

Ph.D. Qualifying Examination

Thermodynamics

Spring 2012

Logistics Notes:

- Time allowed: 2 hours.
- Exam is open-book and closed-notes (except for one sheet of “notes”: 8.5×11 in., both sides)
- State your assumptions, methods, and procedures. Show your work on these exam sheets. (Add additional sheets, if needed.)
- Calculators are allowed.
- Laptops and cell phones are not allowed.

Problem 1 (40 percent, clearly state your assumptions).

Consider an air compressor that receives ambient air at 100 kPa, 25 °C. It compresses the air to a pressure of 1 MPa, where it exits at a temperature of 540 K. Since the air and compressor housing are hotter than ambient, it loses 50 kJ per kilogram air flowing through the compressor. Find irreversibility of the process and the reversible work in the process.

Problem 2 (60 percent, clearly state your assumptions).

A steam turbine receives steam at a pressure of 1 MPa, 300 °C. The steam leaves the turbine at a pressure of 15 kPa. The output of the turbine is measured and is found to be 600 kJ/kg of steam flowing through the turbine. Determine the efficiency of the turbine. What is the irreversibility of the process?