UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOF TECHNOLOGY *CHEMICAL ENGINEERING*
SUBJECT	:	**CHEMICAL ENGINEERING TECHNOLOGY 4A - FLUID FLOW**
CODE	:	**WARA432**
DATE	:	SUPPLEMENTARY WINTER EXAMINATION
DURATION	:	(SESSION 1)
WEIGHT	:	40: 60
TOTAL MARKS	:	100

EXAMINER	:	PROF. PETER OLUBAMBI
MODERATOR	:	
NUMBER OF PAGES	:	

REQUIREMENTS : CALCULATORS ALLOWED (ONE PER STUDENT)

INSTRUCTIONS TO CANDIDATES:

1. NUMBER ALL QUESTIONS CORRECTLY.
2. ANSWER ALL QUESTIONS.
3. THE MARKS ALLOCATED TO EACH QUESTION ARE INDICATED AFTER THE QUESTION AND THE TOTAL MARKS AT THE END.

QUESTION 1

a) A spherical storage tank which has a diameter of 1.5m is to be erected above the ground. Calculate the drag force experienced by this tank when the wind blows horizontally at 35km/hr

b) What is the drag force on a cube shaped tank immersed in an air stream with one side normal to the direction of flow, if the length of each side of the cube is 0.2m, and air flows at 2m/s. take the density of air to be1.24kg/m^3 and the viscosity of air to be 1.85×10^{-5}kg/m.s

[25]

QUESTION 2

Water with a density of 998 kg/m3 is flowing at steady mass flow rate of 120kg/s through a uniform 12.5cm diameter pipeline of length 28.2m. The entrance pressure of the fluid is 68.9 kN/m2 abs in the pipeline, which connects to a pump which supplies 155.4 J/kg of fluid flowing in the pipeline. The exit section of the pipeline 3.05 m higher than the entrance, and the exit pressure is 137.8 kN/m 3 abs. Calculate the equivalent pipe roughness.

[25]

QUESTION 3

A U-bend with an inlet diameter of 0.4m and outlet diameter 0.15m, connects two parallel horizontal pipes, one being vertically above the other. The bend is jointed to the pipes by bolting. Water exits the bend at a velocity of 8m/s and the inlet an exit pressures are 150 Pa and 122 Pa respectively. The weight of the material of the bend is 1.5 kN and the volume of the bend is 0.3 m^3. Calculate the magnitude and direction of the force on the bolts to keep the bend in place.

[35]

QUESTION 4

Water flows steadily with circular stream lines around a horizontal bend as shown in the figure. The radial variation of the velocity profile is given by $rV = r_0V_0$. What is the pressure inside the bend at a radius of curvature of 1.6m, if the pressure at the surface of the bend is 30kPa and the radius of curvature of the bend is 1.4m. the velocity at the surface of the bend is 8m/s.

[15]

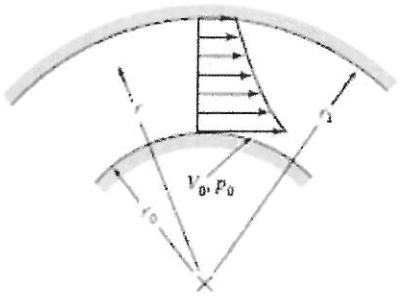


Figure 1

FORMULAS

$$-\frac{dp}{ds} - \gamma\, Sin\theta = \rho\, a_s \qquad -\frac{dp}{dn} - \gamma\, Cos\theta = \rho\, a_n \qquad \boldsymbol{tan\theta = \frac{v}{u}}$$

$$\frac{d}{dt} B_{sys} = \frac{d}{dt}\int_{cv} b\rho d\forall + \sum_{cs} b\rho \vec{V}.\vec{A}$$

