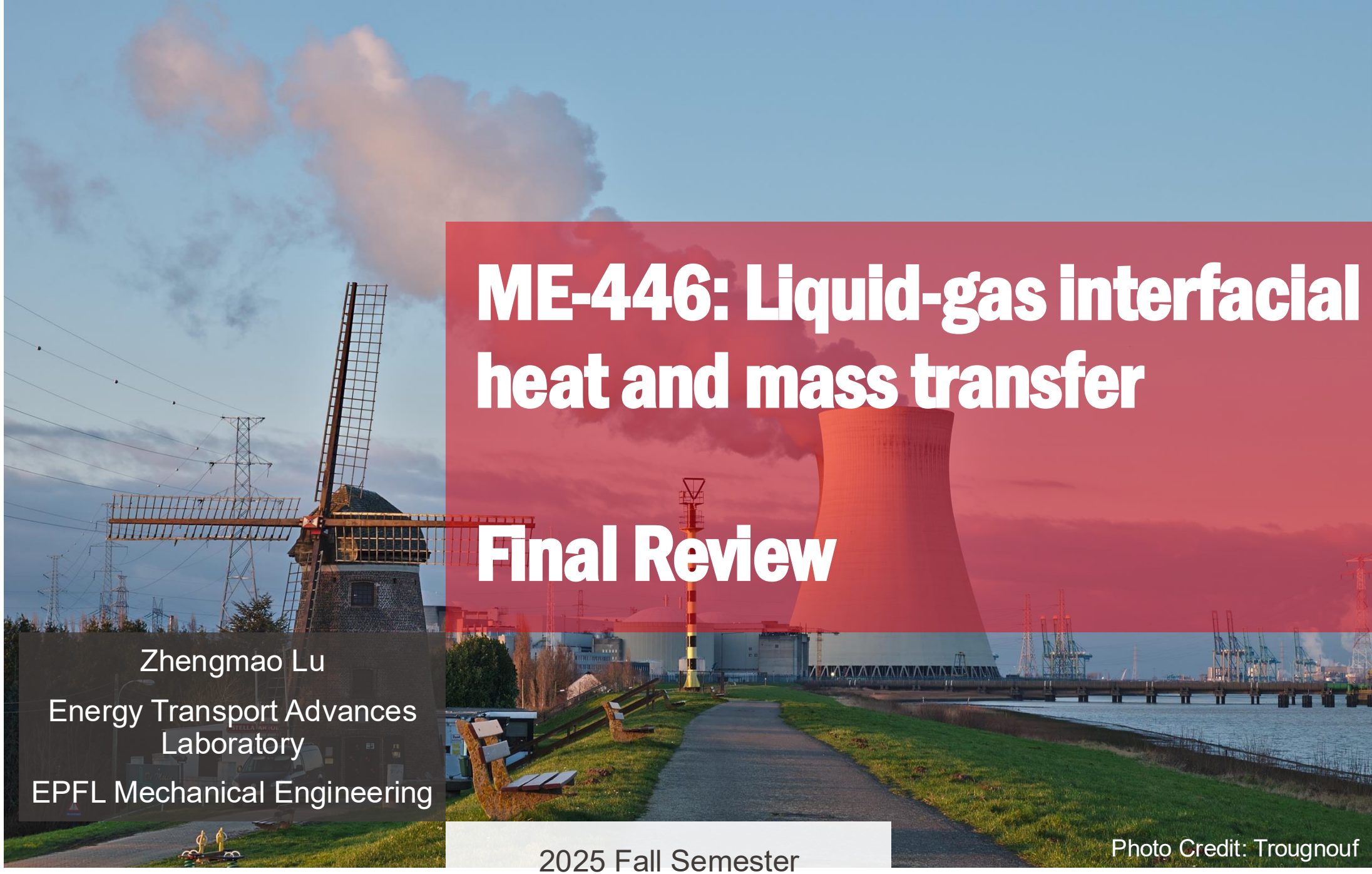

ME-446: Liquid-gas interfacial heat and mass transfer

Final Review

Zhengmao Lu

Energy Transport Advances Laboratory

EPFL Mechanical Engineering

2025 Fall Semester

Photo Credit: Trougnouf

Assessment

- Homework presentation 25%
  - In each week's exercise session, 3-4 of you will form a HW group, work together on a problem set, and present your solution to the class.
  - We will post a Google Sheet of the HW group with preassigned names on Moodle, but feel free to trade slots.
  - The rest of the class is also expected to work on the same problem set prior to the exercise session. Solution will be posted the week after for self-correction. You do NOT need to submit anything.
  - For the HW presentation, you get the full score if you show reasonable amount of effort regardless whether you get the correct answer.

Assessment

- Journal presentation 25%

  - We will post several more recent papers in the area of liquid-gas interfacial phenomena. You can sign up for the one that you are most interested.

  - People who choose the same paper form a JP group. Each group has a size limit based on the specific paper. The sign-up sheet and the papers will be posted later, first come first service.

