Course Code:20ME0303 **R20**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
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QUESTION BANK (DESCRIPTIVE)

Subject with Code: Basic Thermodynamics (20ME0303) **Course & Branch**: B. Tech – ME
Year & Sem: I - B. Tech & II - Sem **Regulation:** R20

UNIT –I

Basic Concepts, Work & Heat Transfer, Zeroth Law of Thermodynamics

1		What is a thermodynamic system? Explain different types of systems with suitable examples.	[L1&L2]	[CO1]	[12M]
2	a)	Define the following terms a) System b) Boundary c) Surroundings	[L1]	[CO1]	[6M]
	b)	What do mean by property? Distinguish between intensive and extensive property.	[L1], [L4]	[CO1]	[6M]
3	a)	List the difference between a closed system and an open system.	[L1]	[CO1]	[6M]
	b)	Compare the cyclic process and non-cyclic process.	[L5]	[CO1]	[6M]
4	a)	Define the following a) Enthalpy b) Internal Energy	[L1]	[CO1]	[6M]
	b)	What is quasi static process? Explain in detail.	[L1&L2]	[CO1]	[6M]
5	a)	What is meant by thermodynamic equilibrium? Explain its types briefly.	[L1&L2]	[CO1]	[6M]
	b)	Describe thermodynamic control volume.	[L1]	[CO1]	[6M]
6		Explain thermodynamic State, Process and Cycle	[L2]	[CO1]	[12M]
7	a)	What do you understand by path function and point function? What are the exact and inexact differentials?	[L1]	[CO1]	[6M]
	b)	Show that work is a path function and not a property.	[L1]	[CO1]	[6M]
8		Classify different work transfers. Explain them.	[L2]	[CO1]	[12M]
9	a)	Compare the differences between heat and work transfers.	[L4]	[CO1]	[6M]
	b)	Explain about Work and Heat transfer.	[L2]	[CO1]	[6M]
10		Describe Pressure, Temperature, Enthalpy, Internal energy and Entropy.	[L1]	[CO1]	[12M]
11	a)	Explain Zeroth law of thermodynamics.	[L2]	[CO1]	[6M]
	b)	Define Heat, Temperature and concept of thermal Equilibrium.	[L1]	[CO1]	[6M]

UNIT – II

First Law of Thermodynamics, Second Law of Thermodynamics

1	a)	Define first law of thermodynamics. Justify that internal energy is a property of the system.	[L1&L5]	[CO2]	[6M]

	b)	In an internal combustion engine, during the compression stroke the heat rejected to the cooling water is 50kJ/kg and the work input is 100kJ/kg. Calculate the change in internal energy of the working fluid stating whether it is a gain or loss.	[L4]	[CO2]	[6M]
2	a)	A tank containing air is stirred by a paddle wheel. The work input to the paddle wheel is 9000 kJ and the heat transferred to the surroundings from the tank is 3000 kJ. Determine : (i) Work done ; (ii) Change in internal energy of the system.	[L3]	[CO2]	[6M]
	b)	In an air motor cylinder the compressed air has an internal energy of 450kJ/kg at the beginning of the expansion and an internal energy of 220kJ/kg after expansion. If the work done by the air during the expansion is 120kJ/kg, calculate the heat flow to and from the cylinder.	[L4]	[CO2]	[6M]
3		A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle the sum of all heat transfer is -170 KJ. The system completes 100 cycles per min. Complete the following table showing the method for each item, and computes the net rate of work output in kW.	[L3]	[CO2]	[12M]

Process	Heat transfer in KJ/min	Work done in KJ/min	Change in internal energy KJ/min
a-b	0	2170	-
b-c	21,000	0	-
c-d	-2,100	-	-36,600
d-a	-	-	-

