# Aviation and Aerospace Engineering

| Course type | Course Code | Course Title | Hours | Credits | Semester | College | Remark |
|---|---|---|---|---|---|---|---|
| Compulsory Course | 6A120006L | Chinese | 60 | 4 | Autumn | Col. of Foreign Languages | |
| | 6A080001L | Matrix Theory | 60 | 4 | Autumn | Col. of Science | Compulsory For master students |
| | 6A010001L | Overview of Aeronautics and Astronautics | 30 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 6A010102L<br>6A020102L<br>6A070102L<br>6A150102L | Thesis Proposal and Literature Review | | 1 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | Compulsory For master students |
| | 8A010102L<br>8A020102L<br>8A070102L<br>8A150102L | Thesis Proposal and Literature Review | | 1 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | Compulsory For doctoral students |
| Optional Course | 6B012001L | Aircraft Design | 48 | 3 | Autumn | Col. of Aerospace Engineering | |
| | 6B013005L | Finite Element Structural Analysis | 40 | 2.5 | Autumn | Col. of Aerospace Engineering | |
| | 7D016010L | Computational Gasdynamics | 32 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 7D021004L | Aero-Engine Performance Analysis | 32 | 2 | Autumn | Col. of Energy & Power Engineering | |
| | 7D021014L | Aircraft Engine Control System Design and Certification | 32 | 2 | Autumn | Col. of Energy & Power Engineering | |
| | 6B073007L | Aircraft Electricity System | 32 | 2 | Autumn | Col. of Aviation | |
| | 7D072009L | Model Building for Mathematical Optimization | 40 | 2.5 | Autumn | Col. of Aviation | |
| | 7D073006L | Maintenance Engineering | 32 | 2 | Autumn | Col. of Aviation | |
| | 6B154003L | Dynamics in the Middle and | 32 | 2 | Autumn | Col. of Astronautics | |

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|---|---|---|---|---|---|---|---|
| | | Upper Atmosphere | | | | | |
| Topic | 8D010001L<br>8D020001L<br>8D070001L<br>8D150001L | Topic 1 | 32 | 2 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | |
| | 8D010001L<br>8D020001L<br>8D070001L<br>8D150001L | Topic 2 | 32 | 2 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | |

**Course Code**：6A120006L

**Course Title(Chinese)**：汉语

**Course Title(English)**： Chinese

**College and Department**：Col. of Foreign Languages
**Semester**：Autumn
**Class Hours**：60
**Teaching Methods**：Lecture
**Suitable Majors**: International postgraduates
**Assessment Instruments**：Examination
**Pre-requisites**：Elementary Chinese

## 1.Course Objective and Requirements

To practice spoken Chinese. Students are required to learn some dialogues and sentence pattern in certain situation. Through the classroom learning and some outdoor activities, students are supposed to communicate with Chinese natives and know more about Chinese culture. After taking the course the students should be able to:

1. master several Chinese daily language.
2. communicate with Chinese natives in basic Chinese.
3. know more about Chinese customs and traditions.

## 2.Course Content and Schedule

第一课 你常去图书馆吗（4 小时）
一、课文
（一）你常去图书馆吗
（二）晚上你常做什么
二、语法
（一）时间词语作状语
（二）"还是"和"或者"
第二课 他在做什么呢（4 小时）
一、课文
（一）他在做什么呢
（二）谁教你们语法
二、语法
（一）动作的进行
（二）双宾语句
（三）询问动作行为的方式：怎么+动词
第三课 我去邮局寄包裹（4 小时）
一、课文
（一）我去邮局寄包裹
（二）外贸代表团明天去上海参观四、语法：连动句
第四课 可以试试吗（4 小时）
一、课文
（一）可以试试吗
（二）便宜一点儿吧
二、语法
（一）动词重叠
（二）又……又……
（三）"一点儿"和"有一点儿"
第五课 祝你生日快乐（4 小时）
一、课文
（一）你哪一年大学毕业
（二）祝你生日快乐
二、语法
（一）时间、价格、日期、数量、天气、年龄、籍贯等的表达：名词谓语句
（二）年、月、日
（三）怎么问（6）：疑问语调
第六课 我们明天七点一刻出发（4 小时）
一、课文
（一）我的一天
（二）明天早上七点一刻出发
二、语法：时间的表达
第七课 我打算请老师教我京剧（4 小时）
一、课文：我打算请老师教我京剧

二、语法：兼语句
第八课 学校里边有邮局吗（4 小时）
一、课文
（一）学校里边有邮局吗
（二）从这儿到博物馆有多远
二、语法
（一）方位词
（二）存在的表达
（三）介词"离"、"从"、"往"
第九课 我想学太极拳（4 小时）
一、课文
（一）我想学太极拳
（二）您能不能再说一遍
二、语法
（一）能愿动词
（二）询问原因
第十课 她学得很好（4 小时）
一、课文
（一）她学得很好
（二）她每天都起得很早
二、语法：描写、判断和评价：状态补语（1）：动词+得+形容词
第十一课 田芳去哪儿了（4 小时）
一、课文
（一）田芳去哪儿了
（二）他又来电话了
二、语法
（一）语气助词"了"（1）
（二）"再"和"又"
第十二课 玛丽哭了（4 小时）
一、课文
（一）你怎么了
（二）玛丽哭了
二、语法
（一）动作的完成：动词+了
（二）因为-...一所以.....
第十三课 我吃了早饭就来了（4 小时）
一、课文
（一）我吃了早饭就来了
（二）我早就下班了
二、语法
（一）"就"和"才"
（二）要是.....（的话），就.....
（三）虽然.....但是.....
第十四课 我都做对了（4 小时）
一、课文
（一）我都做对了
（二）看完电影再做作业
二、语法
（一）动作结果的表达：结果补语
（二）结果补语"上"、"成"和"到"
（三）主谓词组作定语
第十五课 我来了两个多月了（4 小时）
一、课文
（一）我来了两个多月了
（二）我每天都练一个小时
二、语法
（一）动作或状态持续时间的表达：时量补语
（二）概数的表达
（三）离合动词

