

UGANDA COAST GUARDS UNIVERSITY

FORT PORTAL CAMPUS

FACULTY: ENGINEERING AND APPLIED SCIENCE

DEPARTMENT: DEPARTMENT OF MECHANICAL ENGINEERING

COURSE CODE: DME2203 **COURSE NAME:** THERMODYNAMIC II

FINAL ASSESSMENT

ACADEMIC YEAR 2023/2024 SEMESTER I

DIPLOMA IN MECHANICAL ENGINEERING

Date of Examination: 13TH DECEMBER 2023

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

Instructions to Candidates:

Read the following before answering the examination questions.

- 1) The paper consists of six (6) questions.
- 2) Question one is **COMPULSORY**.
- 3) Attempt any other **three** questions.
- 4) All Questions carry equal marks.
- 5) Show all the necessary workings.
- 6) Start each question on a fresh page.
- 7) Read other instructions on the answer booklet.
- 8) 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 (COMPULSORY)

- a) Explain the principles of operation of a Diesel Engine. (10 Marks)
- b) Describe how the following automobile components work.
 - i. Wenkel Engine. (5 Marks)
 - ii. Turbo Charger. (5 Marks)
- c) Explain three advantages and two disadvantages of two-stroke cycle over four-stroke cycle engines. (5 Marks)

QUESTION TWO

- a) Explain the term "Engine blowby loss". (2 Marks)
- b) Differentiate between thermal efficiency and Heat Balance (3 Marks)
- c) A gasoline engine works on Otto cycle. It consumes 8 liters of gasoline per hour and develops power at the rate of 25 kW. The specific gravity of gasoline is 0.8 and its calorific value is 44000 kJ/kg. Find the indicated thermal efficiency of the engine. (10 Marks)
- d) A single cylinder engine operating at 2000 rpm develops a torque of 8 N-m. The indicated power of the engine is 2.0 kW. Find the loss due to friction as the percentage of brake power. (10 Marks)

QUESTION THREE

- a) Explain the "term isothermal compression efficiency" (2 Marks)
- b) Explain the relevance of clearance in reciprocating compressors. Elaborate its effect on the performance of reciprocating compressor. (3 Marks)
- c) With the aid of a P-V diagram, discuss the operational stages of a two-stage reciprocating air compressor. (10 Marks)
- d) A single stage reciprocating compressor takes 1m^3 of air per minute at 1.013 bar and 15°C and delivers it at 7 bars. Assuming that the law of compression is $PV^{1.35} = \text{constant}$, and the clearance is negligible, determine the indicated power. (10 Marks)

QUESTION FOUR

- a) An air compressor cylinder has 150mm bore and 150mm stroke and the clearance is

15%. It operates between 1 bar, 27°C and 5 bar. Take polytrophic exponent $n = 1.3$ for compression and expansion processes, determine the following.

- i. Cylinder volume at the various salient points of in cycle. (5 Marks)
 - ii. Flow rate in m^3/min at 720 rpm. (4 Marks)
 - iii. The deal volumetric efficiency. (6 Marks)
- b) Calculate the diameter and stroke for a double acting single stage reciprocating air compressor of 50kW having induction pressure 100 kN/m^2 and temperature 150°C . The law of compression is $PV^{1.2} = C$ and delivery pressure is 500 kN/m^2 . The revolution/sec = 1.5 and mean piston speed in 150 m/min. Clearance is neglected. (10 Marks)

QUESTION FIVE

A single acting reciprocating air compressor has a swept volume of 2000 cm^3 and runs at 800 rpm. It operates with pressure ratio of 8 and clearance of 5% of the swept volume. Inlet pressure and temperature are 1.013 bar, and 15°C respectively. Assume $n = 1.25$ for both compression and expansion. Given that the mechanical efficiency is 85%, determine the following parameters.

- i. Indicated power. (4 Marks)
- ii. Volumetric efficiency. (4 Marks)
- iii. Mass flow rate (4 Marks)
- iv. FAD. (4 Marks)
- v. Isothermal efficiency (4 Marks)
- vi. Actual Power required to drive the compressor (5 Marks)

QUESTION SIX

- a) With the aid of labelled sketches, explain the working principle of four stroke petrol engine. (10 Marks)
- b) Following data refer to a four stroke double acting diesel engine having **cylinder Diameter 200 mm and Piston stroke 350 mm.**
 - MEP on cover side = 6.5 bar
 - MEP on crank side = 7 bar Speed = 420 rpm
 - Diameter of the Piston rod = 20mm

- Dead load on the brake = 1370 N
- Spring balance reading = 145 N
- Brake wheel diameter = 1.2 m
- Brake rope diameter = 20 mm.

Determine mechanical efficiency.

(15 Marks)

QUESTION SEVEN

In a trial of a single cylinder oil engine working on dual cycle, the following observations were made.

- Compression ratio = 15.
- Oil consumption = 10.2 kg/h.
- Calorific value of fuel = 43890 kJ/kg.
- Air consumption = 3.8 kg/min.
- Speed = 1900 r.p.m.
- Torque on the brake drum = 186 N-m
- Quantity of cooling water used = 15.5 kg/min.
- Temperature rise = 36 °C.
- Exhaust gas temperature = 410 °C.
- Room temperature = 20 °C.
- C_p for exhaust gases = 1.17 kJ/kgK.

Calculate:

- i. Brake power. (8 Marks)
- ii. Brake specific fuel consumption. (8 Marks)
- iii. Brake thermal efficiency. (9 Marks)

END