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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV (New) EXAMINATION – WINTER 2019

Subject Code: 2143406 **Date: 07/12/2019**

Subject Name: Thermo Dynamics and Thermal Eng.

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.**

Q.1 **(a)** Explain system, boundary and surroundings. **03**

(b) A tube contains an oil of specific gravity 0.9 to a depth of 120 cm. Find the gauge pressure at this depth (in kN/m^2). **04**

(c) To a closed system 150 kJ of work is supplied. If the initial volume is 0.6 m^3 and pressure of the system changes as $p = 8 – 4V$, where p is in bar and V is in m^3, determine the final volume and pressure of the system. **07**

Q.2 **(a)** State second law of thermodynamics. **03**

(b) A close system of constant volume experiences a temperature rise of 25°C when a certain process occurs. The heat transferred in the process is 30 kJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 kJ/Kg°C, and the system contains 2.5 kg of this substance. Determine: **04**
(i) The change in internal energy;
(ii) The work done.

(c) Air at 1.02 bar, 22°C, initially occupying a cylinder volume of 0.015 m^3, is compressed reversibly and adiabatically by a piston to a pressure of 6.8 bar. Calculate: **07**
(i) The final temperature;
(ii) The final volume;
(iii)The work done.

OR

(c) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and exhaust pressure is 0.2 bar. Determine: **07**
(i) The pump work,
(ii) The turbine work
(iii)The Rankine efficiency,
(iv)The condenser heat flow,
(v) The dryness at the end of expansion.

Assume flow rate of 9.5 kg/s.

Q.3 **(a)** Define Thermal efficiency, Relative efficiency & Volumetric efficiency. **03**

(b) Prove that the internal energy of an ideal gas is a function of temperature alone. **04**

(c) An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following: **07**

(i) The air standard efficiency of the cycle.
(ii) The mean effective pressure for the cycle.

Assume the ideal conditions.

OR

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Q.3 **(a)** Differentiate the Otto cycle and Diesel cycle. **03**

(b) Prove that specific heat at constant volume (C_v) of a van der waals' gas is a function of temperature alone. **04**

(c) An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. The cut-off is 8% of the stroke. Determine: **07**

(i) Pressures and temperatures at all salient points.
(ii) Theoretical air standard efficiency.
(iii)Mean effective pressure.
(iv)Power of the engine if working cycles per minute are 380.

Assume that compression ratio 15 and working fluid is air.
Consider all conditions to be ideal.

Q.4 **(a)** Define Available and Unavailable energy. **03**

(b) Write a short note on Gibbs-Dalton law **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 & 290 K respectively.
(ii) If the air is cooled at constant pressure to the atmospheric temperature, determine the availability and effectiveness.

OR

Q.4 **(a)** Differentiate ideal and real gases. **03**

(b) Explain Maxwell relations. **04**

(c) 8 Kg of air at 650 K and 5.5 bar pressure is enclosed in a closed system. If the atmospheric temperature and pressure are 300 K and 1 bar respectively, determine: **07**

(i) The availability if the system goes through the ideal work producing process.
(ii) The availability and effectiveness if the air is cooled at constant pressure to atmospheric temperature without bringing it to complete dead state. Take C_v = 0.718 kJ/Kg K; C_p = 1.005 kJ/Kg K

Q.5 **(a)** State Fourier's law of heat conduction **03**

(b) Calculate the rate of heat flow per m^2 through a furnace wall consisting of 200 mm thick inner layer of chrome brick, a center layer of kaolin 100 mm thick and an outer layer of masonry brick 100 mm thick. The unit surface conductance at the inner surface is 74 W/m^2°C and the outer surface temperature is 70°C. The temperature of the gases inside the furnace is 1670°C. What temperatures prevail at the inner and outer surface of the center layer? **04**

Take: $k_{\text{chrome brick}}$ = 1.25 W/m°C; $k_{\text{kaolin brick}}$ = 0.074 W/m°C; $k_{\text{masonary brick}}$ = 0.555 W/m°C.
Assume steady heat flow.

(c) A cold storage room has walls made of 220 mm of brick on the outside, 90 mm of plastic foam, and finally 16 mm of wood on the inside. The outside and inside air temperatures are 25°C and -3°C respectively. If the inside and outside heat transfer coefficients are respectively 30 and 11 W/m°C, and the thermal conductivities of bricks, foam, and wood are 0.99, 0.022 and 0.17 W/m°C respectively, determine: **07**

(i) The rate of heat removal by refrigeration if the total wall area is 85 m^2;
(ii) The temperature of the inside surface of the brick.

OR

Q.5 **(a)** Define black body, white body & gray body. **03**

(b) A steel pipe with 50 mm OD is covered with 6.4 mm asbestos insulation [k = 0.166 W/mK] followed by a 25 mm layer of fiber-glass insulation [k = 0.0485 W/mK]. The pipe wall temperature is 393 K and the outside insulation **04**

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temperature is 311 K. Calculate the interface temperature between the asbestos and fiber-glass.
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(c) A longitudinal copper fin (k = 380 W/m°C) 600 mm long and 5 mm diameter is exposed to air stream at 20°C. The convective heat transfer coefficient is 20W/m^2°C. If the fine base temperature is 150°C, determine: **07**

(i) The heat transferred;
(ii) The efficiency of the fin.

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