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(Following Paper ID and Roll No. to be filled in your Answer Book)

Paper ID :140303 | Roll No. | | | | | | | | | |

B.Tech.

(SEM. III) THEORY EXAMINATION, 2015-16

THERMODYNAMICS

[Time:3 hours] **[Total Marks:100]**

Section-A

1. Attempt **all** parts. All parts carry equal marks. Write answer of each part in short. (2×10=20)

   (a) Briefly explain quasi static process.

   (b) State steady and unsteady flows.

   (c) Explain free expansion process?

   (d) State Carnot theorem.

   (e) State the various statements of second law of thermodynamics?

(f) A system composed of 2 kg air expands in a frictionless piston and cylinder machine from an initial state of 1 MPa, 100°C to a final temperature of 30°C. If there is no heat transfer, find the net-work for the process. Take air as ideal gas having (c_v=0.718 KJ/kgK & R= 0.287 KJ/kgK.).

(g) An adiabatic vessel contains 2 kg of water at 25°C. By paddle-wheel work transfer, the temperature of water is increased to 30°C. If the specific heat of water is assumed constant at 4.187 kJ/kg K, find the entropy change of the universe.

(h) What is Exergy?

(i) Define second law efficiency.

(j) Prove that $COP_P = 1 + COP_R$

Section-B

Attempt **any five** questions from this section. (10×5=50)

2. Derive Available energy and Irreversibility for Open System and Closed system?

3. Define Thermodynamic equilibrium & also show that energy is a property of a system.

4. State first law of thermodynamics with its limitations.

5. A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it.

   (a) Find the velocity at exits from the nozzle.

   (b) If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg, find the mass flow rate.

   (c) If the specific volume at the nozzle exit is 0.498 M^3/kg, find the exit area of the nozzle.

6. A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine ejects heat to it. If the efficiency of the engine is 40% of the maximum possible and the COP of the heat pump is 50% of the maximum possible, what is the temperature of the reservoir to which the heat pump ejects heat? What is the rate of heat ejection from the heat pump if the rate of heat supply to the engine is 50 kW?

7. Each of three identical bodies satisfies the equation $U=CT$, where C is the heat capacity of each of the bodies. Their initial temperatures are 200 K, 250K, and 540 K. If C =8.4 kJ/K, what is the maximum amount of work that can be extracted in a process in which these bodies are brought to a final common temperature?

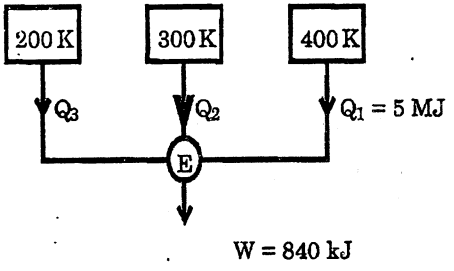
8. An air preheater is used to heat up the air used for combustion by cooling the outgoing products of combustion from a furnace. The rate of flow of the products is 10 kg/s, and the products are cooled from 300°C to 200°C, and for the products at this temperature c_p = 1.09 kJ/kg K. The rate of air flow is 9 kg/s, the initial air temperature is 40°C, and for the air c_p = 1.005kJ/kg K.

   (a) What is the initial and final availability of the products?

   (b) What is the irreversibility for this process?

   (c) If the heat transfer from the products were to take place reversibly through heat engines, what would be the final temperature of the air?

9. Discuss exergy destruction. A reversible engine, as shown in figure during a cycle of operations draws 5 MJ from the 400 K reservoir and does 840 kJ of work. Find the amount and direction of heat interaction with other reservoirs.



Section-C

Attempt **any two** questions. All questions carry equal marks. (15×2=30)

10. Explain the working of a two stroke SI engine giving neat sketches and differentiate between two stroke and four stroke spark ignition engine.

11. Explain simple Rankine cycle with neat schematic diagram and also show different processes involved in it on T-S diagram, H-S diagram and P-V diagram.

12. What is Perpetual motion machine of second type. A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship $p = a + b V$, where a and b are constants. The initial and final pressures are 1000kPa and 200kPa respectively and the corresponding volumes are 0.20 m^3 & 1.20 m^3. The specific internal energy of the gas is given by the relation.

$$u = 1.5\ pv - 85\ kJ/kg.$$

Where p is the kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion.

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