

## TEST

## Fluid Mechanics and Hydraulics

Time: 60 Minutes

1. In a fluid the velocity field is given by:  
 $V = (3x + 2y)i + (2z + 3x^2)j + (2t - 3z)k$   
 The velocity at point (1, 1, 1) at time 2 second is  
 (A) 6.82 units (B) 7.14 units  
 (C) 7.93 units (D) 8.26 units

**Direction for questions 2 and 3:**

The velocity along the centre line of a nozzle of length  $l$  is given by,

$$V = 2t \left( 1 - \frac{x}{2l} \right)^2$$

where  $V$  = velocity in m/s,  $t$  = time in seconds,  $x$  = distance from inlet of the nozzle

2. Convective acceleration when  $x = 1$  m and  $l = 1.5$  m and  $t = 5$  seconds is  
 (A)  $-19.75 \text{ m/s}^2$   
 (B)  $19.75 \text{ m/s}^2$   
 (C)  $26.35 \text{ m/s}^2$   
 (D)  $-26.35 \text{ m/s}^2$
3. Total acceleration for the same conditions as above is  
 (A)  $20.64 \text{ m/s}^2$   
 (B)  $-20.64 \text{ m/s}^2$   
 (C)  $-18.86 \text{ m/s}^2$   
 (D)  $18.86 \text{ m/s}^2$
4. Velocity distribution in the boundary layer of fluid flow over a surface is given by:  
 $\frac{u}{U} = \frac{3}{2} \frac{y}{\delta} - \frac{1}{2} \frac{y^2}{\delta^2}$   
 When  $\delta$  = the boundary layer thickness  
 $U$  = maximum velocity of fluid  
 $u$  = fluid velocity at  $y$   
 The ratio of displacement thickness to boundary layer thickness is  
 (A)  $\frac{5}{12}$  (B)  $\frac{7}{12}$   
 (C)  $\frac{5}{7}$  (D)  $\frac{3}{7}$
5. A Kaplan turbine develops 20000 kW at an average head of 35 m. Assuming a speed ratio of 2, flow ratio of 0.6 and overall efficiency of 90% and taking boss to runner diameter ratio as 0.35, speed of the turbine is  
 (A) 365 rpm (B) 388 rpm  
 (C) 409 rpm (D) 418 rpm
6. A liquid is flowing between two parallel plates. One plate is moving relative to other with a velocity of 4 m/s in the negative direction. If pressure gradient  $\frac{\partial p}{\partial x} = -100 \times 10^6 \text{ N/m}^3$ , viscosity  $\mu = 0.4$  poise and distance between the plates is 1 m, discharge per metre width is  
 (A) 182.5 lit/s (B) 190.2 lit/s  
 (C) 206.8 lit/s (D) 242.4 lit/s
7. A moving vane with velocity 20 m/s having an inlet angle zero degree and an outlet angle  $25^\circ$  receives water from a jet at a velocity of 48 m/s. Assuming mass flow rate of 1 kg/s, the force acting on the vanes and its inclination is  
 (A) 62.16 N,  $15^\circ$  (B) 58.72 N,  $13.6^\circ$   
 (C) 54.68 N,  $12.5^\circ$  (D) 50.25 N,  $10.4^\circ$
8. In the model study of a motor boat in a lake, 1 : 25 scale model is used. It is assumed that viscous resistance due to water and air is negligible compared to the wave resistance. If the speed of the model is 2 m/s, determine the speed of the prototype for dynamically similar conditions  
 (A) 8 m/s (B) 10 m/s  
 (C) 12 m/s (D) 15 m/s
9. A pipe line through which oil flows has a sudden expansion in it such that maximum pressure rise occurs. Energy loss in the sudden expansion (in metres) of oil is given by ( $V_1$  = velocity before expansion)  
 (A)  $\frac{V_1^2}{4g}$  (B)  $\frac{V_1^2}{6g}$   
 (C)  $\frac{V_1^2}{8g}$  (D)  $\frac{V_1^2}{2\sqrt{2}g}$
10. Prandtl's velocity distribution for a boundary layer is given by  
 (A)  $\frac{u}{U} = 2 \left( \frac{y}{\delta} \right) - \left( \frac{y}{\delta} \right)^2$   
 (B)  $\frac{u}{U} = \frac{3}{2} \left( \frac{y}{\delta} \right) - \frac{1}{2} \left( \frac{y}{\delta} \right)^3$   
 (C)  $\frac{u}{U} = 2 \left( \frac{y}{\delta} \right) - 2 \left( \frac{y}{\delta} \right)^3 + \left( \frac{y}{\delta} \right)^4$   
 (D)  $\frac{u}{U} = \sin \left( \frac{\pi y}{2 \delta} \right)$
11. Specific speed of a hydraulic pump is the speed of geometrically similar pump working against unit head and  
 (A) consuming unit power.  
 (B) having unit velocity of flow.  
 (C) having unit radial velocity.  
 (D) delivering unit quantity of water.

