Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2015

Subject Code: 2140106 **Date: 03/06/2015**

Subject Name: Basic Engineering Thermodynamics

Time: 10:30am-1.00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the followings **07**

1. Microscopic and macroscopic point of view
2. Control volume and control surface
3. Intensive and extensive properties

(b) Explain Zeroth law of thermodynamics **03**

(c) A water chilling plant, remove heat from water at the rate of 52 MJ/hr. Heat leaks in to the water from the surroundings at the rate of 8 MJ/hr. Find time required for cooling 100 kg water from 35°C to 10°C. Take C_p = 4.187kJ/kgK for water. **04**

Q.2 **(a)** Define first law of thermodynamics. Also define internal energy of the system and show that the internal energy is property of the system. **07**

(b) A cylinder contains 0.45 m^3 of gas at 1×10^5 N/m^2 and 80°C. The gas is compressed to a volume of 0.13 m^3. The final pressure being 5×10^5 N/m^2. Assume γ = 1.4 and R = 294.2 J/kgK for gas, calculate mass of gas, index of compression n, increase of internal energy of gas and heat rejected by gas during compression. **07**

OR

(b) Write the generalized energy equation for steady flow process. Reduce it for the following system **07**

1. Gas turbine
2. Nozzle

Q.3 **(a)** Write the limitations of first law of thermodynamics and explain PMM2. **03**

(b) Prove that all reversible engines working between the two constant temperature reservoirs have the same efficiency. **04**

(c) A reversible heat engine operates between two reservoirs at temperature 727°C and 27°C. The engine drives a reversible refrigerator working between reservoirs at temperature of 27°C and -20°C. The heat absorbed by engine is 2600 kJ and net work output of the combined engine refrigerator plant is 500 kJ. Determine the heat transferred to the refrigerator and net heat transfer to the reservoir at 27°C **07**

OR

Q.3 **(a)** Answer the following **03**

1. State and explain Boyle's law and Charles law.
2. Define characteristic gas constant. How does it differ from universal gas constant

(b) For ideal gas, prove that $C_p - C_v = R$ **04**

(c) One kg of air initially at 7 bar pressure and 360 K temperature expands polytropically ($pv^{1.2}$ = c) until the pressure is reduced to 1.4 bar. Determine **07**

1. Final specific volume and temperature
2. Change in internal energy, work done and heat interaction

3. Change in entropy

Take R = 287 J/kgK and γ = 1.4

Q.4 **(a)** Prove that the maximum available useful work from steady flow through open system is given by **07**

$$W_{max} = (u_1 + p_1 v_1 - T_0 s_1) - (u_0 + p_0 v_0 - T_0 s_0)$$

(b) A system at 500 K receives 2200 kW heat from a heat source at 1200K. the temperature of heat sink is 300 K. The temperature of both the system and source remain constant during heat transfer. Calculate net change of entropy, available energy of heat source and system and decrease in available energy after heat transfer. **07**

OR

Q.4 **(a)** If the internal energy of a system is a function of entropy and volume, prove that $\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial p}{\partial s}\right)_v$ **07**

(b) What does the Joule-Thomson coefficient represent? Describe the inversion line and the maximum inversion temperature. **03**

(c) Using the Clapeyron equation, estimate the enthalpy of vaporization of steam at 300 kPa, and compare it to the tabulated value. **04**

Q.5 **(a)** Explain the effect of following variables on the performance of Rankine cycle with help of p-h and T-s diagram. **07**

1. Effect of increase in boiler pressure
2. Effect of decrease in condenser pressure
3. Effect of superheating the steam

(b) A steam is supplied to steam turbine at pressure 20 bar and degree of superheat to be 137.6°C. The exhaust pressure is 0.08 bar and expansion of steam takes place isentropically. Determine the following. **07**

1. Heat supplied
2. Heat rejected
3. Thermal efficiency
4. Theoretical steam consumption in kg/kWh

OR

Q.5 **(a)** Prove that the air standard efficiency of ideal diesel cycle is given by **07**

$$\eta = 1 - \frac{1}{r^{\gamma-1}}\left[\frac{\rho^{\gamma} - 1}{\gamma(\rho - 1)}\right]$$

r = compression ratio, ρ = cut-off ratio, γ = ratio of specific heat

(b) Air standard Bryton cycle in which the air enters the compressor at 1 bar and 27°C. The pressure of air leaving the compressor is 4 bar and the temperature at turbine inlet is 700°C. Calculate per kg of air **07**

1. Efficiency of the cycle
2. Heat supplied to air
3. Heat rejected in the cooler
4. Temperature of air leaving the turbine

For air, γ = 1.4 and C_p = 1.005 kJ/kgK

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