Charles Darwin University

Final Examination

Family Name	
Given Name/s	
Student Number	
Teaching Period	Semester 1, 2019

ENG247 – Fluid and Thermodynamics	DURATION	
	Reading Time:	**10** minutes
	Writing Time:	**180** minutes

INSTRUCTIONS TO CANDIDATES

1. Read all questions carefully.
2. Answer all **8** questions.
3. Exam is worth 50% of total marks for this unit.
4. Total marks available for this test is 100.
5. Questions are not of equal value.

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper Formula Sheet/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Answer ALL questions in the Answer Booklet provided.

Marks for each question are indicated.

Question 1 (10 marks)

(a) (CCT 9–21C) How do the efficiencies of the ideal Otto cycle and the Carnot cycle compare for the same temperature limits? Explain.

(Marks: 2)

(b) (CCT 7–55C) Why does a nonquasi-equilibrium expansion process deliver less work than the corresponding quasi-equilibrium one?

(Marks: 2)

(c) (CCT 7–59C) Briefly describe the four (4) processes that make up the Carnot cycle.

(Marks: 6)

Question 2 (15 marks)

(CCT 12–29) Water at 20°C and having a vapour pressure $P_v = 2.338\ kPa$ (absolute) is siphoned from a reservoir as shown in Fig. P12–29. For *d* = 10 cm and *D* = 16 cm, determine

(a) the minimum flow rate that can be achieved without cavitation occurring in the piping system

(Marks: 10)

(b) the maximum elevation of the highest point of the piping system to avoid cavitation.

(Marks: 5)

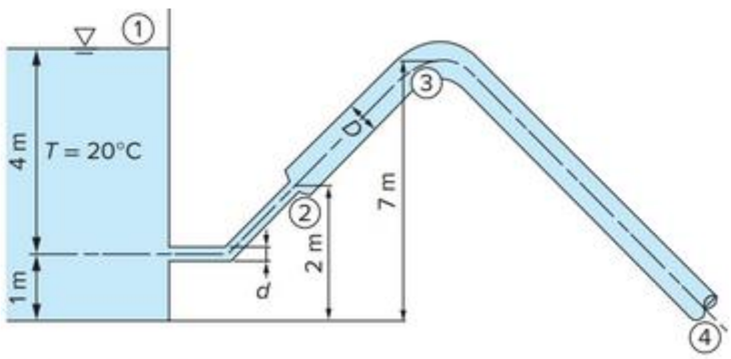

FIGURE P12–29

Question 3 (15 marks)

(CCT 12–59) Underground water is to be pumped by a 78 % efficient 5 kW submerged pump into a pool whose free surface is 30 m above the underground water level as shown in Fig. P12–58. The diameter of the pipe at the inlet and exit of the pump is 5 cm and 7 cm, respectively. Given that the kinetic energy correction factor $\alpha = 1$ and density of water $\rho = 1000\ kg/m^3$, determine the

a) mass flow rate of water

(Marks: 8)

b) pressure difference across the pump if the irreversible head loss of the piping system is 4 m.

(Marks: 7)

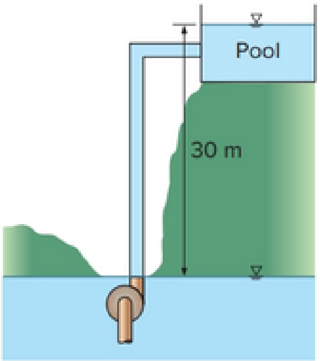

FIGURE P12–58

Question 4 (15 marks)

(CCT 13–30) A fan with 61 cm diameter blades moves 0.95 m^3/s of air at 20°C at sea level. Determine the

(a) force required to hold the fan from moving in the horizontal direction

(Marks: 10)

(b) minimum power input required for the fan. [Choose a control volume sufficiently large to contain the fan, with the inlet sufficiently far upstream so that the gage pressure at the inlet is nearly zero. Assume air approaches the fan through a large area with negligible velocity and air exits the fan with a uniform velocity at atmospheric pressure through an imaginary cylinder whose diameter is the fan blade diameter. The gas constant of air $R = 0.287\ kPa.m^3/kg.K$, atmospheric pressure at sea level $P_{atm} = 101.3\ kPa$ and $\beta = 1$.]

(Marks: 5)

Question 5 (15 marks)

(CCT 5–2) The volume of 1 kg of helium in a piston–cylinder device is initially 5 m^3. Now, the helium is compressed to 2 m^3 while its pressure is maintained constant at 180 kPa. The gas constant of helium is $R = 2.0769\ kPa.m^3/kg.K$.

(a) Draw a P-V diagram for the set –up. (Marks: 5)

(b) Determine the initial and final temperatures of the helium . (Marks: 5)

(c) Determine the work required to compress the helium. (Marks: 5)

Question 6 (10 marks)

(CCT 6–6) A steady-flow compressor is used to compress helium at the inlet from 100 kPa and 20°C to 1400 kPa and 315°C at the outlet. The outlet area and velocity are 0.001 m^2 and 30 m/s, respectively, and the inlet velocity is 15 m/s. Determine the mass flow rate and the inlet area.

Question 7 (10 marks)

(CCT 7–87) A refrigerator is to remove heat from the cooled space at a rate of 300 kJ/min to maintain its temperature at -8°C. If the air surrounding the refrigerator is at 25°C, determine the minimum power input required for this refrigerator.

Question 8 (10 marks)

(CCT 9–27) An ideal Otto cycle has a compression ratio of 10.5, takes in air at 90 kPa and 40 °C, and is repeated 2500 times per minute. Using constant specific heats at room temperature, determine the thermal efficiency of this cycle and the rate of heat input if the cycle is to produce 90 kW of power. [Use $c_p = 1.005\ kJ/kg.K\ and\ c_v = 0.718\ kJ/kg.K$]

THE END