



**FACULTY OF ENGINEERING AND ENVIRONMENT**

**DEPARTMENT OF MINING ENGINEERING**

**THERMODYNAMICS AND FLUID MECHANICS**

**EMN 3111**

**Final Examination Paper**

**December 2023**

This examination paper consists of 3 pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Examiner's Name: Eng. M. Kanganga**

**INSTRUCTIONS**

1. This question paper consists of 5 questions, answer ANY **FOUR QUESTIONS**
2. Each question carries 25 marks
3. Answer each question on a new page and write as eligible as possible

**Additional Requirements**

Steam Tables

Calculator

**MARK ALLOCATION**

<b>Question 1 to 5</b>	<b>25 Marks Each</b>
<b>Part Questions</b>	<b>As shown in each part question</b>
<b>Total Attainable</b>	<b>100</b>

**Question 1**

- a. Define the terms system, boundary, surroundings and universe. Discuss various types of systems giving examples of each. [10]
- b. Why does free expansion have zero work transfer? [5]
- c. Show that work transfer is not a property of a system. [10]

**Question 2**

- a. A gas is contained in a cylinder fitted with a piston loaded with a small number of weights. The initial pressure of the gas is 1.3 bar, and the initial volume is  $0.03 \text{ m}^3$ . The gas is now heated until the volume of the gas increases to  $0.1 \text{ m}^3$ . Calculate the work done by the gas in the following processes:
  - i. pressure remains constant [5]
  - ii. temperature remains constant [5]
  - iii.  $pV = \text{constant}$  during the process. [5]

Show the processes on P-V diagram. [5]

- b. What do you understand by flow work? [5]

**Question 3**

- a. Define internal energy and prove that it is a property of the system [5]
- b. A system undergoes a cycle consisting of four processes. The energy transfers are given in the table below:

Process	Q(kW))	W(kW))	$\Delta U(\text{kW})$
1-2	-100	A	0
2-3	400	B	C
3-4	D	300	200
4-1	0	E	-600

Find the value of A, B, C, D and E? [20]

**Question 4**

- c. Consider a steam power plant operating on the simple ideal Rankine cycle. Steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of this cycle. [25]

**Question 5**

- a. Enumerate the factors which influence the stability of laminar flow [15]
- b. The diameters of a tapering pipe at the sections 1-1 and 2-2 are 100 mm and 150 mm respectively. If the velocity of water flowing through the pipe at section 1-1 is 5 m/s, find:
- i. Discharge through the pipe, and [5]
  - ii. Velocity of water at section 2-2. [5]