课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	工程数学物理方法 Engineering Mathematical Physics
2.	**授课院系** **Originating Department**	材料科学与工程系 Department of Materials Science and Engineering
3.	**课程编号** **Course Code**	MSE207
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业基础课 Major Foundational Course
6.	**授课学期** **Semester**	秋季 Fall
7.	**授课语言** **Teaching Language**	中英双语 Chinese and English
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	李磊，副教授，材料科学与工程系 LI, Lei，Professor，Department of Materials Science and Engineering, E-mail：lil33@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	43	5			48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	高等数学（下）A、线性代数 B Calculus II A, Linear Algebra B
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	
14. 其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

This course will cover some advanced topics in mathematics, in particular those topics used popularly in engineering and physical sciences. The content includes: Fourier series and Fourier transform; Laplace transform, partial differential equations: wave equation, heat diffusion equation, Poisson equation; Functions of complex variables; and series solution of ordinary differential equations: Legendre, Bessel, Hermite and Laguerre functions.

16. 预达学习成果 Learning Outcomes

After learning the Engineering Mathematical Physics, the students shall be able to know how to use methods like separation of variables, Fourier series, Fourier transform, and Laplace transform, Green's function, to solve most problems encountered in engineering and physics quantitatively such as vibrations of string, rectangular and circular membranes, wave equations (Helmholtz equations and Schrodinger equation), heat diffusion/conduction equation. The students also need to understand how some special functions like Bessel function, Legendre polynomial and Hermit function are related to engineering problems.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

Part I: Vector analysis: Review (4 Credit Hours)

1.1: Vector: Basis
1.2: Rotation of the Coordinate Axes
1.3 Scalar or Dot product
1.4 Vector or Cross Product
1.5 Triple Scalar Product, Triple vector Product
1.6 Gradient, Divergence, and Curl
1.7 Vector Integration
1.8 Gauss's Theorem
1.9 Stokes' Theorem,

Part II: Functions of a Complex variable (8 Credit Hours)

1 Complex algebra
2 Cauchy-Riemann Conditions
3 Cauchy's Integral Theorem
4 Cauchy's Integral Formla
5 Laurent Expansion
6 Mapping, Conformal Mapping
7 Singularities
8 Calculus of Residues

Part III: Fourier Series and Transforms (9 Credit Hours)

Chapter 3.1 Fourier Series

1. Introduction
2. Simple Harmonic motion and wave motion: periodic functions
3. Application of Fourier Series
4. Average value of function
5. Fourier coefficient
6. Dirichelet Conditions
7. Complex form of Fourier series
8. Symmetric consideration: Even and odd function
9. Non-periodic functions
10. Integration and differentiation
11. Parseval theorem

Chapter 3.2 Fourier Transform

12. Fourier Transform: definition
13. The Uncertainty principle
14. Fraunhofer Diffraction
15. The Dirac \delta-function
16. Relation of the \Delta-function to Fourier transform
17. Properties of Fourier transform

    Differentiation; integration; translation; exponeitial multiplication
18. Odd/Even functions: Fourier sine/cosine transform
19. Convolution and de-convolution
20. Correlation functions and energy spectra
    a. Wiener-Kinchin theorem
21. Parceval's theorem
22. Fourier transform in higher dimensions

Part IV: Ordinary Differential Equations and Laplace Transform (16 Credit Hours)

Chapter 4.1: Second order linear ODEs

1. Homogeneous Linear ODE's of 2nd Order
2. Homogeneous Linear ODE's with constant coefficient
3. Differential Operators

4. Euler-Cauchy Equations
5. Existence and Uniqueness of Solutions: Wronskian
6. Nonhomogeneous ODEs
7. Solution by variation of parameters.

Chapter 4.2 Higher order linear ODEs

8. Homogeneous Linear ODEs
9. Homogeneous Linear ODE's with constant coefficient
10. Nonhomogeneous linear ODEs.

Chapter 4.3 Series solutions of differential equations: Legendre, Bessel, Hermite and Laguerre functions

11. Introduction
12. Legendre's Equation
13. Leibniz' Rule for Differentiating Products
14. Rodrigues' Formula
15. Generating Function for Legendre Polynomials
16. Complete Sets of Orthogonal Functions
17. Orthogonality of the Legendre Polynomials
18. Normalization of the Legendre Polynomials
19. Legendre Series
20. The Associated Legendre Functions
21. Generalized Power Series or the Method of Frobenius
22. Bessel's Equation
23. The Second Solution of Bessel's Equation
24. Graphs and Zeros of Bessel Functions
25. Recursion Relations
26. Differential Equations with Bessel Function Solutions
27. Other Kinds of Bessel Functions
28. The Lengthening Pendulum
29. Orthogonality of Bessel Functions
30. Approximate Formulas for Bessel Functions
31. Series Solutions; Fuchs's Theorem
32. Hermite Functions; Laguerre Functions; Ladder Operator

Chapter 4.4 Laplace Transform

33. The Laplace Transform
34. Solution of Differential Equations by Laplace Transform
35. Convolution
36. The Dirac-Delta function
37. Brief introduction of Green's function

Chapter 4.5* Systems of ODEs, Phase Space, Qualitative Methods

38. Phase plane method
39. Stability analysis: Lyapunov exponent
40. Fixed point ..

Part V: Partial Differential Equations (6 Credit Hours)

1.Basic Concepts of PDEs

2. Laplace's Equation; Steady-State Temperature in a Rectangular Plate

3. The Diffusion or Heat Flow Equation; the Schroedinger Equation

4. The Wave Equation; the Vibrating String

5. Steady-state Temperature in a Cylinder:

6. Vibration of a Circular Membrane: Bessel function

7. Steady-state Temperature in a Sphere: Legendre function

8. Poisson's Equation: Green's function method

9. Integral Transform Solutions of Partial Differential Equations

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

Textbook: Mary L. Boas, *Mathematical Methods in the Physical Sciences*. 2006 John Wiley & Sons

Other recommended textbooks：

Basic:

1. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, 2000.
2. Erwin Kreyszig et al, *Advanced Engineering Mathematics*, the 10th edition. (Part A, B,C), John Wiley & Sons. 2011
3. Michael D. Greenberg, Advanced Engineering Mathematics, 2nd edition, Prentice Hall. 1998

More Advanced:

4. B. Kusse and E Westwig, *Mathematical Physics: Applied Mathematics for Scientists and Engineers*, John Wiley & Sons, Inc. 1998
5. G B. Arfken and H J. Weber, *Mathematical Methods for Physicists*, Academic Press, 4th Edition, 1995.
6. Chiang C Mei, *Mathematical Analysis in Engineering*, Cambridge University Press. 1995.

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance	每节课	20		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments	每两周一次，共 8 次	20		
期中考试 Mid-Term Test		20		
期末考试 Final Exam		40		
期末报告 Final Presentation				
其它（可根据需要改写以上评估方式）				

Others (The above may be modified as necessary)				

20. 记分方式 **grading system**

☑ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 Review and Approval

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority