

KATHMANDU UNIVERSITY  
End Semester Examination  
July/August, 2024

Level : B.E.  
Year : III  
Time : 2 hrs. 30mins.

Course : MEEG 303  
Semester : I  
F. M. : 55

SECTION "B"

[5 Q. × 11 = 55 marks]

*Attempt ALL questions. Assume suitable data if any is missing (Required data sheets are included)*

1.

- a. Explain Accuracy and Precision error in Engineering Measurements with example in the context of Fluid Mechanics. Describe the ways of minimizing these errors. [4]
- b. A 0.6 mm diameter glass tube is inserted into water at 20°C in a cup. Determine the capillary rise of water in the tube by equating the vertical component of the surface tension force to the weight of the liquid column. The surface tension of water is 0.073 N/m and the contact angle of water with glass is approximately 0°. [3]
- c. A steady, incompressible, two-dimensional velocity field is given by the following components in the xy-plane:

$$u = 1.85 + 2.33x + 0.656y$$

$$v = 0.754 - 2.18x - 2.33y$$

Calculate the acceleration field (find expressions for acceleration components  $a_x$  and  $a_y$ ) and calculate the acceleration at the point  $(x,y) = (-1,2)$  [4]

2.

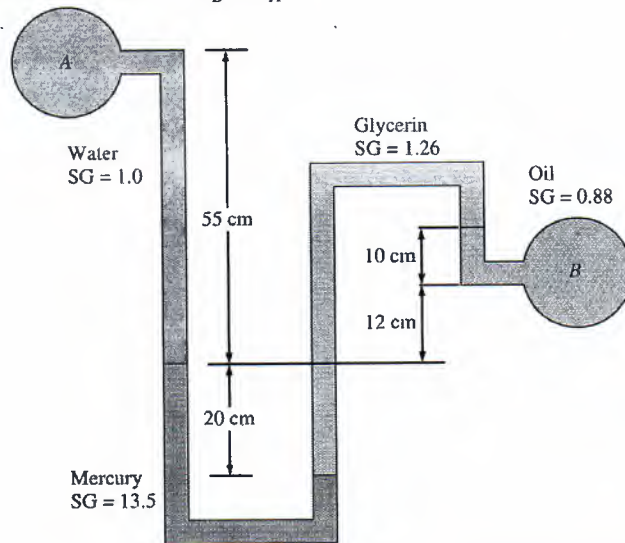
- a. Air is flowing past a symmetrical airfoil at zero angle of attack. Is the (a) lift and (b) drag acting on the airfoil zero or nonzero? Explain. [3]
- b. Explain velocity triangles and lift generation of Wind Turbines with suitable figures. [3]
- c. Explain the role of following components in hydropower turbines. [5]
  - i. Guide vanes of reaction turbine
  - ii. Draft tubes of reaction turbine
  - iii. Braking jet of Pelton turbine
  - iv. Deflector of Pelton turbine
  - v. Spiral casing

3.

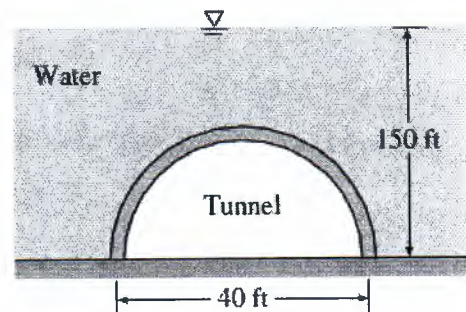
- a. You may have noticed that dams are much thicker at the bottom. Explain why dams are built that way. [2]

P.T.O.

