Contact Mechanics and Elements of Tribology

Foreword

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@ Centre des Matériaux (& virtually)
February 7, 2022

Outline

- Acquaintance
- Questionnaire
- Teaching team
- Course content
- Complexity of contact physics
- Notations

Teaching team





- **Henry Proudhon** (@CNRS, France) - Fretting and Wear
- **Andrei Shvarts** (@Glasgow University, UK) - Lubrication and Sealing
- **Ramin Aghababaei** (@Aarhus University, The Netherlands) - Nanoscopic wear
- **Pierre Arnaud** (@MINES, France) - Fretting wear, 3rd body & oxygenation
- **Vladislav Yastrebov** (@CNRS, France)

Please introduce yourself

https://forms.gle/N543vtroXBxFa8W69

Zoom and operational mode

- That's our **second** experience to give our course in hybrid mode for so many participants, so please be patient with technical problems ☺.
- In case of such problems, please write in Zoom chat, we'll try to solve them asap.
- Please do not record the course, one day, I'll do it on my own ☺
- Please don't share zoom links neither. If someone would like to attend, please write me an email.
- During lectures, I'll accept oral question only from people in the classroom.
- For all Zoom participants, please write your questions in Google.Sheet, I'll try to address them later.
- All slides are available on www.yastrebov.fr/teaching.html
- All links will be provided in Google.Sheet of the course (please be careful with this online document).
- You can use all my figures and my slides (CC BY license) under condition that you cite the author.

Program

Monday

- Lecture: Industrial Applications
- Lecture: Continuum Contact Mechanics
- Blackboard: Flamant's problem

Tuesday

- Lecture: Contact mechanics and material behavior
- Lecture: Contact at small scales: roughness
- Practical work: Integration of Flamant's solution

Wednesday

- Lecture: Fretting and wear (*H. Proudhon*)
- Lecture: Computational Contact Mechanics
- Practical work: Contact algorithms (FEM)

Program

Thursday

- Lecture: Contact at Small Scales: mechanics and transport
- Lecture: «Lubrication and Sealing»
- Practical work: some contact problems (analytical and numerical solutions)

Friday

- Seminar: *Third body and oxygenation in fretting wear* (P. Arnaud, MINES)
- Seminar: *Nano-/micro-scale wear* (R. Aghababaei)
- Seminar: *Elastodynamic friction*
- Seminar: *Triboelectric nanogenerator* (A. Shvarts, Glasgow)
- Exam for all
- Concluding remarks

Exam and notes

- On Friday, February 11th at 14h00.
- 20-25 questions on lectures of the first four days (Monday-Thursday)
- Duration: 2.5 hours
- Type of questions: technical questions which generally require some calculations
- Please take notes during the class, I generally give some extra information on the blackboard
- You will be allowed to use whatever source of information you need, but not be helped by others
- The exam is “mandatory” for all the participants:
  - If you need a certificate of attendance. By the way to get it, you’ll need to attend 80% of lectures and practical sessions...
  - If you would like to try to get certificate of Excellence
- Final notes are essential for DMS participants to validate the course

Exam and notes

Certificate of excellence

For excellent performance
in the master/doctoral-level 30h course

"Contact Mechanics and Elements of Tribology"

The certificate is decerned to

First name LAST NAME

Evry, France on February 15, 2021

MINES ParisTech | PSL | cnrs

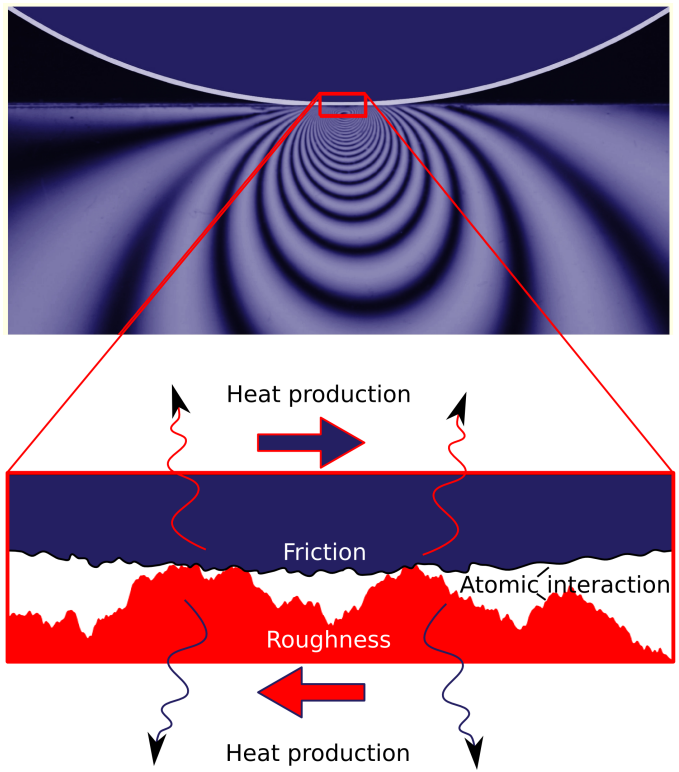
Vladislav A. Yastrebov
Lecturer

2021, I signed five such certificates out of 50 participants who followed almost all lectures and passed the exam, in total you were 90 registered participants. ☺

Contact complexity: physics and mathematics

Particular difficulties related to contact problems:
multiphysical aspects, mathematical aspects

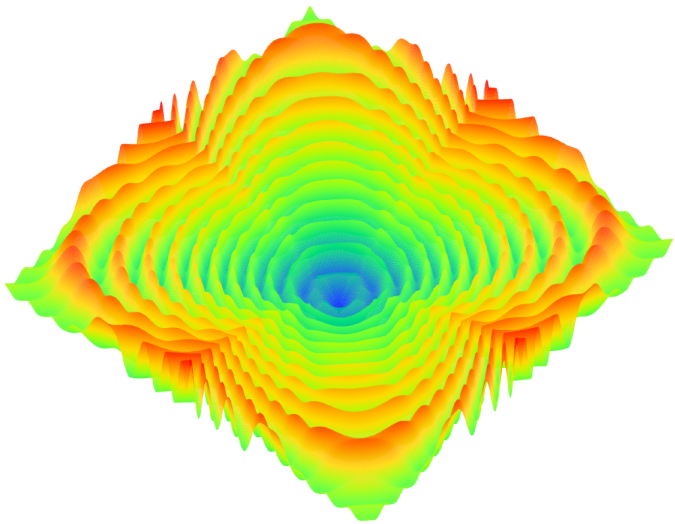
- Fractality of surfaces
- Interface chemistry
- Hardly accessible contact interface for measurements
- Generation and diffusion of heat
- Multiscale and multiphysical nature of friction



Contact complexity: physics and mathematics

Particular difficulties related to contact problems:
multiphysical aspects, **mathematical aspects**

- One of the most hard problems in mechanics
- Lack of standard optimization problem
- Non-convexity and non-differentiability
- Non-continuous character
- Bad scalability



☺ Welcome to the CMET course!