Registration No. : | | | | | | | | | | |

*Total number of printed pages – 3*

B. Tech

CPME 6301

# Fifth Semester (Special) Examination – 2013

# ENGINEERING THERMODYNAMICS

**BRANCH : MECH**

**QUESTION CODE : D 277**

**Full Marks – 70**

**Time : 3 Hours**

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

*The figures in the right-hand margin indicate marks.*

1. Answer the following questions : 2×10

   (a) Define control volume and write the mass balance equation for an unsteady flow process.

   (b) Explain the term "entropy generation" and state its significance.

   (c) What is a reversible cycle ? Give an example of such a cycle and plot the same on a T-S diagram.

   (d) What is an air standard cycle ? State the assumptions considered for its analysis.

   (e) What are the known methods of increasing the thermal efficiency of an Rankine cycle ?

   (f) State and derive the second T.dS equation.

   (g) What is optimum pressure ratio of a gas turbine ?

   (h) In a Lithium bromide–water absorption system, which is the refrigerant ? What is its limitation ?

   (i) Define isothermal efficiency of an air compressor. State the methods commonly adopted for its improvement.

   (j) Define second law efficiency. What is its significance ?

2. (a) A rigid, insulated and initially empty steam chamber is connected to 1.5 MPa steam header via an isolation valve. Steam at 350° C is supplied to the vessel as the valve is slowly opened. The valve is kept open till the vessel pressure raises to 1.5 MPa at which point the valve is closed. Determine the final temperature of the steam in the vessel. 5

(b) Steady heat transfer at the rate of 1.035 kW is taking place normal to the house wall of cross section 5 m × 7 m and thickness 0.3 m on a day when ambient temperature is 273 K and the inside room temperature is 300 K. The inner and outer temperature of the brick wall is 278 K and 298 K respectively. Determine the rate of (a) entropy generation in the wall and (b) total entropy generation associated with the heat transfer. 5

3. Two kg of air at 300 kPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature equals to surroundings which is at 100 kPa, 5°C. For this process, determine :

(a) The maximum work

(b) The change in availability

(c) The irreversibility

For air, take $C_V$ = 0 -718 kJ/kg-K, u = $C_V$.T where $C_V$ is constant and PV = mRT where P is pressure in kPa, V volume in m3, m mass in kg, R a constant equals to 0,287 kJ/kg-K and T in K. 10



4. Steam (30 bar and 400°C) is allowed to expand isentropically is a steam turbine to a pressure of 0.08 bar. Determine the (a) dryness fraction at the end of expansion and thermal efficiency. 10

(a) Now the same feed steam is allowed to expand isentropically upto a pressure limit of 3 bar and then reheated to 380°C and then allowed to expand again in the turbine to a final pressure of 0.08 bar.

(b) Determine the dryness fraction at the end of expansion and thermal efficiency of the cycle.

(c) Draw the schematic and h-s diagram for both the cases and comment on the result.

5. In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of the isentropic compression the temperature and pressure is 15°C and 0.1 MPa respectively. Heat is added until the temperature at the end of the constant pressure process is 1500°C. Calculate : 10

(a) The Cut-off ratio

(b) Heat supplied per kg of air

(c) Cycle efficiency

(d) Mean effective pressure.

6. A gas turbine plant is operating on a Brayton cycle. In order to increase the cycle efficiency a regenerator is fitted. Determine the percentage increase in the cycle efficiency due to the regeneration from the following data available. 10

The regenerator effectiveness = 75%

The inlet condition of the air to the compressor = 100 kPa and 303 K

The pressure ratio = 6

The maximum operating temperature = 1173 K

The turbine efficiency = 80%

The compressor efficiency is 80%

7. A single acting single-stage air compressor has a swept volume of 2000 cc and runs at 750 rpm. It operates at a pressure ratio of 10 with a clearance of 4% of the swept volume. Assume NTP room conditions and at inlet (pressure = 101.3 kPa and Temperature = 17°C) and polytropic compression and expansion with index of 1.35. calculate : 10

(a) indicated power

(b) volumetric efficiency

(c) mass flow rate

(d) FAD

(e) Isothermal efficiency

(f) Actual power needed to drive the compressor if mechanical efficiency is 90%.



8. Explain briefly : 2.5×4

(a) Maxwell's relation

(b) Availability function for an open system

(c) COP of a vapour absorption refrigeration cycle

(d) Multistage compression.