KATHMANDU UNIVERSITY
End Semester Examination
August, 2018

Marks scored:

Level : B.E.
Year : III

Course : MEEG 309
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date AUG: 0 8 2018

SECTION "A"
[20 Q × 1 = 20 marks]

Tick the most appropriate answer. Formula sheet is not required in this section.

1. Reciprocating pumps are no more to be seen in industrial applications (in comparison to centrifugal pumps) because of
   [ ] high initial and maintenance cost
   [ ] lower discharge
   [ ] lower speed of operation
   [ ] necessity of air vessel

2. The diameters of impeller of a centrifugal pump at inlet and outlet are 20 cm and 40 cm respectively. What is the minimum speed in rpm for starting the pump if it works against a head of 25 m?
   [ ] 1221.2 [ ] 2212.2 [ ] 1121.2 [ ] 1212.2

3. Head developed by a centrifugal pump depends on
   [ ] impeller diameter
   [ ] speed
   [ ] type of casing
   [ ] impeller diameter and speed

4. Centrifugal pump is started with its delivery valve
   [ ] kept fully closed
   [ ] kept fully open
   [ ] irrespective of any position
   [ ] kept 50 % open

5. Low specific speed of a pump implies it is_____pump.
   [ ] centrifugal
   [ ] mixed flow
   [ ] axial flow
   [ ] any one of the above

6. The level of the exit of the runner of a reaction turbine is 5 m above the tailrace and the atmospheric pressure is 10.3 m. The pressure at the exit of the runner for a divergent draft tube would be, in absolute units,
   [ ] 5 m [ ] 5.3 m [ ] 10 m [ ] 10.3 m

7. In a centrifugal pump, the liquid enters the pump
   [ ] at the top [ ] at the bottom [ ] at the center [ ] from sides

8. Motion of a liquid in a volute casing of a centrifugal pump is an example of
   [ ] rotational flow
   [ ] radial
   [ ] forced spiral vortex flow
   [ ] spiral vortex flow

9. A Francis turbine runner has a runner of 4 m outer diameter. The breadth at the inlet and also at outlet is 0.8 m and the velocity of flow is constant at 3 m/s. The discharge through the turbine is
   [ ] 15.08 m^3/s [ ] 28.28 m^3/s [ ] 30.16 m^3/s [ ] 37.7 m^3/s

10. Runaway speed of a hydraulic turbine is
[ ] full load speed
[ ] the speed at which turbine runner will be damaged
[ ] the speed if the turbine runner is allowed to revolve freely without load and with the wicket gates wide open
[ ] the speed corresponding to maximum overload permissible

11. Medium specific speed of turbine implies it is
[ ] Propeller turbine [ ] Francis turbine [ ] Impulse turbine [ ] Kaplan turbine

12. Guide angle as per the aerofoil theory of Kaplan turbine blade design is defined as the angle between
[ ] lift and resultant force [ ] drag and resultant force
[ ] lift and tangential force [ ] lift and drag

13. A Pelton wheel operates with a sped of 600 rpm, speed ratio of 0.44 and a neat head of 300 m. The diameter of the wheel is
[ ] 0.82 m [ ] 1.07 m [ ] 1.51 m [ ] 2.14 m

14. Impulse turbine is generally fitted
[ ] at the level of tail race
[ ] little above the tail race
[ ] slightly below the tail race
[ ] about 2.5 m above the tail race to avoid cavitation

15. The angle of taper on draft tube is
[ ] greater than 15^0 [ ] greater than 8^0 [ ] greater than 5^0 [ ] less than 8^0

16. The ratio of forces exerted by water jet when it is made to strike a stationary flat plate held normal to it and a flat plate moving in the direction of jet at one-third the velocity of jet would be
[ ] 3:1 [ ] 9:4 [ ] 3:2 [ ] 2:1

17. Amongst the following which turbine is least efficient under part load conditions?
[ ] Pelton [ ] Francis [ ] Kaplan [ ] Propeller

18. The function of surge tank is to
[ ] avoid reversal of flow
[ ] relieve the pipeline of excessive pressure transients
[ ] act as a reservoir for emergency conditions
[ ] prevent occurrence of hydraulic jump

19. The ranges of speed ratio and flow ratio of Kaplan turbines are respectively
[ ] 0.35 - 0.75 and 1.3 - 2.25 [ ] 1.3 - 2.25 and 0.35 - 0.75
[ ] 0.6 - 0.9 and 1 - 1.3 [ ] 0.4 - 0.8 and 0.1 - 0.4

20. A Francis turbine has a runner of outer diameter 0.6 m and works under a head of 30 m. If rotational speed of the runner is 600 rpm, the speed ratio for this turbine is
[ ] 0.39 [ ] 0.78 [ ] 1.56 [ ] 2

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Year : III
Time : 2 hrs. 30 mins.

