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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Third Semester, B.E. - Mechanical Engineering

Semester End Examination; March / April - 2022

Basic Thermodynamics

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Understand the basic concepts and definitions used in engineering thermodynamics.

CO2: Apply the first laws of thermodynamics and the concepts of thermodynamics to basic energy systems.

CO3: Understand the properties of pure substances.

CO4: Understanding of the second law of thermodynamics and analysis in different applications.

CO5: Calculate entropy for various simple real life systems.

Note: ***I) PART - A*** *is compulsory.* ***Two*** *marks for each question.*

II) PART - B*: Answer any* ***Two*** *sub questions (from a, b, c) for Maximum of* ***18 marks*** *from each unit.*

III) *Use of thermodynamic data handbook and steam tables are permitted.*

Q. No.		Questions	Marks	BLs	COs	POs
		I : PART - A	**10**			
I	a.	List out the similarities between Work and Heat.	2	L2	CO1	PO1
	b.	Define Enthalpy and write down its significance.	2	L1	CO2	PO1
	c.	Define sensible heat and latent heat of pure substance.	2	L1	CO3	PO1
	d.	What do you mean by thermal reservoir, source and sink?	2	L2	CO4	PO1
	e.	Express the entropy with a neat sketch in terms of temperature and change in heat.	2	L2	CO5	PO1
		II : PART - B	**90**			
		UNIT - I	**18**			
1	a.	i) Show that Work and Heat are path functions.	3	L2	CO1	PO1
		ii) Obtain expressions for displacement work during adiabatic process.	3	L3	CO1	PO1
		iii) Explain, what do you understand by thermodynamic equilibrium?	3	L2	CO1	PO1
	b.	A platinum wire is used as resistance thermometer. The wire resistance was found to be 10 ohm and 16 ohm at ice point and steam point respectively and 30 ohm, at boiling point of 444.6ºC. Find the resistance of the wire at 800ºC, if the wire varies with temperature by the relation $R = R_0[1 + At + Bt^2]$.	9	L3	CO1	PO2
	c.	i) A system consists of a cylinder and a piston machine. The external normal load is applied to the piston is given by, $F = (-150 + 100x)$ kN where x is the distance from the closed end of the cylinder to piston. How much work is achieved when piston moves from $x = 2.5$ to $x = 5$ m.	6	L3	CO1	PO2

Contd... 2

ii) A gas has an initial volume 0.4 m^3 and expands to a final volume of 0.8 m^3. Initial pressure of gas is 0.1 MPa. Find the work done during isothermal process and also find work done during constant volume process. | 3 | L3 | CO1 | PO2

UNIT - II | **18**

2 a. A piston cylinder machine contain a fluid system which passes through a complete cycle, the sum of all heat transfer is −284 kW. The system complete 100 cycles per minutes. Complete the following table showing the method of each items and compute the rate of work output in kW. | 9 | L3 | CO2 | PO2

Process	Q(kJ/min)	W(kJ/min)	ΔE(kJ/min)
a - b	0	2170	-
b - c	21000	0	-
c - d	–2100	-	–36600
d - a	-	-	-

b. Apply the steady flow energy equation with neat sketch for change in enthalpy. | 9 | L3 | CO2 | PO1

i) Boiler ii) Air compressor iii) Steam Nozzle

c. A centrifugal air compressor compresses 5.7 m^3/min of air from 85 kPa to 650 kPa. The initial specific volume is 0.3 m^3/kg the final specific volume is 0.1 m^3/kg. The suction inlet diameter is 0.1 m and that of discharge line is 0.625 m. Determine; | 9 | L3 | CO2 | PO2,3

i) Change in flow work ii) Mass flow rate iii) Velocity change

UNIT - III | **18**

3 a. With a neat sketch, explain the bucket calori meter. | 9 | L3 | CO3 | PO1

b. Steam initially at 1.5 MPa and 350ºC expands to condenser pressure 0.08 bar. The expansion in a turbine, is reversible and isentropic. Find the dryness fraction at exit of the turbine by analytical method using steam table. | 9 | L3 | CO3 | PO1,3

c. The following observations were taken with a separating and a throttling calorimeter:

Water separated = 2 kg, steam discharged from the throttling calorimeter = 20.5 kg, temperature of steam after throttling = 110ºC, initial pressure = 12 bar absolute, barometer reading = 760 mm of Hg, final pressure = 5 mm of Hg. Find the quality of steam supplied. | 9 | L3 | CO3 | PO1,3

Contd... 3

	UNIT - IV	**18**			
4 a.	i) Explain Carnot cycle with PV and TS diagram.	6	L2	CO4	PO1
	ii) Define Perpetual Motion Machine Kind-II (PMMK-2) and explain the same.	3	L2	CO4	PO1
b.	Prove that Kelvin-plank and Clausius statements of second law of thermodynamics are equivalent.	9	L2	CO4	PO1
c.	A reversible heat engine operates between two reservoirs maintaining at temperature of 700ºC and 50ºC. The engine drives a reversible refrigerator which operates between reservoir maintaining at temperature of 50ºC and −25ºC. The heat transfer to the engine is 2500 kJ and network output of combined engine refrigerator is 400 kJ. Determine the heat transfer to refrigerant and net heat transfer to the reservoir at 50ºC.	9	L3	CO4	PO2,3
	UNIT - V	**18**			
5 a.	i) State and prove Clausius inequality.	6	L2	CO5	
	ii) Define Dalton Law, Gibbs law and Amagots law for ideal gas and gas mixtures.	3	L1	CO5	
b.	Prove that change in entropy for polytropic process with usual notations $S_2 - S_1 = C_V \left(\frac{\eta - \gamma}{\eta - 1} \right) ln \frac{T_2}{T_1}$.	9	L2	CO5	
c.	An insulated cylinder of capacity 6 m^3 contains 30 kg of nitrogen. Paddle work is done on the gas by stirring it till the pressure in the vessel gets increased from 3 bar to 7.5 bar. Determine; i) Change in internal energy ii) Work done iii) Heat transferred iv) Change in entropy Take for Nitrogen C_P = 1.04 kJ/kg-K and C_V = 0.7432 kJ/kg-K	9	L3	CO5	

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