Reg. No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

ME205: THERMODYNAMICS (AN, MA, ME, MP)

Max. Marks: 100 Duration: 3 Hours

PART A
(Answer any THREE questions)

1. a) Explain thermodynamic equilibrium . (3)

   b) What is quasi-static process? What is its characteristic feature? (3)

   c) What is the concept of continuum? How will you define density and pressure using this concept? (4)

2. Write short notes on

   a) Different forms of energy. (3)
   b) System, boundary and surroundings. (4)
   c) Point and path functions. (3)

3. a) Define specific heat and derive it for constant pressure and constant volume. (4)

   b) A turbo compressor delivers 2.33 m^3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. (6)

4. a) Calculate the internal energy and enthalpy of 1kg of air occupying $0.03m^3$ at 3MPa. (4)

   b) Explain Joule's experiment with neat sketches and state first law. (6)

PART B
(Answer any THREE questions)

5. a) State and prove Clausius' theorem (4)
   b) A fluid undergoes a reversible adiabatic compression from 0.5MPa, $0.2m^3$ to $0.05m^3$ according to the law, $pv^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process. (6)

6. a) Establish the Inequality of Clausius? (5)
   b) Explain entropy principle and its applications? (5)

7. a) What is the critical state? Draw the phase equilibrium diagram on p-v coordinates for a substance which shrinks in volume on melting. (4)

b) Steam initially at 0.3 MPa, 250°C is cooled at constant volume. (a) At what temperature will the steam become saturated vapour? (b) What is quality at 80°C? (c) What is the heat transferred per kg of steam in cooling from250°C to 80°C? (6)

8. a) What is exergy, dead state and triple point? (4)
   b) A rigid vessel contains 1 kg of a mixture of saturated water and saturated steam at a pressure of 0.15 MPa. When the mixture is heated, the state passes through the critical point.
   Determine
   (i) The volume of the vessel.
   (ii) The mass of liquid and of vapour in the vessel initially.
   (iii) The temperature of the mixture when the pressure has risen to 3 MPa.
   (iv) The heat transfer required to produce the final state. (6)

PART C
(Answer any FOUR questions)

9. a) Derive the equations used for computing the entropy change of an ideal gas. (4)
   b) Two tanks are connected by a valve. One tank contains 2 kg of CO_2 gas at 77°C and 0.2 bar. The other tank holds 8 kg of the same gas at 27°C and 1.2 bar. The valve is opened and the gases are allowed to mix while receiving energy by heat transfer from the surroundings. The final equilibrium temperature is 42°C. Determine the final equilibrium pressure and heat transfer for the process. (6)

10. a) Explain equation of state and law of corresponding state. (4)
    b) Derive law of corresponding state from vanderwaals equation. (6)

11. a) State and explain Amagat's law of partial volumes of a gas mixture. (4)
    b) A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80°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 0.10m^3, during which work done on gas is 25 kJ. Evaluate the c_p and c_v of the gas and the increase in entropy of the gas. (6)

12. Explain Joule-Thomson coefficient and Inversion curve. (10)

13. a) What is Joule - Kelvin effect? What is inversion temperature? (5)
    b) Explain how enthalpy change and entropy change of a gas are estimated from an equation of state. (5)

14. a) Derive Clausiusclapeyron equation. (6)
    b) A certain gas has Pc = 0.913 and Vc = 0.653 kJ/kg K. Find the molecular weight and the gas constant R of the gas? (6)

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Reg. No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

ME205: THERMODYNAMICS (AN, MA, MP, ME)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any THREE questions.

1. a) Define thermometric property. Why is a gas chosen as standard thermometric substance (3)

   b) Explain temperature scale. How can the ideal gas temperature for the steam point be measured? (4)

   c) Show that work is a path function and not a property (3)

2. a) State first law for closed system undergoing a change of state and show that energy a property of system (3)

   b) Define enthalpy. Why the enthalpy of an ideal gas does depend only on temperature? (3)

   c) A gas of 4 kg is contained within the piston cylinder machine. The gas undergoes a process for which $pV^{1.5}$ = Constant. The initial pressure is 3 bar and the initial volume is $0.1m^3$, and the final volume is $0.2m^3$. The specific internal energy of the gas decreases by 4.6kJ/kg. There is no significant change in KE and PE. Determine net heat transfer for the process. (4)

