ELIZADE UNIVERSITY, ILARA-MOKIN
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
FIRST SEMESTER 2019/2020 SESSION
Course Title: Fluid Mechanics II. **Course Code:** CVE 309 **UNITS:** 3
EXAMINATION TIME: 3 Hours

Instruction: Answer any **FIVE (5)** questions. Draw neat sketches where necessary.

QUESTION ONE (20 marks)

a. Define the following properties of fluid, with appropriate symbols or formulas:

i. Density
ii. Specific weight
iii. Relative density
iv. Viscosity
v. Surface tension

(10marks)

b. Calculate as expected

i. The specific weight
ii. Specific mass
iii. Specific gravity of a liquid having a volume of $4m^3$ and weighing 29.43 KN.

(5marks)

c. The density of an oil at 20^0C is $850\ kg/m^3$. Find its relative density and kinematic viscosity, if the dynamic viscosity is $5x10^{-3}$ kg/m.s. **(5marks)**

QUESTION TWO (20 marks)

a. Two parallel plates are 6.3 mm apart. The inner plate moves at 1.5 m/s and the upper one at 6 m/s. if a force of 3.57 N/m̈ is needed to maintain the upper plate in motion. Find the dynamic and kinematic viscosity of the oil whose density is $850\ kg/m^3$ contained between the plates. State unit clearly.

(10marks)

b. A 50mm shaft runs in a bearing of diameter 50.25 mm and length 250 mm. The clearance space is filled with oil of 2.0 stokes (= 0.2 m̈/s). calculate the power lost in the bearing when the shaft rotates at 40 rev/min **(10marks)**

QUESTION THREE (20 marks)

a. Water flows at 10 m^3/s in a 1500 mm diameter pipe, the head loss in a 1000 m length of this pipe is 20 m. Find the rate of energy loss due to pipe friction.

(10marks)

b. Neglecting friction, find the velocity and volumetric discharge at 2 in the figure below **(10marks)**

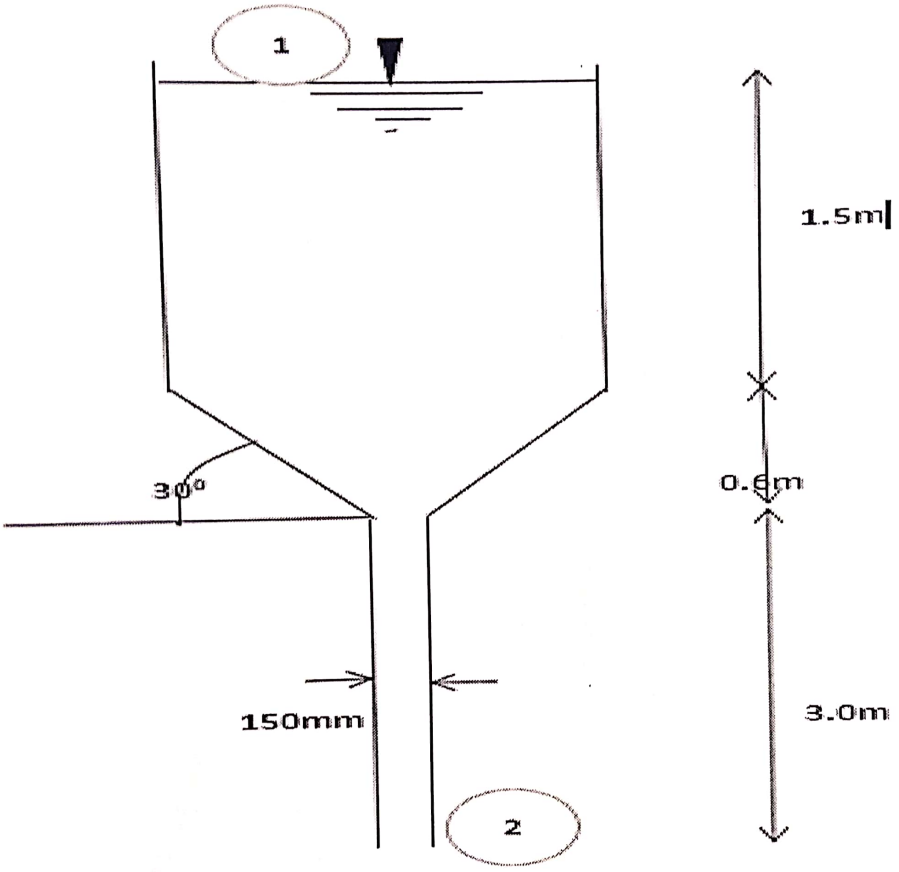

Figure 1: Pipe flow channel

QUESTION FOUR (20 marks)

