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END SEMESTER (REGULAR/RETEST) EXAMINATION, MAY/JUNE-2025

Semester : 4th

Branch: Mechanical Engineering

Subject Code : Me-401

THERMODYNAMICS

Full Marks – 70

Time –Three hours

The figures in the margin indicate full marks for the questions.

Instruction :

- Question Nos. 1, 2 and 3 are compulsory and answer any *five* from the rest.

1. Fill in the blanks : 1×5=5

   (a) A process in which the equilibrium of the system is almost maintained from its initial state to the final state is called _____ process.

   (b) Value of universal gas constant is _____ in SI system.

   (c) In Isochoric process work done is _____.

[Turn over

(d) Latent heat _____ with decrease in pressure.

(e) Otto cycle consists of two _____ processes and two _____ processes.

2. Choose the correct answer : 1×5=5

(a) A gas is at 30°C and pressure 5 bar in a Piston cylinder arrangement when volume is $3cm^3$. 200 kJ/kg heat being added to the arrangement so that the internal energy of the gas change by an amount of 50 kJ/kg and volume change to $4cm^3$. The amount of work done by the system on the surrounding is

(i) 150 kJ/kg (ii) 4 kJ/kg

(iii) 250 kJ/kg (iv) None of these

(b) A closed vessel contains 2 kg of gas at 30°C and 0.7 bar pressure having internal energy 100 kJ/kg. Heat is supplied to the vessel till the gas acquires a pressure of 1.4 bar and internal energy of 300 kJ/kg. The amount of heat supplied is

(i) 200 kJ/kg (ii) 3 kJ/kg

(iii) 400 kJ/kg (iv) None of these

(c) Air standard efficiency of a Dual cycle engine is given by (with usual notation)

$\eta = 1 - \frac{1}{r^{\gamma-1}}\left(\frac{r_p r_c^{\gamma} - 1}{(r_p - 1) + \gamma r_p (r_c - 1)}\right)$, the cycle approaches diesel cycle when _____

(i) $r_p = 1$ (ii) $r_c = 1$

(iii) $\gamma = 1$ (iv) None of these

(d) Calculate the total heat required to produce 5 kg of dry saturated steam at a pressure of 8 bar. The sensible heat and Latent heat at 8 bars are 750 kJ/kg and 2250 kJ/kg respectively.

(i) 15000 kj (ii) 7500 kJ

(iii) 5 kJ (iv) None of these

(e) In a Rankine cycle, the steam enters at inlet to turbine is saturated at a pressure of 35 bar having enthalpy 3000 kJ/kg and exhaust pressure is 2 bar having enthalpy 1000 kJ/kg. The turbine output is

(i) 2000 kJ/kg (ii) 4000 kJ/kg

(iii) 3 kJ/kg (iv) None of these.

3. Write True or False : 1×5=5

(a) Carnot cycle is also known as the constant temperature cycle.

(b) Value of dryness fraction is greater than unity.

(c) During constant pressure process, change in internal energy is zero.

(d) The value of specific heat at constant pressure is greater than specific heat constant volume.

(e) Heat released in a reaction at constant pressure is called enthalpy.

4. Answer the following questions :

(a) Define the "Thermodynamic system." What are its different types – explain ? 1+3=4

(a) Define the following : 2

(i) Zeroth law of thermodynamics

(ii) Enthalpy.

(c) A certain quantity of air occupying 0.08 m^3 has initial temperature of 200°C. Then, it is expanded at constant pressure to a final volume of 0.3 m^3. Determine 3+2=5

(i) Final temperature

(ii) Value of γ if R=287 J/kg-k and C_v= 0.7125 J/kg-k.

5. Answer the following questions :

(a) Define the following process : 2

(i) Isochoric. (ii) Isobaric process.

(b) State the Thermodynamic First Law. What are the drawbacks of Thermodynamics First Law. 2+2=4

(c) How much heat must be supplied to 1.5 kg of gas to raise its temperature from 90°C to 225°C at constant pressure ? Find also the external work done during the supply of heat. Take C_p= 1.0 J/kg-k and C_v= 0.7125 J/kg-k 2+3=5

6. Answer the following questions :

(a) Enlist the advantages of "Liquid Fuel" over "Solid Fuel". 2

(b) State Higher Calorific value and Lower Calorific value. 2+2=4

(c) Draw a schematic layout of arrangement of components used in Rankine cycle. Also Draw P-v and T-s diagram of Rankine Cycle. 1+2+2=5

7. Answer the following questions :

(a) Explain the term "Dryness fraction". 2

(c) What do you mean by : 1+1+1=3

(i) Sensible heat

(ii) Degree of Superheat

(iii) Saturation Temperature ?

(c) Find the total Enthalpy for 5 kg of steam at 5 bar 2+2+2=6

(i) When steam is 0.75 dry.

(ii) When steam is dry and saturated.

(iii) When steam is superheated to 250°C.

8. Answer the following questions :

(a) State three mode of heat transfer. Define "Black Body". 2

(b) State the assumptions made for Air-standard cycle. 3

(c) An Engine 20 cm bore and 30 cm stroke works on otto cycle. The clearance volume is 1600cm^3. The initial pressure and temperature are 1 bar and 60°C. The maximum pressure is limited to 24 bar. Find the following :

(i) The Air standard Efficiency of the cycle.

(ii) The Pressure and temperature at the end of compression. 2+2+2=6

9. Answer any *two* from (a) to (c) and (d) is compulsory : 4×2+3=11

(a) State the T-s diagram of Carnot cycle and determine the maximum efficiency of reversible heat engine operating between two given heat reservoirs. 1+3=4

(b) Calculate the heat supplied to the boiler per kg of steam when the steam is generated at constant pressure of 10 bar and water is supplied at 50°C if : 2+2=4

(i) The steam is dry and saturated.

(ii) Steam is superheated to 260°C.

(c) An ideal gas undergoes Isothermal process at 300K during which its volume is reduced to 1/5th of its original. Calculate :

(i) Work Transfer.

(ii) Change in Internal Energy and Heat transfer. 2+2=4

(d) State the Charles Law and Perpetual Motion Machine of First kind. 1+2=3