Thermodynamics (PHYS 425/525, APN 525) **Fall 2024**

Extra Credit Project 2 (due on date of Exam II)

(**15 points** undergraduates, **10 points** graduates)

7) **Text Problem 4.20** - Diesel cycle, discussed in class; determine diesel efficiency similarly to **Text Problem 4.18**;

first show that: $\dfrac{Q_c}{Q_h} = \dfrac{1}{\gamma}\dfrac{V_1(P_4 - P_1)}{P_2(V_3 - V_2)}$, where $\gamma = \dfrac{f+2}{f}$;

then using the fact that 3-4, and 1-2 are adiabatic, relate the initial and final pressures to the volumes and show that the expression above can be re-written as:

$$\frac{Q_c}{Q_h} = \frac{1}{\gamma}\frac{V_1}{V_3 - V_2}\left[\left(\frac{V_3}{V_1}\right)^{\gamma} - \left(\frac{V_2}{V_1}\right)^{\gamma}\right]$$

finally, to express the efficiency in terms of the compression ratio , divide the numerator and denominator of each volume ratio by V_2, then factor out the compression ratio, V_1/V_2, to show that:

$\dfrac{Q_c}{Q_h} = \left(\dfrac{V_2}{V_1}\right)^{\gamma-1} \cdot \dfrac{1}{\gamma}\dfrac{(V_3/V_2)^{\gamma} - 1}{(V_3/V_2) - 1}$, where the first term is the efficiency of

the Otto cycle, determined in Text Problem 4.18. The efficiency is then determined from Eq. (4.3), $\epsilon = 1 - \dfrac{Q_c}{Q_h}$

Programming Part:

Now, make a plot of the "correction factor" $\dfrac{1}{\gamma}\dfrac{(V_3/V_2)^{\gamma}-1}{(V_3/V_2)-1}$ versus the cutoff ratio, V_3/V_2 for a diatomic ideal gas ($\gamma = 7/5$). Set the y-axis range $[0, 1.6]$, x-axis range $[1, 5]$. Is the efficiency of the diesel larger than or less than that of the Otto Cycle? *hint:* Will the correction factor make the efficiency of the diesel engine larger than or less than the efficiency of the Otto cycle?