Series 4 (12 March 2024)

Prof: Nikos Stergiopulos
TA: Soroush Rafiei

Dimensional Analysis

Exercise 1

A stenotic heart valve provokes an increase in the resistance of the flow.

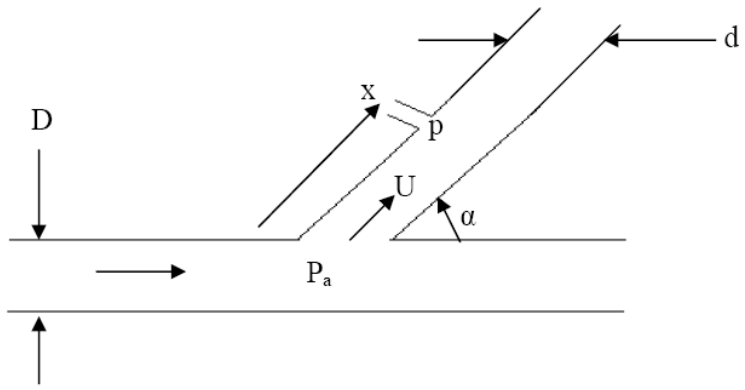
a) By using the methods of dimensional analysis, determine the relationship among the section of the valve, the blood pressure measured upstream and downstream of the valve, the density and the blood flow.
b) Discuss the physical significance of the empirical constant appearing in this relationship and compare the result with that given by the equation of Bernoulli.

Exercise 2

The variation in the pressure p along a branch is to be studied experimentally. Assume that the important variables are:

$$p = p(x, \alpha, D, d, U, \mu, \rho, P_a)$$

a) Use dimensional analysis to develop a suitable set of Π-terms.
b) Consider that this system is to simulate blood flow at 5cm/s in a branch. What velocity U should be used for the model, if size was ten times that of the actual branch of interest?



Exercise 3

It has been suggested that diastolic blood pressure (P_{dia}) be a function of the mean flow (Q), the total peripheral resistance (R), the overall systemic compliance ($C = dV/dp$) and the heart rate (ν). What dimensionless group could be used to study this problem?