

Ph.D. Qualifying Examination

Thermodynamics

Fall 2012

Logistics Notes:

- Time allowed: 2 hours.
- Exam is open-book (one book) and closed-notes; one sheet (8.50 in. × 11.00 in.) of notes is allowed.
- Calculators are allowed.
- Laptops, cell phones, and similar electronic devices are not allowed.

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Clearly state your assumptions

Problem 1. (45 points) Water vapor enters a subsonic diffuser at the pressure of 0.7 bars, a temperature of 160°C , and a velocity of 180 m/s. The inlet to the diffuser is 100 cm^2 . During the passage through the diffuser the fluid velocity is reduced to 60 m/s, the pressure is increased to 1.0 bar, and 0.6 kJ/kg of heat is transferred to the surroundings. Determine (a) the final temperature, (b) the mass flow rate, and (c) the outlet area in cm^2 . Show the process on p-v diagram.

Problem 2. (55 points) A pressure cooker with a volume of 4 liters has an operating pressure of 175 kPa. Initially, one-half of the volume is filled with liquid water and the other half by water vapor. The cooker is now placed on the top of a 500-W electrical heating unit that is kept on for 30 minutes. Assuming the surroundings to be 25°C and 100 kPa, determine (a) the amount of water that remained in the cooker and (b) the irreversibility associated with the entire process, including the conversion of electric energy to heat energy.