Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (New) EXAMINATION – WINTER 2015

Subject Code:2131905 **Date:18/12/2015**

Subject Name: Engineering Thermodynamics

Time: 2:30pm to 5:00pm **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 Which of the following is the extensive property of a thermodynamic system?
(a) Pressure (b) Volume (c) Temperature (d) Density.

2 The main cause of the irreversibility is
(a) mechanical and fluid friction
(b) unrestricted expansion
(c) heat transfer with a finite temperature difference
(d) all of the above

3 The processes or systems that do not involve heat are called
(a) isothermal processes (b) equilibrium processes
(c) thermal processes (d) adiabatic processes

4 Kelvin-Planck's law deals with
(a) conservation of energy (b) conservation of heat
(c) conservation of mass
(d) conversion of heat into work

5 Second law of thermodynamics defines
(a) heat (b) work (c) enthalpy (d) entropy

6 The difference of reversible maximum work and the actual work called
(a) irreversibility (b) unavailability
(c) reversibility (d) availability

7 Increase of entropy during the process is a measure of
(a) the loss of availability of the energy of system
(b) the loss of unavailability of the energy of system
(c) loss of heat
(d) loss of work

8 Rankine cycle efficiency of a modern steam power plant may be in the range of (a) 15 to 20% (b) 35 to 45%
(c) 70 to 80% (d) 90 to 95%

9 Regenerative heating i.e., bleeding steam to reheat feed water to boiler
(a) decreases thermal efficiency of the cycle
(b) increases thermal efficiency of the cycle
(c) does not affect thermal efficiency of the cycle
(d) may increase or decrease thermal efficiency of the cycle depending upon the point of extraction of

10 The thermal efficiency of theoretical Otto cycle
(a) increases with increase in compression ratio
(b) increases with increase in isentropic index γ
(c) does not depend upon the pressure ratio
(d) follows all the above.

11 In air standard Diesel cycle, at fixed compression ratio and fixed value of adiabatic index (γ)
(a) thermal efficiency increases with increase in heat addition cut-off ratio
(b) thermal efficiency decreases with increase in heat addition cut-off ratio
(c) thermal efficiency remains same with increase in heat addition cut-off ratio
(d) none of the above.

12 With the increase in pressure ratio thermal efficiency of a simple gas turbine plant with fixed turbine inlet temperature
(a) decreases
(b) increases
(c) first increases and then decreases
(d) first decreases and then increases.

13 In a two stage gas turbine plant, with intercooling and reheating
(a) both work ratio and thermal efficiency improve
(b) work ratio improves but thermal efficiency decreases
(c) thermal efficiency improves but work ratio decreases
(d) both work ratio and thermal efficiency decrease.

14 In an ideal gas the partial pressure of a component is
(a) inversely proportional to the square of the mole fraction
(b) directly proportional to the mole fraction
(c) inversely proportional to the mole fraction
(d) equal to the mole fraction

Q.2 **(a)** Differentiate between open system, closed system and an isolated system. **03**

(b) Write the limitation of first law of thermodynamics. Explain the second law of thermodynamics by Clausius statement and Kelvin-Plank statement. **04**

(c) In steam power plant, steam pressure, temperature and velocity are 2 MPa, 400^0 C and 50 m/s respectively at inlet of steam turbine. At exit of steam turbine, steam pressure, dryness fraction and velocity are 15 kPa, 0.9 and 180 m/s respectively. Elevation difference between inlet and exit of steam turbine is 4 m. The power output of an adiabatic steam turbine is 5 MW. **07**
(1) Compare the magnitudes of Δh, Δke, and Δpe.
(2) Determine the work done per unit mass of the steam flowing through the turbine.
(3) Calculate the mass flow rate of the steam.

OR

(c) 300 kJ/s of heat is supplied at a constant fixed temperature of 290° C to a heat engine. The heat rejection takes place at 8.5° C. The following results were obtained : **07**
(i) 215 kJ/s are rejected.
(ii) 150 kJ/s are rejected.
(iii) 75 kJ/s are rejected.
Classify which of the result report a reversible cycle or irreversible cycle or impossible results.

Q.3 **(a)** Define following terms **03**
(1) Heat Engine
(2) Thermal Energy Reservoir
(3) Refrigerator

	(b)	Prove that all reversible engines working between the two constant temperature reservoirs have the same efficiency.	**04**
	(c)	An iron cube at a temperature of 400° C is dropped into an insulated bath containing 10 kg water at 25° C. The water finally reaches a temperature of 50° C at steady state. Given that the specific heat of water is equal to 4186 J/kg K. Find the entropy changes for the iron cube and the water. Is the process reversible? If so why?	**07**
		OR	
Q.3	**(a)**	Define following terms (1) Availability (2) Dead State (3) High Graded Energy	**03**
	(b)	Explain the available energy referred to finite heat source.	**04**
	(c)	1 kg of ice at 0° C is mixed with 12 kg of water at 27° C. Assuming the surrounding temperature as 15°C, calculate the net increase in entropy and unavailable energy when the system reaches common temperature : Given: Specific heat of water = 4.18 kJ/kg K; specific heat of ice = 2.1 kJ/kg K and enthalpy of fusion of ice (latent heat) = 333.5 kJ/kg.	**07**
Q.4	**(a)**	Enlist the various components used in Rankine cycle based power plant.	**03**
	(b)	Sketch the Ideal Rankine cycle on p-V, T-s, and h-s diagram.	**04**
	(c)	Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 3 MPa and 350° C and is condensed in the condenser at a pressure of 10 kPa. Determine (1) the thermal efficiency of this power plant, (2) the thermal efficiency if steam is superheated to 600° C instead of 350° C	**07**
		OR	
Q.4	**(a)**	Enlist the various components used in intercooling and reheating gas cycle based power plant.	**03**
	(b)	Compare the Otto, Diesel and Dual cycle for (1) same compression ratio and heat supplied (2) constant maximum pressure and heat supplied	**04**
	(c)	An air-standard diesel cycle has a compression ratio of 20, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process, the pressure is 0.1 MPa and the temperature is 15^0 C. Consider ideal gas and constant specific heat model. Determine (1) The pressure and temperature at each point in the cycle. (2) The thermal efficiency. (3) The mean effective pressure.	**07**
Q.5	**(a)**	State the various method of improving efficiency of Ideal Rankine cycle.	**03**
	(b)	What are the air standard assumptions?	**04**
	(c)	Find the required air-fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80%, respectively. Maximum cycle temperature is 875° C. The working fluid can be taken as air (c_p = 1.0 kJ/kg K, γ = 1.4) which enters the compressor at 1 bar and 27°C. The pressure ratio is 4. The fuel used has calorific value of 42000 kJ/kg. There is a loss of 10% of calorific value in the combustion chamber.	**07**
		OR	
Q.5	**(a)**	State the Boyle's law, Charle's and Avogadro's law for perfect gas.	**03**
	(b)	Derive the Van der Waal's equation of state.	**04**
	(c)	Explain briefly Dalton's law, Gibbs-Dalton law and Amagat's law for perfect gas mixture.	**07**

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