Ministry of Higher Education Faculty of Engineering, Kafrelsheikh University		وزارة التعليم العالي كلية الهندسة جامعة كفرالشيخ
Final Examination of Academic Year 2020 / 2021		
Department: Mechanical Engineering	Year: 1st term of Fourth year	Total Marks: 75
Course Title: Turbomachines	Allowed Time: 3 hours	Date: 8/3/2021

Choose the correct answer with the detailed calculations. Choosing only takes 10% of the full mark.

Question No. 1:

Water enters an inward flow turbine at an angle of (22°) to the tangent to the outer rim and leaves the turbine radially. The speed of the wheel is (300 rpm) and the velocity of flow is constant at (3 m/sec). Find the necessary angle of the blades when the inner and outer diameters of the turbine are (30 cm) and (60 cm) respectively. If the width of wheel at inlet is (15 cm), calculate the hp developed. Thickness of blade may be neglected.

(a) 75 hp.
(b) 80 hp.
(c) 85 hp.
(d) 135 hp.

Question No. 2:

A jet of water, having a velocity of (30 m/s) impinges on a series of curved vanes moving with a velocity of (15 m/s). The jet makes an angle of (30°) to the direction of motion of vanes when entering, and leaves at an angle of (120°). (Note: Neglect friction losses).
Sketch velocity triangles at entrance and exit, and determine:

1. Angle of vane tips, so that water enters without shock.
2. Work done per kg of water entering the vanes.
3. Overall efficiency.

(a) 15.67°, 433.18 W, and 96.26%.
(b) 15.67°, 344.18 W, and 94.26%.
(c) 15.67°, 344.18 W, and 97.50%.
(d) 18.76°, 430.50 W, and 95.50%.

Question No. 3:

A single stage centrifugal pump with impeller diameter of (30 cm) and rotates at (2000 rpm) is used to lift (3 m^3/s) of water to a height of (30 m) with an efficiency of (75%). Find the number of stages required and the diameter of each impeller of a similar multi-stage centrifugal pump to lift (5 m^3/s) of water to a height of (200 m) when rotating at (1500 rpm).

(a) 8 stages and 40.4 cm.
(b) 7 stages and 39.1 cm.
(c) 6 stages and 40.4 cm.
(d) 5 stages and 39.1 cm.

Question No. 4:

A multi-stage centrifugal pump is discharging (45000 L/min) of water against a manometric head of (60 m). There are four equal impellers, keyed to the same shaft, which is running at (350 rpm). The vanes are curved back at an angle of (60°) to the tangent at outer periphery. The velocity of flow at outlet is (0.27) times the corresponding peripheral velocity, and the hydraulic losses in the pump are (1/3) of the velocity head at outlet of the impeller. Find:

1. Diameter of the impeller, and
2. Manometric efficiency.

(a) 87.5 cm and 86.5%.
(b) 78.4 cm and 85.9%.
(c) 80.2 cm and 84.4%.
(d) 78.4 cm and 84.4%.

Question No. 5:

A centrifugal fan has to deliver (4.2 m^3/s) of air when running at (750 rpm). The diameter of the impeller at inlet is (52.5 cm) and at outlet is (75 cm). It may be assumed that the air enters radially with a speed of (15 m/s). The vanes are set backward at outlet at an angle of (70°) to the tangent, and the width at outlet is (10 cm). The volute casing gives (30%) recovery of the outlet velocity head. The losses in the impeller may be taken as equivalent to (25%) of the outlet velocity head. The specific volume of the air is (0.8 m^3/Kg) (taken constant) and the blade thickness effect may be neglected. Determine the manometric head, manometric efficiency and the power required to drive the fan. Take the mechanical efficiency as 92%.

(a) 38.21 of air, 55.72 %, and 3.845 kW.
(b) 39.48 of air, 56.35 %, and 3.655 kW.
(c) 39.48 of air, 58.98 %, and 3.567 kW.
(d) 39.48 of air, 57.27 %, and 3.845 kW.

Question No. 6:

A Pelton wheel is working under a head of (45 m) and the rate of flow of water through the jet is (800 L/s). The mean bucket speed of the wheel is (14 m/s). Assuming that the buckets are very smooth, find:

1. Power available at the nozzle, and
2. Efficiency and horsepower produced by the wheel, if the jet is deflected by the buckets through an angle of (165°).

Take coefficient of velocity as (0.985).

(a) 452.4 hp, 96.2%, and 460.6 hp.
(b) 464.4 hp, 94.1%, and 440.4 hp.
(c) 473.4 hp, 95.2%, and 450.7 hp.
(d) 485.4 hp, 93.5%, and 470.5 hp.

Question No. 7:

A Pelton wheel has to develop (18000 bhp) under a net head of (800 m), while running at a speed of (600 rpm). If the coefficient of the jet is (0.97), speed ratio is (0.46) and the ratio of the jet diameter to wheel diameter is (1/15), calculate the;

1. Quantity of water supplied to the wheel,
2. Diameter of the pitch circle,
3. Diameter of the jet, and
4. Number of jets.

Assume overall efficiency as (85%).

(a) 3.013 m^3/s, 1.889 m, 12.9 cm, and 1 jet.
(b) 2.013 m^3/s, 1.779 m, 11.9 cm, and 2 jets.
(c) 1.013 m^3/s, 1.999 m, 12.9 cm, and 3 jets.
(d) 4.013 m^3/s, 1.559 m, 13.9 cm, and 4 jets.

ALL THE BEST.

DR./ FADL ESSA