GX656

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway.

Summer Examinations, 2000.

First Year Mechanical & Biomedical Engineering Examination

THERMODYNAMICS

Professor J.J. O'Connor
Professor J.F. McNamara
Mr. A.W. Reynolds

Attempt *Three* Questions
Time allowed: 2 Hours

The following are available:
Copies of Property Tables A-1 to A-8, A11 to A-13, A15 to A-17, and Figures A-9, A-10, and A-14 from Thermodynamics – An Engineering Approach by Cengel and Boles.

1(a) Most of the energy generated in the engine of a car is rejected to the air by the radiator through the coolant. Should the radiator be analyzed as a closed or open system? Explain, illustrating your answer with a schematic diagram of the system (Maximum 100 words)

(10)

1(b) A piston-cylinder assembly contains 0.1 m^3 of liquid water and 0.9 m^3 of water vapor in equilibrium at 800 kPa. Heat is transferred at constant pressure until the temperature reaches 350°C. What is the initial temperature of the water in °C? Determine the total mass of the water in kg. Calculate the final volume in m^3. Draw a schematic diagram of the system. Show the process on a *P-v* diagram with respect to saturation lines.

(20)

2 A well-insulated 4m x 4m x 5m room initially at 10°C is heated by the radiator of a steam heating system. The radiator has a volume of 15L and is filled with superheated vapor at 200 kPa and 200°C. At this moment both the inlet and exit values to the radiator are closed. A 120-W fan is used to distribute the air in the room. The pressure of the steam is assumed to drop to 100 kPa after 30 minutes as a result of the heat transfer to the room. Determine the mass of steam in the radiator in kg. Calculate the heat transfer from the steam to the room in kJ. Assuming constant specific heats of air at room temperature, determine the

average temperature of the air in 30 minutes in ^{0}C. Assume the air pressure in the room remains constant at 100 kPa and the specific heat of air is 0.178 kJ/kg-K. Draw a schematic diagram of the system.

(30)

3(a) What is the first law of thermodynamics for a control volume? Label all variables used.

(5)

3(b) Steam flows steadily through an adiabatic turbine in a small power plant. The inlet conditions of the steam are 10MPa, 450°C and 80m/s. The exit conditions of the steam are 10kPa, 92 percent quality, and 50 m/s. The mass flow rate of the steam is 12kg/s. Draw a schematic diagram of the system. Calculate the change in kinetic energy in kJ/kg. What is the enthalpy of the exit steam in kJ/kg? Determine using the 1st Law of Thermodynamics for open systems the power output from the turbine in MW. Compute the turbine inlet area in m^2.

(25)

4(a) What are the three modes of heat transfer? Write a mathematical equation for each mode, and label all the variables used in the equations.

(15)

(b) A 50cm long 800-W resistance-heating element whose diameter is 0.5cm and surface temperature 120^{0}C is immersed in 40kg of water initially at 20^{0}C. Determine how long it will take in hours for this heater to raise the water temperature to 80^{0}C. Also determine the convection heat transfer coefficients at the beginning and at the end of the heat process. Assume the specific heat capacity of water is 4.184 kJ/kg-K.

(15)