II B. Tech I Semester Regular Examinations, March - 2021
THERMODYNAMICS
(Com to ME, AME)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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1 a) What is a thermodynamic system? Explain different classes of systems with suitable examples. [8M]

b) Compare macroscopic and microscopic approaches in thermodynamic studies? [7M]

Or

2 a) What is a quasi-static process with example? [8M]

b) The properties of a closed system will change following the relation between pressure and volume as PV = 3.0 where P is in bar, V is in m3. Calculate the work done when the pressure increases from 1.5 bar to 7.5 bar. [7M]

3 Write down the general equation for steady flow systems and simplify when applied for the following systems: [15M]
(a) Steam turbine.
(b) Steam nozzle.
(c) Centrifugal compressor.
(d) Condenser.

Or

4 a) Define the first law of thermodynamics? [5M]

b) A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine: [10M]
(i) The thermal efficiency.
(ii) The rate of heat rejection

5 a) Define Carnot efficiency and which is the more effective way to increase the efficiency of a Carnot cycle: to increase T_1 keeping T_2 constant; or to decrease T_2, keeping T_1 constant? Where T_1 is upper temperature and T_2 is lower temperature. [8M]

b) Discuss the significance of Gibbs and Helmholtz functions. [7M]

Or

6 a) Prove that entropy is a property of a system. [7M]

b) 5 kg of air at 550 K and 4 bar is enclosed in a closed system. [8M]
(i) Determine the availability of the system if the surrounding pressure and temperature are 1 bar and 290 K respectively.
(ii) If the air is cooled at constant pressure to the atmospheric temperature, determine the availability

7 a) A mass of wet steam at temperature 165°C is expanded at constant quality 0.8 to pressure 3 bar. It is then heated at constant pressure to a degree of superheat of 66.5°C. Find the enthalpy and entropy changes during expansion and during heating. Draw the T–s and h–s diagrams. [8M]

b) Explain about phase transformation and various properties involved during phase change? [7M]

Or
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8 a) Discuss about triple point & critical point. [7M]

b) A pressure cooker contains 1.5 kg of saturated steam at 5 bar. Find the quantity of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature of the steam at the new state. [8M]

9 a) Explain about adiabatic mixing of perfect gases. [7M]

b) A mixture of hydrogen (H_2) and oxygen (O_2) is to be made so that ratio of H_2 to O_2 is 2:1 by volume. If the pressure and temperature are 1 bar and 25 respectively, calculate: [8M]

(i) The mass of O_2 required.

(ii) The volume of the container

Or

10 a) Explain about compressibility charts. [7M]

b) Explain the following [8M]

i)Heating and humidification

ii) Cooling and dehumidification.

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1 a) Briefly discuss about the work and heat transfer. [8M]

b) A Gas of volume 6000CC at a pressure of 100 kPa is compressed quasi statically according to PV^2 = aconstant until the volume becomes 2000CC. Determine the final pressures and work transfer. [7M]

Or

2 a) Show that work is a path function and not a property. [7M]

b) A gas under goes two processes: Process 1-2 expansion from pressure P1 = 340 kPa and volume V1 = 0.0425 m^3 to pressure P2 = 136 kPa, during which the P-V relation is given by PV2 = constant. Process 2-3 constant pressure compression to volume V3 = V1. Sketch the processes on a P-V diagram and determine the work done. [8M]

3 a) Apply first law to a process and a cycle. [8M]

b) A cyclic heat engine operates between a source temperature of 800°C and a sink temperature of 30°C. What is the least rate of the heat rejection per kW net output of the engine? [7M]

Or

4 a) Define internal energy and prove that it is a property of the system. [7M]

b) A system executes a cyclic process during which there are four transfers of heat as given below: Q_{1-2} = 880 kJ; Q_{2-3} = 100 kJ; Q_{3-4} = -720 kJ; Q_{4-1} = 200 kJ. The work transfers during the processes are given as: W_{1-2} = 60 kJ; W_{2-3} = -40 kJ; W_{3-4} = 80 kJ. Find W_{4-1}. [8M]

5 a) Explain in detail about Clausius inequality. [7M]

b) Derive the Maxwell relations. [8M]

Or

6 a) Explain the working of car not cycle and derive the expression for its thermal efficiency. [8M]

b) Define about thermal reservoir and heat engine performance parameters? [7M]

7 a) Derive Clausius Clapeyron equation [8M]

b) Using Clausius Clapeyron equation, estimate the enthalpy of vaporization at 220 saturation temperature. Take the following data Ts = 220°c, vg = 0.086 m^3 /kg, vf = 0.001109 m3 /kg, (dP/dT) = 52 kPa/K. [7M]

Or

8 a) A rigid vessel of capacity 0.2 m^3 holds 10 bar steam at 250^0C. The vessel is slowly cooled till the steam pressure drops to 3.5 bar. Determine the (i) final temperature and dryness fraction of steam; (ii) change in entropy. [8M]

b) Define critical-point phase transformation? [7M]

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9 a) A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon dioxide and at a pressure of 300 KPa and temperature of 20^0 C. Find (i) the mole fraction of each constituent, [10M]
(ii) the equivalent molecular weight of the mixture,
(iii) the equivalent gas constant of the mixture,
(iv) the partial pressures and partial volumes,
(v) the volume and density of mixture, and
(vi) the Cp and Cv of the mixture. If the mixture is heated at constant volume to 40^0 C, find the changes in internal energy, enthalpy and entropy of the mixture. If heating is done at constant pressure, calculate the changes in internal energy, enthalpy and entropy of the mixture. Take γ for CO_2 and N_2 to be 1.286 and 1.4 respectively.

b) State van-der-Waals equation of state? [5M]

Or

10 a) Explain about adiabatic mixing of perfect gases. [7M]

b) State Dalton's law of partial pressures and Avogadro's laws of additive volumes. [8M]

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1 a) What is a system? Explain different types of systems with example. [8M]

b) Explain the zeroth law of thermodynamics with neat sketch. Explain how it is important in establishing the temperature scale? [7M]

Or

2 a) Explain the working of constant volume gas thermometer. [7M]

b) A three process cycle operating with nitrogen as the working substance has constant temperature compression at 34^0C with initial pressure 100 kPa. Then the gas undergoes a constant volume heating and then polytropic expansion with 1.35 as index of expansion. The isothermal compression requires -67 kJ/kg of work. Determine [8M]
i) pressure, volume and temperature around the cycle
ii) Heat in and out
iii) Net work For Nitrogen gas CX=0.7431 kJ/kg-K.