3. a) Define specific heat and derive it for constant pressure and constant volume? (4)

   b) A turbo compressor delivers 2.33 m^3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible? (6)

4. a) Write steady flow energy equation for a single stream entering and single stream leaving a control volume and explain the various terms in it. (4)

   b) A pump steadily delivers water at a volumetric flow rate of $0.05m^3/s$ through a pipe of diameter 18 cm located 100 m above the inlet pipe which has a diameter of 15 cm. The pressure is nearly equal to 1 bar at both the inlet and the exit, and the temperature is nearly constant at 20°C throughout. Determine the power required by the pump. Take g= 9.81 m/s^2 (6)

PART B

Answer any THREE questions.

5. a) Establish the equivalence of Kelvin-Plank and Clausius statements. (4)

   b) 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 30kW. If the heat

pump extracts 17kJ/s from 5°C reservoir. Determine (a) rate of heat supply from the 840°C source and (b) the rate of heat rejection to the 60°C sink. (6)

6. a) Establish the Inequality of Clausius? (4)

   b) Two kg of air at 500 kPa, 80°C expands adiabatically in a closed System until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5°C. For this process, determine (a) the maximum work, (b) the change in availability and (c) the irreversibility. For air, take c_v = 0.718 kJ/Kg K, u = c_vT where c_v is constant, and pV = mRT where p is pressure in kPa, V volume in m^3, m mass in kg, R a constant equal to 0.287 kJ/kg K, and T temperature in K. (6)

7. a) Explain mollier chart, P-V, P-T, P-V-T diagrams for pure substances. (7)

   b) A domestic food freezer maintains a temperature of -150C. The ambient air temperature is 300C. If heat leaks into the freezer at the continuous rate of 1.75KJ/S what is the least power necessary to pump this heat out continuously? (3)

8. a) What is energy, dead state and triple point? (4)

   b) A rigid vessel contains 1 kg of a mixture of saturated water and saturated steam at a pressure of 0.15 MPa. When the mixture is heated, the state passes through the critical point. Determine (i) The volume of the vessel (ii) The mass of liquid and of vapour in the vessel initially(iii) The temperature of the mixture when the pressure has risen to 3 MPa (iv) The heat transfer required to produce the final state. (6)

PART C

Answer any FOUR questions.

9. Derive Maxwell relations from basic thermodynamic relations? (10)
10. a) Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state? (4)

    b) Express the changes in internal energy and enthalpy of an ideal gas in a reversible adiabatic process in terms of pressure ratio. (6)

11. Explain different properties of real gas mixtures and the laws associated. (10)
12. a) Define adiabatic flame temperature. How is it estimated? (5)

    b) What is enthalpy of combustion? What do you understand by higher heating value and lower heating value of fuel? . (5)

13. a) Derive TDS Equations (4)

    b) A supply of natural gas is required on a site 800 m above storage level. The gas at - 150°C, 1.1 bar from storage is pumped steadily to a point on the site where its pressure is 1.2 bar, its temperature 15°C, and its flow rate 1000 m^3 /hr. If the work transfer to the gas at the pump is 15 kW, find the heat transfer to the gas between the two points. Neglect the change in K.E. and assume that the gas has the properties of methane (CH_4 M=16) which may be treated as an ideal gas having γ = 1.33 (g = 9.75 m/s^2) (6)

14. a) Derive Clausius clapeyron equation. (6)

    b) A certain gas has P c = 0.913 and V c = 0.653 kJ/kg K. Find the molecular weight and the gas constant R of the gas. (6)

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Total Pages: 2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: ME205

Course Name: THERMODYNAMICS (MA, ME, MP, AN)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Define property of a system with any two examples. Why thermodynamic properties are taken as coordinates in thermodynamics? (3)

b) Explain free expansion? Why the displacement work is absent in free expansion? (4)

c) List any 6 applications of thermodynamics. (3)

2 a) What is PMM1? Why it is not possible? (3)

b) Define enthalpy. Prove that for ideal gas enthalpy is a function of temperature alone. (3)

c) Explain the working of thermocouple with neat sketch. (4)

3 a) A rigid tank of $2m^3$initially contains air at 100kPa and 25^0C. The tank is connected to a supply line which contains air at 600kPa and 25^0C through a valve. The valve is opened and air is allowed to enter the tank until the pressure in the tank reaches the line pressure at which the valve is closed and the temperature of the air inside the tank at this instant measures 80^0C. Determine (a) the mass of air that has entered the tank and (b) the amount of heat transfer. (6)

b) What is total energy of a system? Prove that total energy is thermodynamic property of a system. (4)

