.

Compute the tip as 18 percent of the meal amount (without the tax).

The output from your program should include the tax amount, the tip amount, and the grand total for the meal including both the tax and the tip.

Format the output so that all of the values are displayed using two decimal places.

Exercise 7: Sum of the First n Positive Integers

Write a program that reads a positive integer, **n**, from the user and then displays the sum of all of the integers from **1** to **n**.

The sum of the first **n** positive integers can be computed using the formula:

$$S_n = \frac{n(n+1)}{2}$$

Exercise 8: Tax and Tip

An online retailer sells two products: widgets and gizmos.

Each widget weighs 75 grams.
Each gizmo weighs 112 grams.

Write a program that reads the number of widgets and the number of gizmos from the user.

Then your program should compute and display the total weight of the parts.

Exercise 9: Compound Interest

Pretend that you have just opened a new savings account that earns 4 percent interest per year.

The interest that you earn is paid at the end of the year, and is added to the balance of the savings account.

Write a program that begins by reading the amount of money deposited into the account from the user.

Then your program should compute and display the amount in the savings account after 1, 2, and 3 years.

Display each amount so that it is rounded to 2 decimal places.

Exercise 10: Arithmetic

Create a program that reads two integers, a and b, from the user. Your program should compute and display:

- The sum of **a** and **b**
- The difference when **b** is subtracted from **a**
- The product of **a** and **b**
- The quotient when **a** is divided by **b**
- The remainder when **a** is divided by **b**
- The result of $log_{10}a$
- The result of a^b

Hint: You will probably find the log10 function in the math module helpful for computing the second last item in the list

Exercise 11: Fuel Efficiency

In the United States, fuel efficiency for vehicles is normally expressed in miles-per gallon (MPG).

In India, fuel efficiency is normally expressed in litres-per-hundred kilometres (L/100 km).

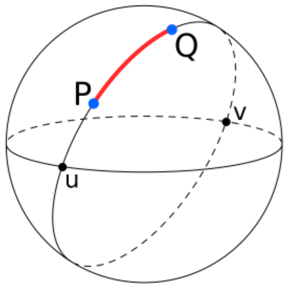
Use your research skills to determine how to convert from MPG to L/100 km.

Then create a program that reads a value from the user in American units and displays the equivalent fuel efficiency in Indian units.

Exercise 12: Distance Between Two Points on Earth

The surface of the Earth is curved, and the distance between degrees of longitude varies with latitude.

As a result, finding the distance between two points on the surface of the Earth is more complicated than simply using the Pythagorean theorem.



Let (t_1, g_1) and (t_2, g_2) be the latitude and longitude of two points on the Earth's surface.

The distance between these points, following the surface of the Earth, in kilometres is:

$$distance = 6371.01 \times \arccos(\sin(t_1) \times \sin(t_2) + \cos(t_1) \times \cos(t_2) \times \cos(g_1 - g_2))$$

The value 6371.01 in the previous equation wasn't selected at random. It is the average radius of the Earth in kilometres.

Create a program that allows the user to enter the latitude and longitude of two points on the Earth in degrees.

Your program should display the distance between the points, following the surface of the earth, in kilometres.

Hint: Python's trigonometric functions operate in radians. As a result, you will need to convert the user's input from degrees to radians before computing the distance with the formula discussed previously. The math module contains a function named radians which converts from degrees to radians.

Exercise 13: Making Change

Consider the software that runs on a self-checkout machine. One task that it must be able to perform is to determine how much change to provide when the shopper pays for a purchase with cash.

Write a program that begins by reading a number of cents from the user as an integer.

Then your program should compute and display the denominations of the coins that should be used to give that amount of change to the shopper.

The change should be given using as few coins as possible.
Assume that the machine is loaded with **pennies**, **nickels**, **dimes**, **quarters**, **loonies** and **toonies**.

A one dollar coin was introduced in Canada in 1987. It is referred to as a loonie because one side of the coin has a loon (a type of bird) on it. The two dollar coin, referred to as a toonie, was introduced 9 years later. It's name is derived from the combination of the number two and the name of the loonie.

