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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN RENEWABLE ENERGY TECHNOLOGY

COURSE CODE: **RET 231**

COURSE TITLE: **FLUID MECHANICS**

DATE: 13-12-2022 **TIME: 1500-1700**

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning ($g = 9.81 \frac{m}{s^2}$ *and* $P_{atm} = 101,325\ Pa$)
4. Sharing of Calculators is PROHIBITED

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE [30 marks]

1)

a) Using shear stress and velocity gradient graph, distinguish between Newtonian and non-Newtonian fluids and give an example for each **(5 marks).**

b) Distinguish the following terms

i. Dynamic (absolute) and kinematic viscosity in the context of intermolecular forces of cohesion and molecular momentum exchange **(2 marks)**

ii. Absolute, gage and atmospheric pressure using a diagram **(4 marks)**

iii. Steady and non-steady fluid flow **(2 marks)**

iv. Laminar and Turbulent flow **(2 marks)**

v. Incompressible and non-compressible flow **(2 marks)**

c) If the equation of a velocity profile over a plate is $v = 5y^2 + y$ (where v is the velocity in m/s) determine the shear stress at $y = 0$ and at $y = 7.5$cm. Given the viscosity of the liquid is 8.35 poise. **(4 marks)**

d) The gauge pressure of a hydro plant on a penstock at turbine entry reads 7 bars. Express the head as a function of specific gravity and calculate the operating head of the plant **(3 marks).**

e) The absolute viscosity of the oil used for lubrication between a turbine shaft and a sleeve is 6 Poise. The shaft is of diameter 0.4 m and rotates at 250 RPM. Calculate the Power lost in the bearing for the sleeve length of 90 mm and oil film thickness of 1.8 mm. **(6 marks).**

QUESTION TWO [20 marks]

2)

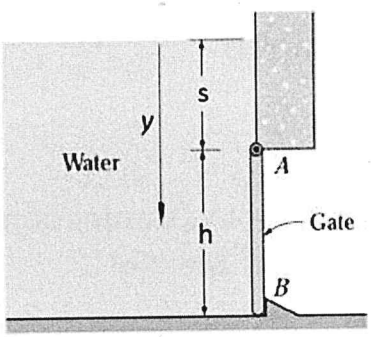
a) As a design engineer, you are to evaluate a rectangular gate into a canal of height h **(3 m)** and width **6.5 m** (into the page) that holds water in a reservoir. The total water level is **5.2 m** from the base. The gate design has a hinge at point A, which can allow the gate to swing, when necessary, as shown in figure below**Error! Reference source not found.**. Calculate the following:

i) Pressure and force acting on the left side of the gate **(2 marks)**

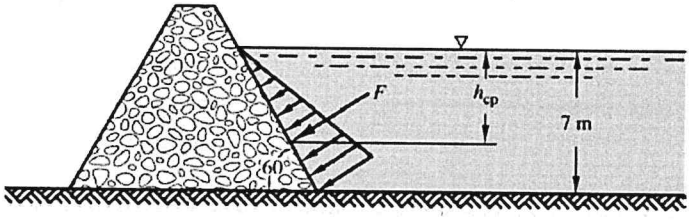
ii) Pressure and force acting on the right side of the gate **(1 mark)**

iii) Total resultant force acting on the plate and point of action **(3 marks)**

iv) Draw the pressure distribution and resultant force acting on the gate **(2 marks)**



b) A hydropower dam whose length is 20 m is shown in figure below. Calculate the resultant force and the location of the center of pressure **(6 marks)**.



c) Water is flowing through a pipe as shown in figure below. Determine the difference in the datum head if the rate of flow through is 40liters/sec. **(6 marks)**

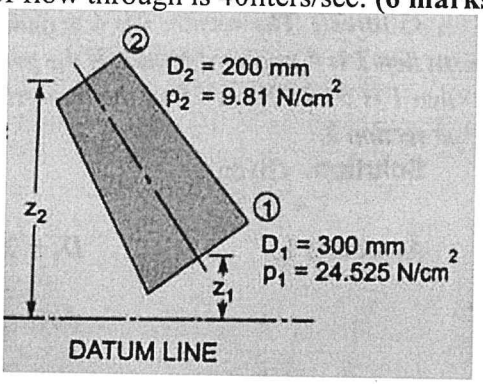


Figure 1 Water flow through the pipe

QUESTION THREE [20 marks]

3)

a) A 2 km long channel with finished concrete lining is to convey water from the weir (2180 masl) to Forebay (2178.4 masl) for a design flow of 2.8 m3/s. The canal is to operate with a freeboard of 0.25m. Analyze the following design (take b=2h)

