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

Question Paper Code : 57164

B.E./B. Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Third Semester

Mechanical Engineering

CE 6451 – FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering, Automobile Engineering, Mechatronics Engineering, Mechanical and Automation Engineering and Production Engineering and also common to Fourth Semester Industrial Engineering, Industrial Engineering and Management and Manufacturing Engineering)

(Regulation 2013)

Time : Three Hours **Maximum : 100 Marks**

Any missing data can be suitably assumed.

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Brief on the effect of temperature on viscosity in gases.
2. How does Redwood viscometer work ?
3. Brief on Darcy-Weisbach equation.
4. What is the condition for maximum power transmission w.r.t. head available ?
5. Brief on Euler number.
6. What is meant by kinematic similarity ?
7. When does negative slip occur ?
8. Why is forward curved blading rarely used in pumps ?
9. List down the main components of pelton wheel.
10. Differentiate between Kaplan turbine and propeller turbine.

PART – B (5 × 16 = 80 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%. **(10)**

(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

(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. **(10)**

(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. **(6)**

12. (a) Shell-and-tube heat exchangers with hundreds of tubes housed in a shell are commonly used in practice for heat transfer between two fluids. Such a heat exchanger used in an active solar hot-water system transfers heat from a water-antifreeze solution flowing through the shell and the solar collector to fresh water flowing through the tubes at an average temperature of 60 °C at a rate of 15 L/s. The heat exchanger contains 80 brass tubes 1 cm in inner diameter and 1.5 m in length. Disregarding inlet, exit and header losses, determine the pressure drop across a single tube and the pumping power required by the tube-side fluid of the heat exchanger. The density and dynamic viscosity of water at 60 °C are $\rho = 983.3$ kg/m^3 and $\mu = 0.467 \times 10^{-3}$ kg/m s, respectively. The roughness of brass tubing is 1.5×10^{-6} m. **(16)**

OR

(b) Water at 15 °C is to be discharged from a reservoir at a rate of 20 L/s using two horizontal cast iron pipes connected in series and a pump between them. The first pipe is 22 m long and has a 6 cm diameter, while the second pipe is 33 m long and has a 4 cm diameter. The water level in the reservoir is 30 m above the centerline of the pipe. The pipe entrance is sharp-edged, and losses associated with the connection of the pump are negligible. Determine the required pumping head and the minimum pumping power to maintain the indicated flow rate. The density and dynamic viscosity of water at 15 °C are $\rho = 999.1$ kg/m^3 and $\mu = 1.138 \times 10^{-3}$ kg/ms. The roughness of cast iron pipes is 0.00026 m. **(16)**

13. (a) The temperature difference θ at a location x at time τ in a slab of thickness L originally at a temperature difference θ_o with outside is found to depend on the thermal diffusivity α, thermal conductivity k and convection coefficient h. Using dimensional analysis determine the dimensionless parameters to correlate the situation. **(16)**

OR

(b) Convective heat transfer coefficient in free convection over a surface is found to be influenced by the density, viscosity, thermal conductivity, coefficient of cubical expansion, temperature difference, gravitational acceleration, specific heat, the height of surface and the flow velocity. Using dimensional analysis, determine the dimensionless parameters that will correlate the phenomenon. **(16)**

14. (a) An axial flow pump running at 620 rpm deliver 1.5 m^3/s against a head of 5.2 m. The speed ratio is 2.5. The flow ratio is 0.5. The overall efficiency is 0.8. Determine the power required and the blade angles at the root and tip and the diffuser blade inlet angle. Inlet whirl is zero. **(16)**

OR

(b) Discuss about air vessel used with reciprocating pump. A single acting reciprocating pump handles water. The bore and stroke of the unit are 22 cm and 32 cm. The suction pipe diameter is 12 cm and length is 10 m. The delivery pipe diameter is 12 cm and length is 30 m. Take frictional factor as 0.02. The speed of operation is 32 rpm. Determine the friction power with and without air vessels. **(16)**

15. (a) At a location selected to install a hydro electric plant, the head is estimated as 540 ms. The flow rate was determined as 22 m^3/s. The plant is located at a distance of 2 km from the entry to the penstock pipes along the pipes. Two pipes of 2 m diameter are proposed with a friction factor of 0.03. Additional losses amount to about $1/4^{th}$ of frictional loss. Assuming an overall efficiency of 85%, determine how many single jet unit running at 330 rpm will be required. **(16)**

OR

(b) A Kaplan turbine delivering 40 MW works under a head of 40 m and runs at 150 rpm. The hub diameter is 3 m and runner tip diameter is 6 m. The overall efficiency is 90%. Determine the blade angles at the hub and tip and also at a diameter of 4 m. Also find the speed ratio and flow ratio based on tip velocity. Assume hydraulic efficiency as 95%. **(16)**
