课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	**MAE5027 界面现象** **Interfacial Phenomena**
2.	**课程性质** **Compulsory/Elective**	专业选修 Major Elective Courses
3.	**课程学分/学时** **Course Credit/Hours**	3 学分，48 学时 3 Course Credits/48 Hours
4.	**授课语言** **Teaching Language**	中英文 Chinese and English
5.	**授课教师** **Instructor(s)**	邓巍巍 教授 力学与航空航天工程系 dengww@sustech.edu.cn Weiwei Deng, Professor Department of Mechanics and Aerospace Engineering dengww@sustech.edu.cn
6.	**是否面向本科生开放** **Open to undergraduates or not**	是 Yes
7.	**先修要求** **Pre-requisites**	PHY105A 大学物理 A(下) 或者 PHY102B 大学物理 B(下) College Physics
8.	**教学目标** **Course Objectives**	
	本课程介绍在物质界面的作用力和独特现象，以及界面现象的理论分析和实验方法。知识点包括：表面张力，润湿，反润湿，斥水，毛细折纸，接触线动力学，长程力，薄液膜的流体力学，表面活性剂，Janus 颗粒，有纹理或柔软表面的润湿，以及表面张力梯度引起的流动。学生将应用学习到的概念针对不同问题建立模型或构造实验来分析。本课程将训练在跨学科研究和实际工程应用背景下分析和解决界面现象问题的能力。 The objective of this course is to introduce students to the forces and unique phenomena that occur at interfaces. This course will also introduce analytical and experimental methods for physical process and phenomena dominantly influenced by interfacial tension. Topics covered in the course include: Surface Tension, Wetting, Dewetting, Water-repellency, Capillary Origami, Contact Line Dynamics, Long-Range Forces, Fluid Dynamics of Liquid Thin Films, Surfactants, Janus Particles, Wetting of Textured and Soft Surfaces, and Flow induced by Surface Tension Gradient (Marangoni Flows). Students will work to formulate the analytical models and design experiments to understand interfacial phenomena through the application of these concepts. Students will also develop the problem-solving skills essential to good engineering practice of interfacial phenomena in cross-disciplinary research and practical applications.	
9.	**教学方法** **Teaching Methods**	
	教学方法：课堂讲授、多媒体演示、课堂实验演示、实验室观摩和实际操作等教学环节。 Teaching Methods: class lecture, multimedia demo, in-class demo of experiments, lab tour and hands-on experience.	

10.	**教学内容** **Course Contents**
	第一周：表面张力和可变形的界面（4 课时） 第二周：毛细现象和重力（2 课时） 第三周：三相接触线的迟滞和弹性（4 课时） 第四周：润湿和长程力（2 课时） 第五周：界面的流体动力学 I（4 课时） 第六周：界面的流体动力学 II（2 课时） 第七周：界面输运现象（4 课时） 第八周：反润湿 I（2 课时） 第九周：反润湿 II（4 课时） 第十周：表面活性剂 I（2 课时） 第十一周：表面活性剂 II（4 课时） 第十二周：Janus 颗粒（2 课时） 第十三周：三相接触线动力学（4 课时） 第十四周：特殊界面 I（2 课时） 第十五周：特殊界面 II（4 课时） 第十六周：期末报告（2 课时） **Week 1: Surface Tension and Deformable Interfaces (4 hr)** Surface Tension; Measurements of Surface Tensions; Laplace Pressure; Minimal Surfaces With Zero Curvature; Contact Between Three Phases: Wetting, The Spreading Parameter, Wetting Criteria: Zisman's Rule. **Week 2: Capillarity and Gravity (2 hr)** Capillary Length; Shape of Drops; Experimental Techniques for Characterizing Drops; Meniscus Facing a Vertical Plate and on a Vertical Fiber; Capillary Rise; Floating Lenses; Soft Solid Interfaces. **Week 3: Hysteresis and Elasticity of Triple Lines (4 hr)** Advancing and Receding Angle; Pinning of the Triple Line; Elasticity of the Triple Line; Hysteresis Due to Strong, Sparse Defects; Surfaces With Dense Defects; Hele-Shaw Cells. **Week 4: Wetting and Long-Range Forces (2 hr)**

Energy and Properties of Films; Thickness Change and Disjoining Pressure; Stress in a Film; Three Types of Wetting; Nature and Manifestations of Long-Range Forces; The Healing Length; Fine Structure of the Triple Line

Week 5: Fluid Dynamics of Interfaces, Part I (4 hr)

The Lubrication Approximation; Dynamics of Thin Films; Thinning of a Vertical Film; Levelling of a Horizontal Film; Rayleigh-Taylor Instability; Plateau-Rayleigh Instability.