Exercise 14: Height Units

Many people think about their height in feet and inches, even in some countries that primarily use the metric system.

Write a program that reads a number of feet from the user, followed by a number of inches.

Once these values are read, your program should compute and display the equivalent number of centimetres.

Hint: One foot is 12 inches. One inch is 2.54 centimetres.

Exercise 15: Distance Units

In this exercise, you will create a program that begins by reading a measurement in feet from the user.

Then your program should display the equivalent distance in inches, yards and miles.

Use the Internet to look up the necessary conversion factors if you don't have them memorised.

Exercise 16: Area and Volume

Write a program that begins by reading a radius, **r**, from the user.

The program will continue by computing and displaying the area of a circle with radius **r** and the volume of a sphere with radius **r**.

Use the pi constant in the math module in your calculations.

Exercise 17: Volume of a Cylinder

The volume of a cylinder can be computed by multiplying the area of its circular base by its height.

Write a program that reads the radius of the cylinder, along with its height, from the user and computes its volume.

Display the result rounded to one decimal place.

Exercise 18: Free Fall

Create a program that determines how quickly an object is travelling when it hits the ground.

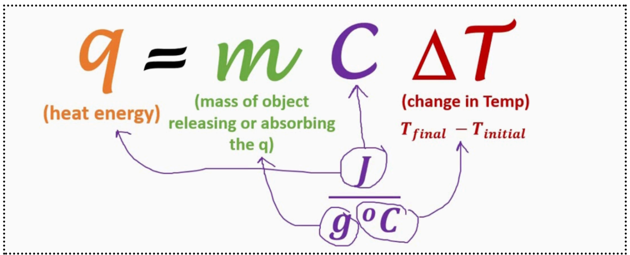
The user will enter the height from which the object is dropped in metres (m). Because the object is dropped its initial speed is 0 m/s.

Assume that the acceleration due to gravity is 9.8 m/s^2. You can use the formula $v_f = \sqrt{v_i^2 + 2ad}$ to compute the final speed, v_f, when the initial speed, v_i, acceleration, a, and distance, d, are known.

Exercise 19: Heat Capacity

The amount of energy required to increase the temperature of one gram of a material by one degree Celsius is the material's **specific heat capacity, C**.

The total amount of energy, **q**, required to raise **m** grams of a material by **ΔT** degrees Celsius can be computed using the formula:



Write a program that reads the mass of some water and the temperature change from the user.

Your program should display the total amount of energy that must be added or removed to achieve the desired temperature change.

Hint: The specific heat capacity of water is 4.186 $\frac{J}{g\,^{\circ}C}$.

Because water has a density of **1.0 grams per millilitre**, you can use grams and millilitres interchangeably in this exercise.

Extend your program so that it also computes the cost of heating the water. Electricity is normally billed using units of **kilowatt hours** rather than Joules.

In this exercise, you should assume that electricity costs ₹8.9 per kilowatt hour.

Use your program to compute the cost of boiling the water needed for a cup of coffee.

Hint: You will need to look up the factor for converting between Joules and kilowatt hours to complete the last part of this exercise.

Exercise 20: Area of a Triangle

The area of a triangle can be computed using the following formula, where **b** is the length of the base of the triangle, and **h** is its height:

$$\text{area} = \frac{b \times h}{2}$$

Write a program that allows the user to enter values for **b** and **h**. The program should then compute and display the area of a triangle with base length b and height h.

Exercise 21: Area of a Triangle (Again)

In the previous exercise you created a program that computes the area of a triangle when the length of its base and its height were known.

It is also possible to compute the area of a triangle when the lengths of all three sides are known.

Let **s1**, **s2** and **s3** be the lengths of the sides. Let **s = (s1 + s2 + s3)/2**. Then the area of the triangle can be calculated using the following formula:

$$\text{area} = \sqrt{s \times (s - s_1) \times (s - s_2) \times (s - s_3)}$$

Develop a program that reads the lengths of the sides of a triangle from the user and displays its area.