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F. M. : 55

SECTION "B"
[5 Q. × 11 =55 marks]

Attempt *ALL* the questions. Formula sheet is supplied in this exam along with the question. Assume suitable data if missing/necessary.

1. a. Sketch and briefly explain a double over hung Pelton wheel. [2]
   b. How does output power from the runner is varying when the fluids leave the vanes of turbine runner with an absolute velocity in the direction: (i) same as the motion of the wheel, and (ii) against the motion of the wheel? [3]
   c. A Pelton wheel of 1.2 mean bucket diameter works under a head of 650 m. The jet deflection is 165^0 and its relative velocity is reduced over buckets by 15% due to friction. If the water is to leave the bucket without any whirl, determine: (a) rotational speed of the wheel, (b) ratio of bucket speed to jet velocity, (c) impulsive force and the power developed by the wheel, (d) available power (water power) and the power input to buckets, and (e) efficiency of the wheel with power input to buckets as reference input. Assume the coefficient of velocity 0.97. [6]

2. a. What are the important components parts of a reaction turbine and what are their functions? [3]
   b. Draw the energy diagram for a Francis and Kaplan turbine at best efficiency point in same diagram. Add the right names in the diagram and explain the physics with your own words for both cases. [3]
   c. An experimental Francis turbine rotates at 370 rpm. The wheel vanes are radial at inlet and the inlet diameter of the wheel is twice the outlet diameter. The constant velocity of flow in the wheel is 2 m/s. Water enters the wheel at an angle of 10.4^0 to the tangent to the wheel at inlet. The breadth of the wheel at inlet is 75 mm and the area of flow blocked by the vanes is 5% of the gross area at eh inlet. Find (i) the net available head at the wheel, (ii) the wheel vane angle at outlet, (iii) the inlet and out diameter of the wheel, and (iv) the theoretical power developed by the wheel. [5]

3. a. Why is the efficiency of Kaplan turbine nearly constant irrespective of speed variation under load? [3]
   b. With the help of neat sketches, describe the components of a Kaplan turbine. What are the main variants of the Kaplan turbine that are in common use? [3]
   c. A Kaplan turbine develops 9000 kW under a neat head of 7.5 m. Overall efficiency of the wheel is 86%. The speed ratio based on the outer diameter is 2.2 and the flow ratio is 0.66. Diameter of the boss is 0.35 times the external diameter of the wheel. Determine the diameter of the runner and the specific speed of the runner. [5]

4. a. What is meant by cavitation? What is Thoma's cavitation factor, what is its significance for water turbines? [2]

   b. What is the purpose of draft tube in hydraulic turbine and how does it operate? [3]

   c. The following data refer to a radial, single stage, double suction, centrifugal pump: Discharge at the pump outlet = 90 L/sec; diameter at inlet = 100 mm; diameter at outlet = 290 mm; head = 36 m; speed of impeller = 1750 rpm, width at inlet = 25 mm per side; width at outlet = 23 mm in total; overall efficiency = 60%; leakage losses = 2.7 L/sec; mechanical losses = 1.5 kW; contraction factor due to vane thickness = 0.87; outlet vane angle = 270. Assuming that the water enters the impeller at inlet radially, determine: the inlet vane angle, the angle at which water leaves the wheel, speed ratio, absolute velocity of water leaving the impeller, the manometric efficiency, volumetric efficiency, and the mechanical efficiency. [6]

5. a. Explain how the suction height of a turbine above tail race level is limited by cavitation. [3]

   b. Draw a neat sketch of centrifugal pump and explain how does it operate. [3]

   c. A Kaplan turbine develops 1500 kW under a head of 6 m. The turbine is set 2.5 m above the tail race level. A vacuum gauge inserted at the turbine outlet records a suction head of 3.1 m. If the hydraulic efficiency is 82%, what would be the efficiency of draft tube having inlet diameter of 3 m? What will be the reading of suction gauge if power developed is reduced to 750 kW, the head and speed remaining constant? [5]