4 a) Derive steady flow energy equation. (5)

b) In an adiabatic gas turbine, air expands at 1200kPa and 500^0C to 100kPa and 150^0C. Air enters the turbine with a velocity of 40m/s through an opening of area $0.2m^2$ and exhausts through a $1m^2$ opening. Determine (a) mass flow rate of air through the turbine and (b) the power produced by the turbine. (5)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Give two statements of second law of thermodynamics and prove its equivalence (5)

b) State and explain principle of increase of entropy. Discuss its physical significance. (5)

6 a) State and prove Clausius inequality. (6)

b) What is meant by (i) exergy (ii) dead state (iii) availability (4)

7 a) State and prove Carnot's theorem. (5)

b) Define dryness fraction. Draw the p-v-T surface of a substance that contracts on freezing. (5)

8 Derive the expression for availability of flow process. (10)

PART C

Answer any four full questions, each carries 10 marks.

9 a) What are reduced properties? State the law of corresponding states? (4)

b) A $0.5m^3$ rigid tank containing Hydrogen at 20^0C and 400kPa is connected by a valve to another $0.5m^3$ rigid tank that holds Hydrogen at 50^0C and 150kPa. Now the valve is opened and the system is allowed to reach thermal equilibrium with the surroundings, which are at 15^0C. Determine the final pressure in the tank and the amount heat transferred to the surrounding. Take γ=1.38 (6)

10 a) The volumetric analysis of mixture of gases is 30 percent Oxygen, 40 per cent Carbon dioxide and 30 percent Nitrogen. The mixture is heated from 20^0C to 200^0C while flowing through a pipe in which the pressure is maintained at 150kPa. Determine the heat transfer to the mixture per unit mass of the mixture. Take C_p values of Oxygen, Carbondioxide and Nitrogen as 0.918, 0.846 and 1.039kJ/kg K. (6)

b) What is virial expansion? Explain the term compressibility factor. (4)

11 a) What is Kay's rule? Give its importance. (4)

b) Explain law of partial pressures and Amagat's law of additive volumes for the mixture of ideal gases. (6)

12 a) Comment on the physical significance of Clasius- clapeyron equation. (4)

b) Define Gibbs and Helmholtz function. Give its significance on chemical reaction. (6)

13 a) What are Maxwell's equations? Also derive TDS equations. (5)

b) Define Joule-Thomson coefficient. What is its significance? Determine its value for an ideal gas. (5)

14 a) Define equivalence ration. What is its significance? (4)

b) Explain (i) enthalpy of combustion and (ii) enthalpy of formation. (6)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: ME205

Course Name: THERMODYNAMICS (AN, MA, ME, MP)

(Permitted to use Steam tables and Mollier charts)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks Marks

1 a) How the Zeroth law of Thermodynamics forms the basis for the measurement of temperature? (4)

b) How the state function varies from path functions with one example each? (6)

2 a) Draw the isochoric, isobaric, isothermal, adiabatic and polytropic processes in a single P-v diagram. Give reason for the shape of each process (6)

b) What is a quasi-static process? Is it a reversible process? How? (4)

3 a) How the First Law of Thermodynamics is applied to a process? Show how this formulation changes when it completes a thermodynamic cycle. (6)

b) 1 kg of air at 4 bar and 150°C is contained in a system. It is expanded by a reversible process till the pressure falls to 1.01325 bar. The gas is then heated at constant pressure process until the heat content is increased by 72.5 kJ. Calculate: (4)

i) The work done

ii) The pressure and temperature at the end of the constant pressure process

iii) The index of expansion, if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states.

Take Cp = 1 kJ/kg K, Cv = 0.714 kJ/kg K.

4 a) Deduce the Steady Flow Energy Equation (SFEE) applied to a steam turbine. (4)

b) 10kg of air per minute is delivered by a centrifugal air compressor. The inlet and outlet conditions of air are C_1 = 12 m/s, p_1 = 1 bar, v_1 = 0.5 m^3/kg and C_2 = 90 m/s, p_2 = 8 bar, v_2 = 0.15 m^3/kg. The increase in enthalpy of air passing through the compressor is 250 kJ/kg and heat loss to the surroundings is 900 kJ/min. Find (6)

i) Motor power required to drive the compressor;

ii) Ratio of inlet to outlet pipe diameter.

