No. of Printed Pages : 4

BME-019

B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING) / BTMEVI

00670

Term-End Examination

June, 2016

BME-019 : ENGINEERING THERMODYNAMICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted. Use of steam tables is also allowed.*

1. (a) A rigid tank contains a hot fluid that is cooled while being stirred by a paddle wheel. Initially, the internal energy of the fluid is 800 kJ. During the cooling process, the fluid loses 500 kJ of heat and the paddle wheel does 100 kJ of work on the fluid. Determine the final internal energy of the fluid. *5*

(b) With the help of suitable sketches, explain the phase change processes of pure substances. *5*

2. (a) Explain the similarities and differences between work and heat. 5

(b) Give a statement of the First Law of Thermodynamics for non-cyclic processes. Prove that internal energy is a property of the system. 5

3. (a) A frictionless piston cylinder device contains 5 kg of steam at 400 kPa and 200°C. Heat is now transferred to the steam until the temperature reaches 250°C. If the piston is not attached to a shaft and its mass is constant, determine the work done by the steam during this process. 5

(b) Derive expressions for internal energy, enthalpy, and specific heats of ideal gases. 5

4. (a) Explain the Zeroth Law of Thermodynamics. 4

(b) A heat pump is to be used to heat a house during the winter. The house is to be maintained at 21°C at all times. The house is estimated to be losing heat at a rate of 1,35,000 kJ/h when the outside temperature drops to – 5°C. Determine the minimum power required to drive the heat pump. 6

5. (a) From first principles derive the following relations : 5

$$ds = \frac{du}{T} + \frac{Pdv}{T}$$

$$ds = \frac{dh}{T} - \frac{vdP}{T}$$

(b) Air is compressed in a car engine from 22°C and 95 kPa in a reversible and adiabatic manner. If the compression ratio $\frac{V_1}{V_2}$ of this engine is 8·0, determine the final temperature of the air (k = 1·39). 5

6. (a) Explain the Carnot cycle on p-v and T-s diagrams. 5

(b) A certain substance of constant c_p (= 0·6 kJ/kg K) undergoes a change of state from 1 to 2 because of heating accompanied by stirring. The mass of the system is 2·5 kg and the temperature at the two states are t_1 = 30°C and t_2 = 80°C. At the end of this process the substance is subjected to a reversible constant pressure cooling process which restores it to the initial state. Find the increase in entropy in the first process. 5

7. (a) A piston-cylinder device initially contains water at 150 kPa and 20°C. The water is now heated at constant pressure by the addition of 4000 kJ of heat. Determine the entropy change of the water during this process. 5

(b) Explain the Clausius inequality. Hence prove that entropy is a property of the system. *5*

8. In a Rankine cycle, the steam of inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0·2 bar. Determine (a) pump work, (b) turbine work, (c) Rankine efficiency, (d) condenser heat flow, and (v) dryness at the end of expansion.

Assume flow rate of steam as 9·5 kg/s. *10*

9. (a) Classify energy resources and explain their characteristics. *6*

(b) Explain the term 'Excess air'. Calculate the stoichiometric (chemically correct) ratio of CH_4 and air. *4*

10. (a) A reciprocating air compressor operates between 100 kPa and 500 kPa with a polytropic exponent of 1·3. How much clearance would have to be provided in the ideal case, to make the volumetric efficiency 50% and to make it zero ? *6*

(b) With the help of p-v diagram, explain the importance of 'intercooling' in a multistage air compressor. *4*