12. Match List I with List II and select correct answer using the codes given:

List I	List II
a. Pelton turbine (single jet)	1. Medium discharge, low head
b. Francis turbine	2. High discharge, low head
c. Kaplan turbine	3. Medium head
	4. Low discharge high head

**Codes:**

a	b	c	a	b	c
(A) 1	2	3	(B) 4	3	2
(C) 2	3	4	(D) 3	4	1

13. Efficiency of the turbine is least under part load condition in the case of a  
 (A) Pelton turbine  
 (B) Francis turbine  
 (C) Kaplan turbine  
 (D) Propeller turbine
14. Cavitation in a hydraulic turbine is most likely to occur at the turbine  
 (A) entry (B) exit  
 (C) stator exit (D) rotor exit
15. A hydraulic turbine develops 1000 kW power for a head of 40 m. If the turbine is to work under a head of 20 m the power developed in kW is  
 (A) 250 (B) 500  
 (C)  $\frac{500}{\sqrt{8}}$  (D)  $\frac{1000}{\sqrt{8}}$
16. A water turbine delivering 16 MW power is to be tested with the help of a geometrically similar model of 1 : 4 scale. If the speed of the model is same as that of the prototype then determine, power developed by the model, assuming same efficiencies for model and prototype  
 (A)  $\frac{800}{32}$  kW (B)  $\frac{1000}{128}$  kW  
 (C)  $\frac{1000}{64}$  kW (D)  $\frac{500}{64}$  kW
17. A jet of water of cross-sectional area 'a' strikes on a series of flat plates mounted on a wheel. If the jet velocity is  $v$  and velocity of the plates is  $u$ , the force exerted on plate is  
 (A)  $\rho a(v - u)^2$   
 (B)  $\rho a v^2(v - u)$   
 (C)  $\rho a(v - u)^2 u$   
 (D)  $\rho a v(v - u)$
18. A jet issuing from nozzle with diameter of 180 mm has a velocity of 90 m/s and strikes the pelton wheel and

gives a shaft power of 7500 kW. If the coefficient of velocity of nozzle is 0.98, the overall efficiency of the turbine is

- (A) 80% (B) 77.65%  
 (C) 90% (D) 78.83%

19. In two pelton wheels, the first wheel deflects the water through  $160^\circ$  and the other through  $170^\circ$ . The ratio of the maximum efficiencies of the first and second wheels is (all other operating parameters being same for both)  
 (A) 1.023 (B) 0.966  
 (C) 1.035 (D) 0.977

#### Direction for questions 20 and 21:

A pelton wheel develops 5520 kW under a head of 240 m at an overall efficiency of 80% when revolving at a speed of 200 rpm.

20. The unit discharge is  
 (A) 0.172 (B) 0.189  
 (C) 0.135 (D) 0.212
21. The unit power is  
 (A) 1.645 (B) 1.581  
 (C) 1.485 (D) 1.321

#### Direction for questions 22 and 22:

A 10 cm diameter water jet having a velocity of 45 m/s strikes a flat plate, the normal of which is inclined at  $45^\circ$  to the axis of the jet.

22. What will be the normal force on the plate if the plate is stationary?  
 (A) 5.62 kN (B) 11.25 kN  
 (C) 15.9 kN (D) Data insufficient
23. What will be the normal force on the plate if the plate is moving towards the jet with a velocity of 15 m/s  
 (A) 5 kN (B) 10 kN  
 (C) 20 kN (D) 30 kN

#### Direction for questions 24 and 25:

A pipe line 1200 m long supplies water to 3 single jet pelton wheels. The head above the nozzle is 360 m. The velocity coefficient for the nozzle is 0.98 and coefficient of friction for the pipeline is 0.02. The turbine efficiency based on the head at the nozzle is 0.85. The specific speed of each turbine is 15.3 and the head loss due to friction in the pipeline is 12 m of water. If the operating speed of each turbine is 560 rpm.

24. The total power developed by the turbine in kW  
 (A) 6069 (B) 5059  
 (C) 7079 (D) 4079
25. The diameter of the nozzle in mm  
 (A) 45.7 (B) 95.6  
 (C) 76.2 (D) 81.9

**ANSWER KEYS**

1. B	2. A	3. C	4. A	5. C	6. C	7. C	8. B	9. C	10. B
11. D	12. B	13. D	14. D	15. D	16. C	17. D	18. B	19. D	20. B
21. C	22. B	23. C	24. B	25. B					