Reg. No. : [redacted] ١٦١٤١٦٦

Question Paper Code : 25052

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Third Semester

Aeronautical Engineering

CE 8394 — FLUID MECHANICS AND MACHINERY

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

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the physical phenomena which are responsible for the property of viscosity?
2. Water flows through a pipeline which reduces in cross-section. The centreline of the pipe is horizontal. If $V_1 = 1.54$ ms^{-1} and $V_2 = 2.65$ ms^{-1}, $p_1 = 20 \times 10^3$ N m^{-2} and $p_2 = 16.89 \times 10^3$ N m^{-2}, what is the energy loss between sections 1 and 2? Give the answer in metres of water.
3. How does the velocity of fluid vary within the boundary layer zone?
4. List any four minor losses of flow in pipes.
5. List the primary physical quantities.
6. List any two phenomena for which Froude model law can be a sufficient criterion for dynamic similarity of flow in the model and the prototype.
7. A flat plate is struck normally by a jet of water 50 mm in diameter with a velocity of 18 ms^{-1}. Calculate the force on the plate when it is stationary.
8. Classify rotary pumps.
9. Define specific speed of a turbine.
10. State the principle of impulse turbines.

PART B — (5 × 13 = 65 marks)

11. (a) (i) A sliding fit cylindrical body of 1 kg mass drops vertically down at a constant velocity of 0.05 ms^{-1} as shown in Figure. Estimate the viscosity of oil. (8)

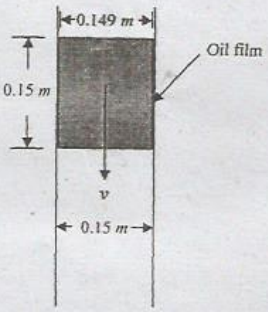

Figure 1 (Q. 11(a) (i))

(ii) Why is the pressure exerted by ejected vapour on the free surface of liquid called "partial pressure"? Discuss the influence of temperature and pressure on vapour pressure of a liquid. (2 + 3 = 5)

Or

(b) Water flows through a pipe AB 1.2 m in diameter at 3 m s^{-1} and then passes through a pipe BC which is 1.5 m in diameter. At C the pipe branches. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The velocity in branch CE is 2.5 m s^{-1}. Find

(i) the volume rate of flow in AB,

(ii) the velocity in BC,

(iii) the velocity in CD,

(iv) the diameter of CE. (13)

12. (a) A single pipe 300 mm diameter and 300 m long carries a discharge of 0.1 m^3 s^{-1}. What is the required length of another 400 mm diameter pipe which is to be placed in parallel with the existing 300 mm diameter pipe in order to augment the discharge by 30%. Take f for each pipe = 0.015 and neglect the minor losses. (13)

Or

(b) (i) How does the velocity of fluid varies within the boundary layer zone? Define boundary layer thickness. Why is it called the nominal thickness of the boundary layer? (1 + 2 + 1 = 4)

(ii) In a water pipeline there is an abrupt change in diameter from 140 mm to 250 mm. If the head lost due to separation when the flow is from the smaller to the larger pipe is 0.6 m greater than the head lost when the same flow is reversed, determine the flow rate. (9)

Table below shows the experimental values of Cc.

A_2/A_1	0.1	0.3	0.5	0.7	1.0
Cc	0.61	0.632	0.673	0.73	1.0

13. (a) (i) In order that the relationships determined for a model can be applied to a real life application (prototype) there has to be a physical similarity between the parameters involved in each one. Discuss in brief the different types of similarity. (6)

(ii) State Reynolds model law. Obtain the scale ratio for velocity on the basis of Reynolds model law. (7)

Or

(b) By dimensional analysis show that the torque T on a shaft of diameter d, revolving at a speed N in a fluid of viscosity μ and mass density ρ is given by the expression

$$T = (\rho d^5 N^2)\phi\left(\frac{v}{d^2 N}\right)$$

Use Buckingham's method. Hence show that power P is given by

$$P = (\rho d^5 N^3)\phi\left(\frac{v}{d^2 N}\right).$$ (13)

14. (a) (i) Draw a typical layout of a centrifugal pumping installation and describe the functions of the various accessories. (7)

(ii) In a single acting pump the cylinder has a diameter of 150 mm and a stroke 300 mm. The water is to be raised to a height of 20 m when the pump is running at 40 rpm. Determine the theoretical discharge and the theoretical power. If the actual discharge of the pump is 3.5 lps, find the coefficient of discharge and the percentage slip of the pump. (6)

Or

(b) A centrifugal pump draws water from a sump through a vertical 150 mm pipe. The pump has a horizontal discharge pipe 100 mm diameter which is 3.5 m above water level in the sump. While pumping 35 litres per second, gauges near the pump at entrance and discharge read – 0.35 kgf cm^{-2} and + 1.8 kgf cm^{-2} respectively. The discharge gauge is 0.5 m above the suction gauge. Determine the horsepower output of the pump. (13)

15. (a) (i) What is a draft tube? Explain its functions. (3 + 2 = 5)

(ii) Define specific speed of a turbine. Discuss briefly on the factors to be borne in mind in the selection of speed of Pelton Turbine. (3 + 5 = 8)

Or

(b) An inward flow reaction turbine develops 260 HP at an overall efficiency of 78% under a head of 70 m. The peripheral speed of vanes at inlet is 35 m s^{-1}. Width of wheel at inlet is one-sixth of the corresponding diameter. Velocity of flow remains constant at 5 m s^{-1}. Outlet diameter of vanes is three-fourth inlet diameter. If inlet angle of runner vane is 90° to the tangent, determine the guide blade discharge angle and runner vane outlet angle. Velocity of whirl at outlet is zero. (13)

PART C — (1 × 15 = 15 marks)

16. (a) (i) In case of Pelton turbine, for generation of maximum impact for a given flow, the angle of deflection of jet after impact on the centre of bucket must be 180°, but it is kept less than 180° at about 165°. Why? (2)

(ii) A single acting pump is equipped with an air vessel on the delivery side. The piston moves with simple harmonic motion. The diameter and stroke of the piston are 300 mm and 600 mm respectively. The delivery pipe is 175 mm in diameter and 60 m long. Determine the power saved (in horse power units) in overcoming friction in the delivery pipe by the air vessel. The pump runs at 120 rpm. Take f = 0.01. (8)

(iii) The viscosity of pure water at 0°C is 0.01793 poise and density is 1 g cm^{-3}. Express the dynamic viscosity and the kinematic viscosity in SI units. (2 + 3 = 5)

Or

(b) (i) If the equation of a velocity profile over a plate is $v = 5y^2 + y$ (where v is the velocity in m s^{-1}), determine the shear stress at $y = 0$ and $y = 7.5$ cm. Given the viscosity of the liquid is 8.35 poise. (7)

(ii) A pipe AB tapering uniformly from a diameter of 0.1 m at A to 0.2 m at B over a length of 2 m carries water. Pressures at A and B are respectively 2.0 and 2.3 bar. The centreline of the pipe slopes upwards from A to B at an angle of 30°. Determine the flow through the pipe ignoring the losses. (8)

———————