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320452(20)

B. E. (Fourth Semester) Examination, ~~2020~~ APR-MAY 2022

(New Scheme)

(Civil Engg. Branch)

FLUID MECHANICS-II

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Attempt all questions. Part (a) of each question is compulsory. Attempt any two parts from (b), (c) and (d) of each question.

Unit-I

1. (a) What do you understand by hydrodynamically smooth and rough pipes? 2

(b) A pipe of diameter 0·1 m carries water at 15°C. If sand grains 0·75 mm in diameter are cemented on the inner surface of the pipe for test purposes, at

what velocity of water will :

(i) the surface roughness just begins to disturb the laminar sublayer, and

(ii) the pipe wall behaves as rough boudnary.

Kinematic viscosity of water at 15°C is 1·14 × 10^{-2} stokes. 7

(c) A liquid of specific gravity 0·88 and absolute viscosity 6·533 × 10^{-4} N.s/m^2 flows through a pipe of diameter 0·15 m at the rate of 60 litres per second. If the loss of head in 100 m length of pipe is 4·56 m, determine whether the pipe is rough or smooth. 7

(d) What is a compound pipe? How would you determine the equivalent size of a compound pipe? 7

Unit-II

2. (a) What are the factors affecting the boundary layer thickness? 2

(b) A smooth two-dimensional flat plate is exposed to a wind velocity of 100 km per hour. If laminar boundary layer exists up to a value of Rex equal to 3 × 10^5, find the maximum distance up to which

laminar boundary layer persists, and find its maximum thickness. Assume kinematic viscosity of air as 1·49 × 10^{-5} m^2/s. 7

(c) Assuming that the velocity distribution in the boundary layer is given by, $\frac{v}{V} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$. Calculate $\frac{\delta^*}{\delta}, \frac{\theta^*}{\delta}$ and $\frac{\delta_k}{\delta}$. If at a certain section, free stream velocity V was observed to be 10 m/s and the thickness of the boundary layer as 25 mm, then calculate the energy loss per unit length due to the formation of the boundary layer. Take $\rho = 1 \cdot 226$ kg/m^3. 7

(d) A submarine which may be supposed to approximate a cylinder 3 m in diameter and 15 m long travels submerged at 1·54 m/s in sea water at 4°C. Find the drag exerted on it. Take ϑ for sea water at 4°C as 1.67 × 10–6 m^2/s and as 1025 kg/m^3. Also find the friction drag. 7

Unit-III

3. (a) State and discuss the assumptions made in the derivation of the dynamic equation for gradually varied flow. 2

(b) A rectangular channel carries a discharge of 2 m^3/s per meter width. If the loss of energy in the hydraulic jump is found to be 2·75 m, determine the conjugate depths before and after the jump. 7

(c) A horizontal rectangular channel 4 m wide carries a discharge of 16 m^3/s. Determine whether a jump may occur at an initial depth of 0·5 m or not. If a jump occurs, determine the sequent depth to this initial depth. Also determine the energy loss in the jump. 7

(d) In a rectangular channel there occurs a jump corresponding to $Fr_1 = 2·5$. Determine the critical depth and head loss in terms of the initial depth y_1. 7

Unit-IV

4. (a) Explain the water hammering effect in pipe. 2

(b) Water at 15°C flows at 4 m/s in a 150 mm pipe. At what velocity must oil at 30°C flow in a 75 mm pipe for the two flows to be dynamically similar? Take υ for water at 15°C as $1·145 \times 10^{-6}$ m^2/s and that for oil at 30°C as $3·0 \times 10^{-6}$ m^2/s. 7

(c) A 1 : 10 scale model of a submarine moving far below the surface of water is tested in a water

tunnel. If the speed of the prototype is 8 m/s, determine the corresponding velocity of water in the tunnel. Also determine the ratio of the drag for the model and the prototype :

$\upsilon_{\text{sea water}} = 1·121 \times 10^{-6}$ m^2/s;

$\upsilon_{\text{water}} = 1·00 \times 10^{-6}$ m^2/s;

$\rho_{\text{sea water}} = 1027$ kg/m^3.

$\rho_{\text{water}} = 1000$ kg/m^3. 7

(d) List the important dimensionless numbers and their significances. 7

Unit-V

5. (a) What are the different types of efficiency considered in hydraulic turbines? 2

(b) A double acting reciprocating pump having piston area 0·1 m^2 has a stroke 0·30 m long. The pump is discharging 2·4 m^3 of water per minute at 45 r.p.m. through a height of 10 m. Find the slip of the pump and the power required to drive the pump. 7

(c) A Pelton wheel has to be designed for the following data. Power to be developed = 6000 kW. Net head available = 300 m; Speed = 550 rpm; Ratio

of jet diameter to wheel diameter = 1/10; and overall efficiency = 85%. Find the number of jets; diameter of the jet; diameter of the wheel; and the quantity of water required. 7

(d) Describe the function of draft tube. 7