CE 3305 Fluid Mechanics
Exercise Set 18
Summer 2018 – GERMANY

The pressure drop over 150 m of 10-cm-diameter galvanized iron pipe is measured to be 100 kPa. Roughness height is $k_s = 0.20$ millimeters. If the pipe is horizontal, estimate the flow rate of water. Express the result in Liters per second. ($\nu = 10^{-6} m^2/sec$)

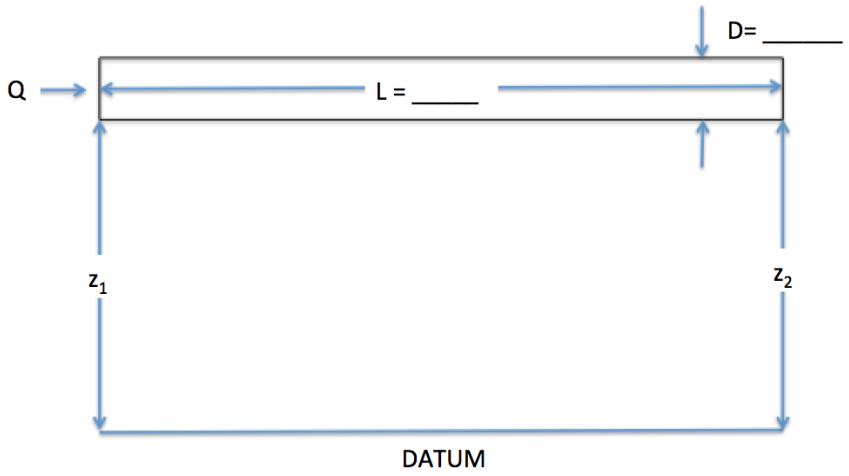

Figure 1: Problem Sketch

a) Write the pipe length on the sketch depicted in Figure 1, include units.

b) Write the pipe diameter on the sketch depicted in Figure 1, include units.

c) Horizontal means (circle correct response)
$z_1 > z_2$
$z_1 = z_2$
$z_1 < z_2$

d) Constant diameter pipe means (circle correct response)
$V_1 > V_2$
$V_1 = V_2$
$V_1 < V_2$

The energy equation for this pipeline is

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{V_1^2}{2g} + z_2 + f\frac{L}{D}\frac{V^2}{2g}$$

e) Cancel the terms that are identical because the pipeline is horizontal.

f) Cancel the terms that are identical because the pipeline is constant diameter.

g) Compute the relative roughness

$\frac{k_s}{D} =$

h) Highlight the appropriate relative roughness curve on the Moody chart on Figure 2.

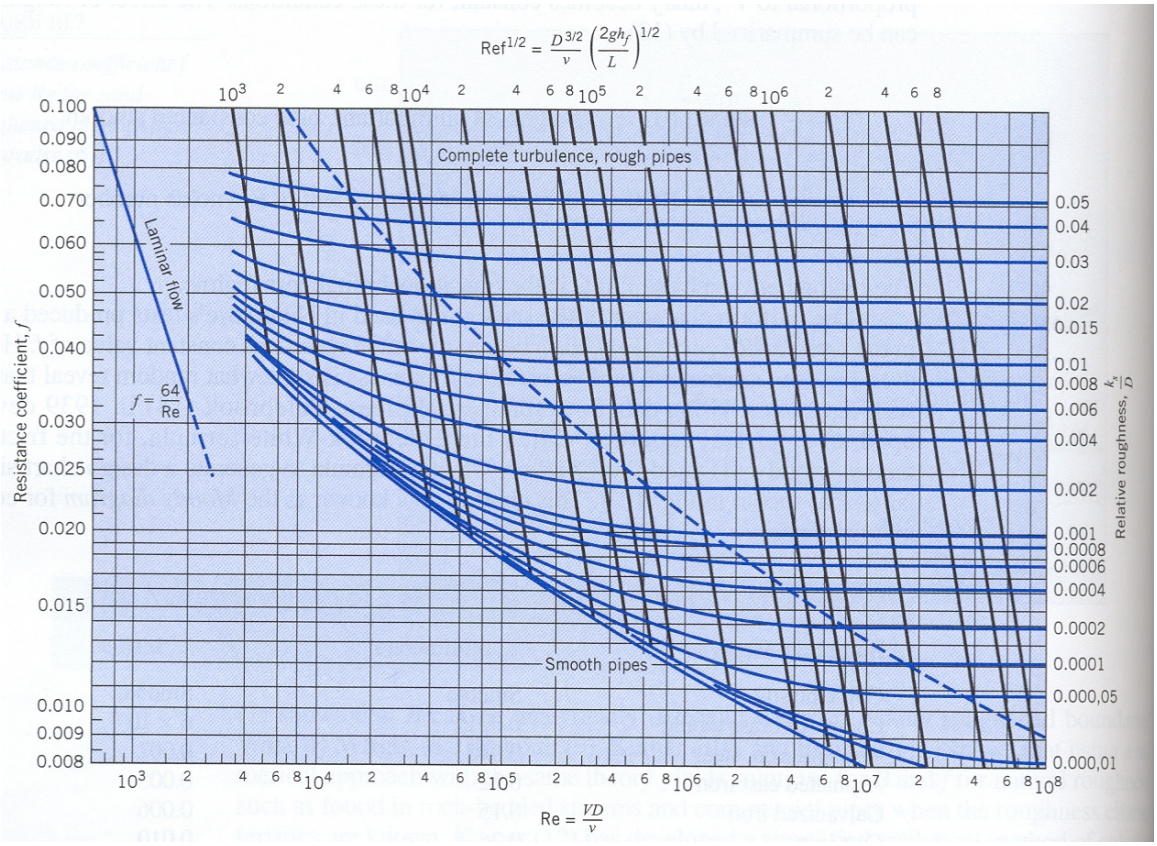

Figure 2: Moody Chart for Problem 1

i) For Reynolds number larger than 10^5 what is the value of the friction factor f?

j) Rearrange the remaining terms of the energy equation to equate the difference in pressure head to the head loss equation.

k) Compute the numerical value of change in pressure head, in meters?

l) What is the velocity in the pipe for the given change in pressure head assuming relatively high Reynolds number?

m) What is the Reynolds number for this velocity?

n) Plot the intersection of the computed Reynolds number and the relative roughness on the Moody chart.

o) Is the initial guess of friction factor reasonable based on the plot?

p) Compute the discharge in the pipe in liters per second.