

B.E./B.TECH. Degree Examination, December 2020

Third Semester

**AE18302-BASIC AND APPLIED THERMODYNAMICS**

(Regulation 2018)

(Approved stream and Refrigeration tabuler permitted)

Time: Three hours

Maximum: 80 Marks

Answer **ALL** questions**PART A - (8 X 2 = 16 marks)**

1. The mechanical boundary moving work in the process involving at the sealed rigid tank where the air is heated from 0.15 MPa and 25°C to a pressure of 0.85 MPa is  
(A) Zero  
(B) Infinite  
(C) 200 J  
(D) 254 J
2. A Carnot engine produces a work output of 100 kJ by operating between the temperatures 500°C and 10°C. What will be the heat input (kJ) provided to the engine?  
(A) 91.25  
(B) 214.27  
(C) 157.75  
(D) 180.85
3. In an ideal gas mixture, the mole percent of the gases are given as 15 % O<sub>2</sub>, 25 % CO<sub>2</sub> and 60 % N<sub>2</sub> at 400°C and 560 mm of Hg pressure. The partial pressure of O<sub>2</sub> gas in mm of Hg is  
(A) 84  
(B) 140  
(C) 336  
(D) None of the mentioned
4. Water is kept a pressure of 9 MPa at 200°C. 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. A bullet proof automobile window has been hit by a bullet having a mass of 12 g which was travelling at velocity of 1000 m/s. Determine the kinetic energy. Assume acceleration due to gravity (g) as 9.81 m/s<sup>2</sup>.

6. PMM2 obeys the First law of thermodynamics but violates Second law of thermodynamics. Justify this statement.
7. A cylinder has a wet steam with dryness fraction of 0.9 which is stored at a pressure 2000 kPa. Determine the specific volume.
8. When volume flow rate of refrigerant is large, which compressor is used - reciprocating or centrifugal?

**PART B - (4 X16 = 64 marks)**

09. (a) A steady flow steam turbine receives 7200 kg/h of steam from the boiler. The steam enters the turbine at enthalpy of 2800 kJ/kg, a velocity of 4000 m/min and an elevation of 4 m. The steam leaves the turbine at enthalpy of 2000 kJ/kg, a velocity of 8000 m/min and an elevation of 1 m. Due to radiation, heat losses from the turbine to the surroundings amount to 1580 kJ/h. Calculate the output of the turbine. **(16)**

**(OR)**

- (b) The condition of 0.5 m<sup>3</sup> of air at the inlet of compressor is 30°C and 1 bar and at the outlet is 0.08 m<sup>3</sup>. Find the final pressure and temperature, work transfer, change in internal energy and change in enthalpy, when the index of polytropic compression has the value of 1.35. Take for air  $C_p = 1.005$  kJ/kg-K and  $C_v = 0.718$  kJ/kg-K. **(16)**
10. (a) A heat engine operating between two reservoirs at 1200 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 rejects heat to it. If the efficiency of the engine is 40 % of the maximum possible and COP of the heat pump is 50 % of the maximum possible, what is the temperature of the reservoir to which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW? **(16)**

**(OR)**

- (b) A perfect gas is compressed according to the law  $pV^{1.25} = C$  from an initial pressure of 1 bar and volume of 0.9 m<sup>3</sup> to a final volume of 0.6 m<sup>3</sup>. Determine the final pressure and change of entropy per kg of gas during the process. Take specific heat ratio as 1.4 and characteristic gas constant as 287 J/kg-K. **(16)**
11. (a) 0.5 kg of CO and 1 kg of air is contained in a vessel of volume 0.4 m<sup>3</sup> at 15°C. Air has 23 % of O<sub>2</sub> and 77 % of N<sub>2</sub> by mass. Calculate the partial pressure of each constituent and total pressure in the vessel. Molar masses of CO, O<sub>2</sub> and N<sub>2</sub> are 28, 32 and 28 kg/kmol. **(16)**

**(OR)**

- (b) Steam at the rate of 7 kg/s enters the steam turbine of a simple Rankine cycle at 50 bar and 500°C. The condenser pressure is 0.1 bar. Find (a) Turbine work and Pump work (b) Power developed (c) Cycle efficiency (d) Specific steaming rate (e) Specific heat rate (f) Work ratio. (16)
12. (a) It is planned to install an air conditioner working on vapour compression refrigerator cycle. The temperature range in the compressor is 25°C to - 15°C. The vapour is dry saturated at the end of compression. What will be the value of COP?. The refrigerant is ammonia with the following properties. (16)

Temperature (°C)	Specific Enthalpy (kJ/kg)		Specific entropy (kJ/kg-K)	
	Liquid	Vapour	Liquid	Vapour
25	100.04	1319.22	0.3473	4.4852
- 15	- 54.56	1304.99	- 2.1338	5.0585

(OR)

- (b) Compare Vapour compression and Vapour absorption refrigeration systems. Identify and explain a system suitable for the capacity of 50 TR. (16)