DESIGN EXERCISE a.y. 2017 - 18

General specifications

- It is not mandatory but optional
- Max two persons per group; one design per group
- In case of more than one person, the discussion is foreseen for the whole group at the same time
- Discussion is possible up to December 2018 (like exams); dates to be chosen with the professor: oral presentation (powerpoint or similar), 20 minutes

High Pressure Turbine Design, (0 - 3 points)

Given a mass flow rate of 200 kg/s of water steam available at the total pressure P_{T0} = 150. bar_A, total temperature T_{T0} = 700 °C, design a turbine operating under the total-total expansion ratio of 2.5 . It is the first stage and for this the inlet flow direction is axial but the outlet may be different. The designer can work under the perfect gas assumption in the expansion range (Cp/Cv = 1.33, R = 8314/MM) or by applying the steam tables if available.

To the designer responsibility the choice of:

- the architecture: axial / radial, n° of stages
- the reaction degree and the design methodology (constant angle, free vortex, general whirl, …, partial admission,…)
- rotational speed and dimensions.

Aiming at a design with the highest achievable efficiency, it is required:

1. The calculations of the velocity triangles along the blade span (depending on the architecture chosen, for example in 3 radial positions for an axial stage) for all the blade rows.
2. the calculation of the losses (free choice of correlations and parameters).
3. the calculation of overall blade row and stage efficiencies.
4. provide a sketch of the blade shape for all the rows (free choice of the deviation angle correlation and profile shape).

For all the choices done, provide a description and a motivation.

Low Pressure Turbine Design (0 - 3 points)

Given a mass flow rate of 150 kg/s of water steam (perfect gas assumption in the expansion range, Cp/Cv = 1.328, R = 8314/MM), design a turbine operating under the total to static expansion ratio of 2.5 with an outlet condition imposed at 35°C and 50 $mbar_A$. It is the last stage.

To the designer responsibility the choice of:

- the architecture: axial / radial, n° of stages
- the reaction degree and the design methodology (constant angle, free vortex, general whirl, …)
- rotational speed and dimensions.

Aiming at a design with the highest achievable efficiency, it is required:

1. The calculations of the velocity triangles along the blade span (depending on the architecture chosen, for example in 3 radial positions for an axial stage) for all the blade rows.
2. the calculation of the losses (free choice of correlations and parameters).
3. the calculation of overall blade row and stage efficiencies.
4. provide a sketch of the blade shape for all the rows (free choice of the deviation angle correlation and profile shape).

For all the choices done, provide a description and a motivation.