Assume that inlet and discharge lines are at 1.5 m height difference.

PART B

Answer any three full questions, each carries 10 marks

5 a) Compare the COP of heat pump to that of a refrigerator. What is the reason for their difference. (4)

b) Explain the internal and external irreversibility with practical examples. (6)

6 a) Explain the working of a Carnot cycle using P-v and T-s diagrams. State why a Carnot engine can't be realised? (6)

b) An inventor claims that he developed a refrigerator for removing a heat of 1440 kJ/min from a temperature of 0°C to 25°C by receiving an external work of 2 kW. Comment on his claim. (4)

7 a) Explain the term availability function. For a non-flow process. (4)

b) In a power station,water enters the boiler at saturated condition and leaves as saturated steam the saturated steam at 200ºC by receiving heat from hot gases in (6)

a steam boiler. Find the increase in total entropy of the combined system of gas and water and increase in unavailable energy due to irreversible heat transfer. Assume that the gases are cooled from 1000°C to 500°C and all the heat from gases goes to water without any losses. Take: cpg (for gas) = 1.005 kJ/kg K, hfg (latent heat of steam at 200°C) = 1940.7 kJ/kg.

8 a) Explain the importance of the critical point during the phase change process of a pure substance usinga P-v diagram. (4)

b) A pressure cooker contains 1.5 kg of saturated steam at 5 bars. Find the quantity of heat that must be removed from the steam so as to reduce the quality steam to 60% dry. What would be the pressure and temperature of the steam at the new state. (6)

PART C

Answer any four full questions, each carries 10 marks

9 a) What are the reasons for the deviation of the real gas behaviour from the ideal gas behaviour. (4)

b) 5 kg of O_2 has a volume of 4.5 m^3 at 110°C. Compute the change in pressure of the gas by using the Van der Waals' equation compared to the ideal gas equation. Assume a = 362850 $Nm^4/(kg\text{-}mol)^2$ and b = 0.0423 m^3/kg-mol. (6)

10 a) State and explain Amagat's law of partial volumes of gas mixtures. (4)

b) A vessel of 0. 5 m^3 capacity contains 0.5 kg of $CO_2$and 1 kg of air at 20°C. Calculate : (6)

i) The apparent molecular mass of the mixture

ii) The partial pressure of each constituent, and

iii) The total pressure in the vessel.

The gravimetric analysis of air is to be taken as 23.3% O_2 and 76.7% N_2

11 a) Derive the first Maxwell's equation from the fundamentals and hence derive the remaining three from the first one. (6)

b) Derivethe law of corresponding state from Vander Waals equation of state. (4)

12 a) Derive the Clausius- Clayperon equation. What is its use? (5)

b) Using Van der Waals equation of state, derive an expression for the change in specific heats at constant pressure and constant volume. (5)

13 a) Explain Joule-Thomson coefficient and Inversion curve. (5)

b) A vessel contains a mixture of 1 mole of CO_2 and 4 moles of airat 1 bar and 20°C. Calculate for the mixture : (5)

i) The masses of CO_2, O_2 and N_2

ii) The percentage carbon content by mass

iii) The apparent molecular weight and the gas constant for the mixture

iv) The specific volume of the mixture.

The volumetric analysis of air can be taken as 21% oxygen and 79% nitrogen.

14 a) What is meant by the term enthalpy of formation? Give reason for the difference between the higher and lower heating values of a fuel. (4)

b) What is equivalence ratio for combustion? Write down the balanced combustion equation with an equivalence ratio of 1.5. (6)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: ME205

Course Name: THERMODYNAMICS

Steam Tables allowed

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Define a thermodynamic systems (3)

b) Distinguish between intensive and extensive properties. Give examples (3)

c) Explain thermodynamic equilibrium. (4)

2 a) How does resistance thermometer measure temperature? (3)

b) Show that heat is path function and not a property (3)

c) Define enthalpy. Why enthalpy of an ideal gas depends only on temperature? (4)

