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RN-8225

B. E. II (Sem. IV) (Mechanical) Examination

May / June – 2010

Engineering Thermodynamics

(GTU Structure)

Time : 3 Hours] [Total Marks : **100**

Instructions : (1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. 2 (Sem. 4) (Mechanical)**

Name of the Subject :

☛ **Engineering Thermodynamics**

☛ Subject Code No. : **8 2 2 5** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Answer all questions.
(3) Use separate answer book for each section.
(4) Figures to the **right** indicate **full** marks.
(6) Assume suitable data, if necessary.
(7) Use of steam table, molier diagram, refrigeration charts are permitted.

SECTION-I

1 Answer the following short questions **(Any ten)** **10**

1. A centrifugal pump forms an _____ system/
2. Specific volume is _____property
3. A substance having homogeneous and invariable composition even with change of phase is called _____ system.
4. Heat is a path function. (True/False)
5. Work done in throttling process is
   (a) zero (b) maximum (c) minimum (d) none of the above
6. A reversible process with no heat transfer between system and surroundings is called as
   (a) isochoric (b) isobaric (c) isothermal (d) adiabatic
7. A polytropic process $pV^n = c$ if n=0, the process is called as
   (a) isochoric (b) isobaric (c) isothermal (d) adiabatic
8. It is impossible to construct a device whose sole effect is transfer of heat in to equal amount of work. This statement is known as
   (a) Kelvin plank statement (b) Clausius statement
   (c) Carnot's principle (d) Carnot's theorem
9. A perpetual motion machine of second kind violates
   (a) zeroth law (b) first law (c) second law (d) third law

10. What is Carnot cycle? Which are the four processes which constitute the cycle?

11. For any reversible process, the change in entropy of the universe will

(a) increase (b) decrease (c) be zero (d)none of the above

12. What do you mean by second law efficiency?

2 **(a)** Define system, state and surroundings. Classify the following properties weather they are intensive or extensive?

Potential energy, kinetic energy, pressure, temperature, volume, velocity and density

(b) Explain the term sublimation.

(c) Define specific heat of an ideal gas at constant pressure and constant volume and show that $C_p - C_v = R$

(d) A mass of 0.8 kg of air at 1 bar and 25°C is contained in a gas tight friction less piston cylinder device. The air is now compressed to a final pressure of 5 bar. During the process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the heat transfer and work done during the process.

OR

(d) Steam enters a nozzle at a pressure of 7 bar and 200°C (h=2850 kJ/kg) and leaves at a pressure of 1.5 bar. The initial velocity of steam at the entrance is 40 m/s. and exit velocity from the nozzle is 700 m/s. the mass flow rate through is 1400 kg/hr. the heat loss from the nozzle is 1105 kJ/hr. determine the final enthalpy of steam.

3 **(a)** What do you understand by reversible process? What are the factors that affect reversibility? **04**

(b) A heat pump is used to maintain an auditorium hall at 24°C when the atmospheric temperature is 10°C. The heat lost from the hall is 1500 kJ/min. Calculate the power required to run the heat pump if it's COP is 30% of the Carnot machine working between same temperature limit. **06**

OR

(b) Define the following **06**

(i) Cycle efficiency

(ii) Carnot principle

(iii)Carnot theorem

(iv)Possibility and impossibility of the process

(v) Work is a high grade energy

(vi)Condition for reversibility of the process

(c) 10 kg metal piece with constant specific heat of 1.0 kJ/kgK at 200°C is dropped in to an insulated tank containing 100 kg water at 20°C. Determine the final equilibrium temperature and total change in entropy for the process. **05**

(d) Show that there is a decrease in available energy when heat is transferred through finite temperature difference with the aid of T-S diagram. **05**

OR

(d) 5 kg of gas initially at 3 bar and 500 K receives 500 kJ of heat from an infinite source at 1300 K. The specific heat of gas at constant volume is 0.8 kJ/kgK and surrounding temperature is 300K. Find the loss of availability due to the above heat transfer. **05**

SECTION-II

1 (a) Answer the following short questions **(Any ten)** **10**

1. Is the Gibbs Dalton's law applicable to real gases? If yes, up to what extent?
2. State the Amagat's law of partial volume.
3. $p_r = p / p_c$ is called_____
4. What is the difference between ideal gas and real gas?
5. Pyrogallic acid solution in Orsat apparatus is used to absorb

   (a) CO_2 (b) O_2 (c) CO (d) N_2
6. An analysis which does not include water vapour in flue gases is called

   (a) dry analysis (b) wet analysis (c) none of the above
7. In rankine cycle, increase in condense pressure will result in_____ in cycle efficiency. (Increase/Decrease)
8. Gas turbine power plant works on _____cycle.
9. In Otto cycle, heat addition takes place at constant_____ while in Diesel cycle, heat addition takes place at constant _____
10. What is called air standard efficiency?
11. Maxwell's thermodynamic relations are valid for

    (a) open system (b) closed system

    (c) thermodynamic system in equilibrium (d) all processes
12. The coefficient of isothermal compressibility, k is expressed by

    (a) $\frac{1}{v}\left(\frac{\partial v}{\partial p}\right)_T$ (b) $\frac{1}{v}\left(\frac{\partial p}{\partial v}\right)_T$ (c) $-\frac{1}{v}\left(\frac{\partial v}{\partial p}\right)_T$ (d) $-\frac{1}{v}\left(\frac{\partial p}{\partial v}\right)_T$

2 **(a)** 2 kg of oxygen at 60°C is mixed with 6 kg of nitrogen at the same temperature. The initial pressure of oxygen and nitrogen is 1.03 bar and remain same after mixing. Find the increase in entropy. **06**

OR

(a) For ideal gas mixture, show that **06**

$$M = \sum \frac{M_i}{y_i}$$ where M = molecular mass and y = mass fraction

(b) Discuss any two equation of state as applied to real gases. **04**

(c) Explain enthalpy of reaction. **04**

(d) A hydrocarbon fuel (C_7H_{16}) has enthalpy of combustion -4856920 kJ/kgmol. Find its value of enthalpy of formation. Take the value of enthalpy of formation of CO_2 and H_2O respectively as -393791 and 136288 kJ/kgmol **06**

OR

(d) For what purpose an Orsat apparatus is used? Discuss its working with the help of neat sketch **06**

3 **(a)** Sketch the diesel cycle on P-V and T-S diagram. Derive an expression for its air standard efficiency. **06**

OR

(a) An engine working on Otto cycle. Atmospheric air has a pressure of 1 bar and temperature 27°C. Air is compressed adiabatically with a compression ratio of 7 and then heat is added at constant volume till the temperature rises to 2000 K. Find the air standard efficiency, pressure and temperature at the end of compression, pressure at the end of heat addition and mean effective pressure. **06**

(b) Sketch the Rankine cycle on P-V, T-S and h-S diagram and compare it with Carnot cycle. Derive the expression for its thermal efficiency with and without pump work. **05**

OR

(b) In a thermal power plant which uses the Rankine cycle, superheated steam is produced at 1.5 MPa and 300°C and fed to the turbine where it expands to a condenser pressure 80 kPa. The saturated liquid coming out of condenser is pumped back to the boiler. Determine **05**
(i) Cycle efficiency
(ii) Steam rate
(iii) Heat rate
(iv) Condition of steam after isentropic expansion.

(c) State four Maxwell relations. **04**

(d) Using cyclic relation of function, $f(p, v, T) = 0$ and definition of β and k, show that **05**

$$\left(\frac{\partial p}{\partial T}\right)_v = \frac{\beta}{k}$$