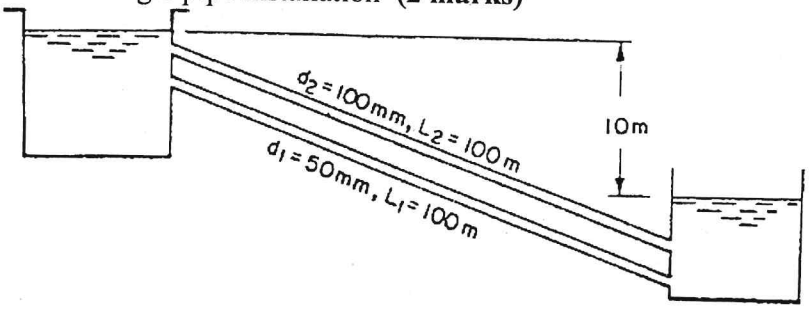
i) Rectangular canal **(6 marks)**

ii) Trapezoidal canal with side slope horizontal: vertical (0.5:1) **(6 marks)**

b) For a pumped-storage with two units, Calculate (use f = 0.03)

i) Power at that instant **(6 marks)**

ii) Diameter of a single pipe installation **(2 marks)**



QUESTION FOUR [20 marks]

4)

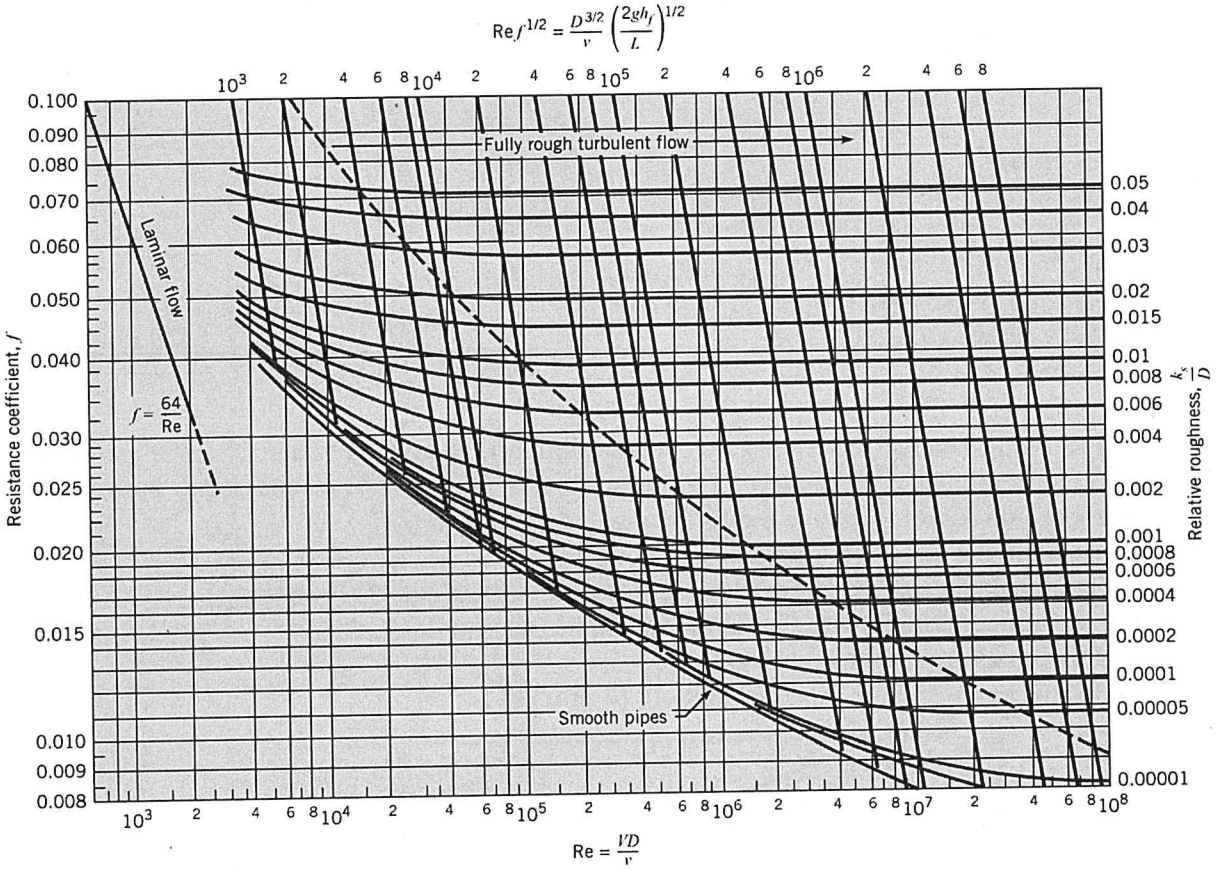
a) A **DN400**, 100 m long penstock delivers water ($1.005x10^{-6}\frac{m^2}{s}$)at a mean velocity of 3.49 m/s. The surface roughness of the pipe is 0.6 mm. Calculate

i) Reynolds number and characterize the flow as either laminar or turbulent **(3 marks)**

ii) The friction losses due to penstock (use Moody chart) **(4 marks)**

iii) Estimate the friction factor and hence losses using the Colebrook equation **(5 marks)**

b) Two pipes connected have a sudden enlargement of a water main from 240mm to 480mm diameter and the hydraulic gradient rises by 10 mm. Estimate the rate of flow **(8 marks)**



Surface Material	Manning's Roughness (n)	Surface Material	Manning's Roughness (n)
Brass	0.011	Concrete - steel forms	0.011
Brick and cement mortar sewers	0.015	Concrete (Cement) - finished	0.012
Corrugated metal	0.022	Concrete - centrifugally spun	0.013
Earth, smooth	0.018	Earth channel - clean	0.022