UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING : MECHANICAL*
SUBJECT	:	**SUBJECT: THERMODYNAMICS 3**
CODE	:	**CODE:IMT 313**
DATE	:	WINTER EXAMINATION 25th May 2019
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100
ASSESSOR	:	: E. BAKAYA-KYAHURWA
MODERATOR	:	: C. Anghel
NUMBER OF PAGES	:	: 4 excluding the cover page plus Annexure A and B.
INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

1. This paper contains 5 questions
2. PLEASE ANSWER **ALL** QUESTIONS
3. Make sure that you understand what the question requires before attempting it.
4. Any additional examination material is to be placed in the answer book and must indicate clearly the question number, and Student number.
5. Draw proper sketches where required with all relevant information
   Answers without calculations will not be considered.
   Answers without units will not be considered.
   All answers to be to the 4th decimal point.
   Number all answer according to the numbering in question paper.

REQUIREMENTS :
Refrigerant tables, Mollier diagram, Steam property tables

QUESTION 1

A food storage chamber requires a refrigeration system of 12 tons of refrigeration with an evaporator temperature of -8°C and a condenser temperature of 30°C. The refrigerant R22 is subcooled by 5°C before entering the metering device, and the vapour is superheated by 6°C before entering the compressor. Compression is isentropic. If the liquid and vapour specific heat capacities at constant pressure are 1.518 and 0.8623 kJ/kgK respectively and 1 ton of refrigeration ≡ 3.516 kW, calculate the:

1.1 Refrigerating capacity in kW. (4)
1.2 Refrigerating effect (kJ/kg). (4)
1.3 Mass of refrigerant circulated per minute. (4)
1.4 Compressor discharge temperature. (4)
1.5 Coefficient of performance COP. (4)

The relevant properties of R22 are given below.

Temperature °C	Enthalpy, kJ/kg		Entropy, kJ/kg K	
	(hf)	(hg)	(Sf)	(Sg)
-8	190.72	402.34	0.96586	1.76398
30	236.66	414.53	1.1253	1.7120

[20]

QUESTION 2

A two-stage single acting reciprocating air compressor draws in air at a pressure of
1 bar and 17° C and compresses it to a pressure of 60 bar. After compression in the L.P. cylinder, the air is cooled at constant pressure of 8 bar to a temperature of 37° C. The low pressure cylinder has a diameter of 150 mm and both the cylinders have
200 mm stroke. If the law of compression is pv1.35 = C, find the power of the compressor, when it runs at 200 r.p.m. Take R = 287 J/kgK

[20]

QUESTION 3

Air initially at 206°C and at a pressure of 7 bar occupies a volume of 0.03 m^3. The air is subjected to a cyclic process as follows. It is first expanded at constant pressure to a volume of 0.09 m^3. It is then expanded polytropically according to the law $PV^{1.5} = C$ before it is compressed isothermally to assume its initial state.

3.1 sketch the process on a P-V diagram (5)
3.2 find the mass of air present. (5)
3.3 determine the total change in entropy during each process (5)
3.4 The net change of entropy during the cycle (5)

[20]

QUESTION 4

During a trial on a 4-cylinder petrol engine running at 3000 r/min, the brake mass on the dynamometer was 27.5 kg on a torque arm length of 350 mm. A Morse test was carried out on the engine and the following masses were used as the cylinders were cut out in turn: 18.35 kg; 19.37 kg; 18.86 kg and 18.86 kg. Calculate the:

4.1 Torque on the engine. (4)

4.2 Brake power of the engine (kW). (4)

4.3 Indicated power in each cylinder (kW). (4)

4.4 Indicated power of the engine (kW). (4)

4.5 Mechanical efficiency of this engine (4)

[20]

QUESTION 5

5.1 Name two examples of heat engines in everyday use (4)

5.2 What is the most efficient heat engine? (4)

5.3 Illustrate diagrammatically the processes encountered in an Otto cycle (4)

5.4 An ideal dual cycle has a compression ratio of 14 and cutoff ratio of 1.2. The pressure ratio during constant pressure heat addition is 1.1. The state of the air at the beginning of compression is 98 kPa and 24°C. using constant specific heats at room temperature determine

5.4.1 thermal efficiency, (6)

5.4.2 amount of heat added, (6)

5.4.3 maximum cycle pressure and temperature (8)

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