4	a)	Explain the First law of Thermodynamics'. Formulate the equation for heat in a non-flow reversible constant pressure process.	[L2&L6]	[CO2]	[6M]
	b)	Define Statements of second law of thermodynamics i) Clausius statement ii) Kelvin-plank statement	[L1]	[CO2]	[6M]
5		What is Steady Flow Process? Derive Steady Flow Energy Equation(SFEE) for an open system	[L1&L3]	[CO2]	[12M]
6	a)	Compare heat pump and a refrigerator.	[L5]	[CO2]	[6M]
	b)	10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are: P_1 = 1.5 bar, ρ_1 = 26 kg/m^3, [CO1] = 110 m/s and u_1 = 910 kJ/kg and at the exit are P_2 = 5.5 bar, ρ_2 = 5.5 kg/m^3, [CO2] = 190 m/s and u_2 = 710 kJ/kg. During the passage, the fluid rejects 55 kJ/s and rises through 55 meters. Determine : (i) The change in enthalpy (Δ h) ; (ii) Work done during the process (W).	[L3]	[CO2]	[6M]
7	a)	Explain reversibility and irreversibility. List examples	[L2&L1]	[CO2]	[6M]
	b)	Describe availability and unavailability.	[L1]	[CO2]	[6M]
8		Derive the reversible adiabatic process law $pv^\gamma = c$	[L3]	[CO2]	[12M]
9	a)	Explain the concept of change in entropy.	[L2]	[CO2]	[6M]

	b)	Give an expression for entropy changes for open systems.	[L2]	[CO2]	[6M]
10	a)	What are the limitations of the First law of Thermodynamics?	[L1]	[CO2]	[6M]
	b)	Prove equivalence of Clausius statement with Kelvin Plank Statement.	[L3]	[CO2]	[6M]

UNIT – III

Law of Perfect Gas, Thermodynamic Processes on Gases

1		Define Avogadro law. Develop equation of state of an Ideal gas.	[L1&L3]	[CO3]	[12M]
2		Prove that for an ideal gas C_p- C_v=R.	[L3]	[CO3]	[12M]
3		Derive the equation for computing the entropy change of an Ideal gas.	[L3]	[CO3]	[12M]
4	a)	State and Explain Dalton law of partial pressure.	[L1&L2]	[CO3]	[6M]
	b)	How the partial pressure in gas mixture related to mole fraction?	[L2]	[CO3]	[6M]
5		Develop the expression of work transfer for an ideal gas in reversible isothermal process.	[L3]	[CO3]	[12M]
6		A certain gas has C_p = 1.968 kJ/kg K, and C_v = 1.507 kJ/kg K. Find its molecular weight and gas constant. A constant volume chamber of 0.3m^3 capacity contains 2kg of this gas at 5^{0}C. Heat is transferred to the gas until the temperature is 100^{0}C. Find the work done, heat transferred and the changes in internal energy, enthalpy and entropy.	[L3]	[CO3]	[12M]
7		A mass of 0.25kg of an ideal gas has a pressure of 300 kPa, a temperature of 80^{0}C and a volume of 0.07 m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 kPa and final volume of 0.12m^3, during which the work done on the gas is 25 kJ. Evaluate the C_p and C_v of the gas and the increase in entropy of the gas.	[L5]	[CO3]	[12M]
8		An insulated cylinder of volume capacity 4 m^3 contains 20 kg of nitrogen. Paddle work is done on the gas by stirring it till the pressure in the vessel gets increased from 4 bar to 8 bar. Determine : (i) Change in internal energy, (ii) Work done, (iii) Heat transferred, and (iv) Change in entropy. Take for nitrogen: C_p = 1.04 kJ/kg K,and C_v = 0.7432 kJ/kgK.	[L3]	[CO3]	[12M]
9.	a)	What is a polytropic process?	[L1]	[CO3]	[4M]
	b)	A cylinder contains 0.45 m^3 of a gas at 1 × 10^5 N/m^2 and 80°C. The gas is compressed to a volume of 0.13 m^3, the final pressure being 5 × 10^5 N/m^2. Determine : (i) The mass of gas ; (ii) The value of index 'n' for compression ; (iii) The increase in internal energy of the gas ; (iv) The heat received or rejected by the gas during compression.	[L3]	[CO3]	[[8M]]

		Take ɣ = 1.4, R = 294.2 J/kg°C.			
10	a)	Derive the equation for work done in a reversible adiabatic process.	[L3]	[CO3]	[6M]
	b)	90 kJ of heat are supplied to a system at a constant volume. The system rejects 95 kJ of heat at constant pressure and 18 kJ of work is done on it. The system is brought to original state by adiabatic process. Determine : (i) The adiabatic work ; (ii) The values of internal energy at all end states if initial value is 105 kJ.	[L3]	[CO3]	[6M]

