Sub Code: BMET-301 **ROLL NO……..……..**

END SEMESTER EXAMINATION, 2022 – 23

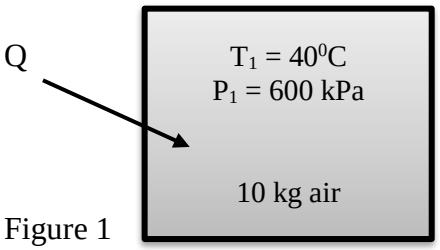
(IInd yr B.Tech. – Mechanical Engineering)

Basic Thermodynamics

Duration: 3:00 hrs **Max Marks: 100**

Note: - Attempt all questions. All Questions carry equal marks. In case of any ambiguity or missing data, the same may be assumed and state the assumption made in the answer.

Use of Steam Table is allowed

Q 1.	Answer any four parts of the following. a) What is Thermodynamic definition of work? Calculate work done for isothermal and isobaric processes undergone by closed system. b) A closed rigid container holds 7 kg of nitrogen at -30^{0}C and a pressure of 430 kPa. Determine the final pressure and the heat required to heat the nitrogen to 90^{0}C. Take Characteristic Gas Constant (R) of Nitrogen = 297 J/kg K. c) Briefly explain: (i) High Grade Energy (ii) Low Grade Energy (iii) Available Energy (iv) Unavailable Energy. d) A closed system of mass 5 kg undergoes a process in which there is work of magnitude 9 kJ to the system from the surroundings. The elevation of the system increases by 700 m during the process. The specific internal energy of the system decreases by 6 kJ/kg and there is no change in kinetic energy of the system. The acceleration of gravity is constant at g = 9.6 m/s^2. Determine the heat transfer, in kJ e) Draw Carnot cycle on p-V and T-s curve. Also derive the expression of its efficiency. f) A blower handles 1 kg/s of air at 20°C and consumes a power of 15 kW. The inlet and outlet velocities of air are 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take C_p of air as 1.005 kJ/kg-K.	5x4=20
Q 2.	Answer any four parts of the following. a) 10 kilograms of air at 600 kPa and 40°C are heated in a closed rigid container, Figure 1, to 250°C. Calculate (i) the heat transfer and (ii) the change in entropy for this process. Take for air C_v = 0.717 kJ/kg K, R = 0.287 kJ/kg K  Figure 1 b) Derive Maxwell relations. c) Air undergoes two processes in series: Process 1–2: Polytropic compression, with n = 1.3, from p_1 = 100 kPa, v_1 = 0.04 m^3/kg to v_2 = 0.02 m^3/kg Process 2–3: constant-pressure process to $v_3 = v_1$ Sketch the processes on a p-v diagram and determine the work per unit mass of air, in kJ/kg.	5x4=20

	d) What is reversible and irreversible process? e) The compression ratio of a diesel cycle is 18 with a cutoff ratio of 2. The pressure and temperature of the air at the beginning of the compression stroke are 100 kPa and 15°C, Determine: (i) The maximum temperature and pressure of the air (ii) The thermal efficiency f) Draw p-V curve for water. Also show various regions and important lines on it.	
Q 3.	Answer any two parts of the following. a) What is kelvin – Plank and Clausius statement? Explain with the help of diagrams. Also Prove that violation of Clausius statement leads to violation of Kelvin-Plank Statement. b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure, and 0.95 m^3/kg volume, and leaving at 5 m/s, 700 kPa, and 0.19 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW. (i) Compute the rate of shaft work input to the air in kW. (ii) Find the ratio of the inlet pipe diameter to outlet pipe diameter. c) A household refrigerator is maintained at a temperature of 2°C. Every time the door is opened, warm material is placed inside, introducing an average of 420 kJ of heat, but the temperature of the refrigerator is always maintained at 2°C. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is 32 paise per kWh. What is the monthly bill for this refrigerator? The atmosphere is at 30°C.	10x2= 20
Q 4.	Answer any two parts of the following. a) What do you understand by Carnot Theorem and its corollaries? Explain with the help of suitable diagrams. b) What is steady flow process? Derive steady flow energy equation (SFEE). c) Draw Brayton cycle on a p-V and T-s diagram. Briefly explain all the processes involved in it and write an expression for its thermal efficiency.	10x2= 20
Q 5.	Answer any two parts of the following. a) Find the enthalpy and entropy of steam when the pressure is 2 MPa and the specific volume is 0.09 m3/kg. Kindly use steam table. b) Draw Otto cycle on p-V and T-s diagram. Briefly explain all the processes involved in it and write an expression for its thermal efficiency. c) Air enters the compressor of a gas turbine (Working on Brayton Cycle) at 300 K and 100 kPa where it is compressed to 700 kPa. The combustor increases the temperature to 1000 K. Determine (i) the thermal efficiency, (ii) the net work. Assume C_p of air 1 kJ/kg K	10x2= 20

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