**TECHNICAL UNIVERSITY OF MOMBASA**

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

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING
**TMC 4214 : FLUID MECHANICS II**

END OF SEMESTER EXAMINATION
**SERIES:** JANUARY 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 any THREE questions.
**Do not write on the question paper.**

## QUESTION ONE

a) 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)**

b) 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)**

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)**

## QUESTION TWO

a) Derive expression for the discharge through a large rectangular orifice. **(10 marks)**

b) 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. **(8 marks)**

c) Briefly describe the difference between an orifice and a mouthpiece. **(2 marks)**

## QUESTION THREE

a) A pipe of 2.5m diameter and 22km long transmits water at velocity of 1.5 m/sec. The friction coefficient of the pipe is 0.005. Determine the head loss due to friction. **(4 marks)**

b) Oil of density 860 kg/m$^3$ has a kinematic viscosity of 40 mm$^2$/s. Determine the critical velocity when it flows in a pipe 50 mm bore diameter. **(4 marks)**

c) 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) Water flows in a steel pipe (d = 35 mm, k =$0.045 \times 10^{-3}\, m$, $\mu$ = 0.001 k/ms) with a rate of 1.25 lit/s.
Determine the friction coefficient and the head loss due to friction per meter length of the pipe using:
(i) Moody chart
**(ii)** Smooth pipe formula **(10 marks)**

b). 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. **(5 marks)**

o. A pipe, 50 m long, is connected to a water tank at one end and flows freely in atmosphere at the other end. The diameter of pipe is 10 cm for first 25 m from the tank, and then the diameter is suddenly enlarged to 35 cm. Height of water in the tank is 12 m above the centre of pipe. Darcy's coefficient is 0.01. Determine the discharge neglecting minor losses? **(5 marks)**

## QUESTION FIVE

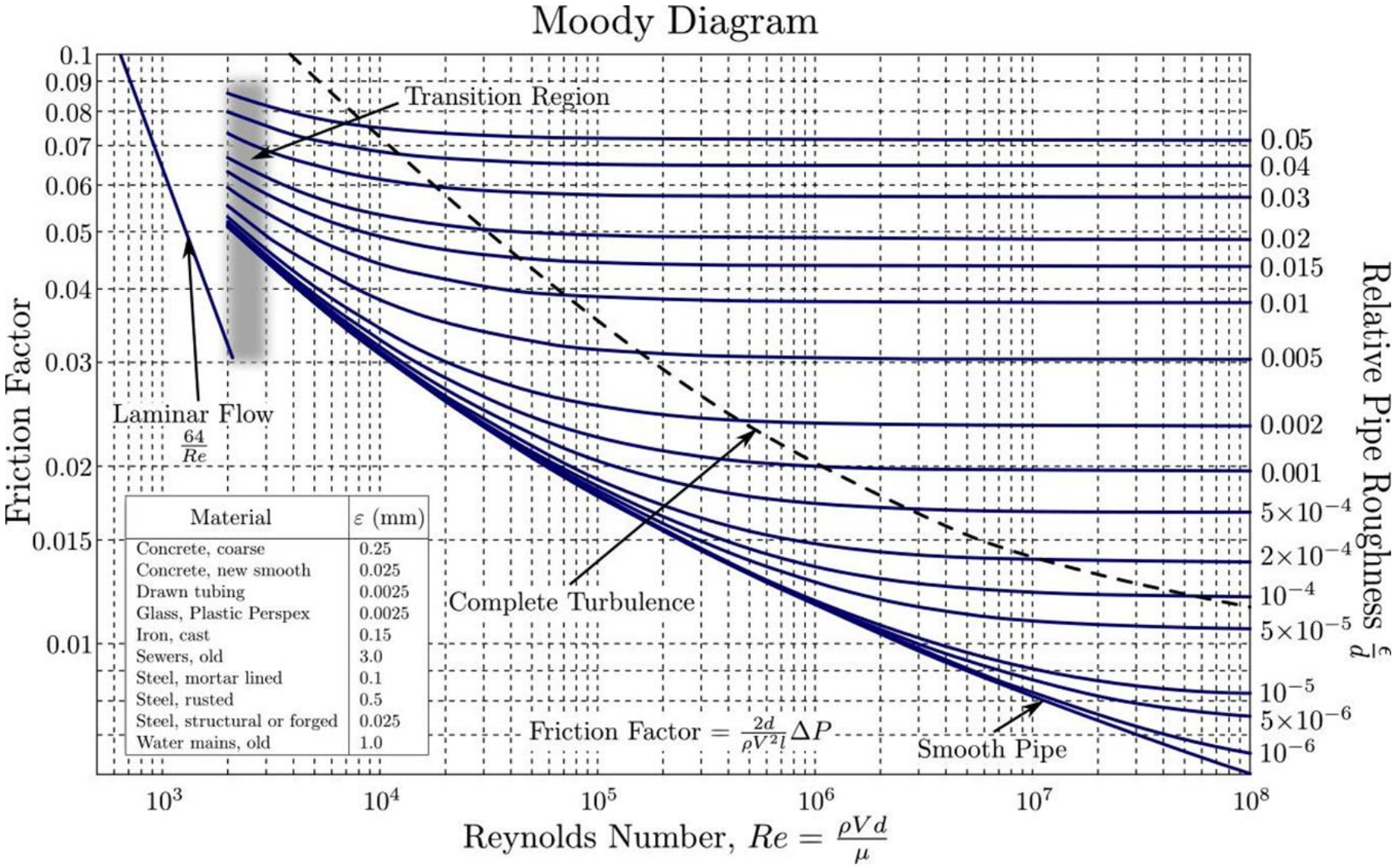
a) Derive expression for maximum efficiency of transmission of power through a pipe. **(6 marks)**

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 | $\varepsilon$ (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 |