PVP 20

Code: 20ES1304

II B.Tech - I Semester – Regular / Supplementary Examinations
DECEMBER 2022

BASIC THERMODYNAMICS
(MECHANICAL ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This paper contains questions from 5 units of Syllabus. Each unit carries 14 marks and have an internal choice of Questions.
2. All parts of Question must be answered in one place.

BL – Blooms Level CO – Course Outcome

			BL	CO	Max. Marks
UNIT-I					
1	a)	Explain Zeroth law of thermodynamics. What is its importance?	L2	CO1	5 M
	b)	A gas undergoes a thermodynamic cycle consisting of the following processes: I) Process1–2: Constant pressure P_1=1.4bar, V_1=0.028 m^3, W_{12}=10.5kJ II) Process2–3: Compression with PV = constant, $U_3 = U_2$ III) Process3–1: Constant volume, U_1–U_3 = – 26.4kJ. Assume there are no significant changes in Kinetic energy (KE) and Potential Energy (PE). Determine the following: i) Calculate the network for the cycle in kJ, ii)Calculate the heat transfer for process 1–2, iii) Show that cycle having $\sum Q = \sum W$.	L3	CO1	9 M
OR					
2	a)	Obtain an expression for work and heat transfer for a Polytropic process and analyze the relationship between them.	L2	CO1	5 M
	b)	12.60 liters of a gas at 20°C and 1.03 bar is compressed adiabatically to 9.8 bar. It is then cooled at constant volume to pressure P_3 and further expanded isothermally so as to reach the initial condition. Find	L3	CO1	9 M

		i. the value of pressure P_3 ii. the work done and iii. the change in internal energy in constant volume process. Assume C_p=14.28 kJ/kg K and C_v=10.13 kJ/kg K.			
UNIT-II					
3	a)	Establish and analyze the equivalence of Kelvin-Planck and Clausius statements.	L3	CO2	5 M
	b)	A nozzle is a device for increasing the velocity of a steadily flowing of fluid. At the inlet to a certain nozzle the enthalpy of the fluid is 3025 kJ/kg and the velocity is 60 m/s. At the exit from the nozzle the enthalpy is 2790 kJ/kg. the nozzle is horizontal and there is negligible heat loss from it. Determine the following: i) The velocity at the nozzle exit, ii) If the inlet area is 0.1 m^2 and specific volume at inlet is 0.19 m^3/kg, find the rate of flow of fluid, and iii) If the specific volume at the nozzle exit is 0.5 m^3/kg, find the exit area of the nozzle.	L3	CO2	9 M
OR					
4	a)	What is an irreversible process? Discuss the types of irreversibility and also mention the causes of irreversibility of a process.	L2	CO2	5 M
	b)	A gas flows steadily through a rotary compressor. The gas enters the compressor at a temperature of 16°C, a pressure of 100 kPa, and an enthalpy of 391.2 kJ/kg. The gas leaves the compressor at a temperature of 245°C, a pressure of 0.6 MPa, and an enthalpy of 534.5 kJ/kg. There is no heat transfer to or from the gas as it flows through the compressor. i) Evaluate the external work done per unit mass of gas assuming the gas velocities at entry and exit to be negligible. ii) Evaluate the external work done per unit mass of gas when the gas velocity at entry is 80 m/s and that at exit is 160 m/s. iii) Analyze above two results of rotary compressor with your comment.	L3	CO2	9 M

UNIT-III					
5	a)	Show that entropy is the property of a system.	L2	CO3	5 M
	b)	A reversible heat engine operates between two reservoirs at a temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between 40°C and -20°C. The heat transfer to the heat engine is 2000kJ and the network output of the combined engine refrigerator plant is 360 kJ. Evaluate the following: i) Sketch the neat diagram of combined engine refrigerator plant with the given data, ii) The heat transfer to the refrigerator, and iii) The net heat transfer to the reservoir at 40°C	L3	CO3	9 M
OR					
6	a)	Define heat engine, heat pump and refrigerator and establish relationship between C.O.P of heat pump and refrigerator.	L2	CO3	5 M
	b)	Calculate the entropy change of the universe as a result of the following processes: i) A copper block of 600 g mass and with C_p of 150 J/K at 100°C is placed in a lake at 8°C. ii) The same block, at 8°C, is dropped from a height of 100 m into the lake. iii) Two such blocks, at 100 and 0°C, are joined together.	L3	CO3	9 M
UNIT-IV					
7	a)	With neat schematic diagram, develop an expression for maximum work done by a closed system with flowing into the system ($T_0 > T$).	L4	CO4	4 M
	b)	Air flows through an adiabatic compressor at 2 kg/s. The inlet conditions are 1 bar and 310 K and the exit conditions are 7 bar and 560 K. Compute the net rate of availability transfer and the irreversibility. Take T_0 = 298K.	L3	CO4	10 M
OR					
8	a)	A house husband is cooking mutton for his family in a pan that is: i) uncovered, ii) covered with a light lid, iii) covered with a heavy lid. For which case will the cooking time be the shortest? Why?	L4	CO4	4 M

	b)	2kg of steam at a pressure of 20bar exists in the following cases: i) wet steam with a dryness fraction of 0.9 ii) superheated to 250^0C. Determine enthalpy, volume, entropy and internal energy. (Note: Take C_p=2.302kJ/kgK for super-heated steam)	L3	CO4	10 M
		UNIT-V			
9	a)	Discuss and draw the neat diagrams for the following cycle: i) Atkinson cycle; ii) Brayton cycle, and iii) Lenoir cycle.	L2	CO5	6 M
	b)	An engine working an Otto cycle is supplied with an air at 0.1 MPa, 35°C. the compression ratio 8. Heat supplied is 2100 kJ/kg. Calculate the following: i) The maximum pressure of the cycle, ii) The maximum temperature of the cycle, iii) The cycle efficiency, and iv) The mean effective pressure. **(Note:** for air, C_p = 1.005 kJ/kg K, C_v = 0.718 kJ/kg K and R = 0.287 kJ/kg K)	L3	CO5	8 M
		OR			
10	a)	Compare the Otto cycle, diesel cycle and dual combustion cycle for the following cases: (i) same compression ratio, (ii) maximum pressure and temperature.	L2	CO5	6 M
	b)	In an air standard Diesel engine cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate the following: i) The cut-off ratio, ii) The heat supplied per kg of air, iii) The cycle efficiency, and iv) The mean effective pressure.	L3	CO5	8 M