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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (Mech. Engg.) II Year I-Semester Old Examinations, May/June-2018

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. State *Zeroth law of thermodynamics*. What is its *importance*?
2. Define the *standard fixed point* of thermometry.
3. Define *enthalpy* and compare it with *internal energy*.
4. List out the *limitations* of the *first law of thermodynamics*?
5. What is *perpetual motion machine* of *second kind (PMM-II)*?
6. Explain the *principle of entropy increase*.
7. Explain the terms *latent heat* and *sensible heat* as applied to a pure substance.
8. Differentiate between *water* and *other pure substances* with the help of a *p-T* diagram.
9. Illustrate *Brayton cycle* on *p-v* and *T-S* planes.
10. State the *law of partial volumes*.

Part-B (5 × 10 = 50 Marks)

11. a) Define *specific heat*. Why do gases have two specific heats? [3]

    b) With the help of a neat sketch, explain the *working principle* of a *constant volume ideal gas thermometer*. [7]

12. a) With the help of first law of thermodynamics, prove that *internal energy* is a property. [3]

    b) *One kg* of air at *1 bar* and *300 K* is compressed *adiabatically* till its pressure becomes *five times* the original pressure. Subsequently it is expanded at *constant pressure* and finally cooled at *constant volume* to return to its original state. Calculate the *heat* and *work* interactions, and *change in internal energy* for each process and for the entire cycle. [7]

13. a) What is an *isentropic process*? Explain the difference between an *isentropic process* and an *adiabatic process*. [3]

    b) Define *entropy* and show that for an irreversible process [7]

$$\int ds > \int \frac{\delta Q}{T}$$

14. a) With the help of a p-v diagram, illustrate and explain an *isothermal process of compression* for water (pure substance) starting from an initial thermodynamic state of superheated vapour. [3]

    b) A rigid tank of *1 m^3* volume contains dry saturated steam at *0.2 MPa*. Due to poor insulation, there is heat transfer to the surroundings and the pressure drops to *0.1 MPa* after some time. Estimate the *final dryness fraction* and the amount of *heat* transferred. [7]

Contd... 2

15. a) State and prove *Dalton's law of partial pressures*. List out the *assumption* on which this law is based. [3]

   b) A gas mixture consists of *0.5 kg* of *carbon monoxide*, *1 kg* of *carbon dioxide* and *1.5 kg* of *nitrogen*. Determine: (i) *mass fraction* of each component, (ii) *mole fraction* of each component, (iii) *equivalent molecular weight* of the mixture, (iv) *equivalent Gas constant* of the mixture.(Molecular weights:: $CO = 28$ *kg/kg-mol*, $CO_2 = 44$ *kg/kg-mol* and $N_2 = 28$ *kg/kg-mol*). [7]

16. a) Explain the terms *closed system* and *open system*. Give *practical examples* of each. [5]

   b) Using the *steady flow energy equation*, develop the *governing equations* for i) *turbine*, ii) *nozzle*, and iii) boiler. [5]

17. Answer any *two* of the following:

   a) Prove that the "efficiency of an engine working on reversible cycle depends only on the temperature of source and sink and is independent of the working fluid." [5]

   b) *0.8 kg* of steam at a pressure of *15 bar* and *250°C* expands to *1.5 bar*. Assuming that steam expands according to the law $pV^{1.25} = constant$, estimate the *final dryness fraction*, *work done*, *heat* transferred and *change of entropy* during the expansion. [5]

   c) An air-standard *Otto cycle* has a compression ratio of *8*. At the start of the compression process, the temperature is *26°C* and the pressure is *1 bar*. If the maximum temperature of the cycle is *1080°C*. Determine (i) the *heat supplied* per kg of air, (ii) the *net work done* per kg of air, and (iii) the *air-standard efficiency* of the cycle [5]

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