Exercise 22: Ideal Gas Law

The ideal gas law is a mathematical approximation of the behaviour of gases as pressure, volume and temperature change. It is usually stated as:

$$PV = nRT$$

where **P** is the pressure in Pascals, **V** is the volume in litres, **n** is the amount of substance in moles, **R** is the ideal gas constant, equal to 8.314 $\frac{J}{mol\,K}$, and **T** is the temperature in degrees Kelvin.

Write a program that computes the amount of gas in moles when the user supplies the pressure, volume and temperature.

Test your program by determining the number of moles of gas in a **SCUBA tank**.

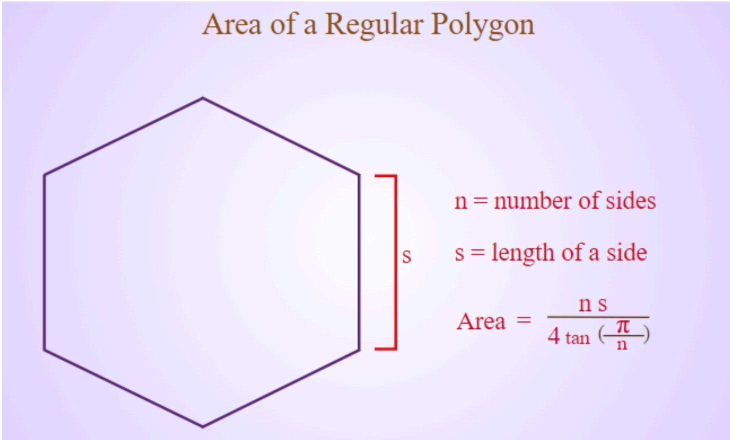
A typical SCUBA tank holds 12 litres of gas at a pressure of 20,000,000 Pascals (approximately 3,000 PSI).

Room temperature is approximately 20 degrees Celsius or 68 degrees Fahrenheit.

Hint: A temperature is converted from Celsius to Kelvin by adding 273.15 to it. To convert a temperature from Fahrenheit to Kelvin, deduct 32 from it, multiply it by $\frac{5}{9}$ and then add 273.15 to it.

Exercise 23: Area of a Regular Polygon

A polygon is regular if its sides are all the same length and the angles between all of the adjacent sides are equal.



The area of a regular polygon can be computed using the following formula, where **s** is the length of a side and **n** is the number of sides:

$$\text{area} = \frac{n \times s^2}{4 \times \tan\left(\frac{\pi}{n}\right)}$$

Write a program that reads **s** and **n** from the user and then displays the area of a regular polygon constructed from these values.

Exercise 24: Units of Time

Create a program that reads a duration from the user as a number of days, hours, minutes, and seconds.

Compute and display the total number of seconds represented by this duration.

Exercise 25: Units of Time (Again)

In this exercise you will reverse the process described in Exercise 24. Develop a program that begins by reading a number of seconds from the user. Then your program should display the equivalent amount of time in the form **D:HH:MM:SS**, where **D**, **HH**, **MM**, and **SS** represent **days**, **hours**, **minutes** and **seconds** respectively. The hours, minutes and seconds should all be formatted so that they occupy exactly two digits.

Use your research skills determine what additional character needs to be included in the format specifier so that leading zeros are used instead of leading spaces when a number is formatted to a particular width.

Exercise 26: Current Time

Python's **time** module includes several time-related functions.

One of these is the **asctime** function which reads the current time from the computer's internal clock and returns it in a human-readable format.

Use this function to write a program that displays the current time and date.

Your program will not require any input from the user.

Exercise 27: When is Easter?

Easter is celebrated on the Sunday immediately after the first full moon following the spring equinox. Because its date includes a lunar component, Easter does not have a fixed date in the Gregorian calendar. Instead, it can occur on any date between March 22 and April 25.

The month and day for Easter can be computed for a given year using the Anonymous Gregorian Computus algorithm, which is shown below.

