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

Question Paper Code : X20297

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Third/Fourth Semester

Mechanical Engineering

CE 6451 – FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering/Automobile Engineering/Industrial Engineering/Industrial Engineering and Management/Manufacturing Engineering/Mechanical and Automation Engineering/Mechatronics Engineering/ Production Engineering)

(Regulations 2013)

(Also common to PTCE 6451 – Fluid Mechanics and Machinery for B.E. (Part-Time) – Third Semester – Mechanical Engineering (Regulations – 2014)

Time : Three Hours | Maximum : 100 Marks

Any missing data can be suitable assumed.

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Calculate the mass density and specific volume of one litre of a liquid which weighs 7 N.
2. What is the use of control volume ?
3. Brief on Darcy-Weisbach equation.
4. What is the condition for maximum power transmission w.r.t head available ?
5. Define Dimensional homogeneity.
6. Derive the expression for Reynolds's Number.
7. List the components of the centrifugal pump.
8. Under which condition negative slip occurs.
9. How do you classify turbines based on flow direction and working medium ?
10. What is meant by Governing of Turbines ?

PART – B **(5×13=65 Marks)**

11. a) i) At a certain location, wind at a temperature of 30°C is blowing steadily at 15 m/s. Determine the mechanical energy of air per unit mass and the power generation potential of a wind turbine with 40-m diameter blades at that location. Also determine the actual electric power generation assuming an overall efficiency of 35%. **(6)**

ii) A conical bearing of outer radius 0.5 m and inner radius 0.3 m and height 0.3 m runs on a conical support with a uniform clearance between surfaces. Oil with viscosity 33 centi. Poise is used. The support is rotated at 450 rpm. Determine the clearance if the power required was 1400 W. **(7)**

(OR)

b) i) In cold climates, the water pipes may freeze and burst if proper precautions are not taken. In such an occurrence, the exposed part of a pipe on the ground ruptures, and water shoots up to 34 m. Estimate the gage pressure of water in the pipe. State your assumptions and discuss if the actual pressure is more or less than the value you predicted. **(7)**

ii) A hydraulic lift shaft of 450 mm diameter moves in a cylinder of 451 mm diameter with the length of engagement of 3 m. The interface is filled with oil of kinematic viscosity of 2.5×10^{-4} m^2/s and density of 900 kg/m^3. Determine the uniform velocity of movement of the shaft if the drag resistance was 320 N. **(6)**

(OR)

12. a) Derive the expression for shear stress and velocity distribution for the flow through circular pipe and using that derive the Hagen Poiseuille formula.

(OR)

b) Three pipes of 400 mm, 200 mm and 300 mm diameters have lengths of 400 m, 200 m and 300 m respectively. They are connected in series to make a compound pipe. The ends of the compound pipe are connected with two tanks whose difference of water levels is 16 m. If the coefficient of friction for these pipes is same and equal to 0.005, determine the discharge through the compound pipe neglecting first the minor losses and then including them.

13. a) Using Buckingham π method of dimensional analysis obtain an expression for the drag force R on a partially submerged body moving with a relative velocity V in a fluid; the other variables being the linear dimension L, height of surface roughness K, fluid density ρ and the gravitational acceleration g.

(OR)

b) The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. Use Rayleigh's method.

14. a) Derive an expression for the pressure head due to acceleration of the piston of a reciprocating pump, assuming motion of the piston to be simple harmonic.

(OR)

b) The internal and external diameter of an impeller of a centrifugal pump which is running at 1200 rpm are 350 mm and 650 mm. The discharge through the pump is 0.05 m^3/s and the velocity of the flow is constant and equal to 2.5 m/s. The diameters of the suction and delivery pipes are 150 mm and 100 mm respectively and suction and delivery heads are 6 m (abs) and 30 m (abs) of water. If the outlet vane angle is 45° and power required to drive the pump is 19 kw determine (i) Vane angle of the impeller at inlet (ii) Overall efficiency of the pump (iii) Manometric efficiency of pump.

15. a) i) A kaplan turbine runner is to be designed to develop 9100 kW. The net available head is 5.6 m. If the speed ratio = 2.09, flow ratio = 0.68, overall efficiency = 86% and the diameter of the boss is 1/3 the diameter of the runner. Find the diameter of the runner, its speed and the specific speed of the turbine. **(8)**

ii) Explain the Performance Characteristics curves of turbine. **(5)**

(OR)

b) The following data is given for a Francis turbine. Net head H = 60 m, Speed N = 700 RPM, Shaft power 294.3 kW, Overall efficiency 84%, Hydraulic efficiency 93%, Flow ratio = 0.2, breadth ratio n = 0.1, Outer diameter of the runner is two times inner diameter of the runner. The thickness of vanes occupies 5% of circumference area of the runner. Velocity of flow is constant at inlet and outlet and the discharge is radial at outlet. Determine (i) Guide blade angle, (ii) Runner vane angle at inlet and outlet, (iii) Diameter of runner inlet and outlet, (iv) Width of wheel at inlet. **(13)**

PART – C **(1×15=15 Marks)**

16. a) Explain the principle and main working components of the centrifugal pump.

(OR)

b) Explain the principle and main working of components of a Kaplan turbine with neat sketch.