SOSC –

KATHMANDU UNIVERSITY
End Semester Examination
March, 2025

Marks Scored:

Level : B.E.
Year : II

Course : MEEG 218
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date 24 MAR 2025

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. The ratio of the density of a substance to the density of water at 4°C is called:
   [ ] Kinematic viscosity [ ] Dynamic viscosity
   [ ] Specific weight [ ] Specific gravity

2. Which of the following fluids is an example of a Newtonian Fluid?
   [ ] Blood [ ] Honey [ ] Water [ ] Toothpaste

3. Property of a fluid by which liquid droplets tends to assume spherical shape is called
   [ ] adhesion [ ] cohesion [ ] surface tension [ ] viscosity

4. Gauge pressure at a point in a fluid is given by:
   [ ] Absolute pressure + Atmospheric pressure [ ] Absolute pressure × Atmospheric pressure
   [ ] Absolute pressure - Atmospheric pressure [ ] Absolute pressure / Atmospheric pressure

5. A floating body is in stable equilibrium if:
   [ ] The C.G. is above the center of buoyancy [ ] The metacentric height is positive
   [ ] The metacentric height is negative [ ] The weight is less than the buoyant force

6. In the context of material derivative for velocity, the term $\boldsymbol{V}.\boldsymbol{\nabla V}$ represents
   [ ] Local acceleration
   [ ] Convective acceleration due to spatial variations in velocity
   [ ] The total acceleration of a fluid
   [ ] The pressure gradient force

7. Which of the following is a common method for visualizing a velocity field in experimental fluid mechanics?
   [ ] Pressure taps [ ] Particle Image Velocimetry (PIV)
   [ ] Pitot tubes [ ] Thermocouples

8. Consider a velocity field $\vec{V} = (u, v) = x^2\,\vec{\imath} + (-2x - 1)\,\vec{\jmath}$. The flow is
   [ ] Rotational
   [ ] Irrotational
   [ ] Uncertain
   [ ] Given information is not enough to draw any conclusion

9. Bernoulli's equation is derived from which fundamental principle?
   [ ] Conservation of momentum [ ] Conservation of energy
   [ ] Conservation of mass [ ] Newton's second law

10. Which of the following conditions is most likely to cause flow separation in a boundary layer?

[ ] Increasing Reynolds number
[ ] Adverse pressure gradient
[ ] Favorable pressure gradient
[ ] Laminar flow

11. Barometer is used to measure

[ ] pressure [ ] discharge [ ] rotation [ ] momentum

12. Velocity distribution in laminar flow through a circular pipe is.

[ ] Straight [ ] Parabolic [ ] Bicubic [ ] logarithmic

13. The hydraulic diameter (D_h) for a rectangular duct of width a, height b, coss section area A and perimeter P is given by:

[ ] $D_h = \frac{a+b}{2}$ [ ] $D_h = \frac{a-b}{a+b}$ [ ] $D_h = \frac{4A}{P}$ [ ] $D_h = \frac{a+b}{2}$

14. For turbulent flow, the Darcy friction factor depends on:

[ ] Reynolds number only
[ ] Pipe roughness only
[ ] Both Reynolds number and pipe roughness
[ ] Velocity profile only

15. Water flows through a horizontal pipe with a varying cross-section. If the velocity at section 1 is 4 m/s and the pressure is 300 kPa, what is the pressure at section 2 where the velocity is 6 m/s? Assume incompressible flow and neglect frictional losses.

[ ] 250 kPa [ ] 288 kPa [ ] 312 kPa [ ] 270 kPa

16. Which of the following is necessary condition for incompressible flow?

[ ] $\nabla.\vec{V} = 0$ [ ] $\nabla \times \vec{V} = 0$ [ ] $\int \vec{V} dt = 0$ [ ] $\frac{d\vec{V}}{dt} = 0$

17. The Navier-Stokes equation for an incompressible Newtonian fluid is derived from:

[ ] The conservation of mass
[ ] The conservation of momentum
[ ] The conservation of energy
[ ] The Bernoulli equation

18. The dominant source of drag in a bluff body (such as a sphere) at high Reynolds number is:

[ ] Skin friction drag
[ ] Pressure drag
[ ] Wave drag
[ ] Induced drag

19. A Kármán vortex street is characterized by:

[ ] Steady flow with no separation
[ ] Alternating vortices shed behind a body in a periodic manner
[ ] A symmetric wake region
[ ] Laminar boundary layer with no turbulence

20. Cavitation occurs in high-velocity flows when:

[ ] Pressure drops below the vapor pressure of the liquid
[ ] Velocity exceeds the speed of sound
[ ] Density of the fluid increases suddenly
[ ] Viscosity of fluid drops to zero

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Time : 2 hrs. 30mins.

