2024 September Examinations

Faculty	:	Engineering and the Environment
Department	:	Metallurgical Engineering
Paper Code/Title	:	EMG 3106/Fluid Mechanics
Duration	:	3 Hours
Examiner	:	P. Garanowako
Authorized material	:	Calculator

INSTRUCTIONS

1. This paper contains **one** section with **five** questions.
2. Answer any **four** questions.
3. Where the question contains subdivisions, the mark of each subdivision is shown in brackets.
4. Each question carries **25 marks**.
5. Start each question on a new page.

NB: DO NOT TURN OVER THE QUESTION PAPER OR COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Question 1

a) Outline the relevance of Fluid Mechanics in metallurgical engineering. [3]

b) State any 4 categories of Non-Newtonian fluids and give examples of substances that fall under each of these categories. [8]

c) With the aid of diagrams, deduce the Newton's law of viscosity. [10]

d) What are the causes of viscosity in gases and liquids. [4]

Question 2

a) Explain the difference between absolute and gauge pressure. [4]

b) What is the maximum gauge pressure of water that can be measured by means of a piezometer tube 2 m high? (Mass density of water ρH_2O = 103 kg m^{-3}.) [6]

c) At an altitude z_1 of 11 000 m, the atmospheric temperature T is −56.6 °C and the pressure p is 22.4 kN m^{-2}. Assuming that the temperature remains the same at higher altitudes, calculate the density of the air at an altitude of z_2 of 15 000 m. Assume $\boldsymbol{R}$ = 287 J kg^{-1} K^{-1}.[7]

d) With the aid of a sketch diagram and Reynolds equation explain the difference between laminar flow and turbulent flow. [8]

Question 3

Water flows from A to D and E through the series pipeline as shown in Figure 1.

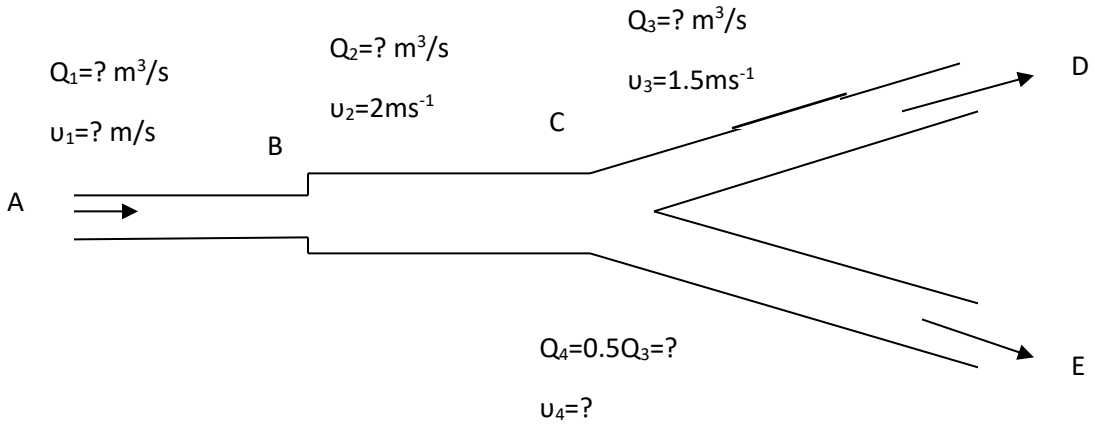

Figure 1.

Calculate Q_1, Q_2, Q_3, Q_4, υ_1, and d_3 for the water flowing system. [25]

Question 4

a) Giving examples, differentiate between compressible and incompressible fluids.[5]

b) Calculate the Pressure drop due to friction and the power to maintain the flow in horizontal pipe of 40mm diameter and 750 m long when water of dynamic viscosity of 1.14 x 10^3N.s./m^2 the flow velocities are:

i. 3.0 L/minute [5]

ii. ii. 40.0 L/minute [5]

The Darcy friction factor is 0.008.

c) Derive Bernoulli's energy equation from first principles, stating any assumptions made[10]

Question 5

a. State the momentum equation for one dimensional flow of a liquid, explaining any symbols used. [5]

b. Water is drawn from a reservoir, in which the water level is 240 m above datum, at the rate of 0.13 m^3 s^{-1}. The outlet of the pipeline is at the datum level and is fitted with a nozzle to produce a high-speed jet to drive a turbine of the Pelton wheel type. If the velocity of the jet is 66 m s−1, calculate:

i. the power of the jet [5]

ii. the power supplied from the reservoir, [5]

iii. the head used to overcome losses [5]

iv. the efficiency of the pipeline and nozzle in transmitting power. [5]

END OF EXIMINATION