



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE : FVB 20502
SUBJECT TITLE : THERMODYNAMICS
LEVEL : BACHELOR DEGREE
TIME / DURATION : 9.00am – 11.00am
(2 HOURS)
DATE : 09 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of 4 questions. Answer all questions.
6. Answer all questions in English.

THERE ARE 4 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer ALL Questions.

Total marks: 100

Question 1 (25 marks)

(a) What is a quasi-equilibrium process and what is its importance in engineering.

(3 marks)

(b) Define the following terms:

I. Isothermal

(1 mark)

II. Isobaric

(1 mark)

III. Isochoric

(1 mark)

(c) The absolute pressure in water at a depth of 5 m is read to be 145 kPa. Determine

I. The local atmospheric pressure and

(3 marks)

II. The absolute pressure at a depth of 5 m in a liquid in which specific gravity is 0.85 at the same location.

(2 marks)

(d) The diameters of the piston shown in figure 1 are $D_1 = 8$ cm and $D_2 = 5$ cm.

Determine the pressure in chamber 3, in kPa, when other pressure are $P_1 = 1050$ kPa and $P_2 = 1400$ kPa.

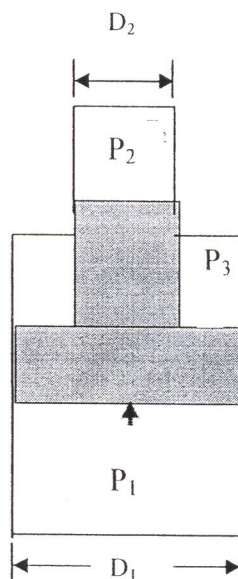


Figure 1

(14 marks)

Question 2 (25 marks)

- (a) Calculate the total potential energy, in kJ, of an object that is 6 m below a datum level at a location where $g = 9.7 \text{ m/s}^2$ and which has a mass of 50 kg. (2 marks)
- (b) At a certain location, wind is blowing steadily at 10 m/s. Determine the mechanical energy of air per unit mass and the power generation potential of a wind turbine with 60-m diameter blades at that location. Take the air density to be 1.25 kg/m^3 . (6 marks)
- (c) What is the difference between the critical point and the triple point? (2 marks)
- (d) The spring-loaded piston-cylinder device shown in Figure 2 is filled with 0.5 kg of water vapor that is initially at 4 MPa and 400°C . Initially, the spring exerts no force against the piston. The spring constant in the spring force relation $F = kx$ is $k = 0.9 \text{ kN/cm}$ and the piston diameter is $D = 20 \text{ cm}$. The water now undergoes a process until its volume is one-half of the original volume. Calculate the final temperature and the specific enthalpy of the water.

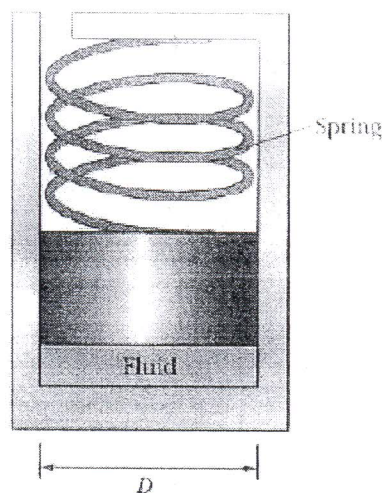


Figure 2

(15 marks)

Question 3 (25 marks)

- (a) A piston cylinder device initially contains 0.07 m^3 of nitrogen gas at 130 kPa and 120°C . The nitrogen is now expanded to a pressure of 100 kPa polytropically with a polytropic exponent in which value is equal to the specific heat ratio (called isentropic expansion). Determine the final temperature and the boundary work done during this process.

(10 marks)

- (b) A passive solar house that is losing heat to the outdoors at an average rate of $50,000 \text{ kJ/h}$ is maintained at 22°C at all times during a winter night for 10 h. The house is to be heated by 50 glass containers each contains 20 L of water that is heated to 80°C during the day by absorbing solar energy. A thermostat-controlled 15 kW back-up electric resistance heater turns on whenever it is necessary to keep the house at 22°C .

I. how long did the electric heating system run that night?

(4 marks)

II. how long would the electric heater run that night if the house incorporated no solar heating?

(4 marks)

- (c) A 1 m^3 rigid tank initially contains air in which density is 1.18 kg/m^3 . The tank is connected to a high pressure supply line through a valve. The valve is opened, and air is allowed to enter the tank until the density in the tank rises to 7.20 kg/m^3 . Determine the mass of air that has entered the tank.

(2 marks)

- (d) The diffuser in a jet engine is designed to decrease the kinetic energy of the air entering the engine compressor without any work or heat interactions. Calculate the velocity at the exit of a diffuser when air at 100 kPa and 20°C enters it with a velocity of 500 m/s and the exit state is 200 kPa and 90°C .

(5 marks)

Question 4 (25 marks)

- (a) A 600-MW steam power plant, which is cooled by nearby river, has a thermal efficiency of 40 percent. Determine the rate of heat transfer to the river water. Will the actual heat transfer rate is higher or lower than this value? Why?

(6 marks)

- (b) Consider a building in which annual air-conditioning load is estimated to be 120,000 kWh in an area where the unit cost of electricity is \$0.10/kWh. Two air conditioners are considered for the building. Air conditioner A has a seasonal average COP of 3.2 and costs \$5500 to purchase and install. Air conditioner B has a seasonal average COP of 5.0 and costs \$7000 to purchase and install. Determine which air conditioner is a better to buy.

(5 marks)

- (c) A completely reversible heat pump produces heat at a rate of 100 kW to warm a house at 21°C . The exterior air, which is at 10°C , serves as the source. Calculate the rate of entropy change of the two reservoirs and determine if this heat pump satisfies the second law according to increase of entropy principles.

(8 marks)

- (d) A freezer is maintained at -7°C by removing heat from it at a rate of 80 kJ/min. The power input to the freezer is 0.5 kW, and the surrounding air is at 25°C . Determine

I. the reversible power

(2 marks)

II. The irreversibility and

(2 marks)

III. The second law efficiency of freezer.

(2 marks)

END OF QUESTION