

Reg. No. :

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T 3342

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

Third Semester

(Regulation 2004)

Aeronautical Engineering

ME 1202 — FLUID MECHANICS AND MACHINERY

(Common to Automobile Engineering/Mechanical Engineering/
Mechatronics Engineering/Production Engineering)

(Common to B.E. (Part-Time) Second Semester – Regulation 2005)

Time : Three hours

Maximum : 100 marks

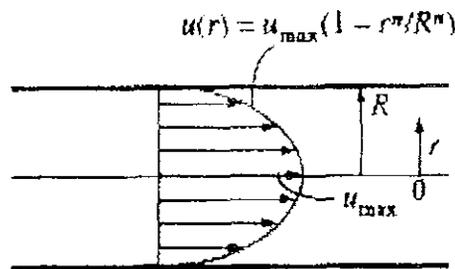
Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is specific gravity? How is it related to density?
2. How does the dynamic viscosity of liquids and gases vary with temperature?
3. Define streakline.
4. What are the three major assumptions made in the derivation of the Bernoulli equation?
5. Write the Navier's stoke equations for unsteady 3-dimensional, viscous, incompressible and irrotational flow.
6. List the minor and major losses during the flow of liquid through a pipe.
7. Differentiate between impulse and reaction turbines.
8. What is the function of a draft-tube?
9. What is meant by priming of pumps?
10. What is the maximum theoretical suction head possible for a centrifugal pump?

PART B — (5 × 16 = 80 marks)

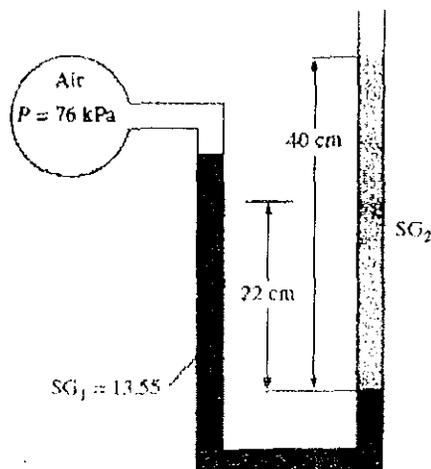
11. (a) (i) Consider the flow of a fluid with viscosity μ through a circular pipe. The velocity profile in the pipe is given as $u(r) = u_{\max} \left(1 - r^n/R^n\right)$, where u_{\max} is the maximum flow velocity, which occurs at the centerline; r is the radial distance from the centerline; $u(r)$ is the flow velocity at any position r ; and R is the Reynolds number. Develop a relation for the drag force exerted on the pipe wall by the fluid in the flow direction per unit length of the pipe. (8)



- (ii) A 1.9-mm-diameter tube is inserted into an unknown liquid whose density is 960 kg/m^3 , and it is observed that the liquid rises 5 mm in the tube, making a contact angle of 15° . Determine the surface tension of the liquid. (8)

Or

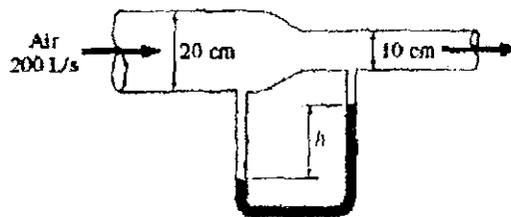
- (b) (i) The maximum blood pressure in the upper arm of a healthy person is about 120 mmHg. If a vertical tube open to the atmosphere is connected to the vein in the arm of the person, determine how high the blood will rise in the tube. Take the density of the blood to be 1050 kg/m^3 . (8)
- (ii) Consider a double-fluid manometer attached to an air pipe shown in Fig. If the specific gravity of one fluid is 13.55, determine the specific gravity of the other fluid for the indicated absolute pressure of air. Take the atmospheric pressure to be 100 kPa. (8)



12. (a) (i) What is the hydraulic gradient line? How does it differ from the total energy line? Under what conditions do both lines coincide with the free surface of a liquid? (8)
- (ii) Consider a steady, two-dimensional, incompressible flow field in the xy -plane. The linear strain rate in the x direction is 2.5 s^{-1} . Calculate the linear strain rate in the y direction. (8)

Or

- (b) (i) Air flows through a pipe at a rate of 200 L/s . The pipe consists of two sections of diameters 20 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 kg/m^3 . (10)



- (ii) A Pitot-static probe is used to measure the velocity of an aircraft flying at 3000 m . If the differential pressure reading is 3 kPa , determine the velocity of the aircraft. (6)
13. (a) (i) In fully developed laminar flow in a circular pipe, the velocity at $R/2$ (midway between the wall surface and the centerline) is measured to be 6 m/s . Determine the velocity at the center of the pipe. (8)
- (ii) Two pipes of identical length and material are connected in parallel. The diameter of pipe A is twice the diameter of pipe B. Assuming the friction factor to be the same in both cases and disregarding minor losses, determine the ratio of the flow rates in the two pipes. (8)

Or

- (b) (i) Water at 15°C ($\rho = 999.1 \text{ kg/m}^3$ and $\mu = 1.138 \times 10^{-3} \text{ kg/m} \cdot \text{s}$) is flowing steadily in a 30-m -long and 4 cm diameter horizontal pipe made of stainless steel at a rate of 8 L/s . Determine (1) the pressure drop, (2) the head loss, and (3) the pumping power requirement to overcome this pressure drop. Assume friction factor for the pipe as 0.015 . (10)
- (ii) Which has a greater minor loss coefficient during pipe flow : gradual expansion or gradual contraction? Why? (6)

14. (a) (i) A Pelton wheel has a mean bucket speed of 12 m/s and supplied with water at the rate of $0.7 \text{ m}^3/\text{s}$ under a head of 300 m. If the buckets deflect the jet through an angle of 160° find the power developed and hydraulic efficiency of the turbine. (10)
- (ii) Explain how the net head on the reaction turbine is increased with the use of draft tube. (6)

Or

- (b) (i) The inner and outer diameters of an inward flow reaction turbine are 50 cm and 100 cm respectively. The vanes are radial at inlet and discharge is also radial. The inlet guide vanes angle is 10° . Assuming the velocity of flow as constant and equal to 3m/s find the speed of the runner and the vane angle at the outlet. (8)
- (ii) With a neat sketch, explain the working of a Pelton wheel. (8)
15. (a) (i) Compare the advantages and disadvantages of centrifugal, submersible and jet pumps. (6)
- (ii) A centrifugal pump has 30 cm and 60 cm diameters at inlet and outlet. The inlet and outlet vane angles are 30° and 45° respectively. Water enters at a velocity of 2.5 m/s radially. Find the speed of impeller in rpm and power of the pump if the flow is $0.2 \text{ m}^3/\text{s}$. (10)

Or

- (b) (i) Define cavitation and discuss its causes, effects and prevention. (8)
- (ii) Calculate the work saved by fitting an air vessel for a double acting single cylinder reciprocation pump. (8)