**3.Textbooks**
《汉语教程》 主编 杨寄洲，北京语言大学出版社，2009 年

**Written by**：WANG Zheng (王征)
**Instructor**：LU Hong（陆红）,WANG Zheng（王征）， ZHANG Weidong （张卫东）et al.

**Course Code**：6A080001L

**Course Title(Chinese)**：矩阵论

**Course Title(English)**：Matrix Theory

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：60

**Teaching Methods**：Lecture, Projects, Homework

**Suitable Majors**: Engineering

**Assessment Instruments**：Examination, Projects, Homework

**Pre-requisites**：Linear Algebra, Calculus, Analytic Geometry

## 1. Course Objective and Requirements

Topics include the basic Concepts in Linear Algebra, Linear Space and Inner-product Space, Linear Transformation, Jordan Canonical Form, Matrix Factorization with Applications, Hermitian Matrix and Positive Definite Matrix, Matrix Norm and Matrix Analysis, Generalized Inverse Matrix, Matrix Computation with MATLAB.

Through the course, students learn, practice, and master basic matrix results and techniques that are very useful for applications in various fields such as mathematics, statistics, physics, computer science, and engineering, etc.

It requires that students should master the basic discipline of matrix theory, be able to carry out the classical theory and methods and have the basic knowledge and skills to solve mathematical problems in engineering so that they are prepared with the necessary foundation for their future study and work.

## 2. Course Content and Schedule

Chapter 1 Review and Miscellanea (8h)
- 1.1 Matrix concept and special matrices
- 1.2 Matrix algebra
- 1.3 Eigenvalue and eigenvector
- 1.4 An introduction to MATLAB

Chapter 2 Linear Space and Inner-product Space (8h)
- 2.1 Linear space
- 2.2 Basis and dimension of vector space
- 2.3 Subspace
- 2.4 Inner-product Space

Chapter3 Linear Transformation (6h)
- 3.1 Introduction
- 3.2 Linear transformation with properties
- 3.3 Range and kernel
- 3.4 Matrix Representation of Linear Transformation
- 3.5 Similarity

Chapter 4 Jordan Canonical Form (8h)
- 4.1 Diagonalizability
- 4.2 Jordan block matrix and Jordan form matrix
- 4.3 lambda-matrix and Smith standard form
- 4.4 Jordan Canonical Form
- 4.5 Cayley-Hamilton Theorem and Minimal polynomial

Chapter 5 Matrix Factorization (8h)
- 5.1 Introduction
- 5.2 Full Rank Decomposition
- 5.3 LU Factorization
- 5.4 QR Factorization
- 5.5 Schur Decompisition
- 5.6 Singular value decomposition(SVD)

Chapter 6 Hermitian Matrix and Positive Definite Matrix (6h)
- 6.1 Hermitian matrix
- 6.2 Positive definite matrix

Chapter 7 Matrix Norm and Matrix Analysis (8h)
- 7.1 Introduction
- 7.2 Vector Norm
- 7.3 Matrix Norm

7.4 Matrix sequence, series and function
Chapter 8 The Moore-Penrose Generalized Inverse (4h)
8.1 Introduction
8.2 The Moore-Penrose Generalized Inverse
Matlab Commands for matrix computations (2h)
Reviews and Examination (2h)

**3. Textbooks**

Wang, Z. S. Introduction to Matrix Theory, Science Press, 2015

**Main Reference Books**

(1) 戴华，矩阵论，科学出版社，2001
（2）Steven J. Leon. Linear Algebra with Applications，7th edition. Person Education Asia Limited and China Machine Press.，2007
（3）Roger A. Horn & Charles R. Johnson, Matrix Analysis, 人民邮电出版社， 2005
（4）Zhang F. Matrix Theory: Basic Results and Techniques (Second Edition), 2010, Springer Press.

**Written by**：WANG Zhengsheng（王正盛）
**Instructor**：WANG Zhengsheng（王正盛）, YANG Xi（杨熙）

**Course Code**：6A010001L

**Course Title(Chinese)**：航空航天导论

**Course Title(English)**：Overview of Aeronautics and Astronautics

**College and Department**：Col. of Airspace Engineering
**Semester**：Autumn
**Class Hours**：30
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Any
**Assessment Instruments**：Examination
**Pre-requisites**：None

## 1.Course Objective and Requirements

Overview of Aeronautics and Astronautics provides a comprehensive and overall introduction about aeronautic technology to the international students in China. It is helpful for the students to build the base to learn the related course. This course will discuss all main contents about aeronautic technology including flight history, basic aerodynamic, flight mechanics, aircraft control and stability, propulsion system, aircraft structure and so on.

