INDIAN MARITIME UNIVERSITY
(A Central University, Government of India)

June 2017 End Semester Examinations
B. Tech (Marine Engineering – First Semester)

Basic Thermodynamics – UG11T 2103/UG11T 1103

Date: 01.07.2017 Maximum Marks : 100
Time: 3 Hrs Pass Marks : 50

PART – A 10x3=30 Marks

1.
a) What is the meaning of internal energy and specific internal energy?
b) State first Law of Thermodynamics and explain non-flow energy Equation.
c) What is meant by specific enthalpy with respect to steady flow energy equation?
d) Explain briefly P-V diagram for steam.
e) Define and explain reversible process.
f) Show a reversible adiabatic process for a perfect gas on a P-V diagram and only write the equation for work done during this process.
g) Explain efficiency of a steam boiler and write its equation.
h) Explain diesel cycle with the help of a P-V diagram.
i) What is meant by indicated power and indicator diagram.
j) Explain Mechanical Efficiency and Thermal Efficiency.

PART – B (5x14=70 Marks)

(Answer any 5 of the following)

2.
a) A turbine of a steam plant delivers 1000 kW. The heat of 2800 kJ per kg is given to the steam in the boiler. 2100 kJ/kg of heat is rejected by the steam in the condenser. The feed pump work is 5kW. Draw block diagram showing steam plant layout, show the system boundary and find out the steam flow rate?

(3+4=7 Marks)

b) In an I C engine the heat rejected to the cooling water during compression stroke is 45 kJ/Kg and the work input is 90 kJ/Kg. What is the specific internal energy of the working fluid? Is it gain or loss? (4 Marks)

c) A pneumatically operated valve has a air motor which is given compressed air with specific internal energy of 420 kJ/Kg at beginning of expansion and specific internal energy of 200 kJ/kg after expansion. Calculate the heat flow to or from the cylinder when the work done by the air during the expansion is 100 kJ/kg.

(3 Marks)

3. a). Draw a diagram of steady flow open system showing system boundary and proceed to derive an expression for steady flow energy equation. Also only state continuity of mass equation which is generally used to find mass flow rate of a working substance.

(3+6=9 Marks)

b). The gases in the cylinder of an internal combustion engine have a specific internal energy of 800 kJ/kg and the specific volume of 0.06 m^3/kg at the beginning of expansion. The expansion of gases may be assumed to take place according to a reversible law $pv^{1.5}$ = constant, from 55 bar to 1.4 bar. The specific internal energy after expansion is 230 kJ/kg. Calculate the heat rejected to the cylinder cooling water per kg of gases during the expansion stroke. (5 Marks)

4. Sketch a pressure volume diagram for steam and mark on it the following points labelling clearly the pressure, specific volume and temperature of each point. (Use steam tables / Mollier chart as required)

1. P=20 bar, t = 250°C
2. t= 212.4°C, v=0.09957 m^3/Kg.
3. P=10 bar, h = 2650 kJ/kg
4. P=6 bar, h = 3166 kJ/kg (10 Marks)

Now calculate the internal energy for each of these four states. (4 Marks)

5. (a). A boiler working at a pressure of 1.4 MN/m^2 evaporates 8 kg of water per kg of coal fired from feed water entering at 39°C. The steam at the stop valve is 0.95 dry. Determine the equivalent evaporation, from and at 100°C, in kg steam / kg coal. (7 Marks)

(b). A surface condenser operating at a pressure of 24 KN/m^2 condenses 1.8 tonne of steam per hour. The steam enters the condenser with dryness fraction of 0.98 and is condensed but not under cooled. Cooling water enters the condenser at a temperature of 21°C and leaves at 57°C. Determine the flow rate of the cooling water. (7 Marks)

6. At the beginning of compression of an ideal Diesel cycle the gas has a temperature and pressure of 40°C and 90 KN/m^2, respectively. The volume ratio of compression is 16:1. The maximum temperature of the cycle is 1400°C. Draw the PV diagram and determine for the cycle:-
   1. the pressure and temperature at each of the cycle process change points.
   2. the work done per kg of gas.
   3. the thermal efficiency.
   4. the work ratio.
   5. the mean effective pressure.
   6. the Carnot efficiency within the cycle temperature limits.

   Take adiabatic index = 1.4, c_p = 1.004 kj/kgK. (14 Marks)

7. (a). A gas at a pressure of 1.4 MN/m^2 and temperature of 360°C is expanded adiabatically to a pressure of 100 kN/m^2. The gas is then heated at constant volume until it again attains 360°C, when its pressure is found to be 220kN/m^2, and finally it is compressed isothermally until the original pressure of 1.4 MN/m^2 is attained. Sketch the P-V diagram for these processes and, if the gas has a mass of 0.23 kg, determine
   1. the value of adiabatic index.
   2. the change in internal energy during the adiabatic expansion.

   Take c_p for gas as 1.005 KJ/kgK. (3+3+3=9 Marks)

(b). 0.675 kg of gas at 1.4 MN/m^2 and 280°C, is expanded to four times the original volume according to the law $PV^{1.3} = C$. Determine

1. the original and final volume of gas
2. the final pressure of the gas.
3. the final temperature of the gas.

Take R = 0.287 k/kgK. (3+1+1= 5 Marks)

8. Explain the following.

(a). Constant volume cycle. (4 Marks)
(b). Constant pressure cycle. (4 Marks)
(c). Differences between 4 stroke and 2 stroke cycles. (6 Marks)

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