King Saud University **Faculty of Engineering**
Mech. Eng. Dept. **Time: 3 hr.**
Final Exam **1st Term 1428-29**

ME 371: Thermodynamics 1

Answer all questions:

QUESTION(1)

(a) Three different heat engines are all operating between reservoirs at 727°C and 127°C and have the data given below for one complete cycle. For each case, determine if any principles of thermodynamics would be violated.

i) Engine A, Q_H = 400 kJ, W_{cycle} = 200 kJ, Q_L = 200 kJ
ii) Engine B, Q_H = 400 kJ, W_{cycle} = 240 kJ, Q_L = 160 kJ
iii) Engine C, Q_H = 400 kJ, W_{cycle} = 210 kJ, Q_L = 200 kJ

(b) The following four processes consist a cycle. Calculate the cycle net work and the cycle efficiency and represent the cycle on the T-S diagram.

Process	I	II	III	IV
	Isentropic	Isothermal	Isentropic	Isothermal
Q, kJ	?	1000	?	- 700

QUESTION(2)

(a) Write Carnot`s princeples.

(b) An insulated rigid tank contains 5 kg of a saturated liquid-vapor mixture of water at 100 kPa. Initially, three quarters of the mass is in the liquid phase. An electric resistor placed in the tank is connected to a 110-V source, and a current of 8 A is drawn. Show the process on a T-s diagram. Determine:

a. Volume of the tank
b. How long it will take to vaporize all the liquid in the tank
c. Final temperature and pressure of the tank
d. Change in entropy

QUESTION(3)

(a) Differentiate between:

i. Adiabatic and isentropic processes.
ii. Heat engine and heat pump.

(b) Consider air in vertical cylinder-piston system initially at 0.3 MPa and 300 K, and occupying a volume of 0.1 m^3. The air undergoes a constant pressure expansion to 0.2 m^3. Represent the process on P-v and T-s diagram, determine:

a. Mass of the air
b. The final temperature
c. The work and heat transfer during the process
d. Change in entropy

QUESTION(4)

(a) Differentiate between:
   a. Closed and open systems.
   b. Heat and temperature.

(b) 5 kg of air is compressed from an initial state of 100 kPa and 17°C to a final pressure of 800 kPa according to $Pv^{1.25} = C$. Represent the process on P-v and T-s diagram. Determine:
   - final temperature
   - work required
   - heat transfer
   - the entropy change of air during this process.

QUESTION(5)

(a) Write Kelven-Plank statement of the secod law of thermodynamics.

(b) Write Clausius inequality.

(c) 8 kg of air at 127 ^{o}C is heated in isothermal process until the pressure is decreased to half of its initial value. Represent the process on P-V and T-S diagrams. Calculate the heat added, work done, and change in entropy in this process.

QUESTION(6)

(a) Express principle of entropy increase.

(b) Steam enters an adiabatic turbine steadily at 3 MPa and 400°C and leaves at 50 kPa and 100°C. If the power output of the turbine is 2 MW, determine
   a. the isentropic efficiency of the turbine
   b. the mass flow rate of the steam flowing through the turbine
   c. entropy generation in this process

Note: For air use: Cp = 1.005 kJ/kgK, k = 1.4