## 2.Course Content and Schedule

**Chapter 1 Rich History** （6h）
- 1.1 From Wheels to Stars
- 1.2 Myths and Legends
- 1.3 Early Scientific Research
- 1.4 Flight in Balloons
- 1.5 The Era of the Dirigible
- 1.6 Heavier-Than-Air Aircraft Development
- 1.7 Wright Brothers' Flyer I
- 1.8 The Adolescence of Airplane
- 1.9 The Golden Age of Aviation
- 1.10 Airplanes in the World War II
- 1.11 Jet Airplane
- 1.12 Advances in Aeronautics

**Chapter 2 Basic Aerodynamics** （6h）
- 2.1 The Atmosphere
- 2.2 Atmospheric Regions
- 2.3 Continuity Equation
- 2.4 Bernoulli's Principle
- 2.5 About Viscous Flow
- 2.6 About Compressiblity
- 2.7 Measurement of Airspeed
- 2.8 Wind Tunnels

**Chapter 3 Airfoil, Wing and Airplane** （6h）
- 3.1 Introduction
- 3.2 Airfoil Lift
- 3.3 Wing Lift
- 3.4 Airplane Lift
- 3.5 High Lift Devices
- 3.6 Wing and Airplane Drag
- 3.7 Mach Number Effects

**Chapter 4 Elements of Airplane Performance** （2h）
- 4.1 Introduction
- 4.2 Equations of Motion
- 4.3 Drag Curves
- 4.4 Power Curves

4.5 Range and endurance
4.6 Gliding Flight
4.7 Climbs
4.8 Takeoff and Landing
4.9 Turnning Flight
4.10 V-n Diagram

**Chapter 5 Airplanes' Stability and Control** （3h）

5.1 Introduction
5.2 Coordinate System
5.3 Control Surfaces
5.4 Stability Definition
5.5 Longitudinal Control Analysis
5.6 Longitudinal Stability
5.7 Directional Stability and Control
5.8 Lateral Stability and Control

**Chapter 6 Aircraft Propulsion** （3h）

6.1 Introduction
6.2 Airplane Propellers
6.3 Piston Engines
6.4 Turbojet Engines
6.5 Afterburners
6.6 Turbofan Engines
6.7 Turboprop Engine
6.8 Turboshaft Engine
6.9 Ramjets

**Chapter 7 Airplane Structure** （2h）

7.1 Introduction
7.2 Mechanics Conception
7.3 An Airplane's Loads
7.4 Structural Layout
7.5 Component Sizing

**Chapter 8 Airplane Instruments** （2h）

8.1 Introduction
8.2 Early Airplane Instruments
8.3 Instrument Classification
8.4 Typical Instruments
8.5 Navigation Conception

## 3.Textbooks

Caijun Xue. Introduction to aeronautics, National Defense Industry Press, 2015

**Written by**：XUE Caijun（薛彩军） **Instructor**：XUE Caijun（薛彩军）

**Course Code**：6B012001L

**Course Title(Chinese)**：飞机设计

**Course Title(English)**：Aircraft Design

**College and Department**：Col. of Aerospace Engineering

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Flight Vehicle Design; Aeronautical Engineering

**Assessment Instruments**：Examination

**Pre-requisites**：Aerodynamics, Flight Mechanics, Automatic Control

## 1.Course Objective and Requirements

Aircraft Design is a separate discipline of aeronautical engineering, and it is a main course for graduate students who major in Aerospace Engineering/Aeronautical Engineering. In this course, the concept and principle and application of aircraft design are introduced. Topics include the process and main works of aircraft design; configuration design; geometry selection; sizing; lofting; aerodynamic analysis; stability and handling quality evaluation; performance and flight mechanics analysis. In addition, some design considerations will be covered. The course provides some experience and interest of aircraft design to the students, for the curriculum is scheduled in a real sequence of aircraft design. Course objectives: develop comprehensive knowledge in Aircraft Design fundamentals; develop practical techniques to conduct aircraft design; develop capability of related computation and analysis.

## 2.Course Content and Schedule

**Chapter 1 Design--A Separate Discipline** (1h)

1.1 What is design?

1.2 Introduction to the textbook

**Chapter 2 Overview of the Design Process** (2h)

2.1 Introduction

2.2 Phases of Aircraft Design

2.3 Aircraft Conceptual Design Process

**Chapter 3 Sizing from a Conceptual Sketch**( 2h)

3.1 Introduction

3.2 Takeoff-Weight Buildup

3.3 Empty-Weight Estimation

3.4 Fuel-Fraction Estimation

3.5 Takeoff-Weight Calculation

3.6 Design Example: ASW Aircraft

**Chapter 4 Airfoil and Geometry Selection**( 4h)

4.1 Introduction

4.2 Airfoil Selection

4.3 Wing Geometry

4.4 Biplane Wing

4.5 Tail Geometry and Arrangement

**Chapter 5 Thrust-Weight Ratio and Wing Loading**( 3h)

5.1 Introduction

5.2 Thrust-to-Weight Ratio

5.3 Wing Loading

5.4 Selection of Thrust-to-Weight and Wing Loading

**Chapter 6 Initial Sizing**( 3h)

6.1 Introduction

6.2 Rubber-Engine Sizing

6.3 Fixed-Engine Sizing

6.4 Geometry Sizing

6.5 Control-Surface Sizing

**Chapter 7 Configuration Layout and Loft**( 2h)

7.1 Introduction
7.2 End Products of Configuration Layout
7.3 Conic Lofting
7.4 Conic Fuselage Development
7.5 Flat-Wrap Fuselage Lofting
7.6 Circle-to-Square Adapter
7.7 Fuselage loft verification
7.8 Wing/tail Layout and Loft
7.9 Aircraft Layout Procedure
7.10 Wetted Area Determination
7.11 Volume Determination

