EL- Mansoura University
Faculty of Engineering
Fundamentals of heat and fluid
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2 pages Exam

Final-Term Exam
ENG234
Time: 2 hours
Total: 50 pts
January 2018

Question (1) (16 pts)

1. **Define each of the following (4 pts)**

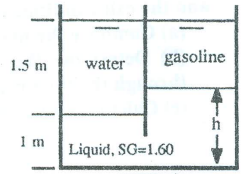
Conservation of energy principle - A saturated vapor – thermal equilibrium – adiabatic process

2. **Choose the correct answer (5 pts)**

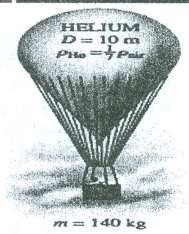
a) A pump transfers ..... energy to a fluid by raising its pressure.
b) The amount of energy absorbed during vaporization is called the latent heat of .....
c) ..... energy is commonly converted to rotating mechanical energy by electric motors to drive fans, compressors, and so forth
d) Energy can cross the boundary of a closed system in two distinct forms heat and .....
e) A .....converts the mechanical energy of fluid to shaft work.

mass - vapor - phase - thermal - liquid – mechanical - pump -fusion – smaller - turbine - weight – vaporization - greater - work – chemical - electrical

3. In the following figure the 20°C water and gasoline are open to the atmosphere and are at the same elevation. What is the height h in the third liquid? Take specific weight of water = 9810 N/m^3 and specific weight of gasoline = 6670 N/m^3. (3 pts)



4. Balloons are often filled with helium gas because it weighs only about one-seventh of what air weights under identical conditions. The buoyancy force, which can be expressed as $F_b = \rho_{air} g V_{balloon}$, will push the balloon upward. If the balloon has a diameter of 10 m and carries two people, 70 kg each, determine the acceleration of the balloon when it is first released. Assume the density of air is ρ = 1.16 kg/m3, and neglect the weight of the ropes and the cage. (4 pts)



Question (2) (12 pts)

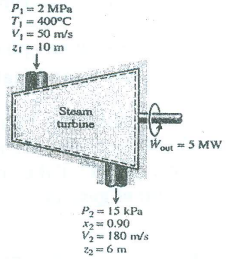
1. Illustrate by drawing *p-t* diagram of a pure substance. (3 pts)
2. The pressure in an automobile tire depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage reads 210 kPa. If the volume of the tire is 0.025 m3, determine the pressure rise in the tire when the air temperature in the tire rises to 50°C. Also, determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume the atmospheric pressure is 100 kPa. (4 pts)
3. A piston–cylinder device 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. (5 pts)
   a) What is the initial temperature of the water?
   b) Determine the total mass of the water.
   c) Calculate the final volume.
   d) Show the process on a *P-v* diagram with respect to saturation lines.

Question (3) (10 pts)

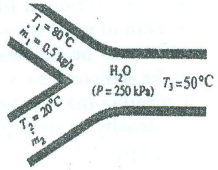
1. Prove that power transmitted to engine shaft is $\dot{W}_{sh} = 2\pi \dot{n} T$ (3pts)
   (Illustrate your answer by drawing)
2. Consider a person standing in a breezy room at 20°C. Determine the total rate of heat transfer from this person if the exposed surface area and the average outer surface temperature of the person are 1.6 m^2 and 29°C, respectively, and the convection heat transfer coefficient is 6 W/m^2·°C. (ε =0.95, σ = 5.67 × 10-8 W/m^2·K^4) (3pts)
3. As liquid water flows steadily through an adiabatic valve the pressure decreases from P_1 = 51 bar to P_2 = 1 bar. If the inlet water temperature is 25°C, what is the exit temperature? Assume that the specific volume of water is temperature independent and equal to 0.001 m^3/kg, and that u= cT, where c = 4.184 kJ kg^{-1} K^{-1}. Neglect effects due to the kinetic and potential energies. (4pts)

Question (4) (12 pts)

1. The power output of an adiabatic steam turbine is 5 MW, and the inlet and the exit conditions of the steam are as indicated in Figure.
   (a) Compare the magnitudes of Δh, Δke, and Δpe.
   (b) Determine the work done per unit mass of the steam flowing through the turbine.
   (c) Calculate the mass flow rate of the steam. (4pts)



2. A hot-water stream at 80°C enters a mixing chamber with a mass flow rate of 0.5 kg/s where it is mixed with a stream of cold water at 20°C. If it is desired that the mixture leave the chamber at 50°C, determine the mass flow rate of the cold-water stream. Assume all the streams are at a pressure of 250 kPa. (4pts)



3. Steam is leaving a 4L pressure cooker whose operating pressure is 150 kPa. It is observed that the amount of liquid in the cooker has decreased by 0.6 L in 40 min after the steady operating conditions are established, and the cross-sectional area of the exit opening is 8 mm^2. (4pts)

Best wishes