**Coursework I - Question Sheet**

When answering the questions below. Make sure you read first the marking scheme documents and construct your answers accordingly in a report form. Pay close attention to the four criteria (**model, output, discussion, and code**) based on which your report will be assessed.

**Part I** For turbulent flow inside pipes, friction factor/coefficient (ƒ) is dependent on the dimensionless surface roughness (ε/D) of the pipe inner surface and the dimensionless Reynolds number (Re), as given by the Colebrook equation below:

where Re can be obtained from: . In the equation of Reynolds number above, Q is the volumetric flowrate of the fluid, D is the inner diameter of the pipe, A is the cross-sectional area of the pipe, and ρ and μ are the density and viscosity of the fluid, respectively.

**Task 1 (Code). Develop your own codes/functions** in Matlab and compute the friction factor for a general turbulent flow. This code must be able to solve friction factor, f, for any Re, and D values. A first-class code will be:

* concise and readable,
* modular (incorporating functions),
* and *robust* (a robust code means that it is not prone to crashing when given less than ideal input)

(Refer to marking sheet for details)

**Task 2a (Output).** Compute the friction factor of a turbulent flow of an oil through a smooth pipe of 4-in inner diameter at a volumetric flowrate of 2000 bbl/day.

The dimensionless surface roughness of a smooth pipe is zero. The density and viscosity of the oil are 0.9 g/cm3 and 8 cp, respectively. Unit conversion: 1 bbl (oil barrel) = 42 gal; 1 cp = 0.001 Pa∙s; 1 gal = 3.785×10−3 m3. Discuss and compare both approaches.

**Task 2b (Output). Plot on the same graph,** friction factor vs. Re (5000 ≤ Re ≤ 100,000) for ε/D = 0, 0.002, 0.004, 0.006, 0.008. From these plots, provide comments on the effects of volumetric flowrate and surface roughness on the friction factor in turbulent flow. (see the marking scheme to know what to expect from a good graph)

**Task 3 (Numerical Method).** Explain the theoretical basis of the numerical method that you employ to solve the tasks above. (refer to the marking sheet)

**Task 4 (Discussion) Analyse the performance and efficiency of your method and code.** A good discussion will include at least error/performance (quantified), and some performance comparison with MATLAB built-in solver (for example 'fzero' or 'vpasolve' (refer to the marking sheet)