American University of Beirut
الجامعة الأمريكية في بيروت

This is an open book 90 minutes exam.
It is recommended that you read the whole exam before you start solving.
Make sure that the units are consistent.
Write your name on both the question and answer sheets.
Clearly identify your control mass / control volume.
State any assumptions you need and provide a convincing justification.

Problem 1

A 400 m^3 storage tank of methane contains 80% liquid and 20% vapor by volume, at 101.3 kPa.
What is the quality in the tank?

Problem 2

Is it reasonable to assume that at the given states the substance behaves as an ideal gas?
a) Oxygen, O_2 at 30°C, 3 MPa
b) Methane, CH_4 at 30°C, 3 MPa
c) Water, H_2O at 30°C, 3 MPa
d) R-134a at 30°C, 3 MPa
e) R-134a at 30°C, 100 kPa

Problem 3

The refrigerant R-410a is contained in a piston/cylinder as shown in the figure, where the volume is 11 L when the piston hits the stops.
The initial state is −30 °C, 150 kPa with a volume of 10 L. This system is brought indoors and warms up to 15 °C.
a. Is the piston at the stops in the final state?
b. Find the work done by the R-410a during this process (Draw the P-v diagram)

R-410a
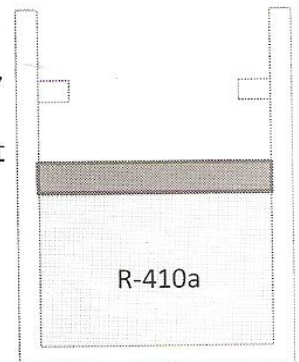
Problem 4

A rigid container has two rooms filled with water, each 1 m^3 separated by a wall (see Fig. below).
Room A has P = 200 kPa with a quality x = 0.80. Room B has P = 2 MPa and T = 400°C. The partition wall is removed and the water comes to a uniform state, which after a while due to heat transfer has a temperature of 200°C. Find the final pressure and the heat transfer in the process.

A   B
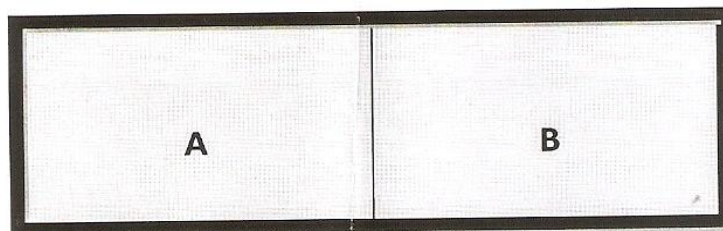
Problem 5 (Facultative 10 pts)

A computer CPU chip consists of 50 g silicon, 20 g copper, 60 g polyvinyl chloride (plastic). It heats from 15 °C to 80 °C as the computer is turned on. How much energy does the heating require?