$$B = mB$$

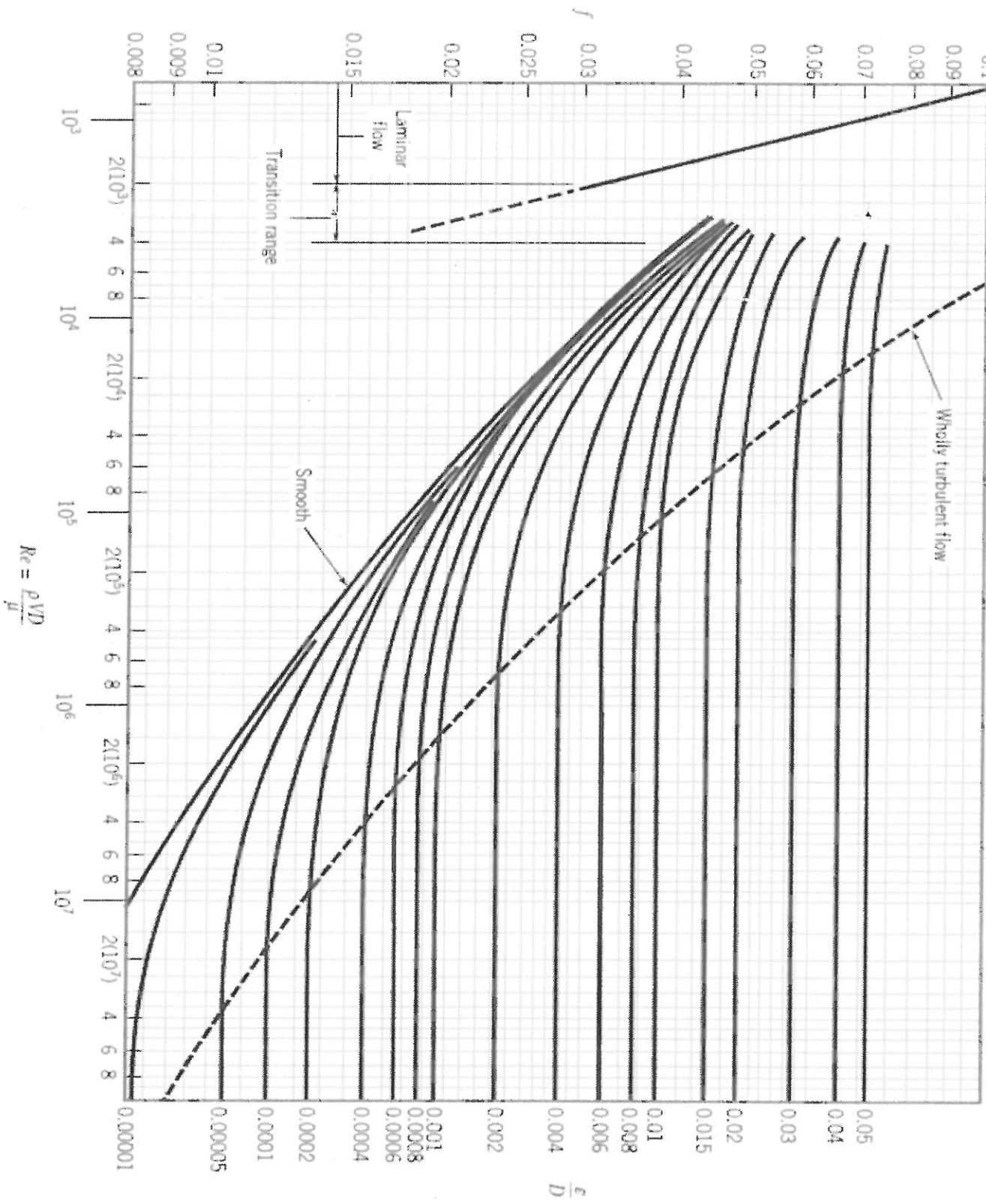
$$f = \left(\frac{\Delta p}{1/2\,\rho V^2}\right)/\left(\frac{L}{D}\right) \qquad K_L = \left(\frac{\Delta p}{1/2\,\rho V^2}\right) \qquad \boldsymbol{Q = \frac{\pi d^4 \Delta P}{128 \mu \Delta x}}$$

$$V = C\sqrt{R_h S_o}$$

$$C_D \,\mathrm{Re}_p^2 = \frac{4}{3}\frac{x^3 \rho_f (\rho_p - \rho_f) g}{\mu^2}$$

$$C_D / \mathrm{Re}_p = \frac{4}{3}\frac{g\mu(\rho_p - \rho_f)}{U_T^3\, \rho_f^2}$$

Moody Chart


f
Re = ρVD/μ
Laminar flow
Transition range
Smooth
Wholly turbulent flow
ε/D
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.025
0.015
0.01
0.009
0.008
10³
2(10³)
4
6
8
10⁴
2(10⁴)
10⁵
2(10⁵)
10⁶
2(10⁶)
10⁷
2(10⁷)
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0008
0.0006
0.0004
0.0002
0.0001
0.00005
0.00001

Drag Coefficient Chart