Mid Semester Examination – I
MEPC 210, Fluid Machines
Date: Friday, 21 February 2025

Max Time: 50 min

Max Marks:

1. The hydraulic efficiency of a turbine is defined as
   (a) The ration of mechanical energy delivered by the rotor to that available from the fluid
   (b) The ration of mechanical energy in output shaft at coupling to that available from the fluid.
   (c) The ration of mechanical energy available from the fluid to that available in output shaft coupling.
   (d) The ration of mechanical energy available from the fluid to that delivered.

2. A hydraulic turbine develops 1000 kW power for a head of 40m. If the head is reduced to 20m, the power developed (in kW) is
   (a) 177 to 178 (b) 353 to 354 (c) 500 to 501 (d) 707 to 708

3. A Pelton wheel produces 44kW at the shaft when available water head across the turbine is 40 m. The energy head transferred from water to the runner is 35 m of water. If the mechanical efficiency is 92%, the overall efficiency of the turbine is
   (e) 75% (f) 89.2% (g) 80.5 % (h) 56.5%

4. Which among the following statements is/are correct regarding the definition of fluid machines?
   (a) A device where the kinetic, potential or intermolecular energy held by the fluid is converted to mechanical energy by a rotating member is known as a turbine.
   (b) The machines where the mechanical energy from moving parts is transferred to a fluid to increase its stored energy by increasing either its pressure or velocity are known as pumps, compressors, fans or blowers.
   (c) Option (a) is correct but (b) is wrong
   (d) Both (a) and (b) are correct

5. Fluid machines use either liquid or gas as the working fluid depending upon the purpose. In this context, the various fluid machines are distinguished as
   (a) A machine transferring mechanical energy of the rotor to the energy of the fluid is termed as pump, when it uses liquid
   (b) A machines transferring mechanical energy of the rotor to the energy of the fluid is termed as a turbine, when it uses gas.
   (c) A blower is a machine where the main objective is to increase the static pressure of the gas. Therefore, the mechanical energy held by the fluid is mainly in the form of pressure energy.
   (d) Turbine can only handle liquid water and not suitable for steam or gas.

6. Consider the following statements pertaining to the classification of fluid machines:
   i. In Rotodynamic machines rotor supply or extract energy to or from the fluid.
   ii. Rotodynamic machines are those whose functioning depends on the change of volume of a certain amount of fluid within the machine
   iii. Positive displacement machines are those whose functioning does not depend on the change of volume of a certain amount of fluid within the machine
   iv. Positive displacement machines are those whereln the energy transfer to the fluid is accomplished by movement of the boundary of a closed volume.

   Now choose the correct option from below
   (a) Only statement (i) is correct
   (b) Statement (i) and (ii) are correct.
   (c) Statement (ii) and (iv) are correct.
   (d) Statements (i) and (iv) are correct

7. The force exerted by a jet on the vane is determined by application of the momentum principles. If M_{in} and M_{out} are the momentum per second entering and leaving a control volume in a given direction, the force exerted by a jet on the vane in the same direction is

(a) $M_{in} - M_{out}$
(b) $M_{out} - M_{in}$
(c) $M_{in} + M_{out}$
(d) $-M_{in} - M_{out}$

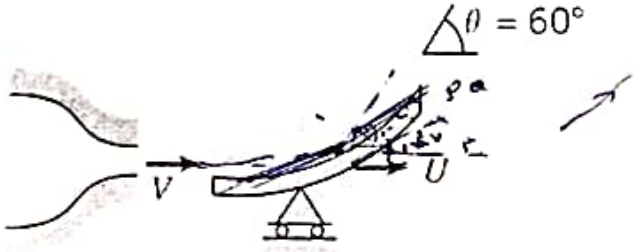
8. When a fluid jet strikes a curved vane, the velocity triangle represents the flow conditions at the entrance and the exit. The force on the vane in the direction of its motion is
(a) $\frac{W}{g}(V_{r1} - V_{r2})$
(b) $\frac{W}{g}(V_{f1} - V_{f2})$
(c) $\frac{W}{g}(V_{w1} - V_{w2})$
(d) $\frac{W}{g}(V_{w1} - V_{w2})u$
Here W is the weight of the fluid striking the vane per second, and V_r, V_f and V_w are velocity of the fluid relative to the vane, velocity of flow, and the velocity of whirl respectively. Suffix 1 and 2 represent inlet and outlet points of the vane.

9. Euler's equation for water turbine is derived on the basis of
(a) Rate of change of velocity
(b) Conservation of mass
(c) Rate of change of linear momentum
(d) Rate of change of angular momentum

10. According to Euler's equation in relation to hydraulic machines, the rate of energy transfer by the fluid to the rotor for unit mass flow rate can be expressed: (where $V_r, u,$ and V_w are the relative velocity of fluid with respect to rotor, linear velocity of the rotor and the whirl component of fluid velocity, respectively, and subscripts 1 and 2 represent inlet and outlet of the rotor, respectively.)
(a) $V_{w1}u_2 - V_{w2}u_1$ (b) $V_{w2}u_2 - V_{w1}u_1$ (c) $V_{w2}u_2 + V_{w1}u_1$ (d) $V_{w1}u_1 - V_{w2}u_2$

11. Considering an annular control volume that encloses the impeller section of a centrifugal pump. Derive the Euler's equation. [6]

12. The sketch shows a vane with a turning angle of 60°. The vane moves at constant speed, U=10 m/s, and receives a jet of water that leaves a stationary nozzle with speed V = 30 m/s. The nozzle has an exit area of 0.003 m². Determine the force components that act on the vane. [7]



13. A reaction turbine works at 450 r.p.m. under a head of 120 meters. Its diameter at inlet is 120 cm and the flow area is 0.4 m2. The angles made by absolute and relative velocities at inlet 20o and 600 respectively with the tangential velocity, Determine:
The volume flow rate, (b) The power developed, and (c) Hydraulic efficiency [7]