Hall Ticket Number:

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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. II Year (Mech. Engg.) I-Semester Supplementary Examinations, May/June-2017

Thermodynamics

Time: 3 hours Max. Marks: 70

Note: i) Answer ALL questions in Part-A and any FIVE from Part-B

ii) Unless otherwise specified, take $g=9.807\ m/s^2$, $\bar{R}$=8.3143 kJ/kg mol K, $R_{air}=0.287$ kJ/kg.K, $P_{atm}=101.325$ kPa.

Part-A (10 × 2 = 20 Marks)

1. Define intensive and extensive properties.
2. What is an isolated system and write two applications?
3. Assume the work is done by the system. Show the isobaric and polytropic processes in a p-v diagram.
4. State the first-law of thermodynamics for a control-mass undergoing a cyclic process.
5. Write, with a neat sketch the Clausius statement.
6. Define Gibbs and Helmhotlz functions.
7. Define triple-point and show it on a p-T diagram.
8. Write the importance of Maxwell's relations.
9. Represent the ideal Brayton cycle on p-v and T-s planes.
10. State Dalton's law for a binary-mixture solution.

Part-B (5 × 10 = 50 Marks)

11. a) Explain Quasi static process. [3]

    b) Explain the working of constant volume gas thermometer with a neat sketch. [7]

12. a) Show how the polytropic exponent, *n*, can be obtained, if you know the end-state properties (p_1, V_1) and (p_2, V_2). [4]

    b) Air flows steadily at the rate of 0.5 *kg/s* through an air compressor, entering at *6 m/s* with a pressure of *1 bar* and a specific volume of *0.85* m^3/kg and leaving at *4.5 m/s, 6.9 bar* and *0.16* m^3/kg. The internal energy of air leaving is 88 kJ/kg greater than that of the air entering. The water jacket absorbs heat from the air at the rate of 59 kJ/s. Compute *i)* power required to drive the compressor *ii)* the ratio of the inlet pipe and the outlet pipe cross section areas. [6]

13. a) In a steam power-plant *1MW* is added in the boiler, *0.58 MW* is taken out in the condenser, and the pump work is *0.02 MW*. Find the plant's thermal efficiency. If everything could be reversed, find the COP as a refrigerator. [6]

    b) A heat-engine receives *6 kW* from a *250°C* source and rejects heat at *30°C*. Examine the following two cases with respect to the Clausius inequality; [4]

    i) $\dot{W} = 6\ kW$ *ii)* $\dot{W} = 0\ kW$.

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14. a) A piston-cylinder device contains *0.8 kg* of steam at *300°C* and *1 MPa*. Steam is cooled at constant pressure until one half of the mass condenses. Determine, *i)* the initial volume of the cylinder prior to the steam cooling *ii)* the change in volume of the cylinder *iii)* the final temperature once the cooling is completed. [6]

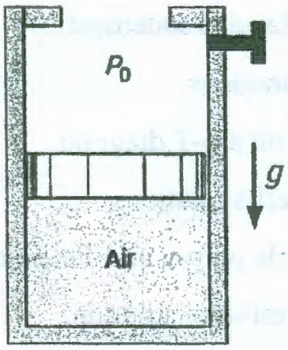
    b) State Clausius - Clayperon equation and write its importance. [4]

15. a) An engine working on Otto cycle is supplied with air at 0.1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100 kJ/kg of air. Calculate the p_{max} and T_{max} of the cycle, the cycle efficiency and the mean effective pressure. [6]

    b) A rigid tank contains *0.5 kmol* of Ar and 2 *kmol* of N_2 at *250 kPa* and *280 K*. The mixture is now heated to *400 K*. Determine the tank volume and final pressure of the mixture. [4]

16. a) Distinguish between macroscopic and microscopic approaches of thermodynamics. [4]

    b) Air in a piston-cylinder assembly at *200 kPa* and *600 K* is expanded in a constant-pressure process to twice the initial volume (state-2), as shown in *Figure*. The piston is then locked with a pin, and heat is transferred to a final temperature of *600 K* (state-3). Find *P*, *T*, and *h* for states 2 and 3, and find the work and heat transfer in both processes. [6]



17. Answer any *two* of the following:

    a) Define heat-pump and give an example with a neat sketch. Also, explain its COP in terms of heat and work interactions. [5]

    b) How is water a separate category of pure substance compared to others? Explain with the help of p-T diagram. [5]

    c) Represent the Rankine cycle on p-v and T-s planes. Obtain the relation for thermal efficiency for the cycle. [5]

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