University of Technology-Electromechanical Engineering Dept.
Final Exam – 2013-2014

Class : **1^{st} Year**
Subject: Thermodynamics
Examiner : Dr. Kassim Khayry Abbas

Time : **3 hours**
Date: / /2014
Note: Answer **Any Five** questions

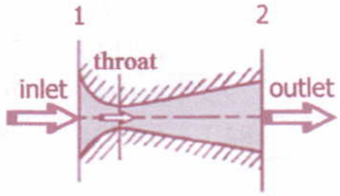
Name:.. **ID No.** .... **Signature:** ....

Q1-A) Define any two of the following , **reconcile** (عزز) your answer with the units and examples wherever and whenever you think are necessary:

1- Power ; 2- Pressure ; 3- Thermal reservoir

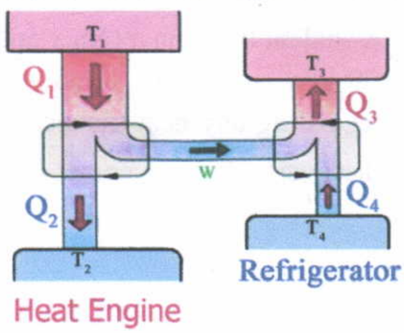
B) A rotary air compressor deals with 450 $\frac{\text{kg}}{\text{min}}$ of natural gas. The gas is taken at 15 °C and 100 $\frac{\text{kN}}{\text{m}^2}$ and is compressed in accordance with the law $pV^{1.25} = c$, to 175 $\frac{\text{kN}}{\text{m}^2}$. The power used in compressing the gas is 800 kW. Neglecting the difference in intake and exit gas velocities and the change in potential energy, **how much heat** is transferred **per minute**? $Take, C_P = 2.26 \frac{kJ}{kg.K}$.

Q2-A) Fluid with a specific enthalpy of 2800 $\frac{kJ}{kg}$ enters a horizontal nozzle as shown in the **Figure** with negligible velocity at the rate of 14 $\frac{kg}{s}$. At the outlet from the nozzle the specific enthalpy and specific volume of the fluid are 2250 $\frac{kJ}{kg}$ and 1.25 $\frac{m^3}{kg}$ respectively. **Assuming adiabatic** flow, **determine** the required **outlet area** of the nozzle.



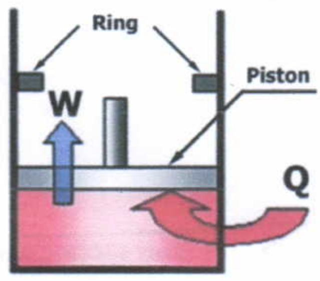
B) A quantity of gas has an initial pressure, volume and temperature of 1.1 bar, 0.16 m^3 and 17 °C, respectively. It is compressed isothermally to a pressure of 6.9 bar. **Determine** the **total** change of entropy and state whether it increases or decreases. Take, $R = 0.3 \frac{kJ}{kg.K}$.

Q3) What is the **Clausius statement** of the second law of thermodynamics? The **Figure** shows a Carnot engine that works between temperatures, $T_1 = 400\ K$ and $T_2 = 150\ K$. The engine drives a Carnot refrigerator that works between temperatures $T_4 = 225\ K$ and $T_3 = 325\ K$. **Determine** the ratio of $\frac{Q_3}{Q_1}$.

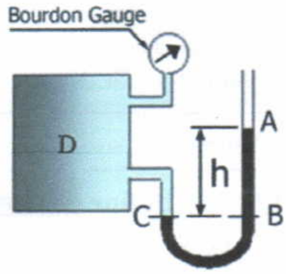


Q4) A piston-cylinder device has a ring to limit the expansion stroke as shown in the **Figure**. Initially, the mass of air is 2 kg at 500 kPa and 30 °C. Heat is now transferred until the piston **touches** the stop ring, at which point the volume is **twice** the original volume. More heat is transferred until the pressure inside also **doubles**. **Sketch** the processes on a P-v diagram **labeled** with the pressure and volume at the end states, and **determine** the **final** temperature and the **total** amount of **heat** transferred.

Take, $R = 0.287 \frac{\text{kJ}}{\text{kg K}}$, and $C_V = 0.717 \frac{\text{kJ}}{\text{kg K}}$.



Q5-A) A Bourdon Gauge and a mercury $\left(\rho = 13600\ \frac{kg}{m^3}\right)$ manometer are connected to a gas tank to measure its pressure as shown in the **Figure.** If the reading on the pressure gauge is 85 kPa, **determine** h in **mm Hg**.



B) For 0.5 kg of just dry saturated steam at 10 bar, **sketch** the state on the T-s diagram , then calculate the enthalpy, entropy, volume, internal energy and latent heat of evapouration of this dry steam.

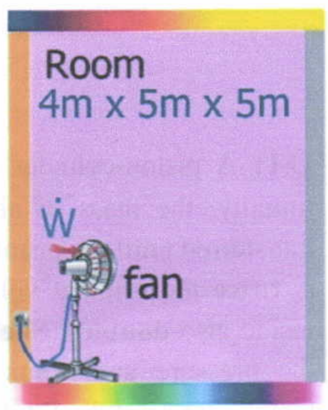
Extract from tables

P, bar	t_f, °C	$v_g, \frac{m^3}{kg}$	$u_f, \frac{kJ}{kg}$	$u_g, \frac{kJ}{kg}$	$h_f, \frac{kJ}{kg}$	$h_{fg}, \frac{kJ}{kg}$	$h_g, \frac{kJ}{kg}$	$s_f, \frac{kJ}{kg.K}$	$s_{fg}, \frac{kJ}{kg.K}$	$s_g, \frac{kJ}{kg.K}$
9	175.4	0.2149	742	2581	743	2031	2774	2.094	4.529	6.623
10	179.9	0.1944	762	2584	763	2015	2778	2.138	4.448	6.586
11	184.1	0.1774	780	2586	781	2000	2781	2.179	4.375	6.554

Q6-A) If a gas undergoes an isothermal process from state 1 to state 2 , prove with the **aid** of the corresponding **P-V diagram** (show the pressure and volume at the end states) that the heat transferred, Q_{12} , may be given by:

$$Q_{12} = m\,R\,T_1\,\ln\left(\frac{P_1}{P_2}\right)$$

B) A student living in a (4m x 5m x 5m) room turns on a **100 W** fan before she leaves the **warm room** at 100 kPa and 30 °C, **hoping** that the room will be cooler when she comes back after **5 hours**. **Disregarding** any heat transfer between the system and its surroundings, **determine** the temperature she discovers when she comes back. For air take, $R = 0.287\ \frac{kJ}{kg.K}$, $C_V = 0.718 \frac{kJ}{kg.K}$ $and\ \rho = 1.2\ \frac{kg}{m^3}$



MAY SUCCESS BE WITH YOU ALWAYS....

Dr. Kassim K. Abbas