Cover Sheet
ME 3414 Experiment #3 – Spring 2026

ignment.

CRN, Group, Date/time you performed the experiment: 22634 153 6 30 PM 3/4/26

Friction Loss in a Pipe

1. If experimentally you measure the pressure gradient, $\Delta p/L = 5.47$ mH_2O/m, for water flowing at steady state in a horizontal tube having an inner diameter = 3.00 mm, $U_{avg} = 2.77$ m/s, $\rho = 997$ kg/m^3, and $\mu = 9.20\times10^{-4}$ (N-s)/m^2, what is the corresponding value of the friction factor, f? Do not calculate this based upon a theoretical prediction (for laminar or turbulent flow), but rather from the definition of the friction factor and the experimental values given in this problem. Show your analysis for determining your value of f, and show all details and steps in the analysis (algebraic form first, then numerical, as usual).

$f =$ 0.042

$$\frac{\Delta p}{L} = \left(\frac{\Delta h}{L}\right)\rho g \quad = 5.47 \cdot 997 \cdot 9.81$$

$$\Delta p = f \frac{L}{D} \frac{\rho U_{avg}^2}{2}$$

$$f = \frac{2\Delta p D}{L \rho U_{avg}^2} = \frac{2 \cdot \frac{\Delta p}{L} \cdot .003 \cdot 5.47 \cdot 9.81}{997 \cdot 2.77^2} = \frac{160.5}{3824.9}$$

$$\simeq 0.042$$

(continued on next page)

Cover Sheet (Continued)
ME 3414 Experiment #3 – Spring 2026

2. Suppose you wanted to design the experiment such that you were certain the flow would be laminar, with a Reynolds number of 1200. The tube diameter is still 3.00 mm and has length 0.524 m. If $\rho = 997$ kg/m^3 and $\mu = 9.20 \times 10^{-4}$ (N-s)/m^2 determine the mean flow velocity, the volumetric flow rate, the theoretical value of the friction factor, f, and the theoretically predicted pressure change through the tube (in Pa). How long would it take to collect 0.500 liters of water? Finally, our manometer tubes are approximately 0.5 m in height with the minimum scale division 1 mm. Would we be able to measure the pressure drop for this flow using these manometer tubes? If not, why not? Show all of your analysis, equations first without any numbers and then your calculations and numerical results, and answer to the final questions.

$Re = 1200$
$D = .003$
$L = 0.524$
$\rho = 997$
$\mu = 9.20E{-}4$
$\forall = .5\ L$

$$U_{avg} = \frac{Re \cdot \mu}{\rho D} = \frac{1200 \cdot 9.20E{-}4}{997 \cdot .003} = V_{avg} = .369$$

$$Q = U_{avg} \cdot A = \frac{U_{avg} \cdot \pi \cdot D^2}{4} = \frac{.369 \cdot 3.14 \cdot .003^2}{4}$$

$$f_{Lam} = \frac{64}{Re} = \frac{64}{1200} = .0533$$

$$\Delta p = f_{Lam} \cdot \frac{L}{D} \cdot \frac{\rho U_{avg}^2}{2} = .0533 \frac{.524}{.003} \cdot \frac{997 \cdot .369^2}{2} = 632.8$$

$$t = \frac{\forall}{Q} = \frac{.5}{.0026} = 191.6$$

V = 0.369 (m/s)
Q = 0.0026 (l/s)
f = 0.0533
Δp = 632.8 (Pa)
t = 191.6 (s)

Manometer feasability = true when $h_{drop} < 500_{mm}$ $\quad h_{drop} = \frac{\Delta p}{\rho \cdot g} = 64.7_{mm}$

∴ Yes, the manometers can read the experimental data accurately in this flow case.

Data Sheet for Experiment #3
ME 3414 Fluids Lab

CRN and Group: 22634 B-3 Date and time: 4/6/26 6:30pm

Honor Pledge: I have neither given nor received unauthorized assistance on this assignment.

Printed names of bench members: Zachary Rehloff Collin Lyons

Signatures of bench members: Zachary Rehloff Collin Lyons

∀	t	Q	U_{avg}	h1 - h2	Pressure gradient	Re	f_{meas}	Lam/Turb ?	f_{theory}
(mL)	(s)	(m^3/s)	(m/s)	(mH_2O)	$\Delta p/L$ (mH_2O)/m)				
500	27.36			2					
500	25.36			1.85					
500	27.36			1.7					
500	27.41			1.55					
500	29.51			1.40					
500	31.84			1.25					
500	34.96			1.10					
500	36.59			0.95					
500	40.54			0.80					
500	45.33			0.65					
500	50.64			0.50					
500	59.47			0.35					

