UGANDA MARTYRS UNIVERSITY

FORT PORTAL CAMPUS

FACULTY: ENGINEERING AND APPLIED SCIENCE

DEPARTMENT: DEPARTMENT OF ELECTRICAL ENGINEERING

COURSE CODE: BEE3105 **COURSE NAME:** THERMODYNAMICS

FINAL ASSESSMENT

ACADEMIC YEAR 2023/2024 SEMESTER I

BSc. ELECTRICAL ENGINEERING

Date of Examination: 10TH DECEMBER 2023

Time allowed: 3 Hours (9:00AM – 12:00PM)

Instructions to Candidates:

Read the following before answering the examination questions.

1) This Exam contains Six questions.
2) Attempt any four (4) questions of your choice.
3) All Questions carry equal marks.
4) Show all the necessary workings.
5) Start each question on a fresh page.
6) Read other instructions on the answer booklet.
7) Do NOT write anything on this question paper.

You should have the following in this Examination.

Answer Booklet, Drawing instruments, graph papers, Steam tables, and non-programmable calculator.

QUESTION ONE

(a) Explain the following terms in relation to steam and steam formation.

(i) Dryness fraction. (02 Marks)

(ii) Latent heat of vaporization. (02 Marks)

(b) With the aid of a curve, explain the three stages involved in steam generation. (08 Marks)

(c) determine the enthalpy, volume, internal energy, and entropy of superheated steam at 15barpressure and 220°C. Neglect the volume of water and take specific heat of superheat to be equal to 2.2kJ/kgK. (13 Marks)

QUESTION TWO

(a) With the aid of an illustration, explain the first law of thermodynamics for a cyclic process. (05 Marks)

(b) Discus the steady flow energy equation (SFEE) for an open system. (05 Marks)

(c) Air at 1 bar pressure, 290 K temperature flows steadily at a rate of 120 m^3/hr into a compressor where is pressure and temperature are respectively raised to 15 bar and 390 K. During the compression process, the heat transferred from the compressor is 10 percent of the work from the machine. Neglecting changes in kinetic energy and potential energy, evaluate the work and heat interactions. Presume that air behaves as a perfect gas and that R = 287 kJ/Kg K. (15 Marks)

QUESTION THREE

(a) Explain the meaning and types of Thermal reservoirs. (06 Marks)

(b) Explain the second law of thermodynamics according to:

(i) Kelvin-plank. (03 Marks)

(ii) Clauss (03 Marks)

(c) A heat engine working on Carnot cycle converts one-fifth of the heat input into work. When the temperature of the sink is reduced by 80°C, the efficiency gets doubled. Determine the temperatures of the Heat source and Heat sink. (15 Marks)

QUESTION FOUR

(a) Explain the meaning of the following thermodynamics terms.

(i) Thermodynamics system. (02 Marks)

(ii) Thermodynamic process. (02 Marks)

(iii)Thermodynamic equilibrium. (02 Marks)

(b) A cylinder contains 1.25m^3 of gas at 80 kPa and 375 K. The gas is compressed polytropically until its volume reduces to one-fourth of its initial volume and the final pressure becomes 480 kPa. Determine,

(i) The mass of the gas. (04 Marks)

(ii) The value of the index n for compression. (04 Marks)

(iii)Change in internal energy. (04Marks)

(iv) Work done and heat transfer to or from the gas. (07 Marks)

(Take R=287 kJ/kg K, γ=1.4)

QUESTION FIVE

(a) Explain the term "Heat Engine". (03 Marks)

(b) The mechanical cycle of a petrol and diesel engines can be modelled into a thermodynamic cycle. Explain four assumptions made in an attempt to fulfil the above. (04 Marks)

(c) In an ideal engine operating on a Carnot cycle, the ratio of isentropic compression is 6 and isothermal expansion is 1.5. If the maximum pressure and temperature are limited to 20 bar and 700 K, determine the following parameters.

(i) Temperature and pressure at salient points of the cycle. (12 Marks)

(ii) Thermal efficiency of the cycle. (06 Marks)

QUESTION SIX

(a) Explain the key difference between an "air standard Otto cycle" and a "Diesel Cycle." (04 Marks)

(b) An air standard Otto Cycle has a heat addition of 2800 kJ/kg of air, a compression ratio of 8, and a pressure and temperature at the beginning of compression process of 1 bar, 300 K respectively. For air, C_p =1.005 kJ/kg K, C_v = 0.718 kJ/kg K.

(i) Represent the cycle on a P-V diagram. (05 Marks)

(ii) Determine the maximum temperature and pressure of the cycle. (12 Marks)

(iii)The cycle thermal efficiency. (04 Marks)

Important thermodynamic relations

For an ideal gas	• $PV = mRT$ • $C_P - C_V = R$ • $\frac{C_P}{C_V} = 1.4$
Equation of State for a perfect gas	• $\frac{PV}{T} = Constant$
Enthalpy equation, h	• $h = u + PV$
For cyclic process	• $Q = W$
Work done	• $W = PdV$
Adiabatic process	• $PV^{\gamma} = Constant$
Isothermal process	• $PV = Constant$
Isentropic process	• $PV^{\gamma} = Constant$
Polytropic process	• $PV^{n} = Constant$
Isochoric process	• $\Delta v = 0$
Isobaric process	• $\Delta p = 0$

END