

LELME2150 - Thermal Cycles

Homework 3 - Steam Turbines

Introduction

The objective of this homework is to simulate advanced steam turbines to quantify the energy and exergy losses in different conditions. Through this work, students will be able to:

- Apply energy and exergy analyses to the steam turbine technology;
- Understand which parameters energy and exergy efficiencies are most sensitive to;
- Discuss how steam turbines could be further improved;
- Demonstrate an in-depth understanding of the steam turbine technology.

The **deadline** for this homework is **Sunday 16 November at 23:59**. Before submitting, we advise you to test your code! A code that does not pass the basic test provided will receive a score of 0. Please submit your **Python** script and the 2-page report in the designated area on Moodle.

Tasks

1. Download the signature (steam_turbine_group_xx.py);
2. Rename the script with your group number (0x if number lower than 10);
3. Download the test code (steam_turbine_test.py);
4. Fill the signature with your own steam turbine model;
5. Prepare a **max 2-page report** to present the key findings. You should not present your methodology. This report must include:
 - relevant and meaningful parametric analyses (variable number of feed-heaters, second reheating, ...);
 - a conclusion where you suggest cycle/system improvements, discuss the main constraints and connect your results to real applications (coal power plant, biomass power plant, waste incinerator, future of steam turbines, ...).

Your codes will be tested: a $\pm 5\%$ deviation on your results with regards to those of the solution will be accepted. The final grade will be highly correlated to the quality of the parametric analyses and discussions.

Before submitting, please make sure that you follow these guidelines:

- Do not import any additional packages beyond those already provided.

- Ensure that when `display` is set to `True`, your code generates the T-s and h-s diagrams, and the energy and exergy pie charts of the cycle. When `display` is set to `False`, your code does not generate any plots.
- Ensure that the code produces no printed output.
- Ensure that all output variables are filled in.
- Your submission must include exactly one PDF file and one code file.
- Do not modify the provided code template.

Statement

Consider the steam turbine cycle as shown in Figure 1.

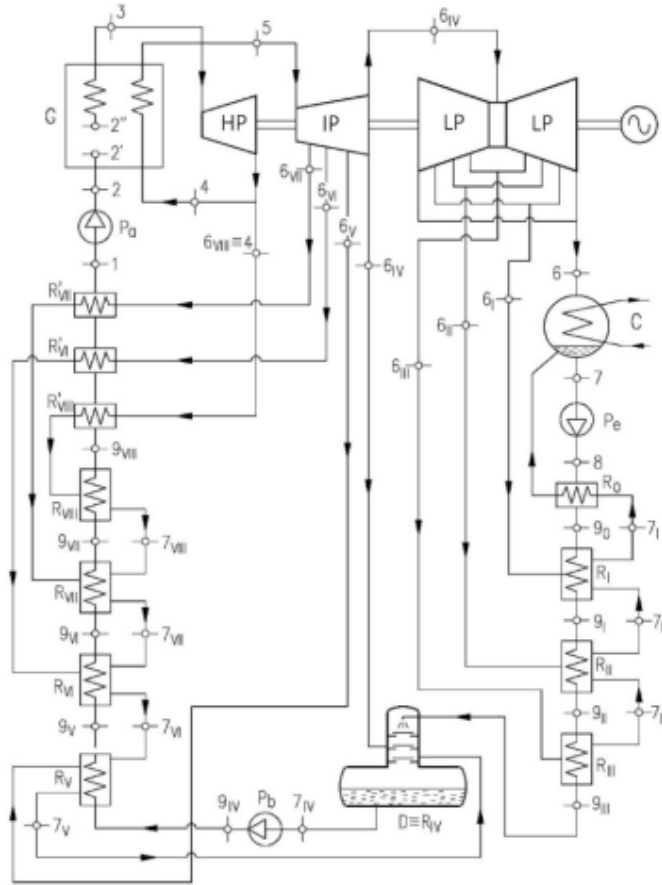


Figure 1: Steam turbine investigated in this homework.

As in HW1, you can model the combustion process as a simple adiabatic heat transfer. You do not need to include a steam generator model to your steam turbine model.

We consider that the IP turbine and the LP turbine have the same isentropic efficiencies.

In addition to this, you will perform exergy analyses of the steam turbine. Based on the methodology learned from lectures 7 to 9, you will assess which part of the system is the main exergy destructor and discuss potential improvements.

The inputs and outputs of your model are given in the code signature. For more information on these variables, please refer to the textbook.