UNIVERSITY OF JOHANNESBURG

PROGRAM : Bachelor of Engineering Technology (BEngTech)
ENGINEERING: MECHANICAL

SUBJECT : **THERMODYNAMICS 2A**

CODE : **TRDMIA2**

DATE : 17 JULY 2019

DURATION : 15 :00 – 18 :00

EVALUATION : SUPPLEMENATRY EXAM

TOTAL MARKS : 100

EXAMINER : Mr. OJ Kaelo

MODERATOR : Mr Bakaya-Kyahurwa, Emmanuel

NUMBER OF PAGES : 3PAGES (including cover page)

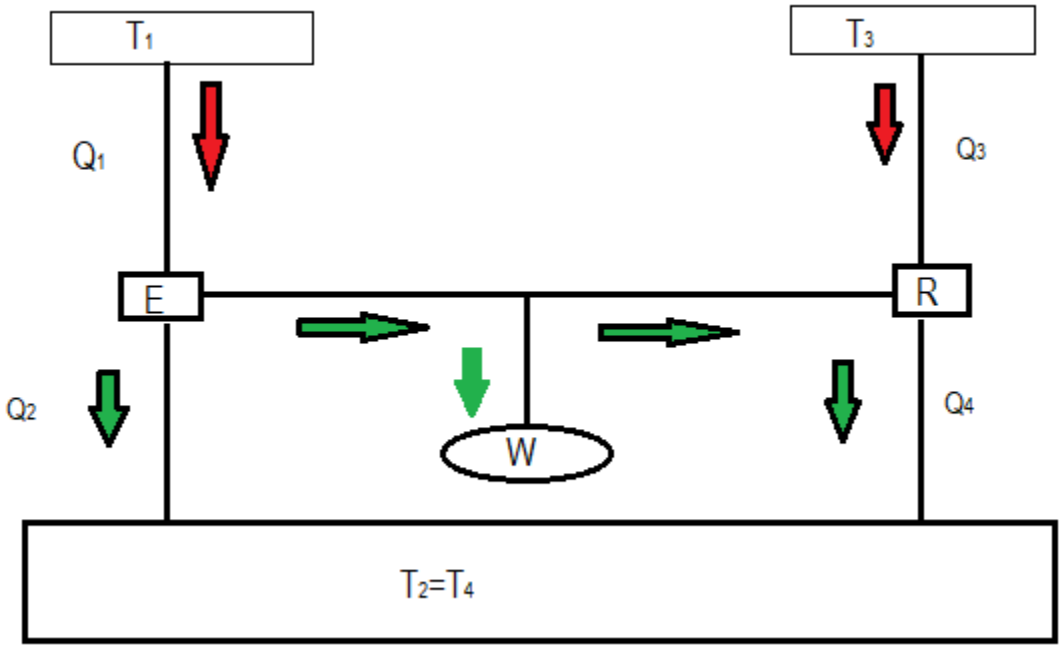
INSTRUCTIONS :

1. ANSWER ALL QUESTIONS NEATLY.
2. SHOW ALL CALCULATIONS
2. ANSWERS WITHOUT UNITS WILL NOT BE CONSIDERED
3. NUMBER YOUR ANSWERS STRICTLY ACCORDING TO THE QUESTIONS
4. WHERE OMITTED, ASSUME THE NECESSARY CONSTANTS FOR YOUR SOLUTIONS

REQUIREMENTS: CALCULATORS.

QUESTION 1

A heat engine operates in the middle of two reservoirs of temperatures of 400 ℃ and 60℃. The engine drives a refrigerator, which operates between reservoir at temperatures of 60℃ and -10℃. The engine received heat of 1500 kJ and the network output of the combined engine and refrigerator is 250 kJ. Find the heat transfer to the refrigerant and the net heat transfer at 60℃ and if the efficiency of the heat engine and C.O.P of the refrigerator are each 40% of their maximum possible values. Assume both heat engine and refrigerator to be reversible.



[20]

QUESTION 2

In a steady flow process of an open system, the velocity of the fluid is increased from 100 to 500 m/s, the volume is decreased from 5 to 2 m^3/kg, the pressure is increased from 1MPa to 2MPa, and the internal energy is increased by 20 kJ/kg. Find the change in enthalpy per kg of the fluid, and the work done on the fluid if no heat is taken in or rejected.

[15]

QUESTION 3

For the petrol engine in the mechanical engineering laboratory, the following data is generated:

Engine capacity	2 liters
Number of cylinders	4
Operating temperatures	t_{max} =600 ºC, t_{min} =20 ºC
Clearance volume	9 % of the stroke volume

4.1. To analyse this engine what assumptions must be made.
4.2. Determine the engine's compression ratio and all the temperatures in the cycle.

Assuming that for air c_v = 713 J/kgK, estimate the thermal efficiency of the cycle per kg of air.

[25]

QUESTION 4

Uncle Sipho has an old bakkie powered by a four-cylinder dual combustion cycle engine. You, as an engineer, are required to assess the efficiency of this engine, knowing that its compression ratio is 12 and cut-off is at 1/9 of the stroke volume, if the pressure at the beginning of compression is 100 kpa and maximum pressure is 500kpa

$\gamma = air = X$

[20]

QUESTION 5

The clearance volume of a single stage, single acting air compressor is 3.3% of its stroke volume, while the bore is 120 mm and stroke is 200 mm. The compressor is running at 300 rpm and the polytropic compression starts at 1 bat and 20ºC. If the pressure of air delivery pressure is not to exceed 6 bar,

5.1. Estimate the compressor power required.

5.2. State three considerations to be given when selecting an air compressor.

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$$PV^n = C\ ; COP = COP_{ideal};\ \ \Delta S = mC_v \ln {T_2}/{T_1} + mR ln \frac{V_2}{V_1}\ ;\ \frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$W_{net} = Q_{in} - Q_{out}\ ; \eta_{thermal} = \frac{W_{net}}{Q_{in}}\ \ ; PV = mRT\ \ ;\ \ \frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}\ \ ;$$

$$C_p - C_v = R\ ;\ \rho_{cutoffratio} = \frac{V_2}{V_1} = \frac{V_2}{V_5}\ ;\ r_{compression} = \frac{V_4}{V_5} = \frac{V_3}{V_1};\ \propto = \frac{P_1}{P_5}$$

$$h_1 + \frac{V_1^2}{2} + gz_1 + q_{1-2} = h_2 + \frac{V_2^2}{2} + gz_2 + w_{1-2}$$

$$\eta = 1 - \frac{1}{r^{\gamma-1}}\left[\frac{\rho^\gamma - 1}{\gamma(\rho - 1)}\right]$$