

Hydraulic Turbomachines

Mock exam – part 1

Duration : 45 minutes;

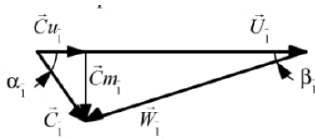
To indicate your answer, cross the corresponding box. Each question has **only one correct answer**.

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.

- ☐ 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?
- ☒ 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.
 - ☒ 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.
 - ☒ 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?
- ☒ 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.
 - ☒ 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.
 - ☒ 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?
- ☒ 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.
 - ☒ 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.