Task 5

@ $\Delta p = \approx 1.70 mm\ H_2O$

$\phi = .5$

$t = 26.96$

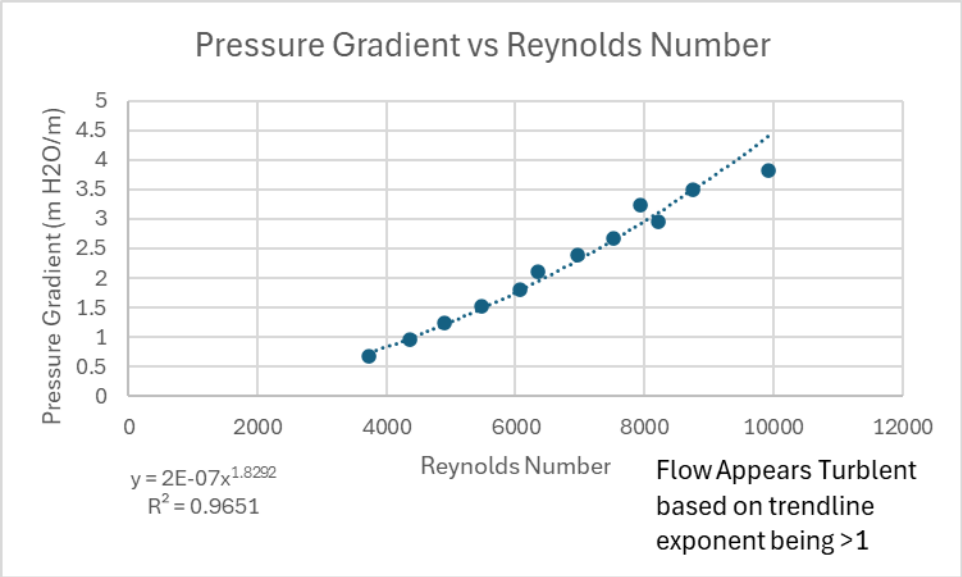
$U_{avg} = \frac{Q}{A} = 2.53\ m/s$ $\quad Re = \frac{\rho \cdot U_{avg} \cdot D}{\mu} = 7931$

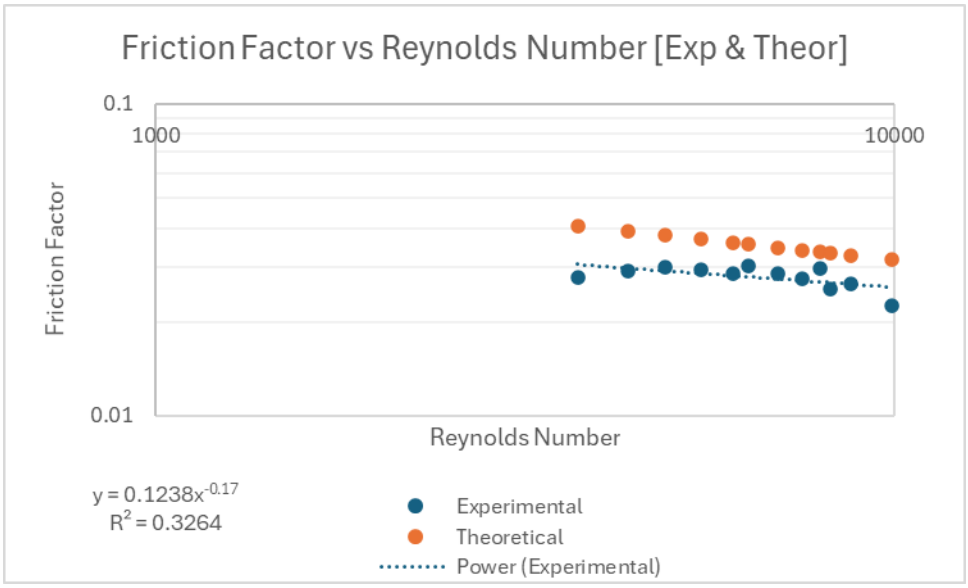
$Q = \frac{.0005}{27.96} = 1.788\ m^3/s$

$f_{meas} = \frac{\Delta p \cdot D \cdot 2 \cdot g.81}{L \cdot U_{avg}} = \frac{1.7 \cdot 0.003 \cdot 2 \cdot 9.81}{2.53 \cdot .524} = 0.0298$

$f_{ther} = \frac{.316}{(Re)^{0.25}} = \frac{.316}{7931^{0.25}} = 0.0335$

∀	t	Q	v_{avg}	h1−h2	Δp/l	Re	f_{meas}	Lam/Turb?	f_{theor}
(mL)	(s)	(m^3s)	(m/s)	(m H_2O)	(m H_2O/m)	Unitless	Unitless	N/A	Unitless
500	22.36	2.24E-05	3.16	2	3.817	9917	0.0225	Turb	0.0317
500	25.36	1.97E-05	2.79	1.83	3.492	8744	0.0264	Turb	0.0327
500	27.96	1.79E-05	2.53	1.7	3.244	7931	0.0298	Turb	0.0335
500	27.01	1.85E-05	2.62	1.55	2.958	8210	0.0254	Turb	0.0332
500	29.51	1.69E-05	2.40	1.4	2.672	7515	0.0274	Turb	0.034
500	31.84	1.57E-05	2.22	1.25	2.385	6965	0.0285	Turb	0.0346
500	34.96	1.43E-05	2.02	1.1	2.099	6343	0.0302	Turb	0.0354
500	36.59	1.37E-05	1.93	0.95	1.813	6061	0.0286	Turb	0.0358
500	40.54	1.23E-05	1.74	0.8	1.527	5470	0.0295	Turb	0.0368
500	45.33	1.10E-05	1.56	0.65	1.24	4892	0.03	Turb	0.0378
500	50.84	9.83E-06	1.39	0.5	0.954	4362	0.029	Turb	0.0389
500	59.47	8.41E-06	1.19	0.35	0.668	3729	0.0278	Trans	0.0405




Friction Factor vs Reynolds Number [Exp & Theor]
0.1
1000
10000
0.01
Friction Factor
Reynolds Number
y = 0.1238x-0.17
R2 = 0.3264
Experimental
Theoretical
Power (Experimental)