Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50334

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023

Third/Fourth Semester

Aeronautical Engineering

CE 8394 – FLUID MECHANICS AND MACHINERY

(Common to: Aerospace Engineering/ Automobile Engineering/ Industrial Engineering/Industrial Engineering and Management/Manufacturing Engineering/Mechanical Engineering/ Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering/Production Engineering/Safety and Fire Engineering)

(Regulations 2017)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define mass density of a fluid.
2. Tell the difference between cohesion and adhesion.
3. What is a compound pipe?
4. Define 'hydraulic grade line'.
5. Name any two methods of dimensional analysis.
6. Write down the dimensions for (a) Bulk modulus (b) kinematic viscosity.
7. Tell the difference between static head and manometric head of a centrifugal pump.
8. Why a reciprocating pump is called positive displacement pump?
9. Define specific speed of a turbine.
10. What is the use of draft tube?

PART B — (5 × 13 = 65 marks)

11. (a) A cubical block of 20 cm edge and weight 20 kg(f) is allowed to slide down a plane inclined at 20° to the horizontal on which there is thin film of oil of viscosity 0.22×10^{-3} kg(f)-s/m^2. What terminal velocity will be attained by the block if the fill thickness is estimated to be 0.025 mm?

Or

(b) Calculate the capillary effect in mm in a glass tube 3mm in diameter when immersed in (i) water (ii) mercury. Both the liquids are at 20°C and the values of the surface tensions for water and mercury at 20°C in contact with air are respectively 0.0736 N/m and 0.51 N/m. Contact angle for water = 0° and for mercury = 130°.

12. (a) Explain branched pipes with three interconnected reservoirs.

Or

(b) Derive the equation for head loss in pipes due to friction.

13. (a) A ship 150 m long moves in fresh water at 15°C at 36 km/hour. A 1:100 model of this ship is to be tested in a towing basin containing a liquid of sp. gr. 0.90. What viscosity must this liquid have for both Reynolds and Froude model laws to be satisfied? At what speed must the model be towed? If 117.7 Watts is required to tow the model at this speed, what power is required by the ship? Dynamic viscosity of water at 15°C is 1.13×10^{-3} N.s/m^2.

Or

(b) A spillway 7.2 m high and 150 m long discharges 2150 m^3 /s under a head of 4 m. If a 1:16 model of the spillway is to be constructed, find the model dimensions, head over the model and the model discharge.

14. (a) A pump operates at a maximum efficiency of 82% and delivers 2.25 m^3/s under a head of 18 m while running at 3600 rpm speed. Compute the specific speed of the pump. Also determine the discharge, head and power input to pump at a shaft speed of 2400 rpm. Cite the assumption made, if any.

Or

(b) A single acting reciprocating pump has a plunger of diameter 250 mm and stroke of 350 mm. If the speed of the pump is 60 rpm. and it delivers 16.5 litres per second of water against a suction head of 5 m and a delivery head of 20 m, find the theoretical discharge, coefficient of discharge, the slip, the percentage slip of the pump and the power required to drive the pump.

15. (a) A Kaplan turbine produces 60,000 kW under a net head of 25 m with an overall efficiency of 90% . Taking the value of speed ratio K_u as 1.6, flow ratio ψ as 0.5 and the hub diameter as 0.35 times the outer diameter, find the diameter and speed of the turbine.

Or

(b) A reaction turbine works at 450 rpm under a head of 120 m. Its diameter at inlet is 1.2 m and the flow area is 0.4 m^2. The angles made by the absolute and relative velocities at inlet are 20° and 60° respectively with the tangential velocity. Determine the volume flow rate, the power developed and the hydraulic efficiency. Assume whirl at outlet to be zero.

PART C — (1 × 15 = 15 marks)

16. (a) Design a Pelton wheel which is required to develop 1 500 kW, when working under a head of 160 m at a peed of 420 rpm. The overall efficiency may be taken as 85% and assume other data required.

Or

(b) The pressure drop 'Δp' in a pipe of diameter D and length I depends on mass density ρ and viscosity μ of the flowing fluid, mean velocity of flow V and average height k of roughness projections on the pipe surface. Obtain a dimensionless expression for $\Delta\rho$.

Also show that

$$h_f = \frac{flV^2}{2gD}$$

Where h_f is the head loss due to friction $\left(= \frac{\Delta p}{w}\right)$

W is the specific weight of the fluid and f is coefficient of friction.

———————