24 MAR 2025

Course : MEEG 218
Semester : I
F. M. : 40

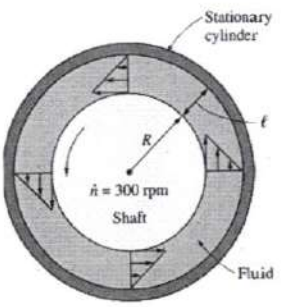
SECTION "B"
[5 Q. × 8 = 40 marks]

Attempt ALL questions. Assume suitable data if necessary.

1.

a. Give brief notes on surface tension and capillary effect with appropriate diagrams. Starting from Newton's second law of motion, derive Bernoulli equation in terms of static, dynamic and hydrostatic pressure. [1+3]

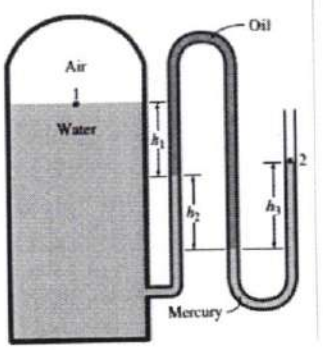
b. The Viscosity of a fluid is to be measured by a viscometer constructed of two 40-cm long concrete cylinders as shown in figure. The outer diameter of the inner cylinder is 12 cm, and the gap between the two cylinders is 0.15 cm. The inner cylinder is rotated at 300 rpm, and the torque is measured to be 1.8 N-m. Determine the viscosity of the fluid. [4]



2.

a. Write a short note on the eulerian description of fluid motion and explain how it is different from the lagrangian description. Derive the equation of Reynolds Transport Theorem and explain its significance. [1+3]

b. The water in a tank is pressurized by air, and the pressure is measured by a multifluid manometer as shown in figure. The tank is located on a mountain at an altitude of 1400 m where the atmospheric pressure is 85.6 kPa. Determine the air pressure in the tank if h1 = 0.1 m, h2=0.2 m, and h3 = 0.35 m. Take the densities of water, oil and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13600 kg/m^3, respectively. [4]



3.

a. Derive the equation for acceleration of fluid particle expressed as the material derivative of velocity vector. Explain the physical significance of material derivative in fluid kinematics. [4]

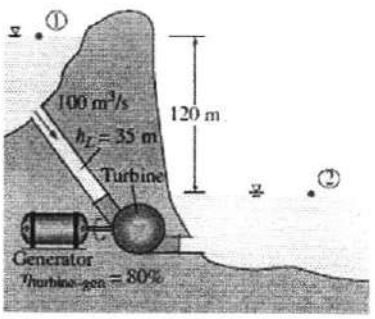
b. The velocity vector in a fluid flow is given as: $\vec{V} = 4x^3\,\vec{i} + (-10x^2y)\,\vec{j} + 2t\vec{k}$. Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t =1. [4]

P.T.O.

4.

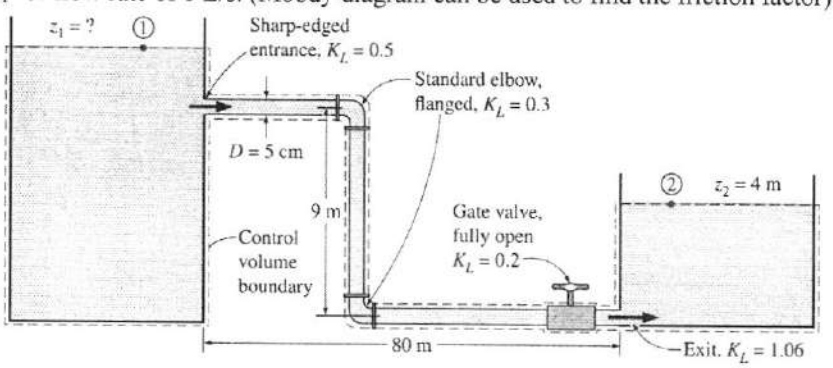
a. Explain with diagrams, the development of parabolic velocity profile for flow inside a circular pipe. Define boundary layer, irrotational and rotational flow region, and hydrodynamic entrance region. Explain the necessary condition for hydrodynamically fully developed flow. [2+1+1]

b. In a hydroelectric power plant, 100 m^3/s of water flows from an elevation of 120 m to a turbine, where electric power is generated (see figure). The total irreversible head loss in the piping system from point 1 to point 2 (excluding the turbine unit) is determined to be 35 m. If the overall efficiency of the turbine-generator is 80 percent, estimate the electric power output. [4]

