

King Saud University  
Mechanical Engineering Department  
ME-371 Thermodynamics I, 2<sup>nd</sup> Midterm Exam, 12-6-1431H, 26-5-2010G

One and half hour exam, Thermodynamics property tables are allowed.

**Question #1**

A piston cylinder device contains 0.7 kg of nitrogen initially at 100 kPa and 27 °C. The nitrogen is now compressed slowly in a polytropic process during which  $PV^{1.3} = \text{constant}$  until the volume is reduced by one-half. Determine the work done and the heat transfer for this process using the ideal gas property tables for Nitrogen. Draw the process on a P-V diagram. Also show the system boundaries.

**Question #2**

Steam flows steadily through an adiabatic turbine. The inlet conditions of the steam are 10 MPa, 450°C, and 70 m/s, and the exit conditions are 10 kPa, 92 % quality, and 40 m/s. The mass flow rate of the steam is 11 kg/s. Determine:

- (a) the change in kinetic energy,
- (b) the power output
- (c) the turbine inlet area
- (d) the entropy change of the system
- (e) Is the process reversible or irreversible and why?
- (f) The isentropic efficiency of the turbine
- (g) Draw the process on P-V and T-S Diagrams.

**Question 3**

A Carnot heat engine operates between a source at 900 K and a sink at 300 K. If the heat engine is supplied with heat at a rate of 800 kJ/min, determine:

- (a) the thermal efficiency
- (b) the power output of this heat engine
- (c) the heat rejected from the heat engine
- (d) draw the cycle on P-V and T- S diagrams show all labels.