3 a) Which property of a system increases when heat is transferred: (a) at constant volume (b) at constant pressure (4)

b) A mass of 8kg gas expands within a flexible container so that the p-v relationship is of the form $pv^{1.2}$=constant. The initial pressure is 1000kPa and the initial volume is $1m^3$. The final pressure is 5 kPa. If specific internal energy of the gas decreases by 40kJ/kg, find the heat transfer in magnitude and direction. (6)

4 a) Derive the steady flow energy equation for a bottle filling process using system approach. (5)

b) In a gas turbine the gas enters at the rate of 5 kg/s with a velocity of 50m/s and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150m/s and enthalpy of 400kJ/kg. The loss of heat from the gases to the surroundings is 25kJ/kg. Assume for gas R = 0.285kJ/kgK and c_p = 1.004kJ/kgK and the inlet conditions to be at 100 kPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe. (5)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Explain the two statements of Second law of thermodynamics. Why PMM2 is impossible (5)

b) A heat engine operating between two reservoirs at temperatures 600^0C and 40^0C drives refrigerator operating between reservoirs at temperatures of 40^0C and -15^0C. The heat transfer to the heat engine is 2500kJ and the net work output of the combined engine and refrigerator plant is 400kJ. The efficiency of the heat engine and COP of the refrigerator are each 40% of the maximum possible values. Estimate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40°C. (5)

6 a) State and prove Clausius theorem (5)

b) Determine the maximum work obtainable by using one finite body at temperature (5)

T and a thermal energy reservoir at temperature T_0, $T>T_0$

7 a) Why second law is called law of degradation? (3)

b) Derive the expression for reversible work done by a closed system if it interacts only with the surroundings (7)

8 a) Draw the phase equilibrium diagram for a pure substance on h-s plot with relevant constant property lines (3)

b) Steam flows in a pipeline at 1.5MPa. After expanding to 0.1MPa in a throttling calorimeter, the temperature is found to be 120°C. Find the quality of steam in the pipeline. What is the maximum moisture at 1.5MPa that can be determined with this set-up if at least 5°C of superheat is required after throttling for accurate reading? (7)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Discuss compressibility factor and law of corresponding states. (5)

b) A fluid having a temperature of 150°C and a specific volume of 0.96 m^3/kg at its initial state expands at constant pressure, without friction, until the volume is 1.55 m^3/kg. Find, for 1kg of fluid, the work, the heat transferred and the final temperature if (a) the fluid is air and (b) the fluid is steam. (5)

10 Express the changes in the internal energy and enthalpy of an ideal gas in a reversible adiabatic process in terms of pressure ratio (10)

11 a) State and explain Amagat's law of partial volumes of a gas mixture (10)

12 a) Derive Maxwell's equations (10)

13 a) Discuss the Joule-Thomson effect with a T-P plot. Prove that Joule Thomson coefficient is zero for ideal gas. (10)

14 a) Explain degree of reaction. What are its limiting values? (5)

b) Define equivalence ratio. What is its significance in combustion process? (5)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: ME205
Course Name: THERMODYNAMICS
(Steam Tables allowed)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries10marks.

			Marks
1	a)	Explain microscopic and macroscopic view points	(3)
	b)	Distinguish between change of state, path and process	(3)
	c)	How will you define density and pressure using the concept of continuum?	(4)
2	a)	Explain constant volume gas thermometer with a neat diagram	(3)
	b)	Why does free expansion have zero work transfer?	(3)
	c)	Define internal energy. Show that energy a property of a system	(4)
3	a)	Define specific heat and derive it for constant volume and at constant pressure	(4)
	b)	A gas of 4 kg is contained within the piston cylinder machine. The gas undergoes a process for which $pV^{1.5}$ = Constant. The initial pressure is 3 bar and the initial volume is $0.1m^3$, and the final volume is $0.2m^3$. The specific internal energy of the gas decreases by 4.6kJ/kg. There is no significant change in KE and PE. Determine net heat transfer for the process.	(6)
4	a)	How can you relate S.F.E.E with Euler and Bernoulli Equations?	(5)
	b)	A pump steadily delivers water at a volumetric flow rate of $0.05m^3/s$ through a pipe of diameter 18 cm located 100 m above the inlet pipe which has a diameter of 15 cm. The pressure is nearly equal to 1 bar at both the inlet and the exit, and the temperature is nearly constant at 20°C throughout. Determine the power required by the pump. Take g= 9.81 m/s^2	(5)

PART B

Answer any three full questions, each carries10marks.

