Hydraulic Turbomachines
Mock exam – part 1

Duration : 45 minutes;

To indicate your answer, cross the corresponding box. Each question has **only one correct answer.**

Exam evaluation: Every correct answer gives you +1 point. A blank answer gives you 0 point, a wrong one -0.25 point. If in one question you cross more than one box, it will be considered as blank answer: 0 point.

Maximum total score: 20 points

1) What is the main cause of power dissipation for a stationary and homogenous flow?

   - ☐ The variation of the flow velocity.
   - ☐ Turbulence production and viscous dissipation.
   - ☐ Heat transfer due to cavitation.

2) If you have a plant with a very high head (> 900 m), you will choose for a new storage hydropower plant:

   - ☐ Multiple Francis turbines.
   - ☐ One or multiple Pelton turbine.
   - ☐ One Kaplan turbine.

3) What are the labyrinth energy losses in a Francis turbine?

   - ☐ The energy losses due the flow going through the labyrinth seal leakage in the runner crown.
   - ☐ The energy losses due the flow going through the labyrinth seal leakage in the guide vanes.
   - ☐ The losses corresponding to the volumetric efficiency.

4) Why Pelton turbines are defined as impulse turbines?

   - ☐ Because they handle very large discharge values.
   - ☐ Because the rotational speed depends on the flow velocity of the jets.
   - ☐ Because the transferred energy is given by the difference in kinetic energy between the inlet and outlet section of the bucket.

5) What is the runaway curve?

   - ☐ The characteristic curve (discharge factor as function of the speed factor) of the hydraulic machine corresponding to the zero-torque condition for all guide vanes opening angles.

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- ☐ The characteristic curve (discharge factor as function of the speed factor) of the hydraulic machine corresponding to the maximum torque condition for all guide vanes opening angles.
- ☐ The characteristic curve (efficiency as function of the speed factor) of the hydraulic machine corresponding to the maximum torque condition for all guide vanes opening angles.

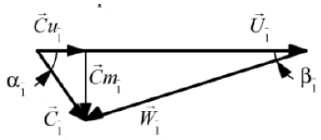
6) What is the interest of using the blade to blade view of the blades channel in a reaction turbine?

- ☐ To visualize all velocity components of the flow at along an iso-span line.
- ☐ To visualize all velocity components of the flow at the same radius
- ☐ To visualize the velocity components of the flow corresponding to the flow recirculation in the blades channel.

7) How is the flow velocity at the outlet section of a reaction machine?

- ☐ The tangential component of the absolute flow velocity is not uniform because there is always flow separation.
- ☐ The tangential component of the absolute flow velocity is not uniform because the flow performs a solid body rotation.
- ☐ Always uniform in all components of the absolute velocity.

8) This is the velocity triangle at the outlet of a Francis turbine. Which is the flow phenomenon that develops during operation?



- ☐ Development of an axisymmetric vortex rotating in the same direction than the turbine rotation.
- ☐ Development of a precession vortex rope rotating in the opposite direction than the turbine rotation.
- ☐ Development of a precession vortex rope rotating in the same direction than the turbine rotation.

9) Consider a pump which is located at a setting level that corresponds to a NPSH value below the NPSH 3%. How the performance will be modified?

- ☐ The pump will experience cavitation at the inlet section which causes at least 3% of head impairment.
- ☐ The pump will experience cavitation only at the outlet section which causes at least 3% of head impairment.
- ☐ The pump will experience cavitation covering 3% of blade impeller surface.

10) What is the typical cavitation phenomenon in the tip of the blades of a Kaplan turbine?

- ☐ The tip leakage cavitation vortex cavitating at the core of the vortex.
- ☐ The tip leakage cavitation vortex which develops in the middle of the blade passage.
- ☐ The tip leakage cavitation vortex attached to the hub.

11) Which turbines have better performance at partial load condition given their operating range?

- [x] Pelton turbines.
- [ ] Francis turbines.
- [ ] It depends on the head.

12) In which conditions a Pelton turbine reaches the best performance?

- [ ] If it has an axial flow at the outlet.
- [ ] If the speed of the jet is half the tangential velocity of the bucket.
- [x] If the speed of the jet is double the tangential velocity of the bucket.

13) What is one the roles of the stay vanes in Francis turbines?

- [ ] To address axially the flow at the inlet of the guide vanes to minimize losses.
- [x] To carry the axial forces in the spiral case.
- [ ] To re-address radially the flow coming from the guide vanes outlet.

14) Which are the primary criteria to be considered for an optimal design of the leading edge of a Francis turbine?

- [x] Nominal head conditions and inlet cavitation limits.
- [ ] Axial flow at the outlet section and outlet cavitation limits.
- [ ] All cavitation limits.

15) You have to define the operating range of a Kaplan turbine, which is the most important information you need from the site to define the blades pitch and opening angles of the blade?

- [ ] The head variation in the plant.
- [ ] The head losses in the penstock.
- [x] The discharge variation which is required.

16) What is the main difference between Kaplan and Bulb turbines?

- [ ] Both are reaction machines but only Kaplan have the possibility to move the blades.
- [x] Bulbs are fully axial machine while Kaplan turbines have a radial flow at the guide vanes inlet and outlet section.
- [ ] Kaplan are fully axial machine while Bulb turbines have a radial flow at the guide vanes inlet and outlet section.

17) What does it mean no-slip condition in a pump?

- [x] Relative flow angle at the outlet equal to the pitch angle of the blade.
- [ ] Absolute flow angle at the outlet equal to the pitch angle of the blade.
- [ ] Relative flow angle at the inlet lower than the pitch angle of the blade.

18) If you have a plant which requires to displace a water flow from 400m to 1300m, which pump you will likely select?

- [ ] An axial pump.
- [x] One or multiple multistage pumps.

- ☐ A double flow single stage pump.

19) Why Francis-type reversible pump-turbines are normally less efficient than Francis turbines in generating mode?

- ☐ Because the mass of Francis-type reversible pump-turbines is greater so they experience higher losses.
- ☐ Because the axial flow condition at the outlet can never be reached in Francis-type reversible pump-turbine.
- ☐ Because the design is a compromise between the generating and pumping mode and priority must be given to the pumping mode as it is more critical for the safety of the operation.

20) What does imply the geometrical similarity between the model and the prototype of a hydraulic turbomachine?

- ☐ That all geometrical dimensions of the machine are scaled with the same scale ratio.
- ☐ That the flow velocity is the same.
- ☐ That the kinematic similarity can be respected only if the model rotates at a rotational speed lower than the one of the prototype.