UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF ENGINEERING *TECHNOLOGY: CIVIL*
SUBJECT	:	**SCIENCE (FLUID MECHANICS) 1B**
CODE	:	**FLMCIB1**
DATE	:	FINAL EXAMINATION 23 November 2019
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	90

ASSESSOR	:	Mr S Ngidi
MODERATOR	:	Mr G Nkhonjera
NUMBER OF PAGES	:	7 PAGES

INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.
REQUIREMENTS	:	2 ANSWER BOOKLETS

INSTRUCTIONS TO STUDENTS

PLEASE ANSWER ALL QUESTIONS.
PROVIDE SHORT AND PRECISE ANSWERS FOR THE THEORETICAL PART.
SHOW ALL THE STEPS FOR CALCULATIONS CLEARLY.

QUESTION 1 [14]

a) Define the following types of fluids:
i. Ideal fluid [2]
ii. Real fluid [2]
iii. Newtonian fluid [2]
iv. Non-Newtonian fluid [2]

b) The space between two flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12.5 mm. The upper plate, which moves at 2.5 m/s requires a force of 98.1 N to maintain the speed. Determine:
i. the dynamic viscosity of the oil, and [3]
ii. the kinematic viscosity of the oil, if the specific gravity of the oil is 0.95. [3]

QUESTION 2 [21]

a) Explain what is meant by gauge pressure, atmospheric pressure and absolute pressure. [6]

b) A U-tube manometer, as shown in Figure Q21, measures the difference of pressure between two points A and B in a liquid of density ρ1. The U-tube contains mercury of density ρ2. Calculate the difference of pressure if a=1.5 m, b=0.75 m and h=0.5 m and if the liquid at A and B is water and ρ2=13.6ρ1. [10]

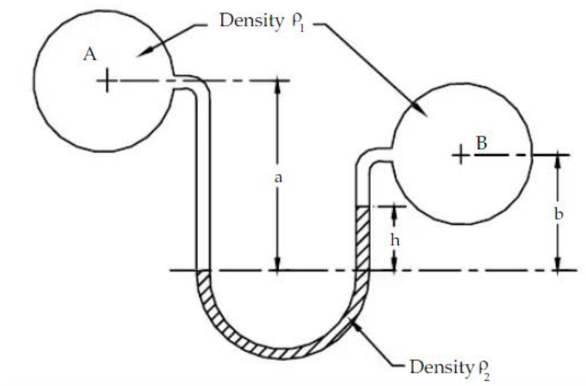


Figure Q21

c) Sketch the pressure distribution of the water on the dam wall shown in Figure Q22. Indicate the direction of the resultant force and position of the centre of pressure on both sides. [5]

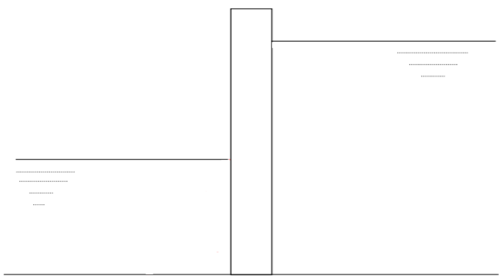


Figure Q22

QUESTION 3 [24]

a) Differentiate between uniform and non-uniform flow with regards to liquids in motion.[4]

b) Derive with the aid of a sketch the continuity of flow equation for liquids, stating assumption and the principle of conservation used. [5]

c) In the system shown in Figure Q3, water at 20ºC is pumped from tank A to reservoir B at a rate of 40l/s. The piping is all commercial steel. The inlet pipe is 10 m long and 120 mm in diameter. The outlet line is 150 m long and 110 m in diameter. Only consider the energy loss near exit of the outlet line, with k = 4. Determine the electrical power required to drive the pump if its overall efficiency is 88%. Reservoir B's free surface is 25 m above that of tank A. [15]

