FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

THERMODYNAMICS AND FLUID MECHANICS

EMN 3111

Final Examination Paper

November/December 2024

This paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner: Eng. M.Kanganga

INSTRUCTIONS

1. This paper contains FIVE questions.
2. Answer any FOUR questions.
3. Each question carries 25 marks.
4. Where a question contains subdivisions, the mark value of each subdivision is shown in brackets.
5. Illustrate your answer, where appropriate, with clearly labeled diagrams.
6. Start each question on a new page.
7. This paper comprises of 3 printed pages

Additional requirements:

Calculator

Question 1

a. What are the four basic components of a steam power plant working on Rankine cycle? Show by a block diagram. [10]

b. Draw the nature of P–V and T–S plots of a Rankine cycle (with saturated steam at turbine inlet). [5]

c. Draw the nature of P–V and T–S plots of a Rankine cycle (with superheated steam at turbine inlet). [5]

d. Why is a Carnot cycle not practicable for a steam power plant? [5]

Question 2

a. Define state, property, change of state, path, process and cycle. [5]

b. Distinguish between an adiabatic system and isolated system. [5]

c. Distinguish between extensive property and intensive property. [5]

d. What is a quasi-static process and how does it differ from a reversible process? [5]

e. What is the basic difference between a process and a cycle? [5]

Question 3

Determine the total work done by a gas system following an expansion as shown in Fig. 1 [25]

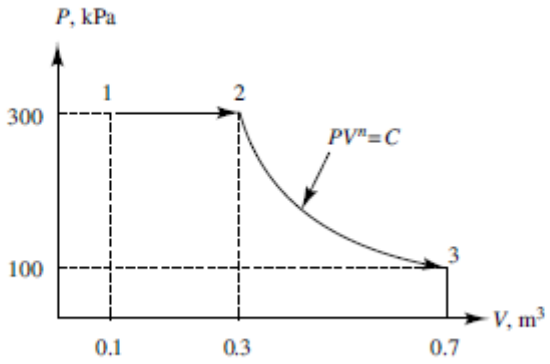

Figure 1

Question 4

An ideal gas undergoes a thermodynamic cycle consisting of the following quasiequilibrium processes

(i) Process 1-2: Constant volume $U_2 - U_1 = 30$ kJ

(ii) Process 2-3: Isothermal expansion

(iii) Process 3-1: Constant pressure P=1 bar, W_{3-1} = -10 kJ, V_3 = 0.2 m^3
The changes of KE and PE are negligible. Sketch the cycle on the P-V diagram. Calculate the net work for the cycle. Also calculate the heat transfer for the process 3-1. [25]

Question 5

a. A jet of water issuing from a 20 mm diameter nozzle is directed vertically upwards. The diameter of the water jet at a point 3 m above nozzle is 40 mm. Find the velocity of jet at point 3 m above nozzle. Assume that jet remains steady and there is no loss of energy. [20]

b. Define Reynolds number. State its significance regarding the determination of type of flow-laminar and turbulent. [5]