5	a)	Establish the equivalence of Kelvin – Plank and Clausius statement	(5)
	b)	A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and deliver 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 30kW. If the heat pump extracts 17kJ/s from 5°C reservoir. Determine (a) rate of	(5)

heat supply from the 840°C source and (b) the rate of heat rejection to the 60°C sink.

6 a) Establish the Inequality of Clausius (5)

b) A fluid undergoes a reversible adiabatic compression from 0.5Mpa, $0.2m^3$ to $0.05m^3$ according to law, $pv^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy and the heat transfer and work transfer during the process. (5)

7 a) What do you understand by exergy and anergy? (3)

b) Derive expression for useful work for a steady flow system which interact only with the surroundings (7)

8 a) What is the critical state? Draw the phase equilibrium diagram on p-v coordinates for a substance which shrinks in volume on melting. (4)

b) Steam initially at 0.3 MPa, 250°C is cooled at constant volume. (a) At what temperature will the steam become saturated vapour? (b) What is quality at 80°C? (c) What is the heat transferred per kg of steam in cooling from250°C to 80°C? (6)

PART C

Answer any four full questions, each carries10marks.

9 a) Show that enthalpy of an ideal gas is a function of temperature only (4)

b) Express Van der Waals equation of state in the virial form and find the Boyle temperature (6)

10 a) Explain different properties of real gas mixtures and the laws associated. (10)

11 a) Show that in a diffusion process a gas undergoes a free expansion from the total pressure to the relevant partial pressure. (10)

12 a) Derive Maxwell relations from relevant equations of the form dz=Mdx+Ndy. (10)
Also derive Clausius-Clapeyron equation from Maxwell relation.

13 a) Explain how enthalpy change and entropy change of a gas are estimated from an equation of state. (10)

14 a) Define adiabatic flame temperature. How is it estimated? (5)

b) Explain enthalpy of combustion. (5)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: ME205

Course Name: THERMODYNAMICS

(Permitted to use Steam tables and Mollier Charts)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries10marks. Marks

1 a) Define the following (1) Microscopic & Macroscopic View Points (2) Thermodynamic Equilibrium (5)

b) Define Quasi-static Process. What are its characteristic features? (5)

2 a) Explain constant volume gas thermometer with neat diagram. (5)

b) Distinguish between flow work and displacement work. Why does free expansion have zero work transfer? (5)

3 a) State the first law for a closed system undergoing a change of state. Show that energy a property of the system. (5)

b) 1.5 kg of liquid having a constant specific heat of 2.5kJ/kgK is stirred in a well insulated chamber causing the temperature to rise by 15^{o}C. Find change in internal energy and work done for the process. (5)

4 Derive steady flow energy equation for a single stream entering and a single stream leaving a control volume and explain the various terms in it. Under what conditions does the steady flow energy equation reduces to Euler's equation (10)

PART B

Answer any three full questions, each carries10marks.

5 a) Explain two statements of second law of thermodynamics. Establish its equivalence. (5)

b) A heat engine operating between two reservoirs at temperatures 600^{o}C and 40^{o}C drives a refrigerator operating between reservoirs at temperatures of 40oC and -15^{o}C. The heat transfer to the heat engine is 2500kJ and the net output of the combined engine and refrigerator plant is 400kJ. The efficiency of the heat engine and the COP of the refrigerator are each 40% of the maximum possible values. Estimate heat transfer to the refrigerant and the net heat transfer to the reservoir at 40^{o}C. (5)

6 a) Establish the inequality of Clausius (4)

b) Determine the maximum work obtainable from two finite bodies at temperature T_1 and T_2. What are the causes of entropy increase? (6)

7 a) Derive expression for useful work for a steady flow system which interacts only with the surroundings. (5)

b) Calculate the decrease in exergy when 25 kg of water at 95^oC mix with 35 kg of water at 35^oC, the pressure being taken as constant and the temperature of the surroundings being 15^oC (c_p of water = 4.2 kJ/kg K) (5)

8 A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^oC. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy (10)

PART C

Answer any four full questions, each carries10marks.

