Homework #3

Problem #1
We’d like to compare the power required to bring 1000 lbm/hr saturated propane at 70°F to 1000 psia. Assume 100% efficiency.
- What is the starting pressure?
- What is the pumping power required starting with the saturated liquid (in hp)?
- Assuming an ideal gas, what is the compression power required starting with saturated vapor (in hp)? What is the outlet temperature for a single stage of compression (in °F)?

Problem #2.2
Liquid methane is pumped from a pressurized cryogenic vessel to second pressurized vessel. The liquid enters the pump at 50 psia (3.4 bara) and −250°F (−157°C) and exits at 100 psia (6.89 bara). The liquid flow rate is 2000 gpm (454 m³/h) The pump is well insulated so the pumping process is approximately adiabatic. The pump efficiency is 70%. Estimate the temperature rise in the liquid methane.
The density of the liquid methane is 25.95 lbm/ft³ (415.7 kg/m³) and \( C_p = 0.845 \text{ Btu/lbm}°\text{R} \) (2.99 kJ/kg°C).

Problem #9.1
A gas mixture has the following composition:
- \( C_1 \) 89 vol%
- \( C_2 \) 6
- \( C_3 \) 5
Using Appendix B.13 (B.14) what is the value of the heat capacity ratio, \( \gamma \), at 150°F?

Problem #9.2
A field compressor boosts a raw gas stream from 8 psig (0.55 barg) to 450 psig (31.0 barg). The maximum acceptable pressure ratio is 3.
- a) How many stages will be required assuming the compression ratio is constant for all stages?
- b) What is the compression ratio based upon the number of stages required?
- c) (Additional to what is in textbook) What are the intermediate pressure(s) (in psig)?