3 a) Explain Joule's experiment? [7M]

b) Derive the steady flow energy equation and apply it to a Heat exchanger? [8M]

Or

4 a) At the inlet to a certain nozzle the enthalpy of fluid passing is 2800 kJ/kg and velocity is 50 m/s. At the discharge end the enthalpy is 2600 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it.(10m) [10M]
(i) Find the velocity at exit of the nozzle.
(ii) If the inlet area is 900 cm^2 and specific volume at inlet is 0.187 m^3/kg find mass flow rate.
(iii) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle.

b) Write the corollaries of first law of thermodynamics? [5M]

5 a) Establish the equivalence of Kelvin- Planck and Clausius statements. [7M]

b) Discuss about Carnot theorem with neat diagram. [8M]

Or

6 a) Prove that entropy is a property of a system. [7M]

b) 1 kg of air initially at 8 bar pressure and 380 K expands polytropically (pv1.2 = constant) until the pressure is reduced to one -fifth value. Calculate: [8M]
(i) Final specific volume and temperature.
(ii) Change of entropy, work done and heat interaction.
(iii) Change in entropy.

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7	a)	Sketch the H-S and P-T diagram of a pure substance.	[7M]
	b)	Describe with a neat sketch, separating throttling calorimeter for measuring the degree fraction of steam.	[8M]

Or

8	a)	A large, insulated vessel is divided into two chambers one containing 5 kg of dry saturated steam at 0.2 MPa and the other 10 kg of steam, 0.8 quality at 0.5 MPa. If the partition between the chambers is removed and the steam is mixed thoroughly and allowed to settle, find the final pressure, steam quality and entropy change in the process.	[7M]
	b)	Draw the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property lines.	[8M]
9	a)	A gaseous mixture consists of 1 kg of oxygen and 2 kg of nitrogen at a pressure of 150 kPa and a temperature of 20^0C. Determine the changes in internal energy, enthalpy and entropy of the mixture when the mixture is heated to a temperature of 100^0C (i) at constant volume and (ii) at constant pressure..	[8M]
	b)	Define the following (i) Thermodynamic wet bulb temperature (ii) Specific humidity (iii)Saturated air	[7M]

Or

10	a)	State and prove Avogadro's law of additive volumes..	[8M]
	b)	Atmosphere air at 1.0132 bar has a dbt of 32^0C and wbt of 26^0C, compute i) the partial pressure of water vapour, ii) specific humidity, iii) dew point temperature, iv) relative humidity, v) degree of saturation, vi)density of air in the mixture, vii) density of vapour in the mixture, vii) enthalpy of the mixture. .	[7M]

Code No: R1921035 **R19** SET - 4

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1 a) Explain quasi – static process? What is its characteristic feature? [8M]

b) Which property of a system increases when heat is transferred. [7M]
i). at constant volume,
ii).at constant pressure.

Or

2 a) A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which pv = constant. The initial density of air is 1.16 kg/m^3. Find the work done by the piston to compress the air. [8M]

b) Show that work is a path function and not a property [7M]

3 a) Define internal energy. How is energy stored in molecules and atoms? [7M]

b) A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation: u = l.5 pv – 85 kJ/kg. Where P is the kPa and V is in m^3 /kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. [8M]

Or

4 a) Distinguish between reversible process and cyclic process. Write the causes of irreversibility? [7M]

b) Derive the steady flow energy equation and apply in to steam nozzle and turbine. [8M]

5 a) A reversible heat engine operates between two reservoirs at temperatures of 600^0C and 40^0C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40^0C and -20^0C. The heat transfer to the engine is 2000 kJ and the net work output of the combined engine-refrigerator plant is 360 kJ. [10M]
(i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40^0C.
(ii) Reconsider (i) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible value.

b) Explain about heat engine and heat pump [5M]

Or

6 a) What is the absolute thermodynamic temperature scale? Show that a definite point exists on the absolute temperature scale but that this point cannot be reached without the violation of the second law. [8M]

b) Write the Maxwell's equations and derive the first and second Tds equations. [7M]

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7 a) Why cannot a throttling calorimeter measure the quality if the steam is very wet? How is the quality measured then? [8M]

b) A steam boiler initially contains 5 m^3 of steam and 5 m^3 of water at 1 MPa. Steam is taken out at constant pressure until 4 m^3 of water is left. What is the heat transferred during the process? [7M]

Or

8 a) Describe with a neat sketch, separating throttling calorimeter for measuring the degree fraction of steam? [8M]

b) Explain the properties during phase-change? [7M]

9 a) Define Compressibility factor 'Z'. Discuss the significance of the compressibility factor. [7M]

b) Explain Beattie – Bridgeman equation of state? [8M]

Or

10 a) Derive the expressions for the internal energy and specific heats for mixtures of ideal gases. [7M]

b) Explain Psychometric properties of atmospheric air. [8M]

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