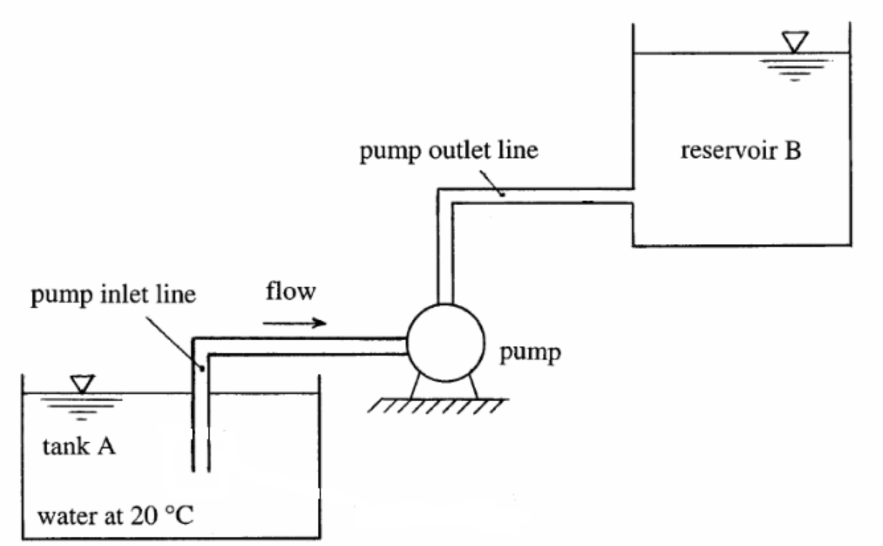


Figure Q3

QUESTION 4 [16]

a) Determine the energy loss due to 1.04 l/s of water through a sudden enlargement from a 25 mm OD x 2 mm wall copper hydraulic tube to a 80 mm OD x 2.8 mm wall tube. [10]

b) Compute the energy loss that would occur as $0.003 m^3/s$ flows from a tank into a steel tube with an outside diameter of 50mm and a wall thickness of 1.7mm. The tube is installed flush with the inside of the tank wall with square edges. [6]

QUESTION 5 [15]

a) State the range of Reynolds number for flow in pipes to be classified as: [3]
