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## Third Semester B.E. Degree Examination, June/July 2019 Basic Thermodynamics

Time: 3 hrs.

Max. Marks: 100

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Use of Thermodynamics data hand book permitted.*

### Module-1

- 1 a. With examples briefly describe the terms:
  - i) Macroscopic approach
  - ii) Intensive properties
  - iii) Closed systems
  - iv) Quasistatic process. (08 Marks)
- b. Define Zeroth law of thermodynamics and explain the concept of temperature measurement. (04 Marks)
- c. A platinum wire is used as resistance thermometer. The wire resistance was found to be  $10\Omega$  and  $16\Omega$  at ice and steam points respectively and  $30\Omega$  at sulphur boiling point  $444.6^\circ\text{C}$ . Find the constants  $a$  and  $b$  in the equation  $R = R_0 (1 + at + bt^2)$  where  $t$  in  $^\circ\text{C}$ . Also find the resistance of the wire at  $500^\circ\text{C}$ . (08 Marks)

OR

- 2 a. Describe the similarities and dissimilarities between work and heat transfer. (06 Marks)
- b. With the help of p-v diagrams, derive expressions for p-dv work for
  - i) isothermal process
  - ii) Polytropic process. (06 Marks)
- c. A gas is initially at  $100\text{kPa}$  and  $6000\text{ cm}^3$ . The final volume is  $2000\text{ cm}^3$ . Determine the moving boundary work for each of the following processes:
  - i) When  $P$  is proportional to  $V$
  - ii) When  $P$  is inversely proportional to  $V$
  - iii)  $PV^2 = \text{constant}$ . (08 Marks)

### Module-2

- 3 a. With a neat sketch, explain Joule's experiment and hence define first law of thermodynamics. (06 Marks)
- b. Briefly describe internal energy as a property of the system. (04 Marks)
- c. Write SFEE and explain the terms. (02 Marks)
- d. A steam nozzle is supplied with  $40\text{kg/min}$  of steam at  $15\text{ bar}$ . At the inlet  $V_1 = 1800\text{m/min}$  and  $v_1 = 0.15\text{ m}^3/\text{kg}$ ,  $u_1 = 2600\text{ kJ/kg}$  and corresponding values at the exit are  $p_2 = 1\text{ bar}$ ,  $v_2 = 1.7\text{m}^3/\text{kg}$  and  $u_2 = 2520\text{ kJ/kg}$ . Calculate the exit velocity. (08 Marks)

OR

- 4 a. Briefly explain the terms:
  - i) Thermal reservoir
  - ii) Refrigerator
  - iii) Heat pump
  - iv) Clausius statement of II law. (08 Marks)



- b. With the help of p-v diagram, derive an expression for the efficiency of a Carnot cycle. (06 Marks)
- c. A reversible engine with 40% efficiency discharges 1520 kJ of heat per minute at 27°C to a pond. Find the temperature of the source which supplies the heat to the engine and power developed by the engine. (06 Marks)

### Module-3

- 5 a. Define the terms:  
 i) Reversible process  
 ii) Reversible heat engine  
 iii) Irreversible process. (06 Marks)
- b. Describe with a sketch heat transfer through a finite temperature difference is irreversible. (06 Marks)
- c. A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the engine is 2000kJ and the network output of the engine refrigerator plant is 360kJ. Evaluate the heat transfer to the refrigerator and net heat transfer to the reservoir at 40°C. (08 Marks)

### OR

- 6 a. With p-v diagram explain Clausius inequality. (06 Marks)
- b. Explain the principle of increase of entropy. (04 Marks)
- c. Show that entropy is the property of a system. (04 Marks)
- d. 10 gram of water at 20°C is converted into ice at -10°C in a constant pressure process of 1 atmosphere. Calculate the change in entropy for the process. Take  $c_{p,water} = 4.187 \text{ kJ/kg K}$ ,  $c_{p,ice} = 2.093 \text{ kJ/kg K}$ , LH of ice = 335 kJ/kg. (06 Marks)

### Module-4

- 7 a. Represent available and unavailable energy as referred to a cycle with T-S diagrams. (06 Marks)
- b. Explain the concept of second law efficiency. (06 Marks)
- c. Calculate the decrease in available energy when 25kg of water at 95°C mix with 35kg of water at 35°C at constant pressure and the temperature of the surroundings being 15°C. (Take  $c_{pw} = 4.2 \text{ kJ/kgK}$ ). (08 Marks)

### OR

- 8 a. Explain the terms:  
 i) Triple point  
 ii) Critical point  
 iii) Sub cooled liquid  
 iv) Quality of steam. (06 Marks)
- b. With a neat sketch and h-s diagram explain throttling calorimeter. (06 Marks)
- c. A vessel of volume 0.04m<sup>3</sup> contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9kg. Find the pressure, mass, specific volume, enthalpy, entropy and internal energy. (08 Marks)



Module-5

- 9 a. Define:
- Dalton's law of partial pressure.
  - Amagat's law of additive volume
  - Ideal gas
- (06 Marks)
- b. Derive an expression for the change in entropy of an ideal gas. (04 Marks)
- c. A gaseous mixture consists of 1kg of oxygen and 2kg of nitrogen at a pressure of 150kPa and a temperature of 20°C. Find:
- Gas constant
  - Molecular weight of the mixture
  - Mole Fractions
  - Partial pressures
  - Specific heats of the mixture.
- (10 Marks)

OR

- 10 a. Define:
- Law of corresponding states
  - Compressibility factor
  - Real Gas.
- (06 Marks)
- b. Write Vander Waal's equation of state and express the constants in terms of critical properties. (06 Marks)
- c. The specific volume of CO<sub>2</sub> is 1m<sup>3</sup>/kg at 100°C. Determine the pressure exerted by CO<sub>2</sub> using Vander Waal's equation and compare the results obtained if CO<sub>2</sub> is treated as an ideal gas. (08 Marks)

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