KATHMANDU UNIVERSITY
End Semester Examination
August/September, 2017

Mark Scored:

Level : B. E.
Year : III

Course : CIEG 314
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

SEP 0 6 2017

Date :

SECTION "A"
[10 Q × 0.5 = 5 marks]

Tick the most appropriate answer.

1. According to the capacity the small scale hydropower plant falls in the range of:
   [ ] 10 MW-100 MW [ ] 10 MW -10 MW
   [ ] 100 kW-1 MW [ ] 5 kW -100 kW

2. Trash racks in a typical hydropower systems is used for:
   [ ] prevent debris reach intake [ ] prevent sediments reach intake
   [ ] prevent turbines run over speed [ ] prevent governor exceed limits

3. The quantity of potential and kinetic energy which 1 kilogram of the water delivers when passing through the HPP from an upper to a lower reservoir is called as:
   [ ] gross hydraulic power [ ] hydrostatic energy
   [ ] specific hydraulic energy [ ] specific speed

4. In which of the following turbines the blades are in action all the times
   [ ] impulse turbines [ ] reaction turbines
   [ ] axial flow turbines [ ] mixed flow turbines

5. The speed number of a hydraulic turbine is given by
   [ ] $\frac{P\sqrt{N}}{H^{4/5}}$ [ ] $\frac{N\sqrt{P}}{H^{4/5}}$ [ ] $\underline{\omega}\cdot\sqrt{\underline{Q}}$ [ ] $\underline{^{*}\omega}\cdot\sqrt{\underline{^{*}Q}}$

6. The maximum efficiency for a system with fluid jet on series of moving flat plates is
   [ ] 0.5 [ ] 0.46 [ ] 1 [ ] 0.96

7. Swirl is formed at the outlet from Francis runners when (the symbol and suffixes have their usual meaning):
   [ ] $\alpha_2 > 90°$ [ ] $\alpha_2 < 90°$ [ ] $\alpha_2 = 90°$ [ ] $\alpha_2 \neq 90°$

8. Which of the following component is used for emergency stopping of Pelton turbine:
   [ ] needle [ ] governor [ ] deflector [ ] main valve

9. A hydropower site has available flow of 10 m^3/s under a head of 360 m. If 2 units of turbine are to be run at a speed of 1000 rpm, what type of turbine is suitable based on the speed number?
   [ ] Pelton [ ] low head Francis
   [ ] Kaplan [ ] high head Francis

10. Which turbine has the best efficiency with the highest load variation

[ ] Pelton [ ] Kaplan [ ] Propeller [ ] Francis

SECTION "B"

[10 Q × 0.5 = 5 marks]

Fill in the blanks with appropriate word/words.

11. The hydraulic efficiency of turbines is governed by _____ equation.

12. The function of a governor regulate the _____ of electricity supplied to the grid.

13. A jet of water having diameter of 0.02 m is moving at 10 m/s. It strikes normal to a curved plate that moves away from the jet with 5 m/s by deflecting the jet by 180°. The maximum efficiency of the system is_____

14. Expression of draft tube efficiency is _____

15. A reaction turbine will have no cavitation if the minimum pressure inside the system is greater than the_____

16. For a conventional reaction turbine the ratio of kinetic energy to pressure energy is 0.5 at _____

17. The runner is at atmospheric pressure only in _____ turbines.

18. For a turbine to operate at 1500 rpm the number of poles pair in the generator must be _____

19. In a Propeller turbine, flow regulation is done by adjusting the angle of _____

20. For the choice of turbine to be a Pelton the speed number should be _____

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SECTION "C"
[5 Q. × 8 = 40 marks]

Attempt all questions.

Q.N.1

a) How are the hydropower components classified based on engineering domain? List out at least 3 major components with its main role on each domain. [1+2]
b) Discuss the turbine selection strategy to reduce sediment erosion? [1]
c) A jet of water having velocity of 40 m/s strikes a curved vane, which is moving with a velocity of 20 m/s. The jet makes an angle of 30^0 with the direction of motion of vane at inlet and leaves at an angle of 90^0 to the direction of motion of the vane outlet. Draw the velocity triangles at inlet and outlet and determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock. [4]

Q.N.2

a) What is meant by speed ratio in a Pelton turbine? What is its role for design of a Pelton runner? [1+1]
b) Draw the energy conversion diagram of a Pelton turbine and explain the working principle of a Pelton turbine with its help. [2+1]
c) A Pelton runner is to be designed with the following specifications: Shaft power = 11,772 kW; Head = 380 m; Speed = 750 rpm; Overall efficiency = 86 %; Jet diameter not to exceed one-sixth of the wheel diameter. Determine: (i) The runner diameter, (ii) number of jets required, and (iii) Diameter of the jet. Take $C_d = 0.985$ and $\varphi = 0.46$. [3]

Q.N.3

a) Describe how the hydraulic energy is converted into mechanical energy in a Francis turbine? [1]
b) Draw the velocity triangles for a Francis runner at the inlet and outlet at the best operating conditions. Indicate how the velocity triangles will change with part load and full load conditions. Briefly discuss the effects of such changes. [2+1+1]
c) Two units of Francis turbine is to be installed in a project site with the net head of 360 m and net flow 10 m^3/s. The turbine is to be synchronized to the generator operating at 1000 rpm. Determine all of the required information and draw the inlet and outlet velocity triangles at BEP. Calculate the major dimensions at the inlet and outlet. [3]

Q.N.4

a) Discuss the similarities and differences between the Kaplan, Francis and Propeller turbines. [3]
b) Describe with illustrations, how adjustable blades in Kaplan turbines helps to improve the efficiency at variable operating conditions? [2]
c) List the main purpose of draft tube in reaction turbines. Derive expression for the draft tube theory. [1+2]

Q.N.5

a) What are the effects of cavitation in reaction turbines? How is it different than the corrosion and sediment erosion? [1+1]

b) What are the major roles of a governing systems in hydropower? Briefly discuss the different types of governing systems used in hydropower plants. Select the type of governing system for a run-off-river project involving Francis turbine of 10 MW capacity. [1+2+1]

c) A Francis turbine works under a head of 25 m and produces 11760 kW while running at 120 rpm. The turbine has been installed at a station where atmospheric pressure is 10 m of water and vapor pressure is 0.2 m of water. Calculate the maximum height of the straight draft tube for the turbine for no cavitation. The critical cavitation coefficient for Francis turbine is given by, $\sigma_c = 0.625 \cdot \left(\frac{n_s}{380.78}\right)^2$, where n_s is the specific speed of the turbine. [2]