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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (Mech. Engg.) II Year I-Semester Backlog Examinations, December-2017

Thermodynamics

Time: 3 hours Max. Marks: 70

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

Part-A (10 × 2 = 20 Marks)

1. Define the terms *system, property, path* and *cyclic process.*
2. Explain *thermodynamic equilibrium.*
3. Identify the *energy property* which changes when heat is supplied to a closed system at (i) *constant pressure*, and (ii) *constant volume.*
4. Explain *perpetual motion machine of kind one* (*PMM-I*).
5. State *Carnot theorem.*
6. *"Change in entropy is a measure of irreversibility"* – Elaborate.
7. What is meant by *pure substance*? Define *critical point* of water.
8. Define the *dryness fraction (x)* and represent *x=0* and *x=1* lines on a *T-S* diagram.
9. Illustrate *Otto cycle* on *p-v* and *T-S* planes.
10. Define the terms *partial pressure* and *partial volume* as applied to gas mixtures.

Part-B (5 × 10 = 50 Marks)

11. a) Explain clearly about *microscopic* and *macroscopic* approaches of thermodynamic system. [4]

b) The temperature *t* on a thermometric scale is defined in terms of a property *k* by the relation $t = a\ ln(k) + b$ where *a* and *b* are constants. The values are found to be *1.83* and *6.78* at the *ice point* and *steam point*, the temperatures of which are assigned the numbers *0* and *100* respectively. Determine the *temperature* corresponding to a reading of *k* equal to *2.42* on the thermometer. [6]

12. a) List the *three corollaries* of the *First law of thermodynamics.* [3]

b) A perfect gas occupies a volume of $0.3\ m^3$ at *1 bar* and $27^{\circ}C$. The gas undergoes a compression to $0.06\ m^3$. Evaluate the *heat absorbed* or *rejected* by the gas for each of the following methods of compression, i) *constant pressure* ii) *isothermal*, iii) *adiabatic,* and iv) according to the law $pV^{1.1} = constant$. For gas $R = 0.287\ kJ/kg\text{-}K$ and $\gamma = 1.4$. [7]

13. a) Explain *Carnot cycle* with the help of *p-v* and *T-S* diagrams. [4]

b) A copper block of heat capacity (C_p) *150 J/K* at $100^{\circ}C$ is placed in a lake at $8^{\circ}C$. Estimate the *entropy change* for the (i) copper block, (ii) lake, and (iii) the universe. [6]

14. a) Starting from the first principles, develop *Maxwell's relations.* [5]

b) Explain the *Mollier diagram* for steam, with the help of a suitable sketch. List its *importance* in thermodynamic calculations? [5]

Contd... 2

15. a) *State* and *prove Amagat-Leduc law* as applied to gas mixtures. [4]

b) At the beginning of compression in a diesel cycle the temperature is *300 K*, pressure is *200 kPa* and after combustion (heat addition) is complete the temperature is *1500 K* and the pressure is *7.0 MPa*. Determine the (i) *compression ratio*, (ii) *thermal efficiency*, and (iii) *mean effective pressure*. [6]

16. a) *0.3 kg* of a perfect gas occupies a volume of *0.2* m^3 at a pressure of *1 bar* and a temperature of *27°C*. The gas is compressed until the pressure is *3 bar* and final volume is *0.1* m^3. Calculate the (i) *molecular weight* of the gas and (ii) *final temperature*. [5]

b) Using the *steady flow energy equation*, develop the *governing equations* for i) compressor, ii) diffuser and iii) condenser. [5]

17. Answer any *two* of the following:

a) In a certain heat exchanger, *50 kg* of water is heated per minute from *50°C* to *110°C* by hot gases which enter the heat exchanger at *250°C*. If the flow rate of gases is *100 kg/min*, estimate the *net change of entropy*. [5]

b) A piston-cylinder arrangement contains steam at *1 bar* and temperature *150°C*. The steam is compressed reversibly and isothermally to a state where the specific volume is *0.28* m^3/kg. Determine the *change of internal energy* and *entropy* for the system. [5]

c) Develop an expression for the *air-standard efficiency* of the *Diesel cycle* in terms of compression ratio, cut off ratio and the adiabatic index. [5]