

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 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 : MAR 21 2018

SECTION "A"
[20Q × 1=20 marks]

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

- Water is pumped through a pipeline to a height of 10 m at rate of $0.1 \text{ m}^3/\text{s}$. If frictional and other losses amount to 5 m, the pumping power required in kW, would be,
 9.8 13.3 14.7 20
- Cavitation in hydraulic turbine may occur
 in the spiral casing in the guide vanes
 at the inlet of the runner at the inlet of the draft tube
- A 2.5 cm diameter water jet exerts a force of 90 N in a direction of the flow on a flat plate which is held inclined at an angle of 30 degree with the axis of stream. What is the rate of flow in m^3/s ?
 0.0132 0.132 1.32 0.00132
- Two hydraulic turbines are similar and homologous when they are geometrically similar and have the same
 Thoma's number Reynolds number
 Specific speed Rotational speed
- A Pelton wheel operates with a speed of 600 rpm, speed ratio of 0.44 and a net head of 300 m. The diameter of the wheel is
 0.82 m 1.07 m 1.51 m 2.14 m
- A turbine is to operate under a head of 25 m at 200 rpm. The discharge is $9 \text{ m}^3/\text{s}$. If the overall efficiency is 90 %, suggest the type of turbine
 Pelton Francis Kaplan Propeller
- If the diameter of centrifugal pump is doubled but discharge is to be remain same, then the head needs to be reduced by
 2 times 4 times 8 times 16 times
- Kaplan turbine is suitable for
 low head and low discharge low head and high discharge
 high head and low discharge high head and high discharge
- Ratio of blade velocity to jet velocity is called
 velocity ratio flow ratio speed ratio jet ratio

10. Find the number of pumps required to take water from a deep well under a total head of 89 m. All the pumps are identical and are running at 800 rpm. The specific speed of each pump is given as 25 while the rated capacity of each pump is $0.16 \text{ m}^3/\text{s}$
 3 4 5 6
11. Manometric efficiency of a centrifugal pump is the ratio of manometric head to
 head imparted by the impeller to liquid work supplied to the shaft
 available head none of the above
12. The installation of draft tube in a reaction turbine helps to
 increase the flow rates
 transport water to downstream without eddies
 prevent air from entering
 convert the kinetic energy to pressure head
13. Given specific mass of water as 1000 kg/m^3 , cross section of jet as $2 \times 10^{-3} \text{ m}^2$ and velocity of jet 20 m/s. If jet impinges normally onto a fixed vertical plate, the force experienced by the plate is
 800 N 40 N 1600 kN 800 kN
14. Operating characteristic curves of a turbine means
 curves drawn at constant speed curves drawn at constant efficiency
 curved drawn at constant head all of the above
15. The flow of the water, leaving the impeller, in a centrifugal casing is
 forced vortex flow free vortex flow
 centrifugal flow forces and free vortex flow
16. Spouting velocity means
 actual velocity of jet ideal velocity of jet
 half of the ideal velocity of jet half of the actual velocity of jet
17. What is the flow rate of centrifugal pump impeller that has reduced its diameter from 0.5 m to 0.45 m having discharge of $1 \text{ m}^3/\text{s}$
 $0.9 \text{ m}^3/\text{s}$ $0.81 \text{ m}^3/\text{s}$ $0.729 \text{ m}^3/\text{s}$ $1.11 \text{ m}^3/\text{s}$
18. Specific speed of turbo machines
 is the speed of a machine having unit dimensions
 relates the shape rather than size of the machine
 remains the same under different conditions of operation
 depends only upon the head under which the machine operate
19. In a Francis turbine, maximum efficiency is obtained when,
 relative velocity is radial at the outlet absolute velocity is radial at the outlet
 velocity of the flow is constant guide vanes angle is 90 degree
20. If the angle of impeller is less than 90 degree then the shape of the vane is
 backward curves radial axial forward curves

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F. M. : 55

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

SECTION "B"

[5 Q. × 11 = 55 marks]

