Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III(New) • EXAMINATION – WINTER 2016

Subject Code:2131905 Date:06/01/2017

Subject Name:Engineering Thermodynamics

Time:10:30 AM to 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Steam table is permitted.**

Q.1 Short Questions **14**

1 The equation $(p + a/v^2)(v - b) = R$ is known as
a. Maxwell's equation b. Van der Wall's equation
c Avogadro's equation d. Real gas equation

2 If a gas is heated against a pressure keeping the volume constant, then work done will be equal to
a. Positive b. Negative c. Zero d. between zero to infinity

3 An inventor claims that his heat engine has the following specification:
Power developed -50 kW, Fuel Burned per hour – 3kg, Heating value of fuel-75,000 kJ per kg, Temperature limits – (627℃ and 27℃), His heat engine is
a. Reality b. Impossible c. Costly d. Cheaper

4 The constant volume cycle is also called
a. Carnot cycle b. Brayton cycle c. Diesel cycle d. Otto cycle

5 Thermal power plants works on
a. Carnot cycle b. Joule cycle c. Brayton cycle d. Rankine cycle

6 Gas turbines work on
a. Constant volume cycle b. Constant temperature cycle
c. Constant pressure cycle d. Dual combustion cycle

7 Triple point of a pure substance on P-V diagram is represented by a
a. Point b. Line c. Curve d. Triangle

8 Which of the following is the unit of entropy?
a. J/kg K b. J/K c. Nm/kg sec d. J/kg

9 For same compression ratio and for same heat added
a. Otto cycle is more efficient than diesel cycle
b. Diesel cycle is more efficient than Otto cycle
b. Efficiency depends on other factors
c. None of the above

10 The contents of a well-insulated tank are heated by a resistor of 23Ω in which 10A current is flowing. Consider the tank along with its contents as a thermodynamic system. The work done by the system and the heat transfer to the system are positive. The rates of heat (Q), work (W) and change in internal energy (ΔU) during the process in kW are
a. Q =0, W = -2.3, ΔU = +2.3 b. Q = +2.3, W = 0, ΔU = +2.3
c. Q = -2.3, W = 0, ΔU = -2.3 d. Q = 0, W = +2.3, ΔU = -2.3

11 Heat and Work are
a. Intensive Property b. Extensive Property
c. Point function d. Path function

	12	All reversible engines operating between two fixed temperatures have _____efficiency.	
	13	**Justify:** Complete conversion of high grade energy to low grade energy is possible but the reverse is not true.	
	14	What are the causes of irreversibility?	
Q.2	**(a)**	A domestic refrigerator is loaded with food and the door closed. During a certain period the machine consumes 1 kW h of energy and the internal energy of the system drops by 5000 kJ. Find the net heat transfer for the system.	**03**
	(b)	A reversible heat engine operates between two reservoirs at temperatures of 600 °C and 40 °C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40 °C and -20 °C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and the net heat transferred to the reservoir at 40 °C	**04**
	(c)	State the SFEE for a single stream inlet and single stream leaving a control volume and explain the various terms in it. Also write SFEE for following Applications: (1) Cooling Tower (2) Centrifugal Pump (3) Expansion valve of refrigerator.	**07**
		OR	
	(c)	Evaluate the following statements: 1. Heat pump provides a thermodynamic advantage over direct heating. 2. Kelvin temperature scale is independent of the peculiar characteristics of any particular substance.	**07**
Q.3	**(a)**	Justify: For the same compression ratio and work capacity, Brayton cycle is more suitable than Otto cycle in gas turbine power plants.	**03**
	(b)	Explain using p-v and T-s diagram, Which of the two cycles – Otto cycle and Diesel cycle, will have higher efficiency for a given maximum pressure and temperature in the cycle?	**04**
	(c)	In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15 °C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480 °C. Calculate (a) the cut-off ratio, (b) the heat supplied per kg of air, and (c) the cycle efficiency.	**07**
		OR	
Q.3	**(a)**	Justify: In Otto cycle, the compression ratio cannot, however, be increased beyond a certain limit.	**03**
	(b)	Sketch the air-standard Brayton cycle on P-v and T-s diagrams. What are the advantages of the Brayton cycle over the conventional heat engine cycles?	**04**
	(c)	In an ideal Brayton cycle, air from the atmosphere at 1 atm, 300 K is compressed to 6 atm and the maximum cycle temperature is limited to 1100 K by using large air fuel ratio. If the heat supply is 100 MW, find (a) the thermal efficiency of the cycle, (b) work ratio, (c) power output, (d) exergy flow rate of the exhaust gas leaving the turbine.	**07**
Q.4	**(a)**	Why steam power plants are popular than gas turbine plant in electric power generation?	**03**
	(b)	What do you understand by the mean temperature of heat addition? For a given T_2, show how the Rankine cycle efficiency depends on the mean temperature of heat addition.	**04**
	(c)	In a single heater regenerative cycle the steam enters the turbine at 30 bar, 400 °C and the exhaust pressure is 0.1 bar. The feed water heater is direct contact type which operates at 5 bar. Find (a) efficiency (b) steam rate and (c) mean temperature of heat addition with regeneration. Neglect pump work.	**07**
		OR	
Q.4	**(a)**	What do you understand by steam rate and heat rate? What are their units?	**03**

	(b)	What is the effect of regeneration? On the (1) specific output, (b) mean temperature of heat addition (c) cycle efficiency and (d) steam rate	**04**
	(c)	Determine the work required to compress steam isentropically from 1 bar to 10 bar, assuming that at the initial state the steam exists as (a) saturated liquid and (b) saturated vapor. Neglect changes in kinetic energy and potential energy. What conclusion do you derive from this example?	**07**
Q.5	**(a)**	What is an equation of state? State its different type and which type is focused in the present subject.	**03**
	(b)	A cylinder of 0.1 m^3 volume is filled with 0.727 kg of C_8H_{18} at 427.85 K. Assuming that C_8H_{18} obeys the Van der Walls equation of state, calculate the pressure of the gas in the cylinder. The Van der walls Constant a and b for C_8H_{18} are 3.789 Pa $(m^3/mol)^2$ and 2.37 10-4 m^3/mol, respectively.	**04**
	(c)	What is entropy principle? With the help of it prove that adiabatic mixing of two fluids is irreversible.	**07**

OR

Q.5	**(a)**	What is an ideal gas equation? What assumptions are made in deriving the ideal gas equation of state from kinetic theory of gas?	**03**
	(b)	State the law of corresponding states and define the compressibility factor and explain its significance.	**04**
	(c)	Calculate the available energy in 40 kg of water at 75 °C with respect to the surroundings at 5 °C, the pressure of water being 1 atm.	**07**

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