UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: MECHANICAL*
SUBJECT	:	**FLUID MECHANICS 3**
CODE	:	**IMF 313**
DATE	:	**WINTER SSA EXAMINATION 2014** 22 JULY 2014
DURATION	:	(SESSION 1) 8:00 -11:00
WEITHT	:	40 : 60
TOTAL MARKS	:	100

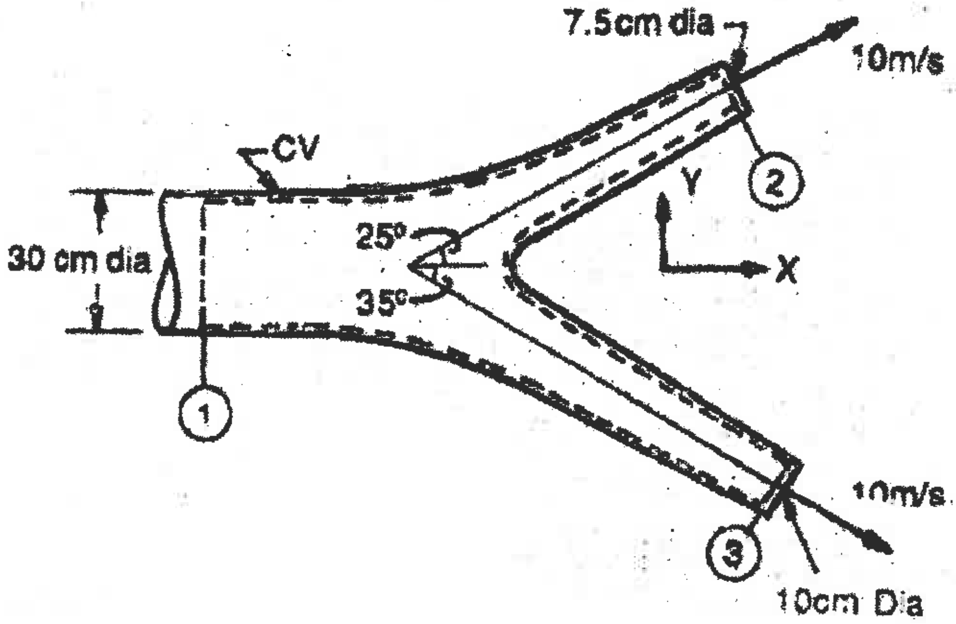
EXAMINER	:	MRS V TRITCHKOVA
MODERATOR	:	MR P SIMELANE 2332
NUMBER OF PAGES	:	4 PAGES AND A MOODY CHART

INSTRUCTIONS TO CANDIDATES:

- PLEASE ANSWER ALL QUESTIONS.
- NUMBER ALL YOUR QUESTIONS CLEARLY AND UNDERLINE YOUR FINAL ANSWERS.
- SHOW ALL THE CALCULATIONS.
- ALL ANSWERS, BOTH INTERMEDIATE AND FINAL MUST HAVE THE CORRECT UNITS, ANSWERS WITHOUT UNITS WILL NOT BE CONSIDERED.
- ASSUME ALL CONSTANTS AND PARAMETERS YOU NEED FOR YOUR CALCULATIONS.
- NO MARKS WILL BE GIVEN TO ILLEGIBLE WORK.
- ALL SKETCHES MUST BE LARGE AND CLEAR

QUESTION 1

A 30 cm diameter pipe divides into two nozzles at a Y-junction as shown in the Figure below.



The nozzles discharge to atmosphere and have a velocity of 10 m/s each. The junction is in horizontal plane and the friction can be neglected. Determine the magnitude and direction of the resultant force on the Y-junction.

[20]

QUESTION 2

A shaft of diameter 74.90 mm rotates in a bearing of diameter 75.03 mm and of length 75 mm. The annular space between the shaft and the bearing is filled with oil having a coefficient of viscosity 0.096 kg/m.s. Determine the power used in overcoming viscous resistance in this bearing at 1400 rpm.

