Chemical Engineering Department

Boğazici University

ChE 232, Spring 2020 **Fluid Mechanics**

Assigned on: 20 April 2020

Due: 7 June 2020, 23:59

Where to submit: che232spring2020 “AT” gmail.com

What to submit:

A zipped folder containing:

- Project report
- Your project’s C or Matlab code and all required files to run the program

Name the zipped folder as GroupName_Project1.

Weight: Same weight as three quizzes.

Academic Honesty:
Students are bounded by academic honesty. Cheating is a violation of academic honesty. The result is failing.

Project 1: Wilkes 3.26 (modified)

General purpose of the program is to solve simple piping problems. Write a general purpose C or Matlab code that will accommodate the solution for as wide a variety as possible of simple piping problems. Make sure that it can handle Case 1-2-3-type problems, and it gives output for these three cases.

Structure of the code:

In the code, please name the variables and use the units according to Table 1.

Table 1. The name of the variables and the units:

Parameter	Representation in the code	SI unit	FPS unit
Pipe length	L	m	ft
Pipe surface roughness	eps	m	ft
Pipe diameter	D	m	ft
Fluid density	rho	kg/m^3	lbm/ft^3
Fluid viscosity	mu	kg/m/s (= Pa.s)	lbm/ft/s
Elevation difference	deltaz	m	ft
Gravitational acceleration	g_SI	$9.81\ m/s^2$	-
	g_FPS	-	$32.17\ ft/s^2$
Conversion factor	gc	-	$32.2\ lbm.ft/lbf/s^2$
Flow rate	Q	m^3/s	ft^3/s
Mean velocity	u_mean	m/s	ft/s
(-) delta pressure drop	deltaP	Pa	psi
Reynolds number	Re	-	-
Friction factor	fF	-	-

In order to simplify the code and avoid unnecessary repetition of calculations, your program should contain the following functions:

1. A function that calculates Reynolds number:
   `Re(double D, double rho, double u_mean, double mu)`
2. A function that calculates friction factor:
   `f(double eps, double D, double Re)`
3. An error function to check the convergence for Re in CASE 2-3:
   `error_func(double old_value, double new_value)`

In the beginning of the code, you can define constants using #define if you decide to use C.
Ex: `#define PI 3.1416`

Please set the tolerance value `tol` to 0.001 for the convergence. The error checking should be performed according to the following formula:

error% = abs((old value-new value)/old value)*100

For CASE-2, initial guess for Re can be set to 100,000 and for CASE-3, initial guess for D can be set to 10.

Your program should be user friendly and clear. Add required **comments** to the source code to make it understandable.

Input/output:

- The program must request the user to enter the case type (1, 2 or 3) and unit system e.g. SI (m/kg/s) or FPS (ft/lbm/s).
- As input, the program must request the diameter (D), flow rate (Q) or pressure drop (ΔP) depending on the case type with specified units in Table 1.

  Example:

```
Please specify the pipe diameter D (m):
```

Or

```
Please specify the flow rate Q (ft3/s):
```

- Outputs of the program should be clearly presented to the user with appropriate units.
- Other values you need could be taken as constants or you can request from user.

Other relevant information:

- Check pages 143 and 146 for possible examples
- Make use of the sequence of calculations to accommodate all three cases in one program.

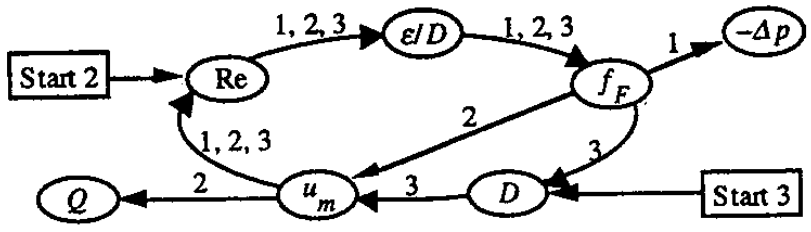

Fig. 1 Sequence of calculations.

Observe that Re, ε/D, and f_F are obtained identically for all cases. Special steps are needed for $-\Delta p$ (Case 1), u_m and Q (Case 2), and D and u_m (Case 3).

- You are also going to submit a report (format given below). You should run your program for FPS system (you can use the values in Example 3.2-3.3) and also for SI system, present the results. Together with your report, you should send your source code and all required files to run your program as a zipped folder to che232spring2020 “AT” gmail.com, named as GroupName_Project1.

Bonus (+20 points): As you can notice, the equation 3.41 for friction factor is valid for turbulent flow. You may alternatively insert a section in your program that checks Reynolds number; thereby determines if the flow is in the laminar, transition or turbulent region and calculates friction factor from 16/Re (laminar) or Eq. 3.41 (turbulent). For transition region ($2000<Re\leq4000$), the program may give a warning message and stop.

FORMAT FOR THE REPORT

Parts of the Report

1. **Cover Page** where project name, group name, group members, submission date, instructor and TAs names are indicated.
2. **Problem Statement:** The purpose of the project is stated.
3. **Algorithm** where you explain the steps of your program.
4. **Results** where you give the results for each case type and units (SI and FPS), as input and output. You may discuss the change in the pressure drop, flow rate or pipe diameter in different conditions.
5. **Appendix:** This section contains source code of the programs.

Formatting guide for the report

- As a character font, use Times New Roman. The font size must be 12 point.
- For the source code in Appendix, use Courier New with font size 10 point.
- Spacing of the text material should be 1½. For the source code in Appendix, spacing should be 1.
- Pagination: Each page in the report is expected to bear a number.