- b. The pressure difference between an oil pipe and water pipe is measured by a double-fluid manometer, as shown in figure below. For a given fluid heights and specific gravities, calculate the pressure difference  $\Delta P = P_B - P_A$  [4]

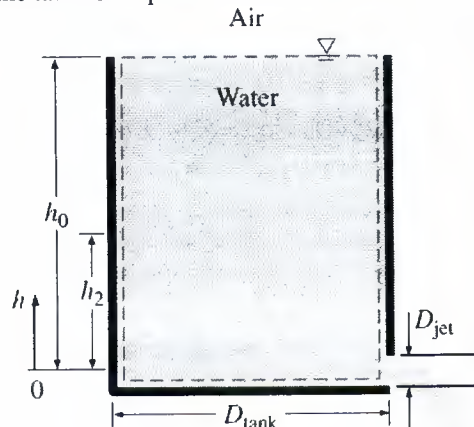


- c. A semicircular 40-ft-diameter tunnel is to be built under a 150-ft-deep, 800-ft-long lake, as shown in the figure below. Determine the total hydrostatic force acting on the roof of the tunnel. [5]

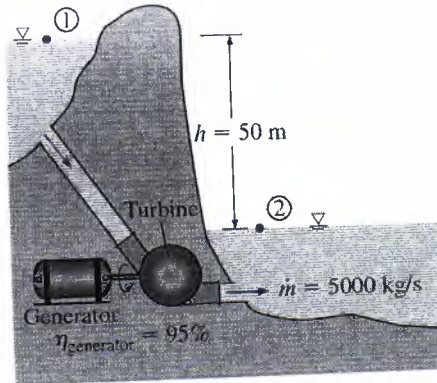


4.

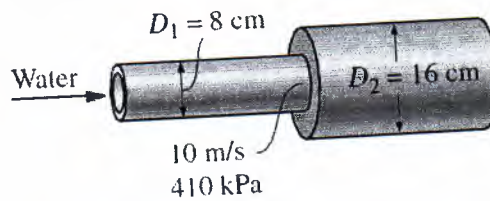
- a. A 1.5 m high, 0.8 m diameter cylindrical water tank whose top is open to the atmosphere is initially filled with water. Now the discharge plug near the bottom of the tank is pulled out, and a water jet whose diameter is 2 cm streams out. The average velocity of the jet is approximated as  $V = \sqrt{2gh}$ , where  $h$  is the height of water in the tank measure from the center of the hole (a variable) and  $g$  is the gravitational acceleration. Determine how long it takes for the water level in the tank to drop to 0.5 m from the bottom. [6]



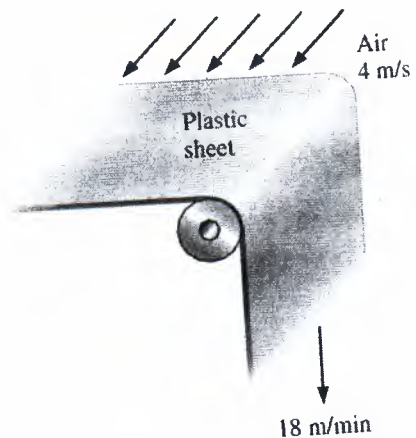
- b. The water in a large lake is to be used to generate electricity by the installation of a hydraulic turbine-generator. The elevation difference between the free surfaces upstream and downstream of the dam is 50 m. Water is to be supplied at a rate of 5000 kg/s. If the electric power generated is measured to be 1862 kW and the generator efficiency is 95 percent, determine (a) the overall efficiency of the turbine-generator, (b) the mechanical efficiency of the turbine, and (c) the shaft power supplied by the turbine to the generator. [5]

