University of Saskatchewan
Department of Mechanical Engineering
M E 417.3 Thermodynamics II
Midterm Examination
October 27, 2004

Time: 1.5 hours | Instructors: Bugg/Bergstrom/Torvi

- Closed book exam.
- Formula sheet provided.
- No personal data assistants (PDAs) are allowed in the examination.
- No Walkmans are allowed in the examination.

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(20) 1. Consider a Rankine cycle with a single reheater and no regeneration. The pump inlet is at 10 kPa and can be considered a saturated liquid. The pump efficiency is 80%. The steam generator operates at 100 bar and the reheater operates at 500 kPa. The output of both turbines is a saturated vapour. The high-pressure turbine stage is isentropic but the low-pressure stage has an efficiency of 90%. Determine the mass flowrate required to produce a 600 MW output. Also, what is the cycle efficiency?

(20) 2. Consider a Brayton cycle with a regenerator. The regenerator has an effectiveness of 80%. The compressor inlet conditions are 1 bar and 300 K and the mass flowrate is 4.5 kg/s. The compressor outlet pressure is 10 bar. Both the compressor and turbine consist of a single isentropic stage. What minimum power output must be achieved before the regenerator begins to have a benefit? Comment on how the isentropic efficiencies of the compressor and turbine influence the potential for regeneration. Use an air-standard analysis throughout this problem.

(20) 3. A converging-diverging nozzle is supplied by a plenum chamber where $P_o = 500\,\mathrm{kPa}$ and $T_o = 400\,\mathrm{K}$. The minimum diameter (throat) is 1.2 cm and the exit diameter is 1.4 cm. The nozzle discharges to a region where $P = 450\,\mathrm{kPa}$. Determine the static temperature at the throat, the velocity at the exit, and the mass flow rate through the nozzle.