Q. N. 1.

- Draw the energy diagram for a Kaplan turbine at best efficiency point and explain the physics with your own words. [2]
- How are the velocity diagrams for the flow over the moving vanes drawn? What are velocity of whirl and velocity of flow and why are they so named? [2]
- A single jet Pelton turbine is required to drive a generator to develop 10,000 kW. The available head at the nozzle is 760 m. Assuming electric generator efficiency 95 %, Pelton wheel efficiency 87 %, co-efficient of velocity for nozzle 0.97, mean bucket velocity 0.46 of jet velocity, outlet angle of the buckets 15 degree and the relative velocity of the water leaving the buckets 0.85 of that at inlet, find: a) the flow in cumecs, b) the diameter of the jet, and c) the force exerted by the jet on the buckets. If the ratio of the mean bucket circle diameter to the jet diameter is not to be less than 10, find the best synchronous speed for generation at 50 cycles per second and the corresponding mean diameter of the runner. [7]

Q. N. 2.

- Justify for the same type of turbine: "If speed number is less, the size of the runner is more". Derive that minimum speed number for Pelton turbine is 0.09. [2]
- Define dynamic force. How is it distinguished from hydrostatic pressure? How the power is developed from this force? [2]
- A propeller turbine runner has an outer diameter of 4.5 m and an inner diameter of 2 m. It develops 22.50 MW when working under a head of 20 m. The turbine is directly coupled to an alternator having 22 pairs of poles. The hydraulic efficiency is 94 % and overall efficiency is 88 %. Find the discharge through the turbine. Find the runner vanes angles at inlet and outlet, at the hub and at the edge of the blade. [7]

Q.N.3

- What are the functions of draft tube? Why does a Pelton turbine not possess any draft tube? [2]
- Why does it become necessary to install a water turbine below the tail race level? What do you mean by 'net positive suction head' (NPSH)? [3]
- Francis turbine is fitted with a vertical conical shaped draft tube. The top and bottom diameters are equal to 60 cm and 90 cm respectively. The tube is running full with water flowing downwards, and it has a vertical height of 6 m out of which 1.5 m is drowned in the tail race water. Assume friction loss of head between the top and the bottom points is 0.3 times the kinetic head at draft tube exit. The velocity at exit is 1.5 m/s. Determine: a) the pressure head at the top point of the draft tube in m of water, b) the total head at the same point with reference to the tail race as a datum, c) the total head at the bottom point with reference to the tail race as a datum, d) the power in the water at the top of the tube, e) the power in the water at the bottom of the tube, and f) the efficiency of the draft tube. [6]

Q.N.4

- a. Derive the expression of specific speed of turbine. How does this figure help in the design of a turbine? [2]
- b. Why centrifugal pumps used sometimes in series and sometimes in parallel? Draw the following characteristics curves for a centrifugal pump: head, power and efficiency versus discharge with constant speed. [3]
- c. A Francis turbine has a wheel diameter of 1 m at the entrance and 0.5 m at the exit. The vane angle at entrance is 90 degree and the guide vane angle is 15 degree. The water at the exit leaves the vanes without any tangential velocity. The head is 30 m and the radial component of flow is constant. What would be the speed of the wheel in rpm and vane angle at exit? State whether the speed calculated is synchronous one or not. If not, what speed would you recommend to couple the turbine with an alternator of 50 cycles? Correct the outlet diameter of the turbine based upon the modified speed. [6]

Q.N.5

- a. Briefly explain inlet and outlet velocity triangle of Pelton turbine. How is the ideal hydraulic efficiency of a Pelton turbine 100 %? [3]
- b. Define minimum starting speed for centrifugal pump and derive an equation for the same. [2]
- c. The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the periphery, and has blades whose tip angles incline backwards 60 degree from the radius. The pump delivers 17 m³/min and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially, calculate: a) speed and direction of water as it leaves the impeller, b) torque exerted by the impeller on water, c) shaft power required, and d) lift of the pump. Take mechanical efficiency 95 % and hydraulic efficiency 75 %. [6]