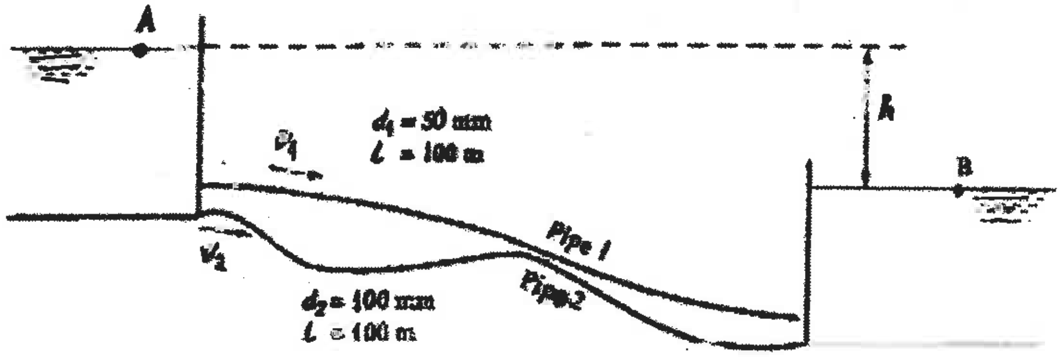
[12]

QUESTION 3

Two sharp-ended pipes of diameter 50 mm and 100 mm, each of length of 100 m are connected in parallel between two reservoirs which have a difference of level 10 m, as shown in the Figure below. If Darcy coefficient is 0.008 for each pipe, determine:

3.1 The rate of flow for each pipe. (9)

3.2 The diameter of a single pipe 100 m long that would give the same flow if it was substituted for the original two pipes. (9)



[18]

QUESTION 4

Water ($\rho = 998$ kg/m^3) flows in a pipe whose diameter is 200 mm and whose length is 800 m. The pipe is made of cast-iron with a wall thickness of 12 mm. There is a reservoir at the upstream end of the pipe and a valve at the downstream end. Under steady-state conditions the discharge is 0.025 m^3/s, then the valve at the end of the pipe is closed very rapidly so that water hammer occurs. Determine:

4.1 How long it takes for an acoustic wave to travel from the valve to the reservoir and back to the valve. (7)

4.2 The change in pressure at the valve if the valve is opened such that the discharge is doubled. (5)

4.3 The change in pressure at the valve if the valve is closed such that the discharge is halved. (4)

Assume for cast iron E = 150 GPa and for water K $= 2.20 \times 10^9$ N/m^2.

[16]

QUESTION 5

A rectangular cross-section tank of 12 m^2 surface area is filled to a depth of 2.5 m with water. Determine the initial rate of discharge of water through the pipe and the time it would take to reduce the depth in the tank by 2.0 m. The tank is drained through a 3 m long, 0.04 m diameter pipe discharging 2 m below the base of the tank. Assume the pipe friction factor of 0.04 and the losses due to bends of 0.9. Using the initial discharge velocity, check if this is a reasonable value for friction factor.