i. Laminar flow
ii. Transition zone
iii. Turbulent flow

b) For the system shown in Figure Q5, Kerosene (sg=0.82) at 20ºCis to be forced from the tank A to reservoir B by increasing the pressure in the sealed tank A above the Kerosene. The total length of DN 50 Schedule 40 steel pipe is 38 m. Calculate the required pressure in tank A to cause a flow rate of 435 l/min, considering the energy loss due to friction but neglecting other losses. (ID of DN 50 Sch 40 pipe = 52.5 mm, μ=1.75x10^{-3}) [12]

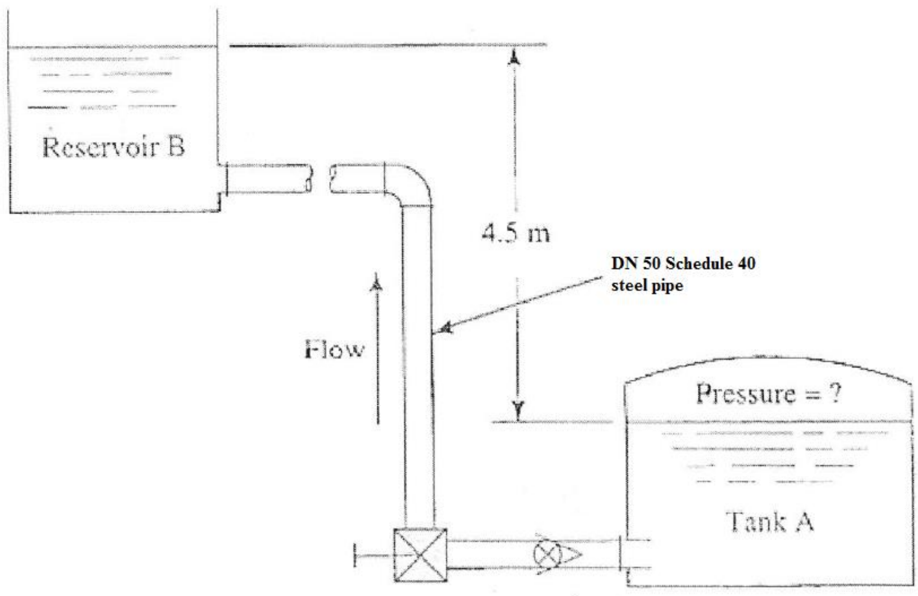
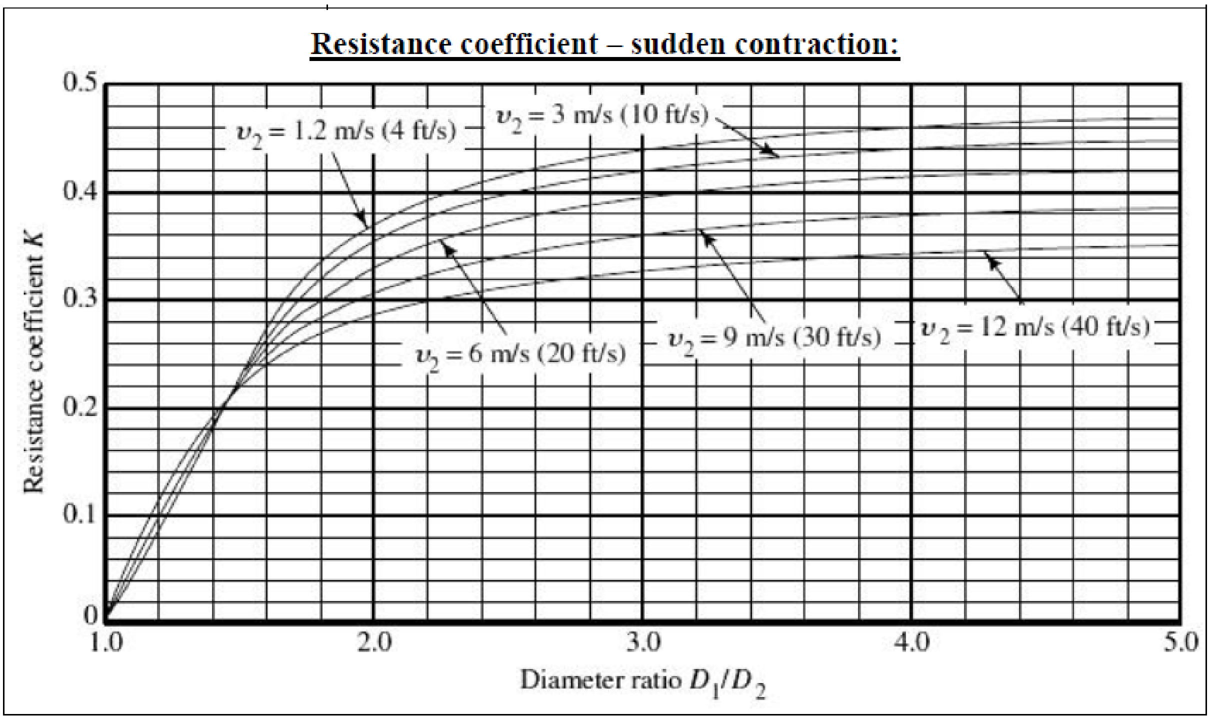