**Chapter 8 Special consideration in configuration Layout**( 2h)

8.1 Introduction
8.2 Aerodynamic Consideration
8.3 Structural Consideration
8.4 Radar Detectability
8.5 Infrared Detectability
8.6 Visual Detectability
8.7 Aural Signature
8.8 Vulnerability Consideration
8.9 Crashworthiness Consideration
8.10 Producibility Consideration
8.11 Maintainability Consideration

**Chapter 9 Aerodynamics**( 5h)

9.1 Introduction
9.2 Aerodynamic Forces
9.3 Aerodynamic Coefficients
9.4 Lift
9.5 Parasite ( Zero-Lift ) Drag
9.6 Drag Due to Lift ( Induced Drag )
9.7 Aerodynamic Code and Computational Fluid Dynamics ( CFD )

**Chapter 10 Weights**( 2h)

10.1 Introduction
10.2 Approximate Group Weights Method
10.3 Statistical Group Weights Method
10.4 Additional Considerations in Weights Estimation

**Chapter 11 Stability, Control, and Handling Qualities**( 6h)

11.1 Introduction
11.2 Coordinate Systems and Definitions
11.3 Longitudinal Static Stability and control
11.4 Lateral Directional Static Stability and Control
11.5 Stick-Free Stability
11.6 Effects of Flexibility
11.7 Dynamic Stability
11.8 Quasi-Steady State
11.9 Inertia Coupling
11.10 Handling Qualities

**Chapter 12 Performance and Flight Mechanics**( 6h)

12.1 Introduction
12.2 Steady Level Flight
12.3 Steady Climbing and Descending Flight
12.4 Level Turning Flight
12.5 Gliding Flight
12.6 Energy Maneuverability Methods
12.7 Operating Envelope
12.8 Takeoff Analysis

12.9 Landing Analysis

12.10 Other Flight Performance Measures of Merit

**Chapter 13 Topic of future trends of fighters design**( 4h)

**Chapter 14 Topic of future trends of UAV design**( 2h)

**Chapter 15 Topic of future trends of civil transports design**( 4h)

## 3.**Homework**

Assignment1~2:

The assignment involves an iterative solution work on the estimation of Take-off Gross Weight of two categories of aircraft.

Assignment 3:

The assignment involves an analysis work on the estimation of the design parameters.

Assignment 4:

The assignment involves an analysis work on the reverse design of a certain aircraft.

## 4.Textbooks

(1) Raymer, D.P. Aircraft Design: A Conceptual Approach, 5th edition, American Institute of Aeronautics and Astronautics, Inc., 2012.

## Main Reference Books

(1) John P. Fielding. Introduction to Aircraft Design, 2nd Edition,Cambridge Aerospace Series,1999

(2) Kirill Nadtochiy.Fundamentals of Aerodynamics. Mcgraw Hill Series in Aeronautical and Aerospace Engineering, 2011

(3) Jan Roskam. Airplane Design. Roskam Aviation and Engineering Corporation, 1985

**Written by**：XU Feng（许锋）

**Instructor**：XU Feng（许锋）,YU Xiongqing（余雄庆）, JIN Haibo（金海波） *et al*.

**Course Code**：6B013005L

**Course Title(Chinese)**：结构有限元分析

**Course Title(English)**：Finite Element Structural Analysis

**College and Department**：Col. of Aerospace Engineering

**Semester**：Autumn

**Class Hours**：40

**Teaching Methods**：Lecture, Projest, Homework

**Suitable Majors**: Solid Mechanics, Aerospace Engineering, Civil Engineering, Mechanical Engineering

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Matrix, Elasticity Mechanics, Mechanical Vibration

## 1.Course Objective and Requirements

The Finite Element Method (FEM) is a very versatile and powerful analytical tool in solid mechanics, aerospace engineering, civil engineering, mechanical engineering and so on. In this course, the concept and principle and application are introduced. The topic of the course is to develop the element for truss, beam and plane structures. The shape functions of different type of element are derived and the stiffness matrix is obtained.

