SIDDHARTH INSTITUTE OF ENGINEERING &TECHNOLOGY
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QUESTION BANK (DESCRIPTIVE)

Subject with Code: Engineering Thermodynamics (**16ME307**) **Course & Branch**: B.Tech - ME

Year & Sem: II-B. Tech & II-Sem **Regulation:** R16

UNIT –I

BASIC CONCEPTS

1	a)	Show that heat and work is a path function and not a property of the system	6M
	b)	What is quasi static process? What are its characteristics features?	6M
2		State the following a) Enthalpy b) Internal Energy c) Specific heat d) Thermodynamic cycle	12M
3		Explain thermodynamics system, surrounding and universal. Distinguish between closed, open, isolated homogenous and heterogeneous systems. Illustrate with examples	12M
4	a)	Discuss the macroscopic and microscopic point of view of thermodynamics	6M
	b)	What is the difference between a closed system and an open system?	6M
5	a)	Define and explain Zeroth Law of Thermodynamics".	6M
	b)	What do mean by property"? Distinguish between intensive and extensive	6M
6	a)	Differentiate between the cyclic process and non-cyclic process	6M
	b)	State the following b) Pressure b) Temperature c) volume d) Density	6M
7	a)	What do you understand by path function and point function? What are the exact and inexact differentials?	6M
	b)	State the thermodynamic system control volume.	6M
8		What is meant by thermodynamics equilibrium? Explains its types briefly.	12M
9		State the differences between heat and work.	12M
10		Explain the following terms	
		a) State	2M
		b) Path	2M
		c) Process	3M
		d) Cyclic process	2M
		e) System.	3M

UNIT – II
FIRST LAW OF THERMODYNAMICS

1 a) State first law of thermodynamics. Prove that internal energy is a property of the system. 6M

b) In a cycle which has five processes, the following are the heat transfers at five points. Q_1 = +50KJ, Q_2 = 85KJ, Q_3= -30KJ, Q_4=-70KJ and Q5= +135KJ, the work transfers are W_1 = +60KJ, W_2 = -40KJ, W_3= 35KJ, W_4=-20KJ and W5= +135KJ, Find out the work transfer at the fifth point. 6M

2 a) Derive Steady Flow Energy Equation for Turbine 6M

b) A turbine operates under steady flow conditions, receiving the steam having an enthalpy of 2786 KJ/Kg and leaves with an enthalpy of 2513 KJ/Kg. Heat is lost to the surroundings at the rate of 5.30 KJ/sec. If the rate of steam flows though the turbine is 0.40Kg/sec. Find the power output of the turbine. 6M

3 A system undergoes a cycle composed of four processes and the energy transfers are tabulated below. 12M

Process	Heat transfer in KJ/min	Work done in KJ/min	Change in internal energy KJ/min
1-2	550	230	-
2-3	230	-	380
3-4	-550	-	-
4-1	0	70	-

a) Complete the table and b) determine rete of work in KW.

4 The system contains piston and cylinder is subjected to a process, such that its volume increases from 0.004 m^3 to 0.034 m^3 at constant pressure of 750KN/m^2. The heat supplied through the walls of cylinder the process is 8 KJ. Calculate the change in internal energy of the system. 12M

5 The air in a system expands from a temperature of 60^0C to 300^0C at a constant pressure of 2 bars. Calculate the heat transfer, work done and change in internal energy. The mass of the air is 0.6 Kg. Assume C_p=1.02 KJ/Kg^K and C_v= 0.71 KJ/Kg^K for air. 12M

6 a) Derive Steady Flow Energy Equation for Nozzle 6M

b) The enthalpy of a steam 3015.6 KJ/Kg enters a nozzle and leaves with an enthalpy of 2819.8 KJ/Kg. Calculate the velocity of steam at the exit, if the velocity of steam at the entry is 50 m/sec 6M