Week 6: Fluid Dynamics of Interfaces, Part II (2 hr)

Forced Wetting; The Landau-Levich-Derjaguin Model; Dynamics of Impregnation; Washburn's Law; Waves and Ripples; Deep Water Condition; Dispersion Relation in the Inertial Regime; Attenuation.

Week 7: Interfacial Transport Phenomena (4 hr)

Chemical Gradients; Thermal Gradients; Marangoni Flows; Finger Formation; Reactive Wetting; Bidrops;"Running Drops" on a Solid Planar Surface; Transport by Electric Field; Relevance of Microsystems; Electrocapillarity; Electro-Osmosis; Electrostatic Lenses; Transfer of Bubbles.

Week 8: Dewetting, Part I (2 hr)

Film and Critical Thickness for Dewetting; Viscous Dewetting; Ideal/ Imperfect Solid Substrates; Surfaces With Hysteresis ; "Slippery" Substrates; Liquid Substrates; Spinodal Dewetting

Week 9: Dewetting, Part II (4 hr)

Inertial Dewetting; Dimensionless Numbers (Re and Fr); Liquid/Liquid Inertial Dewetting; Visco-Elastic Dewetting; Rupture of Ultra-Viscous Films; Life and Death of Viscous Bubbles.

Week 10: Surfactants, Part I (2 hr)

Frustrated Pairs; Hydrophilic/Lipophilic Balance (HLB); Aggregation of Surfactants; Aggregation in Volume: Micelles; Water/Air Interfaces; Insoluble Monolayers; Soluble Monolayers; Dynamical Surface Tensions

Week 11: Surfactants, Part II (4 hr)

Applications of Surfactants: Flotation, Detergents, Emulsification, Wetting and Dewetting Agents; Soap Films and Bubbles; Draining Mechanisms; Aging and Death of Films.

Week 12: Janus Particles (2 hr)

Janus Particles as Particulate Surfactants; Applications: Pickering Emulsification; Multicolored Voxels for Displays; Compartmentalized Microreactors as Artificial Cell Mimics; Steerable Microswimmers for Targeted Cargo Delivery; Synthesis of Janus Particles: On-chip Microfluidics, In Air Microfluidics, and Electrospray.

Week 13: Dynamics of the Triple Line (4 hr)

Relation Between Force and Velocity; Viscous Dissipation Model; Chemical Model; Oscillations Modes of a Triple Line; Dynamics of Total Wetting

Week 14: Special Interfaces, Part I (2 hr)

Wetting of Textured Surfaces; Wenzel's and Cassie-Baxter Model; Composite Rough Surfaces; Hydrophilic Surfaces; Hydrophobic Surfaces; Wetting and Porous Media. Levitating Drop on Vibrating Baths; Quantum Analogy: Double Slit Interference and Tunneling Effect; Faraday Wave.

Week 15: Special Interfaces, Part II (4 hr)

Wetting at Soft Interfaces; "Elastic" Wetting; Reflection Interference Contrast Microscopy; Drop Profile and Measurement; "Elastic" Dewetting of Wedged-in Films; Drainage ; Controlled Dewetting: Nucleators and Cerenkov Wake; Wetting Transitions Under Shear.

Week 16: Final Presentation (2 hr)

11. 课程考核
Course Assessment

（①考核形式 Form of examination；②.分数构成 grading policy；③如面向本科生开放，请注明区分内容。If the course is open to undergraduates, please indicate the difference.）

1. 考查/no final exam

2.课程项目/Projects: 40%
平时作业/Assignments: 20%
期末报告/Final Presentation: 40%

3.There is no difference between undergraduate and graduate students.

12. 教材及其它参考资料
Textbook and Supplementary Readings

参考书（Reference）：

1. Capillarity and Wetting Phenomena: Drops, Bubbles, Pearls, Waves. De Gennes P G, Brochard-Wyart F, Quéré D. Springer, 2013

2. An Introduction to Interfaces & Colloids: The Bridge to Nanoscience, John C. Berg, World Scientific, 2010 (界面和胶体理论，世界图书出版公司，影印版)

补充阅读（Supplementary Readings）：

MIT OpenCourse: Interfacial Phenomena, by John W. M. Bush
https://ocw.mit.edu/courses/mathematics/18-357-interfacial-phenomena-fall-2010/index.htm