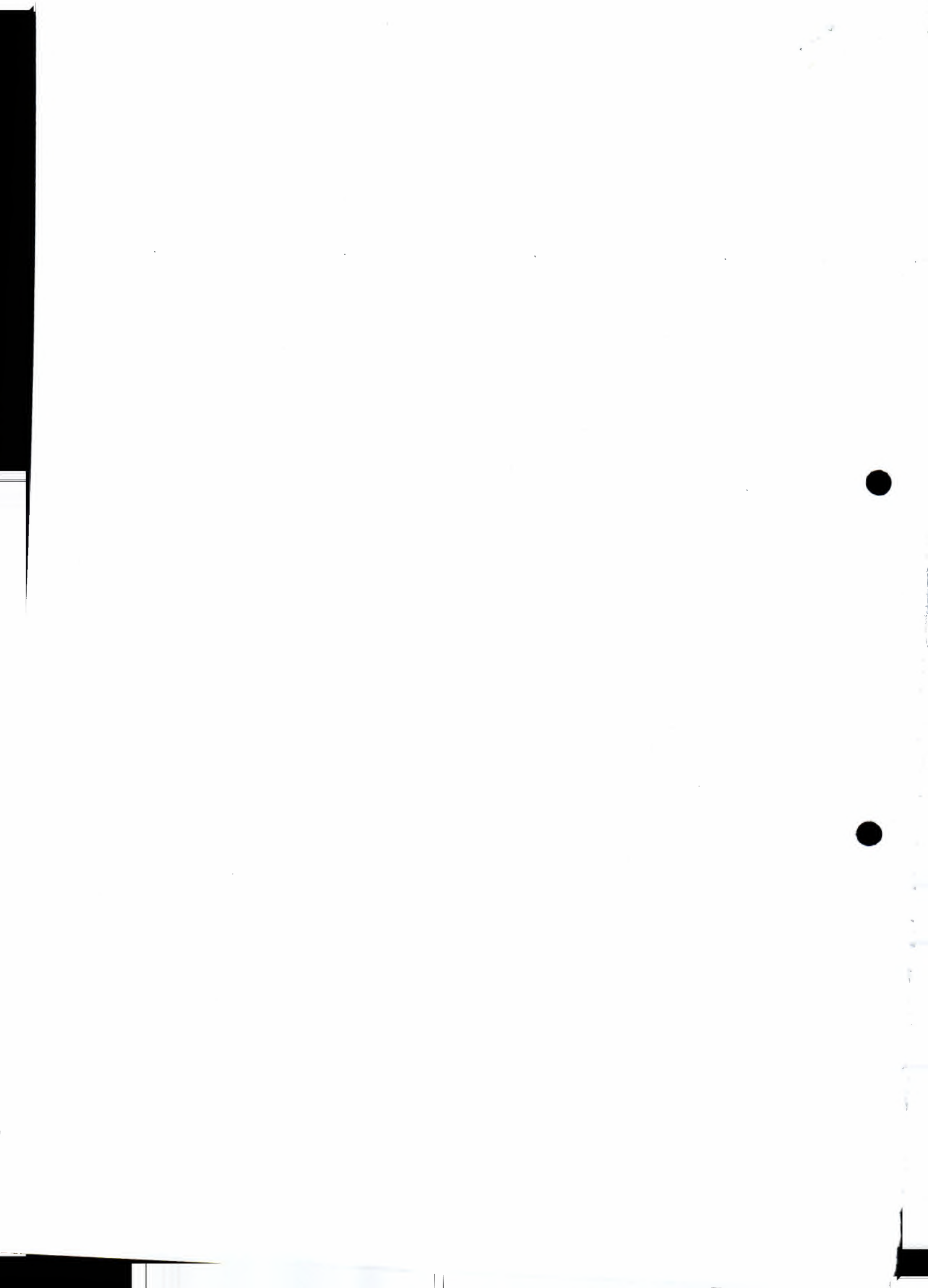


5. a. A horizontal pipe has an abrupt expansion from  $D_1=8 \text{ cm}$  to  $D_2=16 \text{ cm}$ . The water velocity in the smaller section is 10 m/s and the flow is turbulent. The pressure in the smaller section is  $P_1 = 410 \text{ kPa}$ . Taking the kinetic energy correction factor to be 1.06 at both the inlet and the outlet, determine the downstream pressure  $P_2$ , and estimate the error that would have occurred if Bernoulli's equation had been used. [6]



- b. The forming section of a plastics plant puts out a continuous sheet of plastic that is 1.2 m wide and 2 mm thick at a rate of 18 m/min. The sheet is subjected to airflow at a velocity of 4 m/s on both top and bottom surfaces normal to the direction of motion of the sheet. The width of the air cooling section is such that a fixed point on the plastic sheet passes through that section in 2 s. Using properties of air at 1 atm and  $60^\circ\text{C}$ , determine the drag force the air exerts on the plastic sheet in the direction of airflow. [5]





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Marks Scored:

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Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : MEEG 303

Semester : I

F. M. : 20

Date : 13 AUG 2024

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose the most appropriate answer and mark [X].