## 2.Course Content and Schedule

Chapter 1 Introduction to the finite element method: history and functionality (3h)
Chapter 2 Basic Structural Theorems (3h）
2.1 Principle of superposition
2.2 Work done by a load system
2.3 Maxwell-Betti reciprocal thorem
2.4 Energy thorems
Chapter 3 Truss Bar element （6h）
3.1 Introduction to trusses
3.2 Stiffness equations for a truss bar element in local coordinates
3.3 Stiffness equations oriented arbitrarily in a 2D plane
3.4 Stiffness equations oriented arbitrarily in a 3D plane
3.5 Methods of assemblage for stiffness matrix
3.6 Some basic treatments of stiffness equations
3.7 Examples
Chapter 4 Beam and plane frame elements （6h）
4.1 Uniform straight beam element
4.2 Beam element orients arbitrarily in a 2D plane
4.3 Application of beam elements
4.4 Beams under distributed loads
4.5 Examples
Chapter 5 Free vibration of truss bar and beam elements（6h）
5.1 One DOF spring-mass system
5.2 Axial vibration of two DOF truss bar elements
5.3 Axial vibration of four DOF truss bar elements
5.4 Flexural vibration of beam elements
5.5 Axial-flexural vibration of frame elemtns
5.6 Axial-flexural coupling effect in frame vibration
5.7 Reduction of large eigenvalue problem
Chapter 6 Buckling and large deflection of column and plane frame finite element（6h）
6.1 Governing differential equations for a beam element with axial force
6.2 Formulation of a uniform beam finite element with constant axial force
6.3 Consistent incremental stiffness matrix for distributed axial force
6.4 Buckling of column on elastic foundation
6.5 Reduction method for buclkling problem
6.6 Buckling of plane frame
6.7 Large deflection on baems and plane frames
Chapter 7 Plane stress and plane strain finite elements（6h）
7.1 2D elastic equations
7.2 8 DOF rectangular place stress and plane strain finite element
7.3 6 DOF Triangular place stress and plane strain finite element
7.4 Higher-order rectangular elements

7.5 Higher-order triangular elements
7.6 Comparison of results
Chapter 8 Numerical integration and curved isoparametric elements（4h）
8.1 Numerical integration
8.2 Curved isoparametric element

## 3.Project

Topic: one of the example in chapter 3-6

The project involves a theoretical solution on the homework, and one should develop a short computer program, such as Matlab, to verify his/her results.

## 4.Textbooks

(1) Yang, T. Y. finite element structural analysis, Prentice-Hall, Inc. Englewood Cliffs, N.J.07632, 1986.
(2) Oñate , E. Structural Analysis with the Finite Element Method. Linear Statics: Volume 2: Beams, Plates and Shells Springer, 2013.
(3)Liu, G. R., Quek, S. S., The Finite Element Method:A Practical Course, Butterworth-Heinemann, 2003

## Main Reference Books

(1) Bathe, K. J. Finite element procedures, Prentice-Hall, Inc.,1996
(2) Zienkiewicz, O.C. The Finite Element Method for Solid and Structural Mechanics(Sixth Edition). Butterworth-Heinemann, 2005.
(3) 阎军, 杨春秋. 计算结构力学. 科学出版社, 2014.

**Written by**：QING Hai（卿海）　　**Instructor**：QING Hai（卿海）

**Course Code**：7D016010L

**Course Title(Chinese)**：计算气体动力学

**Course Title(English)**：Computational Gasdynamics

**College and Department**：Col. of Aerospace Engineering

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Fluid Mechanics, Aerodynamics

**Assessment Instruments**：Examination or Project

**Pre-requisites**：Fundamentals of Aerodynamics, Fluid Mechanics，Matlab or FORTRAN

## 1.Course Objective and Requirements

The *Computational Gasdynamics* is widely used in aerospace engineering and still in an evolutionary phase. In this course, the main concept and principles related to computational methods involving in gasdynamics are introduced. The main contents will be focused on governing equations, waves, scalar conservation laws, Riemann problem, conservation, CFL conditions and other basic principles. The course will provide an opportunity for students to gain insight into the methods mainly used in gasdynamics. Course objectives: develop comprehensive knowledge in the fundamental mathematical and physical basis of the methods used in computational gasdynamics; know how to build models and program source code for the model problems of gasdynamics and apply appropriate numerical schemes for a solution of gasdynamic problems; develop and exercise critical thinking in interpreting numerical results by subsequent analysis of computational flow fields.

## 2.Course Content and Schedule

Chapter 1 Governing equations of Gasdynamics（4h）
- 1.0 Introduction
- 1.1 The Integral Form of the Euler Equations
- 1.2 The Conservation Form of the Euler Equations
- 1.3 The Primitive Variable Form of the Euler Equations
- 1.4 Other Forms of the Euler Equations

Chapter 2 Waves（4h）
- 2.0 Introduction
- 2.1 Waves for a Scalar Model Problem
- 2.2 Waves for a Vector Model Problem
- 2.3 The Characteristic Form of the Euler Equations
- 2.4 Expansion Waves
- 2.5 Simple Waves
- 2.6 Compression Waves and Shock Waves
- 2.7 Contact Discontinuities

Chapter 3 Scalar Conservation Laws （8h）
- 3.0 Introduction
- 3.1 Integral Form
- 3.2 Conservation Form
- 3.3 Characteristic Form
- 3.4 Expansion Waves
- 3.5 Compression Waves and Shock Waves
- 3.6 Contact Discontinuities
- 3.7 Linear Advection Equation
- 3.8 Burgers' Equation
- 3.9 Entropy Conditions

Chapter 4 The Riemann Problem（5h）
- 4.0 Introduction
- 4.1 The Riemann Problem for the Euler Equations
- 4.2 The Riemann Problem for Linear Systems of Equations
- 4.3 Three-Wave Linear Approximations - Roe's Approximate
- 4.4 Riemann Solver for the Euler Equations
- 4.5 Other Approximate Riemann Solvers

Chapter 5 Conservation and Other Basic Principles （5h）
- 5.0 Introduction
- 5.1 Conservative Finite-Volume Methods

5.2 Conservative Finite-Difference Methods

Chapter 6 Other Topics of Computational Gasdynamics（6h）

6.0 Introduction

6.1 CFL Condition

6.2 Boundary conditions

6.3 Acceleration techniques

6.4 Other methods

## 3.**Experiments**

Project: The project involves an analysis work on the simulation of flows using selected schemes based on reading materials provided. （4h，综合性）

## **4.Textbooks**

(1) Culbert B. Laney, Computational Gasdynamics, CAMBRIDGE, 1998.