- Set **a** equal to the remainder when year is divided by 19
- Set **b** equal to the floor of year divided by 100
- Set **c** equal to the remainder when year is divided by 100
- Set **d** equal to the floor of b divided by 4
- Set **e** equal to the remainder when b is divided by 4
- Set **f** equal to the floor of $\frac{b+8}{25}$
- Set **g** equal to the floor of $\frac{b-f+1}{3}$
- Set **h** equal to the remainder when 19a + b − d − g + 15 is divided by 30
- Set **i** equal to the floor of c divided by 4
- Set **k** equal to the remainder when c is divided by 4
- Set **l** equal to the remainder when 32 + 2e + 2i − h − k is divided by 7
- Set **m** equal to the floor of $\frac{a+11h+22l}{451}$
- Set **month** equal to the floor of $\frac{h+l-7m+114}{31}$
- Set **day** equal to one plus the remainder when h + l − 7m + 114 is divided by 31

Write a program that implements the **Anonymous Gregorian Computus algorithm** to compute the date of Easter.

Your program should read the year from the user and then display an appropriate message that includes the date of Easter in that year.

Exercise 28: Body Mass Index

Write a program that computes the body mass index (BMI) of an individual.

Your program should begin by reading a height and weight from the user. Then it should use one of the following two formulas to compute the BMI before displaying it.

If you read the height in inches and the weight in pounds then body mass index is computed using the following formula:

$$\text{BMI} = \frac{\text{weight}}{\text{height} \times \text{height}} \times 703$$

If you read the height in metres and the weight in kilograms then body mass index is computed using this slightly simpler formula:

$$\text{BMI} = \frac{\text{weight}}{\text{height} \times \text{height}}$$

Exercise 29: Wind Chill

When the wind blows in cold weather, the air feels even colder than it actually is because the movement of the air increases the rate of cooling for warm objects, like people.
This effect is known as **wind chill**.

In 2001, Canada, the United Kingdom and the United States adopted the following formula for computing the wind chill index. Within the formula Ta is the air temperature in degrees Celsius and V is the wind speed in kilometres per hour.

A similar formula with different constant values can be used for temperatures in degrees Fahrenheit and wind speeds in miles per hour.

$$WCI = 13.12 + 0.6215T_a - 11.37V^{0.16} + 0.3965T_a V^{0.16}$$

Write a program that begins by reading the air temperature and wind speed from the user.

Once these values have been read your program should display the wind chill index rounded to the closest integer.

The wind chill index is only considered valid for temperatures less than or equal to 10 degrees Celsius and wind speeds exceeding 4.8 kilometres per hour.

Exercise 30: Celsius to Fahrenheit and Kelvin

Write a program that begins by reading a temperature from the user in degrees Celsius.

Then your program should display the equivalent temperature in degrees Fahrenheit and degrees Kelvin.

The calculations needed to convert between different units of temperature can be found on the Internet.

Exercise 31: Units of Pressure

In this exercise you will create a program that reads a pressure from the user in kilopascals.

Once the pressure has been read your program should report the equivalent pressure in pounds per square inch, millimetres of mercury and atmospheres.

Use your research skills to determine the conversion factors between these units.

Exercise 32: Sum of the Digits in an Integer

Develop a program that reads a four-digit integer from the user and displays the sum of its digits.

For example, if the user enters 3141 then your program should display 3+1+4+1=9.

Exercise 33: Sort 3 Integers

Create a program that reads three integers from the user and displays them in sorted order (from smallest to largest).

Use the min and max functions to find the smallest and largest values.

The middle value can be found by computing the sum of all three values, and then subtracting the minimum value and the maximum value.

Exercise 34: Day Old Bread

A bakery sells loaves of bread for Rs. 250 each. Day old bread is discounted by 60 percent.

Write a program that begins by reading the number of loaves of day old bread being purchased from the user.

Then your program should display the regular price for the bread, the discount because it is a day old, and the total price. Each of these amounts should be displayed on its own line with an appropriate label.

All of the values should be displayed using two decimal places, and the decimal points in all of the numbers should be aligned when reasonable values are entered by the user.