7 a) What are the different modes in which energy is stored in a system 6M

b) Derive Steady Flow Energy Equation for compressor 6M

8 a) During a cycle consisting of four processes, the heat transfer are a s following. Q1 = +60KJ, Q_2 = -40KJ, Q_3= 15KJ, and Q_4=-20KJ, Determine the net work done by the system. 6M

b) Explain the Specific heat capacities (C_p & C_v), 6M

9 a) Define Mass Balance? Derive equation for it. 6M

	b)	What is Steady Flow Process? Derive SFEE for any one engineering system	6M
10		Explain the following terms	
	a)	First law Thermodynamic	2M
	b)	Energy is a Property	3M
	c)	Internal energy	2M
	d)	Enthalpy	3M
	e)	Specific heat capacities (C_p & C_v)	2M

UNIT – III
Second law of Thermodynamics

1	a)	What are the limitations of the First law of Thermodynamics?	6M
	b)	It takes 10 kW to keep the interior of a certain house at 20°C when the outside temperature is 0°C. This heat flow is usually obtained directly by burning gas or oil. Calculate the power required if the 10 kW heat flow were supplied by operating a reversible engine with the house as the upper reservoir and the outside surroundings as the lower reservoir, so that the power were used only to perform work needed to operate the engine.	6M
2		State and explain second law of thermodynamics	6M
		A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in *Q*1 heat units at *T*1 and rejects *Q*2 at *T*2. The heat pump abstracts *Q*4 from the sink at *T*4 and discharges *Q*3 at *T*3. Develop an expression for the ratio *Q*4/*Q*1 in terms of the four temperatures.	6M
3		Show the equivalence of Clausius and Kelvin statement of second law	6M
		An inventor claims to have developed an engine that takes in 105 MJ at a temperature of 400 K, rejects 42 MJ at a temperature of 200 K, and delivers 15 kWh of mechanical work. Would you advise investing money to put this engine in the market?	6M
4		A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 0.525 kJ/s per degree temperature difference between the inside and outside. (a) If the outside temperature in winter is 5°C, what is the minimum power required driving the heat pump? (b) If the power output is the same as in part (a), what is the maximum outer temperature for which the inside can be maintained at 20°C?	12M
5		A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5°C reservoir, determine (a) The rate of heat supply from the 840°C source (b) The rate of heat rejection to the 60°C sink.	12M
6		An adiabatic vessel contain 2 kg of water at 25 0C. By peddle wheel work transfer the temperature of water is increase to 30 0C. If the specific heat of water is assumed constant at 4.187 kJ/kgK, Find entropy change of universe	12M
7		Two vessels, A and B, each of volume 3 m3 may be connected by tube of negligible volume. Vessel A contains air atn0.7 MPa, 95 0C, while vessel B contains air at 0.35 MPa, 250 0C. Find the change of entropy when A is connected to B by working from the first principles and assuming the mixing to be completed and adiabatic.	12M

8		A copper rod is of length 1 m and diameter 0.01m. One end of the rod is at 100 0C, and the other at 0 0C. The rod is perfectly insulated along its length and the thermal conductivity of copper is 380 W/mK. Calculate the rate of heat transfer along the rod and the rate of entropy production due to irreversibility of this heat transfer.	12M
9		A block of iron weighing 100 kg an having a temperature of 100 0C is immersed in 50 kg of water at a temperature of 20 0C. What will be the change of entropy of the combined system of iron and water? Specify heats of iron and water are 0.45 and 4.18kJ/kg K respectively.	12M
10		Calculate the decrease in exergy when 25 kg of water at 95 0C mix with 35 kg of water at 35 0C, the pressure being taken as constant and temperature of the surrounding being 15 0C (cp of water = 4.2 kJ/kg K).	12M