## **Main Reference Books**

(1) Fletcher C.A.J., Computational Techniques for Fluid Dynamics 1, Springer-Verlag, 1988

(2) Fletcher C.A.J., Computational Techniques for Fluid Dynamics 2, Springer-Verlag, 1988.

(3) John D. Anderson, JR., Computational Fluid Dynamics: the basics with applications(影印版), 清华大学出版社, 2005

(4) Wesseling P., Principles of Computational Fluid Dynamics(影印版), 科学出版社, 2006

**Written by**：CHEN Hongquan（陈红全）

**Instructor**：CHEN Hongquan（陈红全）, ZHOU Chunhua（周春华） etal.

**Course Code：7D021004L**

**Course Title(Chinese)：发动机性能分析**

**Course Title(English)：**Aero-Engine Performance Analysis

**College and Department：**Col. of Energy & Power Engineering
**Semester：**Spring
**Class Hours：**32
**Teaching Methods：**Lecture, Hands-on, Homework
**Suitable Majors**: Aeronautical Engineering
**Assessment Instruments：**Examination, Project
**Pre-requisites：**Principle of Turbo-Engines, Fluid Dynamics, Programming Language C/C++

## 1.Course Objective and Requirements

After learning this course, students should understand more deeply the principle of turbo-engines, know the roles of component characteristics, know why and how to use them mathematically, and be familiar with Newton-Raphson iteration method and its application.

Trough class training, students must know how to use programming tools, establish OOP concepts and apply them in engine performance analysis. Design of data structures of turbo-engine's components, such as intake, compressor, combustion chamber, turbine, nozzle and other possible types of components, allows students to improve their programming skills in aeronautical engineering domains.

In this course, students will deal with all the issues appeared in engine performance analysis, ie. data, coefficients, architecture of the software. Hopefully, this course can help students and also help real research projects in our university by improving program quality if the students use the skills they learnt in this course.

## 2.Course Content and Schedule

Chapter 1 Review of Principle of Turbo-Engines（4h）
1.1 Typical Types of Aero-Engines
1.2 Basic Equations Component Characteristics
1.3 Component Characteristics
1.4 Fluid Continuity Equation and Application Engine Sections
1.5 Component Transition Function Abstraction
1.6 Design Point
1.7 Off-Design
1.8 Regulation Rule in Engine Performance
Chapter 2 OOP Concepts Brief Introduction （6h）
2.1 Key Points of OOP
2.2 Abstraction
2.3 Encapsulation
2.4 Class Inheritances
2.5 Dynamic Binding
2.6 Virtual Functions and Applications
Chapter 3 Visual Studio Developer （4h）
3.1 Introduction to This Tool
3.2 How to Create a Project: exe and dll
3.3 How to Create a Class and its Members
3.4 How to Use This Tool to Debug a Program
Chapter 4 Class Design for Engine's Components（6h）
4.1 Intake
4.2 Compressor
4.3 Combustion Chamber
4.4 Turbine
4.5 Nozzle
4.6 Design Point Calculation
Chapter 5 Interpolation in Different Characteristics（3h）
5.1 One Variable Interpolation
5.2 Tow Variables' Interpolation
5.3 Some Techniques Often Used
Chapter 6 Newton-Raphson Iteration Method and Application（5h）
6.1 1D Newton Iteration Method
6.2 Newton-Raphson Iteration Method
6.3 Variable and Function Value Choices
6.4 Implementation of Newton-Raphson Method in the Program

Chapter 7 Realization of a Turboshaft Engine Calculation（4h）
7.1 Input Data
7.2 Eventual Problems in the Program
7.3 Result Dada Analysis
Course Summary

3.**Experiments**
Project1: Turboshaft Engine Performance Program
Students follow class lectures and step-by-step realize the program.
Project2: Turbojet Engine Performance Program
Modify above program to a turbojet engine..

**4. Reference Books**
(1) Ronald D. Flack. Fundamentals of Jet Propulsion with Applications, Cambridge University Press , 2010
(2) Robert Lafore. Object-Oriented Programming in C++, 4th Edition, Sams Publishing, 2001

**Written by**：WU Tieying（吴铁鹰）　　**Instructor**：WU Tieying（吴铁鹰）

**Course Code：7D021014L**

**Course Title (Chinese)：航空发动机控制系统设计与适航认证**

**Course Title (English)：** Aircraft Engine Control System Design and Certification

**College and Department：** Col. of Energy & Power Engineering
**Semester：** Autumn
**Course hours：** 32
**Teaching methods：** Lecture & Seminar
**Suitable majors:** Aerospace Propulsion Theory and Engineering、Mechanical Engineering、Power Engineering, Control Engineering, Aeronautical Engineering
**Assessment instruments：** Project
**Pre-requisites：** Principles for Aircraft Engine Propulsion, Control Systems Engineering

## 1.Course Objective and Requirements

The course provides a comprehensive and systematic introduction to the fundamental principles and concepts in aero-engine control systems. It focus on aero-engine modeling, model reduction, set-point controller design, transient and limit controller design, control system integration, advanced control concepts, engine health monitoring and management, integration of control and health monitoring.