  - In the two weeks before the last lecture week, each JP group will give an oral presentation (presentation period = group size x 5 min + 5 min Q&A)

Assessment

- Final Exam 50%
  - Will be closely related to exercise problems

What We Have Covered This Semester

- Capillarity and wetting
- Evaporation
- Boiling
- Condensation

Capillary and Wetting

- Surface energy and surface tension
- Laplace pressure and Young-Laplace equation
- Contact angle: Young’s equation, hysteresis, effect of surface structures

Effect of Surface Structures

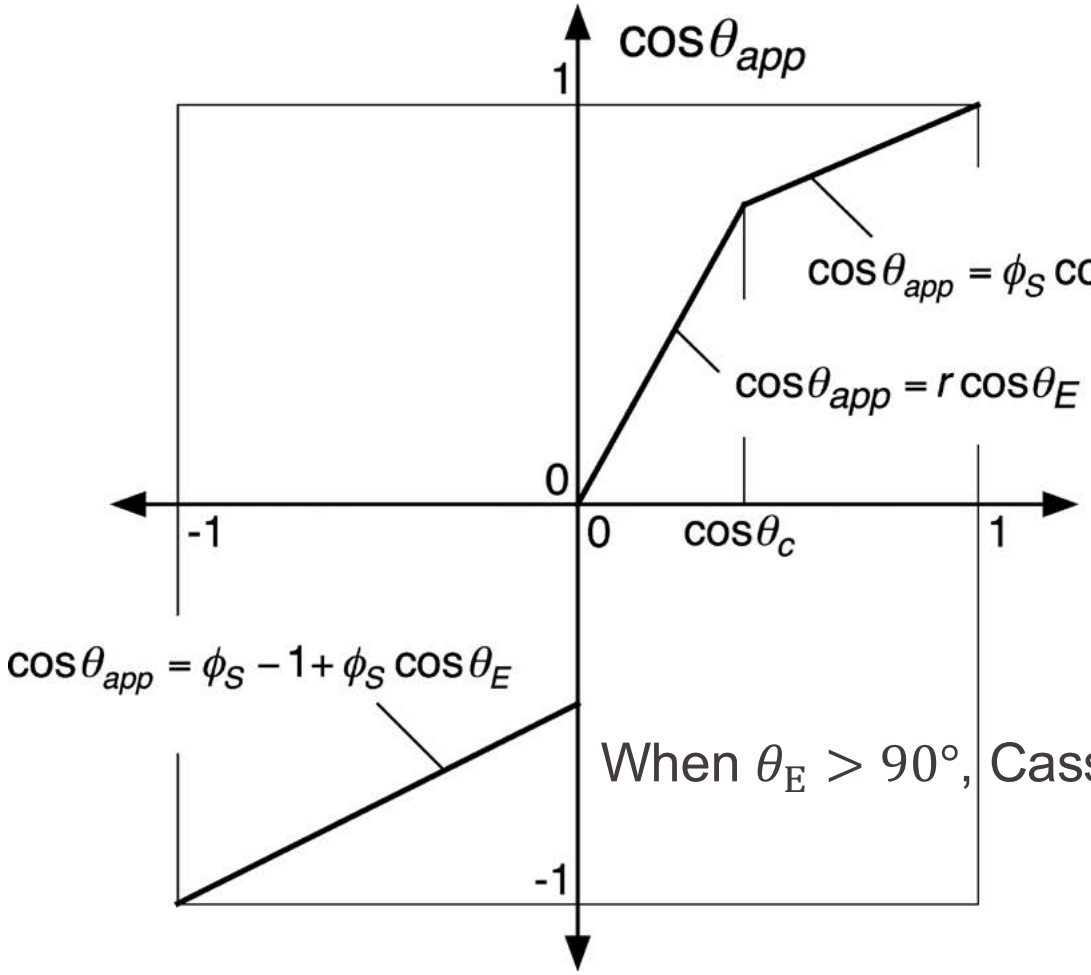

Figure 3.24 in Carey

θ_E: equilibrium contact angle

$$\cos\theta_c = \frac{1-\phi}{r-\phi}$$

When $\theta_E < \theta_c$, hemi-spreading state

When $\theta_c < \theta_E < 90°$, Wenzel state

When $\theta_E > 90°$, Cassie-Baxter state

Evaporation Physics

- Fick’s law of diffusion
- Heat and mass transfer analogy
- Coffee ring effects
- Kinetic theory of gases based on velocity distribution functions
- Schrage equation: expression and limits

Pool Boiling

- Pool Boiling Curve
- Initial stage of boiling: nucleation and bubble departure
- Nucleate boiling heat transfer (correlation)
- Critical heat flux (hydrodynamic instabilities, statistical treatment)

Flow Boiling

- Flow regimes
- Evaluate ONB, HTC, and CHF in flow boiling with correlations
- Instability caused by density waves

Condensation

- Dropwise condensation
- Filmwise condensation
- Jumping droplet condensation
- Lubricant infused surfaces
- Wicking condensation

Final Exam Format

- 3 hour written exam:
  Monday 12.01.2026 from 15h15 to 18h15 (CM 1 106)
- 4 calculation/analysis questions (if an empirical correlation is needed for calculation, it will be given)
- You are allowed to bring a cheat sheet (one A4 paper; you can write things on both sides) and a calculator with you to the exam
- **A favor to ask**: fill in the course evaluation form after finishing your test