



End Semester Exam – Spring 2023 Programme: BE (Mechanical Engineering)

Subject: *Thermodynamics-II*

Course Code: *ME-230*

Total Marks: *100*

Time Allowed: *3 Hours*

Student Name: _____

Registration # _____

Section: _____

Signature: _____

Instructions:

1. This is a closed book examination.
2. Only basic calculators are allowed. Digital diaries / programmable calculators are not allowed.
3. Question paper must be submitted with the answer book at the end of the exam.

Q-1 (CLO 3):

A vertical piston–cylinder device initially contains 0.1 m³ of helium at 20°C. The mass of the piston is such that it maintains a constant pressure of 300 kPa inside. A valve is now opened, and helium is allowed to escape until the volume inside the cylinder is decreased by one-half. Heat transfer takes place between the helium and its surroundings at 20°C and 95 kPa so that the temperature of helium in the cylinder remains constant.

(The gas constant of helium is $R = 2.0769 \text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K}$. The specific heats of helium are $C_p = 5.1926 \text{ kJ/kg}\cdot\text{K}$ and $C_v = 3.1156 \text{ kJ/kg}\cdot\text{K}$)

Interpret and Analyze the exergy principles involved in this problem by finding the following

- The maximum work potential of the helium at the initial state (10)
- The exergy destroyed during this process. (10)

(Marks 20)

Solution

From the ideal gas relation, the initial and the final masses in the cylinder are determined to be

$$m_1 = \frac{P_1 V}{RT_1} = \frac{(300 \text{ kPa})(0.1 \text{ m}^3)}{(2.0769 \text{ kPa} \frac{\text{m}^3}{\text{kg}\cdot\text{K}})(293 \text{ K})} = 0.0493 \text{ kg} \quad \text{.....(1)}$$

$$m_e = m_2 = \frac{m_1}{2} = 0.0247 \text{ kg} \quad \text{.....(1)}$$

The work potential of helium at the initial state is simply the initial exergy of helium, and is determined from the closed-system exergy relation

$$\Phi_1 = m_1 \phi = m_1 [(u_1 - u_o) - T_o(s_1 - s_o) + P_o(v_1 - v_o)] \quad \text{.....(1)}$$

$$v_1 = \frac{RT_1}{P_1} = \frac{(2.0769)(293)}{300} = 2.0284 \text{ m}^3/\text{kg} \quad \text{.....(1)}$$

$$v_o = \frac{RT_o}{P_o} = \frac{(2.0769)(293)}{95} = 6.405 \text{ m}^3/\text{kg} \quad \text{.....(1)}$$

And

$$s_1 - s_o = C_p \ln \frac{T_1}{T_o} - R \ln \frac{P_1}{P_o} = -2.388 \frac{\text{kJ}}{\text{kg}\cdot\text{K}} \quad \text{.....(1)}$$

Putting the values,

$$\Phi_1 = m_1 \phi = (0.0493)[\{3.1156(20 - 20)\} - (293)(-2.388) + (95)(2.0284 - 6.405)] = 14.0 \text{ kJ} \quad \text{.....(4)}$$

Thermodynamics Final Exam

J Spring



Thermodynamics Final Exam:

Thermodynamics Final Exam Book Review: Unveiling the Power of Words

In some sort of driven by information and connectivity, the power of words has become more evident than ever. They have the capability to inspire, provoke, and ignite change. Such could be the essence of the book **Thermodynamics Final Exam**, a literary masterpiece that delves deep to the significance of words and their affect our lives. Compiled by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we will explore the book is key themes, examine its writing style, and analyze its overall effect on readers.

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