TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
Department of BUILDING & Civil engineering
UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING
ECV 4222 : FLUID MECHANICS II

END OF SEMESTER EXAMINATION
SERIES: APRIL 2025
TIME: 2 HOURS

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **five** questions.
Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

QUESTION ONE (Compulsory)

a) Consider the two orifices of diameters d1 and d2 placed at depths of 30 cm and 1.5 m on the side of a tank. Calculate the ratio of d1 and d2 if the discharge from the two orifices is the same. **(6 Marks)**

b) Calculate the coefficient of contraction of an orifice meter with fluid discharging through an orifice diameter of 50 mm and a *vena contracta* diameter of 40 mm. **(4 marks)**

c) A rectangular tank is filled to the brim with water. A hole at its bottom is unplugged, and the tank is emptied in time T. Determine the time taken to empty the tank if it is half–filled. **(10 marks)**

d) In a circular tube with a diameter 100mm and length 15m with laminar flow, the Darcy friction factor is estimated to be 0.005. determine the Reynolds number. **(4 marks)**

e) Oil flows in a pipe 80 mm diameter with a mean velocity of 0.4 m/s. The density is 890 kg/m^3 and the viscosity is 0.075 Ns/m^2.
   (i) Determine the Reynolds number and classify the flow.
   (ii) Determine the pressure loss per metre length. **(6 marks)**

QUESTION TWO

a) A sharp-edged orifice of 5 cm diameter discharges water under a head of 5 m. determine the values of;
   i. Coefficient of velocity
   ii. Coefficient of contraction,
   iii. Coefficient of discharge, if the measured rate of flow is 0.012 cumecs. The diameter of the jet at the *vena contracta* is 4 cm. **(6 marks)**

b) A reservoir discharges water through a large orifice 1m wide and 1.5 m deep. The top of the orifice is 0.80m below the water level in the reservoir. Assuming that the downstream water level is below the bottom of the orifice, determine the following;
   i. Discharge through the orifice if Cd = 0.60, and
   ii. Percentage error if the orifice is treated as small. **(5 marks)**

c) Classify the flow in a pipe having a diameter of 20 mm, fluid velocity of 2.5 m/s, 900 kg/m^3 given that the relative density and the viscosity of the fluid as 0.4 Ns/m^2. **(3 marks)**

d) An orifice of diameter 110 mm is fitted at the bottom of a boiler drum of length 5 m and of diameter 2 m. The drum is horizontal and half full of water. Find the time required to empty the boiler, given the value of C_d = 0.6. **(6 marks)**

QUESTION THREE

a) A tank 4m long and 2m wide is divided into two parts by a partition so that the area of one portion is twice the area of the other. The partition contains an orifice of 50 cm2 area through which the water may flow from one part to the other. If the initial difference of level is 4m, determine the time required to

reduce the difference to 1m. Note: Cd = 0.60; Water level in the larger portion is higher. **(8 marks)**

b) Oil flows in a pipe 100 mm bore with a Reynolds number of 250. The dynamic viscosity is 0.018 Ns/m^2. The density is 900 kg/m^3. Determine the following;

(i) Pressure drop per metre length,
(ii) Average velocity, and
(iii) Radius at which the above (i) and (ii) occurs. **(12 marks)**

QUESTION FOUR

a) A circular tank of diameter 1.25 m contains water up to a height of 5 m. An orifice of 50 mm diameter is provided at its bottom. Cd = 0.62, determine the height of water above the orifice after 15 minutes. **(10 marks)**

b) Oil of density 860 kg/m3 has a kinematic viscosity of 40 mm2/s. Determine the critical velocity when it flows in a pipe 50 mm bore diameter. **(4 marks)**

c) Determine the discharge through a fully submerged orifice of width 2 m if the differences of water levels on both sides of the orifice is 50 cm. The height of water from top and bottom of the orifice are 2.5 m and 2.75 m respectively. Take C_d = 0.6. **(4 marks)**

