**School of Mathematical Sciences**
**Universiti Sains Malaysia**

# MAT 181 Programming for Scientific Applications

## Assignment 1

### Part A: Polar Coordinates

The location of every point in two dimensions can be determined by a pair of coordinates, written as an ordered pair (*x*, *y*). These are also known as **Cartesian coordinates** or rectangular coordinates as shown in Figure 1. The *x*-axis and *y*-axis separate the coordinate plane into four regions called quadrants. The upper right quadrant is the first quadrant, upper left quadrant is second quadrant, lower left quadrant is third quadrant, and lower right quadrant is forth quadrant.

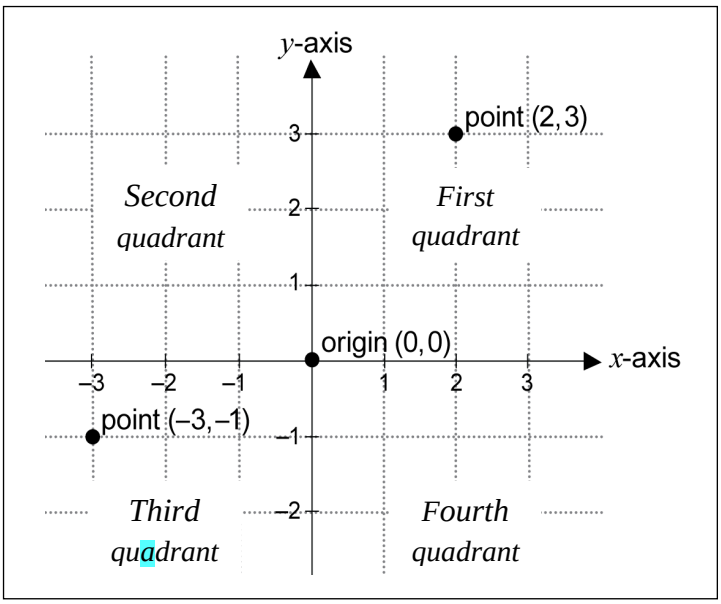


Figure 1

Any point in two dimensions can also be determined by *r* and $\theta$ where *r* is the distance of the point from the origin and $\theta$ is the amount of angle (in radian) rotating from the positive *x*-axis to the point. Coordinates in this form are called **Polar coordinates** $(r, \theta)$.

For further reading, please go to https://mathinsight.org/polar_coordinates.

Refer to Figure 2, conversion between Cartesian coordinates and Polar coordinates is possible. The formulas are given as follows:

$$\textit{Polar to Cartesian conversion formulas:} \quad x = r\cos\theta, y = r\sin\theta.$$

$$\textit{Cartesian to Polar conversion formulas:} \quad r = \sqrt{x^2 + y^2}, \ \theta = tan^{-1}\left(\frac{y}{x}\right).$$

For simplicity, we restrict the range of $\theta$ to be $0 \leq \theta \leq 2\pi$ and *r* is always positive.

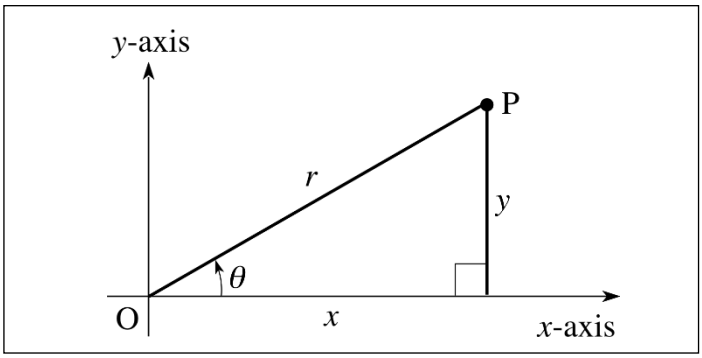


Figure 2

For example, Cartesian coordinates (1,1) is equivalent to Polar coordinates $\left(\sqrt{2}, \frac{\pi}{4}\right)$.

**Part B: Assignment Requirements**

Develop a complete C++ program that performs the above conversion. The user should be allowed to choose any one of the two conversions and prompt the user to input the coordinates of the point to be converted.

The program should indicate the location of the point, whether the point is at the origin, on the *x* (or *y*) axis, or appears in a particular quadrant. By setting $\pi = 3.14159$, sample outputs are given as follows:

Sample output 1

```
--------------------**********--------------------
1. Convert Cartesian to Polar coordinates
2. Convert Polar to Cartesian coordinates

Please enter your choice, 1 or 2: 1

 Converting Cartesian to Polar coordinates
-----------------------------------------
 Enter x coordinate: -1
 Enter y coordinate: -1

 This point is in the third quadrant.

 Cartesian coordinate (-1.000, -1.000) is equal to
 Polar coordinate (1.414, 3.927).

--------------------**********--------------------
Do you want to do another conversion?
Type 'y' for yes; 'n' for no:
```

Sample output 2:

```
--------------------**********--------------------
1. Convert Cartesian to Polar coordinates
2. Convert Polar to Cartesian coordinates

Please enter your choice, 1 or 2: 2

 Converting Polar to Cartesian coordinates
-----------------------------------------
 Enter radius: 5
 Enter angle in radian (3 d.p.): 1.571

 This point is on the y-axis.

 Polar coordinate (5.000, 1.571) is equal to
 Cartesian coordinate (0.000, 5.000).

--------------------**********--------------------
Do you want to do another conversion?
Type 'y' for yes; 'n' for no:
```

For testing and verification, produce output for the following conversion.

I. Cartesian coordinates $(0, 0)$ into Polar coordinates
II. Cartesian coordinates $(-1, -1)$ into Polar coordinates
III. Cartesian coordinates $(2, 3)$ into Polar coordinates
IV. Polar coordinates $(3, 2.5)$ into Cartesian coordinates
V. Polar coordinates $(6, 3.142)$ into Cartesian coordinates
VI. Polar coordinates $(4.5, 5)$ into Cartesian coordinates

**Part C: General Programming Requirements**

1. Your program must ask if the user is willing to continue at the end of the program.
2. Your output must be at least the same as the samples given. You are encouraged to improve the output format with additional features.
3. You are encouraged to explore other C++ features (not taught in class) or built-in functions for your program.

**Part D: Submission Details**

1. You need to submit 3 items:
   a. C++ source file
      The program should be commented properly.

   b. Report (pdf)
      The report should consist of some description of the problem, the source code, and the output. Template of report (Report Template.docx) will be given. Rename the word document using your matric number before you start editing. Please convert the word document into pdf before you submit.

   c. Video (mp4, avi, wmv)
      Record a less than 30 seconds video showing you executing the program, input values, produce the output and exiting the program.

2. Attach all 3 items to **Assignment 1 Submission** activity in e-Learning website before 2359 hr, 16th December 2020. Late submission will not be entertained.

Marks will be given based on programming skills, requested output and submission items. Assessment rubrics will be given for your reference.

**COPYING CASES WILL NOT BE TOLERATED.**
**MARKS WILL BE GIVEN TO BOTH PARTIES.**