

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-III(New) EXAMINATION – SUMMER 2016

Subject Code:2131905

Date:27/05/2016

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.
1. Use of property table is permitted.

		MARKS
Q.1	Short Questions	14
	1 Define zero th law of thermodynamics.	
	2 Define a control volume.	
	3 State the Kelvin–Planck statement of the second law of thermodynamics.	
	4 Define entropy.	
	5 Define the term ‘availability’.	
	6 Define heat pump.	
	7 List thermodynamic processes involved in ideal Rankine cycle.	
	8 List the thermodynamic processes involved in ideal Otto cycle.	
	9 List the methods employed for improvement of thermal efficiency of simple open cycle gas turbine plant.	
	10 State two assumptions made for analysis of air standard cycles.	
	11 State two methods to improve the efficiency of Carnot cycle.	
	12 State Amagat’s law	
	13 Define mole fraction	
	14 Define intensive property.	
Q.2	(a) Explain path function and point function	03
	(b) Justify that energy is property of the system.	04
	(c) A steam power plant operates between boiler temperature of 160°C and condenser temperature of 50°C. Water enters the boiler as saturated liquid and steam leaves the boiler as saturated vapour. Assuming the isentropic expansion in turbine. Enthalpy of water entering boiler = 687 kJ/kg. Enthalpy of steam leaving boiler = 2760 kJ/kg Condenser pressure = 0.124×10^5 N/m ² . Verify the Clausius inequality for the cycle.	07
	OR	
	(c) A piston–cylinder device initially contains 0.5 m ³ of nitrogen gas at 400 kPa and 27°C. An electric heater within the device is turned on and is allowed to pass a current of 2 A for 5 min from a 120-V source. Nitrogen expands at constant pressure, and a heat loss of 2800 J occurs during the process. Consider nitrogen gas as ideal gas and nitrogen has constant specific heats. Take characteristics gas constant for nitrogen is 0.297 kJ/kg.K. Take $C_p = 1.039$ kJ/kg·K for nitrogen at room temperature. Determine the final temperature of nitrogen.	07
Q.3	(a) State the principle of increase of entropy. List the four application of entropy principle.	03
	(b) Identify the cause of irreversibility.	04

- (c) 5 kg of air at 550 K and 4 bar is enclosed in a closed system. 07
(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 and effectiveness.

OR

- Q.3** (a) List various components of steam turbine power plant. 03
(b) Compare Otto, Diesel and Dual cycle for 04
(i) Same compression ratio and heat supplied.
(ii) Same maximum pressure and temperature.
(c) In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pumps work. 07
- Q.4** (a) State the thermodynamic process of open cycle gas turbine power plant 03
(b) Sketch the ideal Rankine cycle on p-V, T-s and h-s diagram for dry saturated steam inlet into steam turbine. 04
(c) A diesel engine takes in air at pressure 1 bar and temperature 30°C. The pressure at the end of the compression is 30 bar and the cut off is 6% of the stroke. Calculate 07
(i) The compression ratio
(ii) The percentage clearance
(iii) The heat supplied in kJ/kg
(iv) The heat rejected in kJ/kg
(v) Mean effective pressure in bar

OR

- Q.4** (a) Discuss deviation of real gas from ideal gas. 03
(b) State and explain the Gibbs-Dalton law of partial pressures 04
(c) 2 kg of N₂ at 155°C and 0.25 m³ is expanded to 0.40 m³ at constant pressure, and then expanded isothermally to volume of 0.6 m³. Assume that specific heat at constant volume is 0.750 kJ/kg.K and gas constant is 0.298 kJ/kg.K. Calculate the overall change of entropy of the process. 07
- Q.5** (a) Identify the reasons for the impracticability of Carnot cycle. 03
(b) Define a thermodynamic system. Differentiate between open system, closed system and an isolated system. 04
(c) A closed cycle ideal gas turbine plant operates between temperature limits of 800°C and 30°C and produces a power of 100 kW. The plant is designed such that there is no need for a regenerator. A fuel of calorific 45000 kJ/kg is used. Calculate the mass flow rate of air through the plant and rate of fuel consumption. 07
Assume $c_p = 1$ kJ/kg K and $\gamma = 1.4$.

OR

- Q.5** (a) Draw the generalized compressibility chart. 03
(b) Draw ideal simple Rankine cycle with reheating on T-s and h-s diagram. Identify the reheating process and locate the increase in work done due to reheating in both graph. 04
(c) Steam enters an adiabatic turbine steadily at 3 MPa and 400°C and leaves at 50 kPa and 100°C. If the power output of the turbine is 2 MW. Determine (a) the isentropic efficiency of the turbine and (b) the mass flow rate of the steam flowing through the turbine. Neglect the change in potential and kinetic energies. 07