a. A pipeline carries oil (s.g.= 0.86) at 2m/s through a 200mm pipe. At another section, the diameter is 80mm. Find the velocity at this section and the mass flow rate **(10marks)**

b. In the laminar flow of a fluid in a circular pipe, the velocity profile is exactly a time parabola, i.e. where r_0 is the radius of the pipe. The ratio of discharge is then represented by the volume of a paraboloid. Prove that for this flow, the ratio of the mean velocity to the maximum velocity is 0.5.

(10marks)

QUESTION FIVE (20 marks)

a. State the forms of energy which a liquid in motion can possess and derive expressions for each of these forms in terms of the pressure (P), velocity (V) and elevation (Z) for unit weight of fluid.

(5marks)

b. What is the total head of the liquid in motion. **(2marks)**

c. State bernoullis theorem for a liquid. **(3marks)**

d. Water at an altitude of 36m above sea level has a velocity of 18m/s and a pressure of 350 kN/m². Calculate the total energy per newton (i.e. N.m/N) of this water reckoned above sea-level. **(10marks)**

QUESTION SIX (20 marks)

a. Water at a gauge pressure of 3.8 atm, at street level flows into an office building at a velocity of 0.06 m/s through a pipe 50 mm in diameter, the pipe tapers down to 26 mm by the top floor 20 m above. Calculate the flow velocity and the gauge pressure in such a pipe on the top floor, assuming no branch pipe. Ignore viscosity **(10marks)**

b. A siphon has a uniform circular bore of 75 mm diameter and consist of a bent with its crest 1.8 m above water level discharging in to the atmosphere at a level as shown in Figure below. Find the velocity of flow, the discharge and absolute pressure at crest level B if the atmospheric pressure is equivalent to 10 m of water. Neglect losses due to friction. **(10marks)**

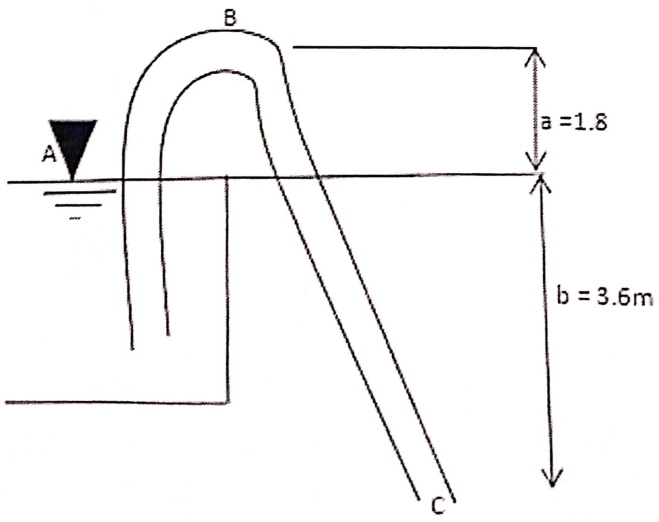

Figure 2: Siphon

QUESTION SEVEN (20 marks)

a. State the differential form of the continuity equation of fluid, and reduce this to that of a steady, in-compressible fluid flow. **(4 marks)**

b. Assuming the density in a two-dimensional flow to be constant, do these flows satisfy continuity

i.

ii.

iii. **(6 marks)**

c. The x-component of velocity is $u = x^3 + z^4 + 6$ and the y-component is $v = y^3 + z^4$. find the simplest z-component of the velocity that satisfied continuity.

(10 marks)

QUESTION EIGHT (20 marks)

a. Define the following terms, with appropriate symbols, used in connection with the flow of a liquid.

i. Uniform flow

ii. Steady flow

iii. Unsteady flow

iv. Mean velocity

v. Flow discharge **(5 marks)**

b. What is meant by continuity of flow and under what condition does it occur?

(5 marks)

c. Oil flows through a pipeline which contracts from 450 mm diameter at A to 300mm diameter at B and then forks, one branch being 150 mm diameter. Discharge at C and the other branch 225 mm diameter discharging at D. if the velocity at A is 1.8 m/s and the velocity at D is 3.6 m/s, what will be the discharge at C and D and velocity at B and C ? **(10 marks)**