B.E./B.TECH. Degree Examination, January 2021

Semester - III

AE18302-BASIC AND APPLIED THERMODYNAMICS

(Regulation 2018)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. The moving boundary work (J) in the process involving at the sealed rigid tank where the air is heated from 0.1 MPa and 25ºC to a pressure of 1.5 MPa is

   (A) 1200

   (B) Infinite

   (C) 2000

   (D) Zero

2. A Carnot heat engine cycle receives 1010 kJ while operating between the temperatures 1000ºC and 40ºC. What will be the work output (kJ)?

   (A) 969.60

   (B) 814.27

   (C) 761.66

   (D) 680.85

3. For a mixture of NO_3 and SO_2, having 25 moles and 100 moles respectively, the total pressure exerted by the gases is 100 atm. What is the partial pressure of NO_3?

   (A) 20 atm

   (B) 40 atm

   (C) 60 atm

   (D) 80 atm

4. H_2O is kept a pressure of 10 MPa at 220ºC. What would be the region of P-V-T surface for this mixture?

   (A) compressed region

   (B) superheated region

   (C) saturated water-vapor region

   (D) triple point

5. Reduce the steady flow energy equation to a steam turbine considering the heat losses between the turbine and atmosphere.

6. Differentiate between PMM1 and PMM2 with respect to agreement or violation of thermodynamic laws.

7. A wet steam with dryness fraction of 0.8 is stored at a pressure 2000 kPa. Determine the specific enthalpy.

8. The entry of water with refrigerant into the expansion device should be avoided. Say true or false. Justify.

PART B - (4 X16 = 64 marks)

09. (a) In a steam power station, steam flows steadily through a 0.21 diameter pipeline from the boiler to the turbine. At the boiler end, the steam conditions are found to be 4 MPa, 400ºC, specific enthalpy 3215 kJ/kg and specific volume 0.073 m^3/kg. At the turbine end, the conditions are found to be 3.5 MPa, 392ºC, specific enthalpy 3203 kJ/kg and specific volume 0.084 m^3/kg. There is a heat loss of 10 kJ/kg from the pipeline. Calculate the steam flow rate. **(16)**

(OR)

(b) A gas mixture obeying perfect gas law has molar mass of 26.7 kg/kmol. The gas mixture is compressed to a compression ratio of 12 according to the law $pV^{1.3} = C$, from initial conditions of 0.9 bar and 330 K. Assume a mean molar specific heat at a constant volume of 21.1 kJ/kmol-K, find per kg of mass, the work transfer and heat flow across the cylinder walls. For the above gas, determine the value of characteristic gas constant, molar specific heat at constant pressure and ratio of specific heats. **(16)**

10. (a) A reversible heat engine operates between two reservoirs at temperatures of 650ºC and 40ºC. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40ºC and -15ºC. The heat transfer to the engine is 2000 kJ and the network output of the combined engine-refrigerator plant is 400 kJ. (a) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40ºC. (b) Reconsider (a) given that the efficiency of the heat engine and the COP of the refrigerator are each 30% of their maximum possible values. **(16)**

(OR)

(b) 1.5 kg of air is contained in a piston cylinder assembly at 10 bar pressure and 600 K temperature. The piston moves outwards and the air expands to 2 bar pressure and 350 K temperature. Determine the maximum work obtainable. Assume the environmental conditions to be 1 bar and 293 K. Also make calculations for the availability in the initial and final states. **(16)**

11. (a) Derive first Tds equation and obtain an expression for change in entropy when a gas obeys Van der Waals equation. **(16)**

(OR)

(b) In a single heater regenerator cycle, the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.1 bar. The feed water heater is a direct contact type which operates at 10 bar. Find the efficiency and the steam rate of the cycle with and without regeneration. Pump work may be neglected. **(16)**

12. (a) It is planned to install an air conditioner working on vapour compression refrigerator cycle. The temperature range in the compressor is 45°C to - 10°C. The vapour is dry saturated at the start of compression and reached a temperature of 60°C after compression. What will be the value of COP? The refrigerant is methyl chloride with the following properties. **(16)**

Temperature (°C)	**Specific Enthalpy (kJ/kg)**		**Specific entropy (kJ/kgK)**	
	Liquid	Vapour	Liquid	Vapour
45	133.0	483.6	0.485	1.587
- 10	45.4	460.7	0.183	1.637

(OR)

(b) Suggest and explain a suitable refrigeration system for an ice producing factory with 60 TR capacity. Also compare Vapour compression and Vapour absorption refrigeration systems. **(16)**