Figure Q5

--ooOOoo—

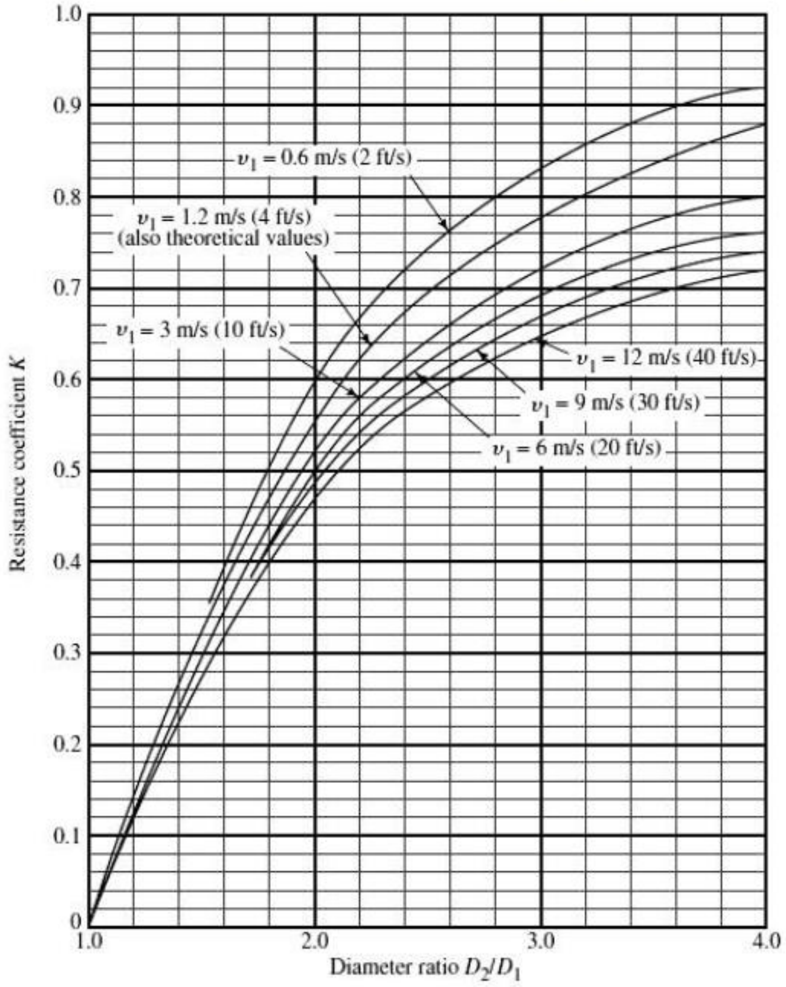
Formula Sheet



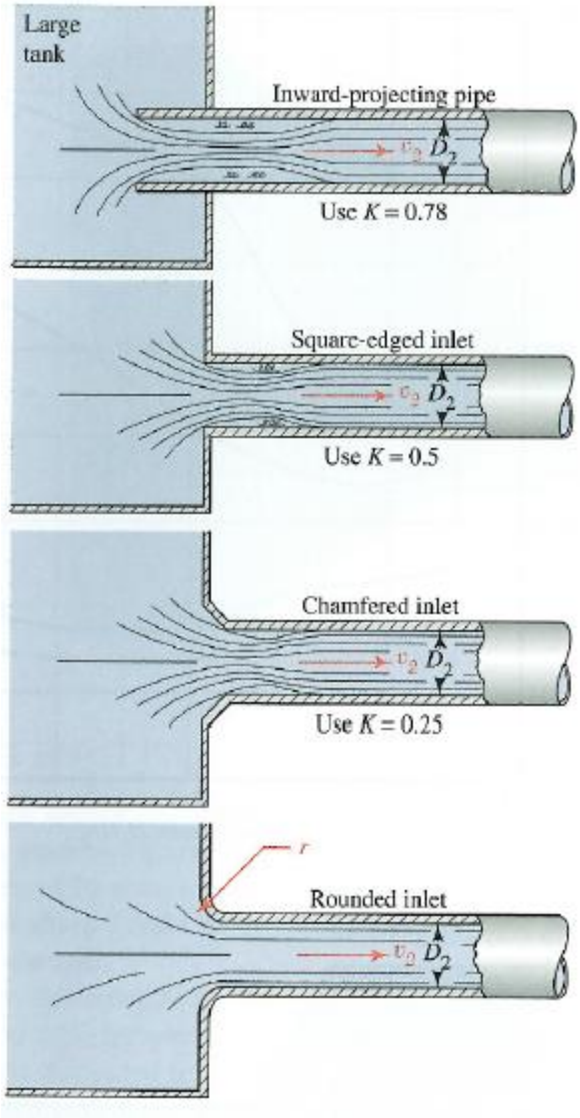
$P=\frac{F}{A}$	$F=\gamma.V=\gamma.h.A$	$\gamma=\rho g$
$P=\gamma.h=\rho gh$	$h_p=h_c+\frac{I_c\sin^2\theta}{h_cA}$	$\tau=\mu\left(\frac{\Delta V}{\Delta y}\right)$
$L_p=L_c+\frac{I_c}{L_cA}$	$\nu=\frac{\mu}{\rho}$	$w=\gamma.V$
Rectangle $I_c=BH^3/12$	Circle $I_c=\pi D^4/64$	Square $I_c=H^4/12$
$sg_{Hg}=13.54$	$sg=\rho s/\rho w@4^\circ C$ $sg=\gamma s/\gamma w@4^\circ C$	Triangle $I_c=BH^3/36$
$\frac{P_1}{\gamma}+z_1+\frac{{V_1}^2}{2g}+h_A-h_R-h_L=\frac{P_2}{\gamma}+z_2+\frac{{V_2}^2}{2g}$		
$R=\frac{A}{WP}$	$R_e=\frac{\rho VD}{\mu}=\frac{VD}{\nu}=\frac{V(4R)}{\nu}$	$h_f=f\ \frac{L}{D}\frac{V^2}{2g}$
$f=\frac{64}{R_e}$	Q=Av	$h_L=k\left(\frac{V^2}{2g}\right)$
$f=\frac{0.25}{\left[\log\left(\frac{1}{3.7\left(\frac{D}{\varepsilon}\right)}+\frac{5.74}{{R_e}^{0.9}}\right)\right]^2}$		
$P_A=h_A\gamma Q$		

Pipe Roughness – design values:	
Material	**Roughness ε (m)**
Glass	smooth
Plastic	3.0×10^{-7}
Drawn tubing; copper, brass , steel	1.5×10^{-6}
Steel, commercial or welded	4.6×10^{-5}
Galvanized iron	1.5×10^{-4}
Cast iron – coated	1.2×10^{-4}
Cast iron – uncoated	2.4×10^{-4}
Concrete, well made	1.2×10^{-4}
Riveted steel	1.8×10^{-3}

Resistance coefficient – sudden enlargement:



<u>Entrance Resistance coefficients</u>



r/D_2	K
0	0.50
0.02	0.28
0.04	0.24
0.06	0.15
0.10	0.09
>0.15	0.04 (Well-rounded)