ME 200 – Thermodynamics, L. Liebenberg

**Name:** Joseph Specht **Net-ID:** jspecht3

**Quiz 5** (Total: 40 points) **Due back on Wed. Feb. 22 at 10 p.m., in Canvas**

* *Assignments will only be graded if the honor code statement is completed and signed.*
* *Save your entire assignment as one* ***PDF document*** *and upload it in the appropriate assignment folder on Canvas.*

**Honor Code Statement**

***ME 200, Quiz 5***

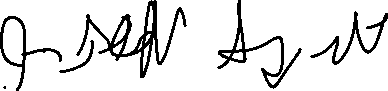
Being a student of high standards, I pledge to embody   
the principles of *academic integrity*.

This quiz is my own work. I did not seek (or get) outside help or collaboration with any of the questions and their solutions. I did not post any of the questions on an electronic platform (like Chegg) nor did I solicit answers or solutions from any electronic platform (like Chegg). I also did not offer my solutions or answers to any other student.

I understand that this quiz is “open book” and “open notes” which means that I was permitted to use my prescribed textbook and lecture notes when addressing any of the questions. I have properly cited any other resources, with full cognizance of the regulations pertaining to plagiarism, copyright infringement, academic cheating, etc., as stipulated in the Student Code.

I acknowledge that academic violations will be dealt with according to the UIUC Student Code,   
Article 1, Part 4.

Student’s signature:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



Student’s Name: Joseph Specht

Net-ID: jspecht3

Date: 2/21/23

A citybus engine has the following characteristics:

Engine displacement: 12.9 liters

6 cylinders, in-line placement;

Fuel: Diesel

Compression ratio: 18.5:1

Cut-off ratio: 2.5

The engine’s inlet conditions are 20ºC and 1 bar

Maximum engine pressure: 5 MPa

Using an ideal air-standard Diesel cycle, calculate the following and remember to show all your calculations:

* 1. the temperature and pressure at state points 1, 2, 3, and 4. (15)

12.9-liter DAF diesel engine, courtesy of *DAF/Paccar Trucks* <https://www.dafcomponents.com/en/products/paccar-daf-engines>

* 1. the heat and work transferred in each of the four processes. (20)
  2. The cycle’s thermal efficiency.

**η = 55.9%**(5)

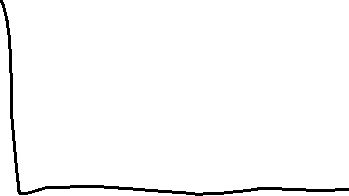
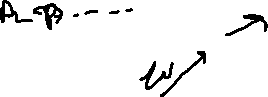
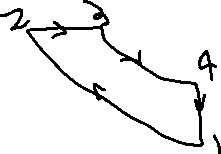
Summarize your calculated values of temperature, pressure, heat, work, and change in internal energy. (-5 points if tables are not completed.)

5000 (given)

100 (given)

5000 (given)

293 (given)



|  |  |  |  |
| --- | --- | --- | --- |
| **Process** | ***q* (kJ/kg)** | ***w* (kJ/kg)** | **Δ*u* (kJ/kg)** |
| ­1 – 2 | 0 |  | 422.35 |
| 2 – 3 |  |  | 1000.07 |
| 3 – 4 | 0 |  | - |
| 4 – 1 | -592.62 | 0 | -592.62 |
| Cycle: | *q*net = 751.6 | *w*net = 751.6 | 0 |

A picture containing graphical user interface

Description automatically generated

Relevant Information For all Processes:

This is taken from Table A-20. The assumed temperature is 900\*K

* c\_v = .834
* c\_p = 1.121
* k = 1.344

1-2: Adiabatic Compression

* Compression Ratio = 18.5:1 = V\_1 / V\_2
* Initial Temp = 20\*C = 293\*K
* Initial Pressure = P\_1 = 1 bar = 100 kPa
* Max Pressure = P\_2 = 5 MPa = 5000 kPa
* V\_1 = 12.9 Litres

Since this is an adiabatic process,

Since this is a adiabatic process in a closed cycle, q=0 and…

This also means that Δu = -w = -422.35 kJ/kg

2-3: Constant Pressure Heat Injection

* Max Pressure = P\_2 = P\_3 = 50 bar = 5000 kPa
* Cut-off Ratio = V\_2 / V\_3 = 2.5

Since this is a constant pressure process…

We also know that in a closed system with constant pressure, so

From the first law, we know that w = q – Δu, so

3-4: Adiabatic Expansion

* P\_4 / P\_3 = (P\_4 / P\_2) / (P\_3 / P\_2) = Compression Ratio / Cut-Off Ratio = 7.4
* P\_3 / P\_4 = 1 / 7.4 = .135
* P\_3 = Max Pressure = 50 bar
* V\_4 = V\_1 = 12.9 Litres

We know this is an adiabatic process, so we can use the equations,

Since this is an adiabatic process,

We also know that work is -Δu, ∴ Δu = -829.80 kJ/kg

4-1: Constant Volume Heat Rejection

* V\_1 = V\_4 = 12.9 Liters

Since the volume is the same, we know work is 0.

To find η, we apply the following formula,