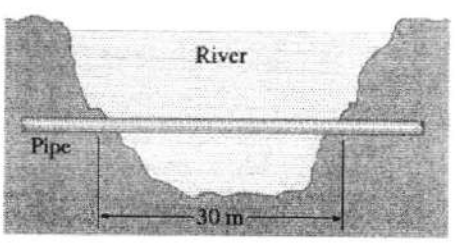


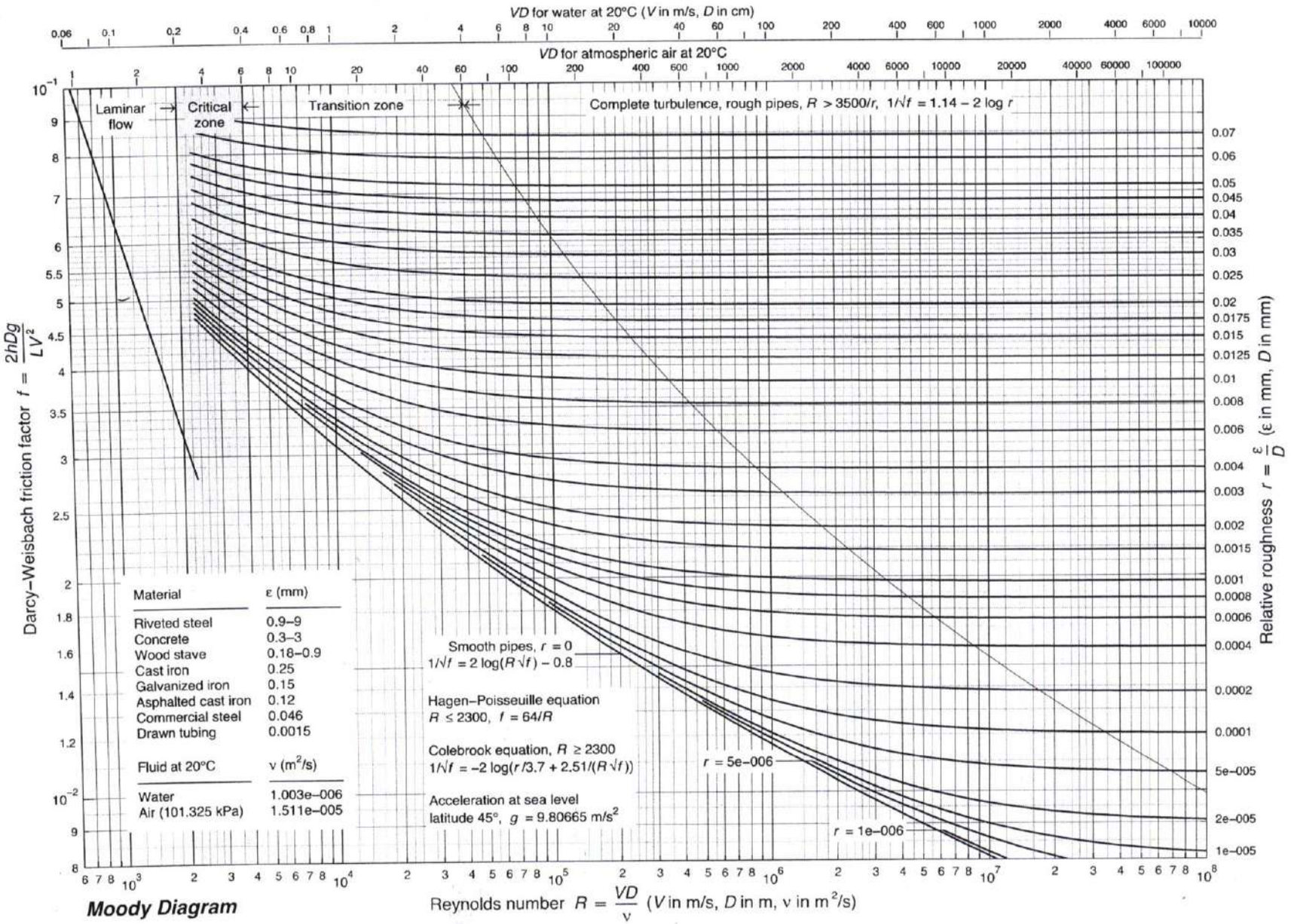
5.

a. Water at 10 °c flows from a large reservoir to smaller one through a 5 cm diameter cast iron piping system, as shown in figure. Consider the relative roughness (ε/D) of the pipe to be 0.004. The head loss factors (K_L) are provided in the figure below. Determine the elevation of Z_1 for flow rate of 6 L/s. (Moody diagram can be used to find the friction factor) [4]



b. A 2.2 cm outer diameter pipe is to span across a river at a 30 m wide section while being completely immersed in water as shown in figure. The Reynolds number for the flow is 7.73×10^4 and the water temperature is 15 °C. Determine the drag force exerted on the pipe by river. Use coefficient of drag C_D=1. The Drag force is given by $F_D = C_D A \frac{\rho V^2}{2}$. The density and dynamic viscosity of water at 15 °C are 999.1 kg/m^3 and $1.138 \times 10^{-3} kg/m.s$ respectively. [4]





Moody Diagram