CHE312A: Homework 5

Instructions: Upload your original, legible and handwritten solution in pdf format, with the exact filename ⟨yourrollnumber⟩.pdf (e.g. 06302016.pdf). Include your name and roll number on the top of the first page. Include all necessary steps in detail, define all symbols and state all assumptions made in your solution. Use material properties reported in appendices of either Incropera's or Cengel's book, unless specified otherwise.

1. The volume expansion coefficient for an ideal gas is $\beta = 1/T$. Derive a similar expression for β, for a van der Waals gas. (2 points)

2. Repeat the *glass door firescreen* problem on page 142 of class notes by assuming air to be a van der Waals gas while calculating the volume expansion coefficient. Use the constants in van der Waals equation of state, $a = 0.138$ J m^3/mol^2 and $b = 3.186 \times 10^{-5}$ m^3/mol. Comment on the resulting rate of convection heat transfer relative to that obtained in the notes (442 W). (2 points)

3. Water is to be boiled at atmospheric pressure in a mechanically polished steel pan placed on top of a heating unit. The inner surface temperature of the bottom of the pan is maintained at 110°C. If the diameter of the bottom of the pan is 30 cm, determine the rate of heat transfer to the water, and the rate of evaporation. (2 points)

4. Steam at 40°C condenses on the outside of a 3 cm diameter thin horizontal copper tube by cooling water that enters the tube at 25°C at an average velocity of 2 m/s and leaves at 35°C. Determine the rate of condensation of steam, the average overall heat transfer coefficient between the steam and the cooling water, and the tube length. (4 points)