Course objectives: develop comprehensive knowledge in the fundamental concepts and principles of aero-engine controls; understand the theoretical foundation of aero-engine modeling、aero-engine controls and aero-engine health management from a systems engineering perspective; exercise the developed theoretical knowledge with physical insights in solving practical problems.

## 2.Course Contents and Schedule (32h)

Chapter 1. Overview of Engine Control Systems （2h）
- 1.1 Introduction to Gas Turbine Engine Control Systems;
- 1.2 Historical Development of Engine Control Systems.

Chapter 2. Engine Modeling and Simulation （4h）
- 2.1 Steady-State Engine Models;
- 2.2 Dynamic Engine Models;
- 2.3 Modeling of Complete Engine Dynamics;
- 2.4 Modeling of Actuator and Sensor Dynamics;
- 2.5 High-Fidelity Engine Simulations;
- 2.6 Derivation of Linear Engine Models.

Chapter 3. Model Reduction and Dynamic Analysis (2h)
- 3.1 Frequency Spectrums of Interest;
- 3.2 Dominant Dynamics in the Primary Control Bandwidth
- 3.3 Integrated Engine and Vehicle Dynamics;
- 3.4 Variations in Engine Dynamics

Chapter 4. Design of Set-Point Controllers (4h)
- 4.1 Controller Design for One-Spool Engines;
- 4.2 Controller Design for Two-Spool Engines;
- 4.3 Control Design for Turboshaft Engines;
- 4.4 Some Practical Considerations.

Chapter 5. Design of Transient and Limit Controllers (4h)
- 5.1 Schedule-based Transient Controllers Design;
- 5.2 Acceleration-Based Transient Controller Design;
- 5.3 Controller Design for Limit Protections;
- 5.4 Rotorcraft Engine Considerations.

Chapter 6. Control System Integration (4h)
- 6.1 Quick Review;
- 6.2 Power Setting;
- 6.3 Transient Schedules;
- 6.4 Control Modes;
- 6.5 Engine Accessories;
- 6.6 Controller Synthesis Examples.

Chapter 7. Advanced Control Concepts (4h)
- 7.1 Multivariable Control;
- 7.2 Active Clearance Control;
- 7.3 Active Stall and Surge Control;
- 7.4 Active Combustion Control.

Chapter 8. Engine Monitoring and Health Management (4h)
- 8.1 Basic Concepts;

8.2 Monitoring System Design;
8.3 Monitoring Algorithm Design;
8.4 Trend Monitoring from Periodically Recorded Data

Chapter 9. Integrated Control and Health Monitoring (4h)

9.1 Integration Architecture, Capabilities and Requirements;
9.2 Life-Extending Control;
9.3 Safety Assurance Control;
9.4 Fast-Response Control for Helicopter Engines

## 3.Textbooks

Link C. Jaw and Jack D. Mattingly, Aircraft Engine Controls: Design, System Analysis, and Health Monitoring, AIAA Inc, 2009.

## Main Reference Books


1 The Jet Engine, Rolls-Royce Plc, fifth edition, 1996.
2 A. Linke-Diesinger, Systems of Commercial Turbofan Engines: an Introduction to Systems Functions, Springer-Verlag, Berlin, 2008.
3 A. Bryson, Control of Spacecraft and Aircraft, Princeton University Press, NJ, 1994.
4 J. Mattingly, Elements of Propulsion: Gas Turbines and Rockets, AIAA, VA, 2006.
5 A. Sobey and A. Suggs, Control of Aircraft and Missile Powerplants, Wiley, NY, 1963.
6 W. Brogan, Modern Control Theory, Prentice-Hall, NJ, 1991.
7 J. Doyle, B. Francis and A. Tannenbaum, Feedback Control Theory, Macmillan Publishing Co., 1990.



**Written by:** HU Zhongzhi (胡忠志) **Instructors:** HU Zhongzhi (胡忠志)

**Course Code**：6B073007L

**Course Title(Chinese)**：飞机电气系统

**Course Title(English)**：Aircraft Electrical System

**College and Department**：College of Civil Aviation
**Semester**：Autumn
**Class Hours**：32
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Electrical Engineering
**Assessment Instruments**：Examination or paper
**Pre-requisites**：electrical, motor, circuity theory, automatic control theory

## 1.Course Objective and Requirements

The Aircraft electrical system is very important for modern aircraft. In this course, the concept and principle and application are introduced. The course include 12chapeter to describe, follow as:

