Thapar Institute of Engineering and Technology

End Semester Examination 13 Dec, 2006

Thermodynamics (ES-103)

Time: 3 hr. Max Marks: 45

Note:

i. Please write your tutorial group no on the front page of answersheet.
ii. Pagemark your answersheet and mention the page no at which the particular question has been done.
iii. Please do the parts of one question at the same place.
iv. Assume any missing data suitably.

1. (a) Explain the following:
   i. Relative humidity and Specific humidity
   ii. Adiabatic Saturation Temperature
   iii. Wet bulb and dry bulb temperature
   iv. Degree of saturation (4)
   (b) Discuss in detail air standard Brayton cycle. (3)
   (c) A steam power plant operates between a boiler pressure of 4 MPa and 300^{0}C and a condenser pressure of 50 KPa. Determine the thermal efficiency of the cycle and the work ratio, assuming a simple ideal rankine cycle. (5)

2. (a) A steam turbine receives steam at 6 MPa, 800°C. It has a heat loss of 49.7 kJ/kg and an isentropic efficiency of 90%. For an exit pressure of 15 kPa and surroundings at 20°C, find the actual work and the reversible work between the inlet and the exit. Also find the second law efficiency. (6)
   (b) A condenser in a power plant receives 5 kg/s steam at 15 kPa, quality 90% and rejects the heat to cooling water with an average temperature of 17°C. Find the power given to the cooling water in this constant pressure process and the total rate of entropy generation when condenser exit is saturated liquid. (6)

3. (a) Water is used as the working fluid in a Carnot cycle heat engine, where it changes from saturated liquid to saturated vapor at 200°C as heat is added. Heat is rejected in a constant pressure process (also constant T) at 20 kPa. The heat engine powers a Carnot cycle refrigerator that operates between –15°C and +20°C. Find the heat added to the water per kg water. How much heat should be added to the water in the heat engine so the refrigerator can remove 1 kJ from the cold space? (5)
   (b) Consider a water pump that receives liquid water at 15^{0}C, 100 kPa and delivers it to a same diameter short pipe having a nozzle with exit diameter of 1 cm (0.01 m) to the atmosphere 100 kPa. Neglect the kinetic energy in the pipes and assume constant u for the water. Find the exit velocity and the mass flow rate if the pump draws a power of 1 kW. (6)

4. (a) Water at 150°C, quality 50% is contained in a cylinder/piston arrangement with initial volume 0.05 m^3. The loading of the piston is such that the inside pressure is linear with the square root of volume as $P = 100 + CV^{0.5}$ kPa. Now heat is transferred to the cylinder to a final pressure of 600 kPa. Find the heat transfer in the process. (5)
   (b) A cylinder having an initial volume of 3 m^3 contains 0.1 kg of water at 40°C. The water is then compressed in an isothermal quasi-equilibrium process until it has a quality of 50%. Calculate the work done in the process splitting it into two steps. Assume the water vapor is an ideal gas during the first step of the process. (5)

Evaluated answer sheets will be shown at 4:00 P.M. on 14 Dec.2006.