d) Differentiate between a large and small orifice. **(2 marks)**

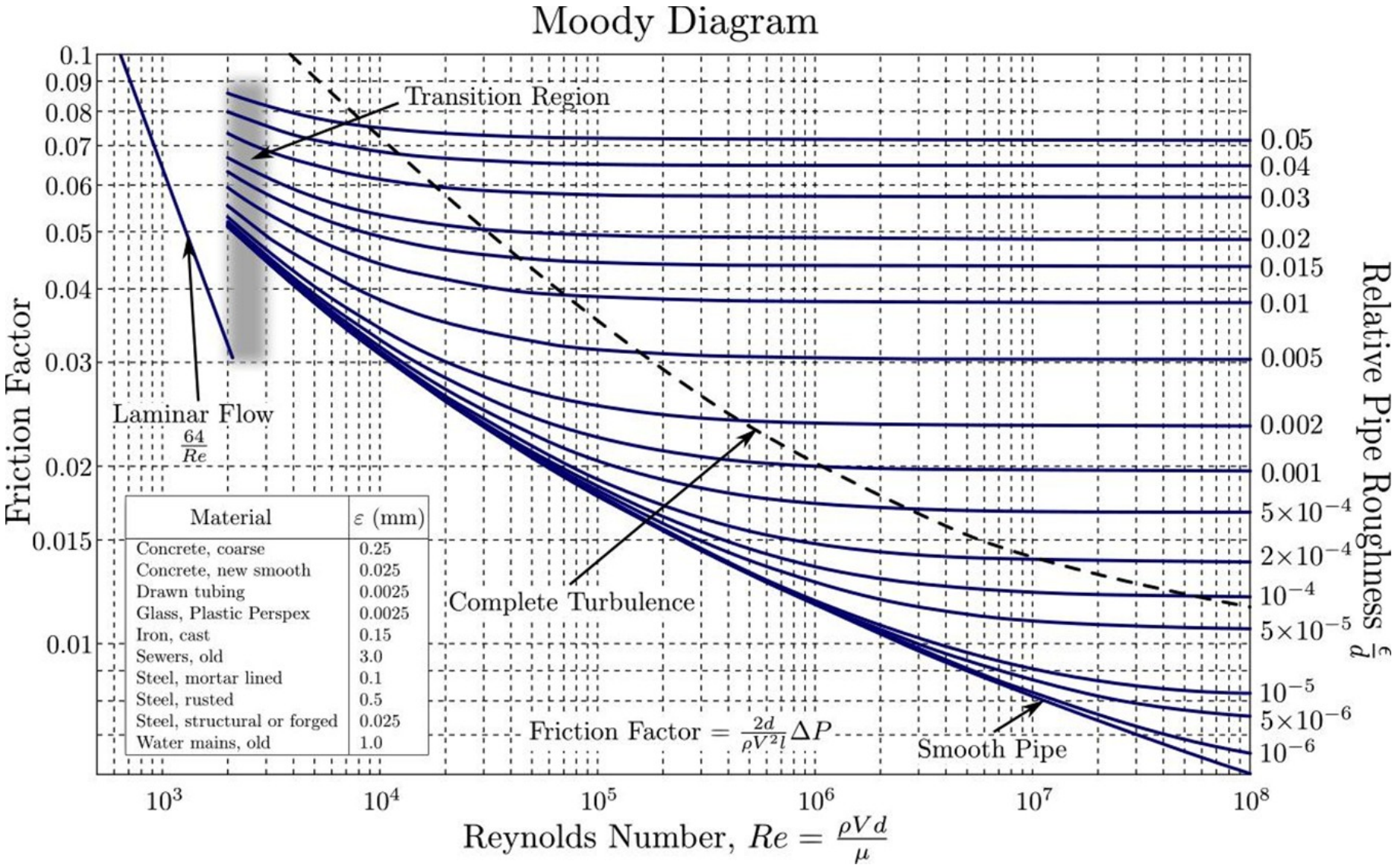
QUESTION FIVE

a) Derive expression for maximum efficiency of transmission of power through a pipe. **(6 marks)**

b) In a hydro project, a turbine is mounted in such a way that it acquires a head of 45m. the water discharge in the feeding penstock with the flow rate of 4000 l/s. If the head loss of 6m takes place in the penstock and the power of 1,000 kW is extracted from the turbine. The hydraulic efficiency of the turbine can be considered as 90%. Determine the residual head loss of the turbine. (*Take g = 10 m/s^2*) **(4 marks)**

c) A rectangular orifice 1.15 m wide and 1.35 m deep is discharging water from a vessel. The top edge of the orifice is 0.6 m below the water surface in the vessel. Calculate:

i. the discharge through the orifice if $C_d = 0.6$, and
ii. percentage error if the orifice is treated as a small orifice. **(10 marks)**



Material	ε (mm)
Concrete, coarse	0.25
Concrete, new smooth	0.025
Drawn tubing	0.0025
Glass, Plastic Perspex	0.0025
Iron, cast	0.15
Sewers, old	3.0
Steel, mortar lined	0.1
Steel, rusted	0.5
Steel, structural or forged	0.025
Water mains, old	1.0

$\lambda = 4\ f$ & values of k_s are provided by pipe manufactures.

Pipe Material	**K, mm**
Brass, Copper, Glass	0.003
Asbestos Cement	0.03
Iron	0.06
Galvanized Iron	0.15
Plastic	0.03
Bitumen-lined Ductile Iron	0.03
Concrete-lined Ductile Iron	0.03