UNIT – IV

Thermodynamic Cycles, Pure Substances

1.	a)	Develop an expression for Carnot Cycle and efficiency of cycle.	[L6]	[CO4]	[6M]
	b)	A Carnot engine working between 400^0 C and 40^0 C produce 130 KJ of work. Determine i) The thermal efficiency. ii) the heat added iii) The entropy changes during the heat rejection process.	[L3]	[CO4]	[6M]
2.		Develop the expression for air standard efficiency, work done of an Otto cycle.	[L6]	[CO4]	[12M]
3.	a)	Develop the expression for air standard efficiency for diesel engine.	[L6]	[CO4]	[6M]
	b)	The stroke and cylinder diameter of a compression ignition engine are 250mm and 150mm respectively. If the clearance volume is $0.0004m^3$ and fuel injection take place at constant pressure for 5% of the stroke. Determine the efficiency of the engine. Assume the engine working on the diesel cycle.	[L3]	[CO4]	[6M]
4		Develop an expression for air standard efficiency of dual combination cycle.	[L6]	[CO4]	[12M]
5		The swept volume of a diesel engine working on dual cycle is $0.0053m^3$. The maximum pressure is 65 bar. Fuel injection end at 5% of stroke. The temperature and pressure at the stroke of compression are 80^0 C and 0.9 bar. Determine efficiency of air take γ =1.4.	[L3]	[CO4]	[12M]
6		Build the phase equilibrium diagram for a pure substance P-T plot with relevant constant property line.	[L3]	[CO4]	[12M]
7		Build the phase equilibrium diagram for a pure substance T-S plot with relevant constant property line.	[L3]	[CO4]	[12M]
8	a)	Show the phase equilibrium diagram for a pure substance h-S plot with relevant constant property line.	[L1]	[CO4]	[6M]
	b)	Show the enthalpy, entropy and volume of steam at 1.4 MPa.	[L1]	[CO4]	[6M]
9	a)	Recall a short note on dryness fraction.	[L1]	[CO4]	[6M]
	b)	Find the saturation temperature change in specific volume and	[L3]	[CO4]	[6M]

		entropy during evaporation and latent heat of vaporization of steam at 1Mpa 380^0C.			
10		Differentiate between Otto cycle, diesel cycle and dual combustion cycle.	[L4]	[CO4]	[12M]

UNIT – V

Vapour Power Cycle, Methods of improving cycle performance

1		Describe Simple steam power cycle with neat sketches.	[L2]	[CO5]	[12M]
2		In a steam turbine steam at 20 bar, 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes, find per kg of steam the net work and the cycle efficiency.	[L3]	[CO5]	[12M]
3		Explain the Rankine cycle with PV and TS diagrams.	[L2]	[CO5]	[12M]
4		A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.	[L3]	[CO5]	[12M]
5	a)	Compare Rankine cycle with Carnot cycle.	[L4]	[CO5]	[6M]
	b)	What will be the effect of operating conditions on Rankine cycle efficiency?	[L1]	[CO5]	[6M]
6		List the advantages and disadvantages of Regenerative cycle over Simple Rankine cycle.	[L1]	[CO5]	[12M]
7		Explain the process of improving Rankine cycle efficiency with regeneration.	[L2]	[CO5]	[12M]
8		A steam turbine is fed with steam having an enthalpy of 3100 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed heating is done at a pressure of 3.2 bar with steam enthalpy of 2500 kJ/kg. The condensate from a condenser with an enthalpy of 125 kJ/kg enters into the feed heater. The quantity of bled steam is 11200 kg/h. Find the power developed by the turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2 bar and the heater is direct mixing type. Neglect pump work.	[L3]	[CO5]	[12M]
9		How the reheating does improve Rankine cycle efficiency?	[L2]	[CO5]	[12M]
10		A steam power plant operates on a theoretical reheat cycle. Steam from boiler at 150 bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagrams. Find : (i) Quality of steam at turbine exhaust ; (ii) Cycle efficiency ; (iii) Steam rate in kg/kWh.	[L3]	[CO5]	[12M]

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