9 a) Define the following: (5)

(1) Avogadro's Law (2) Equations of State

b) Express the changes in internal energy and enthalpy of an ideal gas in a reversible adiabatic process in terms of the pressure ratio. (5)

10 a) Define Virial Expansion. Also explain Law of corresponding state. (6)

b) Explain Van der Waals equation of state. How does it differ from the Ideal gas equation of state? (4)

11 a) State and explain Amagat's law of partial volumes of a gas mixture (5)

b) A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80°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 0.10m^3, during which work done on gas is 25 kJ. Evaluate the c_p and c_v of the gas and the increase in entropy of the gas. (5)

12 a) Derive Maxwell's equation (5)

b) Define Volume expansivity and isothermal compressibility (5)

13 Explain Joule - Kelvin effect. What is the significance of inversion curve? (10)

14 a) Define adiabatic flame temperature. How is it estimated? (5)

b) Explain (1) Enthalpy of Combustion (2) Internal Energy of combustion (5)

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third semester B.Tech examinations (S) September 2020

Course Code: ME205

Course Name: THERMODYNAMICS

(Permitted to use Steam tables and Mollier Charts)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Explain the Zeroth law of thermodynamics. What is its physical significance? (4)

b) What are intensive and extensive properties of a thermodynamic system? (3)

c) What is a thermocouple? What is its engineering application? (3)

2 a) Explain the concept of continuum with a suitable example. (4)

b) Describe a few situations in which forms of work other than displacement or pdv work appear in systems. (6)

3 a) Apply the first law of thermodynamics to a closed system undergoing a change state and show that energy is a property of the system. (5)

b) If a gas of volume 6000cm^3 and at a pressure of 100KPa is compressed quasi-statically according to pV^2=constant until volume becomes 2000 cm^3, determine the final pressure and work transfer. (5)

4 a) Obtain the mass balance and energy balance equations for a variable flow process. (5)

b) In a Water cooling tower, air enters at a height of 1 m above the ground level and leaves at a height of 7 m. The inlet and outlet velocities are 20 m/s and 30 m/s respectively. Water enters at a height of 8 m and leaves at a height of 0.8 m. The velocity of water at entry and exit are 3 m/s and 1 m/s respectively. Water temperatures are 80°C and 50°C at the entry and exit respectively. Air temperatures are 30°C and 70°C at the entry and exit respectively. The cooling tower is well insulated and a fan of 2.25 kW drives the air through the cooler. Find the amount of air per second required for 1 kg/s of water flow. The values of c_p of air and water are 1.005 and 4.187 kJ/kg K respectively. (5)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Explain at least three different causes of irreversibility associated with a process. (6)

b) State and prove Carnot's theorem. (4)

6 a) An ice-making plant produces ice at atmospheric pressure and at 0°C from (4)

water. The mean temperature of the cooling water circulating through the condenser of the refrigerating machine is 18°C. Evaluate the minimum electrical work in kWh required to produce 1 tonne of ice (The enthalpy of fusion of ice at atmospheric pressure is 333.5 kJ/kg).

b) Derive the expression for maximum work obtainable when heat transfer occurs between a finite body and a thermal energy reservoir. (6)

7 a) What do you mean by "dead state" of a system? (3)

b) Obtain an expression for useful work for a steady flow system which interacts only with the surroundings. (7)

8 a) Explain the following i)P-V-T surface ii) Mollier Charts (5)

b) A rigid closed tank of volume 3 m^3 contains 5 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry saturated. Determine the final pressure and the heat transfer to the tank. (5)

PART C

Answer any four full questions, each carries 10 marks.

9 Explain the following i) Law of corresponding states ii)Compressibility factor iii)Virial expansion iv)Van der Waals equation of state (10)

10 a) Explain Amagat's law of additive volumes for a mixture of ideal gases. (4)

b) A certain mass of sulphur dioxide is contained in a vessel of 0.142 m^3 capacity at a pressure and temperature of 23.1 bar and 18°C respectively. A valve is opened momentarily and the pressure falls immediately to 6.9 bar. Sometimes later the temperature is again 18°C and the pressure is observed to be 9.1 bar. Estimate the value of specific heat ratio. (6)

11 Obtain Maxwell's equations from basic thermodynamic relations. (10)

12 a) Derive Clausius –Clapeyron equation. (5)

b) Explain the following terms i) Enthalpy of formation ii) Heating Values (5)

13 Explain the Joule Kelvin effect and the inversion curve. (10)

14 a) Explain the enthalpy of formation in the chemical combustion process. (5)

b) What do you mean by equivalence ratio for combustion? Write down the balanced combustion equation of CH_4 and with 50% excess air. (5)

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