- In a Francis turbine, the guide vanes are used to:  
 Control the flow rate  
 Increase the pressure of the water  
 Reduce the pressure of the water  
 Convert hydraulic energy into mechanical energy
- Consider the vertical rectangular wall of a water tank with a width of 4 m and a height of 8 m. The other side of the wall is open to the atmosphere. The resultant hydrostatic force on this wall is:  
 1570 kN                       2380 kN                       2505 kN                       1254 kN
- If the mechanical efficiency of a centrifugal pump is 68% and the manometric efficiency is 74%, what is the overall efficiency of the pump?  
 0.5032%                       50.32%                       83.2%                       0.832%
- The velocity along the radial direction of the pipe,  $u(r)$  in the case of a hydrodynamically fully developed flow:  
 Remains constant  
 Varies  
 Depends on the location of the entrance region  
 Depends on the material
- The pitot tube is used to measure  
 Velocity at stagnation point                       Stagnation pressure  
 Static pressure                       Dynamic pressure
- During the measurement of the velocity of the flow, the difference in the water column height measurement by a piezometer and a pitot tube was found to be 10 cm. If the radius of the pipe was 2 cm, determine the velocity of the flow.  
 1.4 m/s                       1.6 m/s                       1.25 m/s                       1.8 m/s
- A fluid particle is rotating at a speed of 12 rad/s. What is the vorticity of this particle?  
 12 rad/s                       24 rad/s                       48 rad/s                       6 rad/s
- Which of the following parameter has the unit of force per unit length  
 Dynamic viscosity                       Kinematic viscosity  
 Surface tension                       Wall stress

9. A flow in which the viscosity of fluid is dominating over the inertia force is called  
 Steady flow       Unsteady flow       Laminar flow       Turbulent flow
10. An open tank contains 1 m deep water with 50 cm depth of oil of specific gravity 0.8 above it. The pressure at the bottom of the tank will be  
 4 kN/m<sup>2</sup>       10 kN/m<sup>2</sup>       12 kN/m<sup>2</sup>       14 kN/m<sup>2</sup>
11. Stream lines and path lines always coincide in case of  
 Steady flow       Laminar flow       Uniform flow       Turbulent flow
12. Equation of continuity is based on the principal of conservation of  
 Mass       Energy       Momentum       None of the above
13. The major loss of energy in long pipes is due to  
 Sudden enlargement       Sudden contraction  
 90 degree bend       Friction
14. In the case of an external parallel flow over a flat plat, which of the following drag can be neglected?  
 Pressure drag       Friction drag       Total drag       Both drags are significant
15. With the same cross-sectional area and immersed in same turbulent flow, the largest total drag will be on  
 a circular disc of plate held normal to flow       a sphere  
 a cylinder       a streamlined body
16. For laminar flow in a pipe of circular cross section, the Darcy's friction factor  $f$  is  
 directly proportional to Reynolds number and independent of pipe wall roughness  
 directly proportional to pipe wall roughness and independent of Reynolds number  
 inversely proportional to Reynolds number and independent of pipe wall roughness  
 inversely proportional to pipe wall roughness and independent of Reynolds number
17. A tank of diameter 2 m consists of a hole at the bottom of diameter 0.1 m. The velocity at which the water exists the hole is 6 m/s. Determine the height of the water in the tank.  
 1.83 m       2.22 m       3.04 m       4.33 m
18. The hydraulic grade line is  
 always above the centre line of pipe  
 never above the energy grade line  
 always sloping downward in the direction of flow  
 always above the energy grade line
19. In series-pipe problems  
 the head loss is same through each pipe  
 the discharge is same through each pipe  
 the discharge through each pipe is added to obtain total discharge  
 none of the above

20. In a hydropower plant, the difference between the free surfaces in the headrace and tailrace is 100 m. However, 15 m of head is lost due to the friction in the piping. If the water supplied to the turbine is at the rate of 160 kg/s, and the efficiency of the turbine is 82%, determine the shaft power output from the turbine.

109 kW

113 kW

118 kW

126 kW