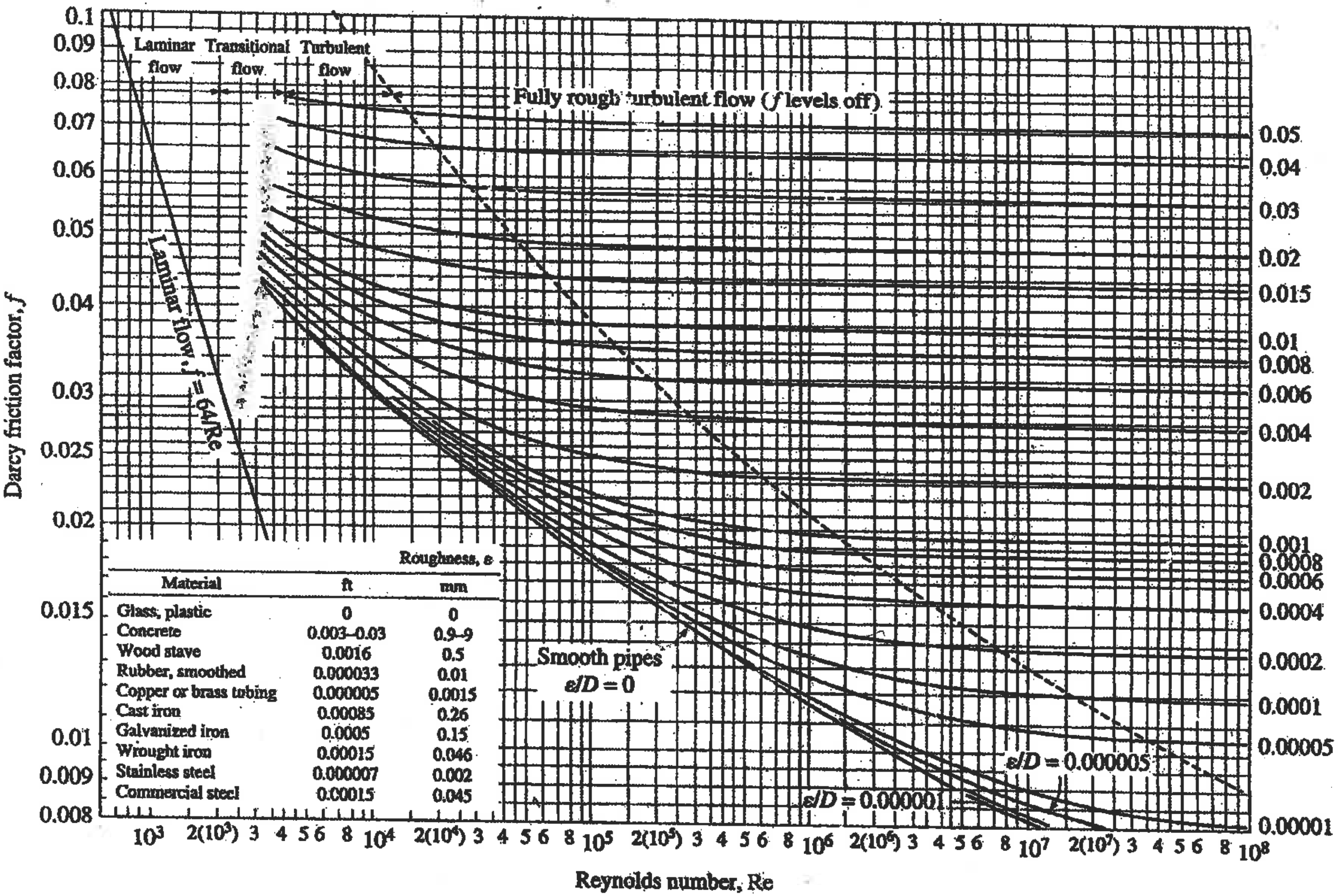
[20]

QUESTION 6

A double–acting, single–cylinder positive displacement pump of 180 mm diameter by 360 mm stroke draws from a source 3 m below the centre line of the pump, and delivers to a height 48 m above the water level. Both suction and discharge pipes are of 100 mm diameter, and their respective lengths are 6 m and 76 m. The pump piston has simple harmonic motion and makes 40 double strokes per minute. Large air vessels are fitted on both sides of the pump. The air vessel on the suction side is 1.5 m away from the cylinder, while that on delivery side is 4.5 m away. The friction coefficient for the pipes is 0.04. Determine the pressure head difference across the pump at the start of the stroke

[20]

FULL MARKS: 100
TOTAL MARKS :106



Material	Roughness, ε (ft)	Roughness, ε (mm)
Glass, plastic	0	0
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045

The Moody chart for the friction factor for fully developed flow in circular pipes for use in the head loss relation $h_L = f\frac{L}{D}\frac{V^2}{2g}$. Friction factors in the turbulent flow are evaluated from the Colebrook equation $\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right)$.