

JK Lakshmipat University, Jaipur

Institute of Engineering and Technology

End Term Examination

B. Tech. II Year/ III Semester 2013-2014



Course Name: Engineering Thermodynamics

Course Code: ME 301

Max Marks: 40

Time: 03.00 hr

Instructions:

1. Attempt all sections.
2. Each subpart of section A is of 1 mark.
3. Attempt any four questions from section B.

Section A

- Q.1** (a) what is the difference between the universal gas constant and a characteristic gas constant?
 (b) What is the difference between a closed system and an open system?
 (c) Define internal energy.
 (d) What are the causes of irreversibility of a process?
 (e) What do you understand by the entropy principle? (1X5 = 05 Marks)

Q.2 (a) Tick the correct option:

Unavailable energy is the portion of energy that (i) cannot be converted into work by a heat engine (ii) cannot be converted into work even by a reversible heat engine (iii) both are true

(b) Identify the wrong option:

A pure substance (i) is a system that has a uniform chemical composition throughout (ii) is a system which remains invariable in composition irrespective of time (iii) must be physically or macroscopically homogeneous (iv) refers to a state that may be macroscopically heterogeneous

(c) Tick the correct option:

At the critical pressure (i) the entropy of a substance is zero (ii) the latent heat of vapourisation is zero (iii) saturated vapour becomes a gas (iv) a real gas obeys ideal gas laws (v) the vapour liquefies.

(d) Tick the correct option:

The critical temperature of steam is (i) 373 K (ii) 347.15°C (iii) 374.15°C (iv) 409°C (v) none of these

(e) Tick the correct option:

The Joule-Thomson effect is not exhibited by (i) ideal gases (ii) real gases (iii) CO₂ (iv) refrigerant vapours (1X5 = 05 Marks)

Section B

- Q.3** Show that the work done per kilogram of a perfect gas during an adiabatic expansion for which $pV^\gamma = \text{constant}$ is given by $W_{1-2} = R (T_1 - T_2) / (\gamma - 1)$ (05 Marks)

Q.4 What is a throttling process? 3.0 kg of air kept at an absolute pressure of 100 kPa and temperature of 300 K is compressed polytropically until the pressure and temperature become 1500 kPa and 500 K respectively. Evaluate the polytropic exponent, the final volume, the work of compression and the heat interaction. Take gas constant $R = 287 \text{ J/kg K}$. (05 Marks)

Q.5 Define Joule-Thomson coefficient, inversion point and inversion curve. A centrifugal pump delivers 2750 kg of water per minute from initial pressure of 0.8 bar absolute to a final pressure of 2.8 bar absolute. The suction is 2 m below and the delivery is 5 m above the centre of pump. If the suction and delivery pipes are of 15 cm and 10 cm diameter respectively, make calculations for the power required to run the pump. (05 Marks)

Q.6 What is a heat pump? How does it differ from a refrigerator? An inventor claims to have developed an engine that operates between a source at 450 K and a sink at 280 K, and capable of delivering 0.15 kWh of work for every 1200 kJ of heat received. As a patent officer, would you issue a patent for such an engine? (05 Marks)

Q.7 Define quality and dryness fraction of steam. How do you differentiate between a saturated liquid and a saturated vapour? Dry saturated steam initially at a pressure of 600 kPa is contained in a thermally insulated cylinder fitted with a frictionless piston. As the piston moves slowly outwards, the steam expands to a pressure of 60 kPa. Calculate the work done by steam. (05 Marks)

Section C

Q.8 Define the terms available energy and unavailable energy. 0.2 kg of air initially at 575 K temperature receives 300 kJ of heat reversibly at constant pressure. Determine the available and unavailable energies of the heat added. Take C_p for air = 1.005 kJ/kg K and temperature of surroundings 300 K. (05 Marks)

OR

Show that there is a decrease in available energy when heat is transferred through a finite temperature difference.

Q.9 Heat flows from a hot reservoir at 800 K to another reservoir at 250 K. If the entropy change of the overall process is 4.25 kJ/K, make calculations for the heat flowing out of the high temperature reservoir. (05 Marks)

OR

Prove the statement "Violation of Clausius statement leading to violation of Kelvin-Planck statement".