UNIT – IV
IDEAL & REAL GASES

1	a)	What is Avogadro’s law?	6M
	b)	What is the gas equation of ideal gas?	6M
2	a)	Write Vander walls equation of state. How does it differ from the ideal gas equation of state	6M
	b)	State Dalton’s law of partial pressures	6M
3		A mass of 0.25 kg of an ideal gas has a pressure of 300 kpa, the temperature of 800C and a volume of 0.07 m3.The gas undergoes an irreversible adiabatic process to final pressure of 300 kpa and final volume of 0.1 m3,during which the work done on the gas is 25 kj. Evaluate CP and Cv of the gas and increase in the entropy of the gas.	12M
4		Consider a gas mixture of molecular weight 33, 300 k and occupying a volume of 0.1 m3. The gas undergoes an d expansion to 0.02 m3 during the pressure –volume relation is PV1.3 = constant. Assume in CV =0.6+2.5x10-4T .where T is in Kelvin and CV is kj /kg k ,and neglecting KE,PE effects .Determine (a)The mass of gas (b) The final pressure (C) The final temperature (D) the work and heat transfer	12M
5		A cylinder Tank containing 4 kg of carbon monoxide gas at -500C has internal diameter of 0.2m and length of 1m.Determine the pressure exerted by the gas using (a) The generalize compressibility chart (b) The ideal gas of equation of state (c) Vander Walls equation of state	12M
6		One kg of air in a closed system, initially at 5°C and occupying 0.3m^3 volume, undergoes a constant pressure heating process to 100°C. There is no work other than *pdv* work. Find (a) the work done during the process, (b) the heat transferred, and (c) the entropy change of the gas.	12M
7		If the above process occurs in an open steady flow system, find the final temperature, and per kg of air, the change in internal energy, the heat transferred,	12M

		and the shaft work. Neglect velocity and elevation changes.	
8		Air in a closed stationary system expands in a reversible adiabatic process from 0.5 MPa, 15°C to 0.2 MPa. Find the final temperature, and per kg of air, the change in enthalpy, the heat transferred, and the work done.	12M
9		A mass of an ideal gas exists initially at a pressure of 200 kPa, temperature 300 K, and specific volume 0.5 m3 /kg. The value of r is 1.4. (a) Determine the specific heats of the gas. (b) What is the change in entropy when the gas is expanded to pressure 100 kPa according to the law pv1.3 = const? (c) What will be the entropy change if the path is pv1.5 = const. (by the application of a cooling jacket during the process)? (d) What is the inference you can draw from this example?	12M
10		Air contained in a cylinder fitted with a piston is compressed reversibly according to the law pv1.25 = const. The mass of air in the cylinder is 0.1 kg. The initial pressure is 100 kPa and the initial temperature 20°C. The final volume is 1/ 8 of the initial volume. Determine the work and the heat transfer.	12M

UNIT – V
GENERAL THERMODYNAMIC PROPERTY RELATIONS & AIR STANDARD CYCLES

1	a)	What is Joule- Thomson coefficient? Why he is zero for ideal gas	6M
	b)	Derive the Clapeyron equation.	6M
2		Write down first and second Tds equations. And derive the expression for the difference in heat capacities Cp and Cv. What does the expression signify?	12M
3		Derive the Maxwell's equations	12M
4		An engine working on the otto cycle is supplied with air at 0.1 MPa ,350C .the compression ratio is 8.the heat supplied is 2100 kJ/kg .calculate the Maximum pressure and temperature of the cycle ,the cycle efficiency and the mean effective pressure.(for air Cp=1.005kj/kg. k , Cv = 0.717 kJ/kgk, and R=0.287 kJ/kgk)	12M
5		In an air standard diesel cycle, the compression ratio is 16, and at the begging of isentropic compression, the temperature is 15 0C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480 0C. Calculate (a) The Cut-off ratio (b) The heat supplied per kg of air(c) The cycle efficiency (d) the mean effective pressure	12M
6		An Air Standard Dual cycle has a compression ratio of 16, and the compression begins at 1 bar, 500C.The maximum pressure is 70 bar, the heat transferred to air at constant pressure is equal to that at constant volume. Estimate (a)The pressure and temperature at the cardinal points of the cycle(b) The cycle efficiency (c) the mean effective pressure (for air Cp=1.005kj/kg. k , Cv = 0.717 kJ/kgk, and R=0.287 kJ/kgk)	12M
7		A diesel Engine has a compression ratio of 14 and cut-off takes place at 6% of the stroke. Find the Air standard efficiency.	12M

8	Derive an expression for the thermal efficiency of Diesel cycle and draw P-V & T-S diagrams.	12M
9	Derive an expression for the thermal efficiency and mean effective pressure of an Otto cycle by drawing PV and TS diagrams	12M
10	Derive an expression for thermal efficiency & mean effective pressure of a dual combustion cycle by drawing PV and TS diagrams.	12M

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