## 2.Course Content and Schedule

Chapter 1 Electrical Power System(2h)
1.1 Summary 1.2 Power Sources
Chapter 2 Battery(2h)
2.1 Standby System 2.2 Aircraft System
Chapter 3 DC Generator(2h)
3.1 Electromagnetic Generation of Power 3.2 DC Generator
Chapter 4 AC Generator(3h)
4.1 Alternating Current (AC) Introduction 4.2 AC generator
Chapter 5 AC External Power(2h)
5.1 General 5.2 Component Detail
Chapter 6 Generator Drive and Start(3h)
6.1 Generator Drive 6.2 Component Details
6.3 Operation 6.4 Starter Circuit
Chapter 7 DC Power Supply System(3h)·
7.1 DC Generation description and operation 7.2 Battery Description and Operation
7.3 Transformer-Rectifier description and operation 7.4 Standby Power Description and Operation
Chapter 8 AC Power Supply(3h)
8.1 AC Power System 8.2 Power Distribution Systems
Chapter 9 AC Generator Control System (2h)
Chapter 10 Electrical System Configurations(3h)
10.1 General 10.2 BOEING 737-300 Electrical Power System
10.3 Boeing 747 Electrical Power System 10.4 Boeing 777 Electrical Power System
Chapter 11 Aircraft Lighting System(1h)
11.1General 11.2 Exterior Light
Chapter 12 More Electricity Aircraft in the Air(4h)
12.1 Introduction 12.2 More Electrical Aircraft
12.3 Power source of aircraft 12.4 The Advantages of MEA
12.5 Power Generation and Distribution System for MEA 12.6 Summary
Examination（2h）

## 3. Textbooks

Aircraft Electricity system, 2016.9 printed by NUAA

## Main Reference Books

Thomas K. Eismin Aircraft electricity and electronics the sixth edition ISBN 978-0-07-179915-7 2014 By Mcgraw-Hill Education

Written by：ZHOU Jiemin（周洁敏） **Instructor**：ZHOU Jiemin（周洁敏）

**Course Code**：7D072009L

**Course Title(Chinese)**：数学优化建模

**Course Title(English)**：Model Building for Mathematical Optimization

**College and Department**：Col. of Aviation

**Semester**：Autumn

**Class Hours**：40

**Teaching Methods**：Face-to-face Lecture, Discussion, Topic Study, Homework

**Suitable Majors:** Traffic and Transportation Engineering; Management Science & Engineering

**Assessment Instruments**：Examination, Course Paper

**Pre-requisites**：Calculus

## 1.Course Objective and Requirements

The model building is the toughest thing for students to solve the real problem through mathematical programming. The objective of the course aims at improving students' formulating ability via a series of case studies and training so as to lay the foundation of solving real domain problem by using mathematical programming.

## 2.Course Content and Schedule

1: Review of Operations Research（1h）
2: Introduction to Formulate a Real Problem（1h）
3: Case Studies（36h）
- 3.1 Product Manufacture（2h）
- 3.2 Factory Planning（2h）
- 3.3 Manpower planning（2h）
- 3.4 Refinery optimization（2h）
- 3.5 Mining（2h）
- 3.6 Economic Planning（2h）
- 3.7 Decentralization（2h）
- 3.8 Curve fitting（2h）
- 3.9 Logical design（2h）
- 3.10 Market Sharing（2h）
- 3.11 Tariff rates（2h）
- 3.12 Three-dimensional Noughts and Crosses(Combinatorial Problem)（2h）
- 3.13 Labor Management（2h）
- 3.14 Depot location（2h）
- 3.15 Product pricing（2h）
- 3.16 Milk collection（2h）
- 3.17 Distribution（2h）
- 3.18 Efficiency analysis（2h）

4: Summary（2h）

## 3.Textbooks

H. Paul Williams, Model Building in Mathematical Programming, 4th edition, John Wiley & Sons, 2002.

## Main Reference Books

（1）Wayne L. Winston, Operations Research, Application & Algorithm, 4th Edition, Thomson Brooks/Cole, 2003

（2）Hamdy A. Taha, Operations Research, An Introduction, 3rd Edition, Macmillan Publishing Co., Inc. 1982.

（3）M. Bazargan, Airline Operations and Scheduling, Ashgate Publishing Ltd.,2006.

**Written by**：LE Meilong（乐美龙）　　**Instructor**：LE Meilong（乐美龙）

**Course Code**：7D073006L

**Course Title(Chinese)：维修工程学**

**Course Title(English)：**Maintenance Engineering

**College and Department：**Col. of Aviation

**Semester：**Autumn

**Class Hours：**32

**Teaching Methods：**Lecture, Experiment, Homework

**Suitable Majors**: Reliability and Maintenance Engineering

**Assessment Instruments：**Examination, Project

**Pre-requisites：**Mathematical statistics, Matlab or Excel software

## 1.Course Objective and Requirements

This course aims at:

- Master the basic theory of reliability, maintenance and logistics support, and study the whole developing procedure and content of the aeronautical maintenance engineering.
- Cultivate the ability of applying those theories (reliability, maintenance and logistics support) to aeronautical maintenance engineering
- Study modeling method of maintenance optimization and corresponding solution methods

Requirements for courses; ability and knowledge in advance:

- Have learned the course of mathematical statistics
- Have the ability of using the Matlab or Excel software.
- Have a general understanding of the civilian aircraft, aviation.

## 2.Course Content and Schedule

Chapter 1： Introduction (necessary parts 2 hours)
- 1.1 background
- 1.2 maintenance Engineering Objectives
- 1.3 definitions

Chapter 2： Maintenance Mathematics (necessary parts 4 hours)
- 2.1 Probability distributions
- 2.2 Boolean algebra
- 2.3 Laplace transforms
- 2.4 Markov Chain

Chapter 3： Reliability (necessary parts 4hours)
- 3.1 Root Cause of Reliability Problem
- 3.2 Bathtub Hazard
- 3.3 Reliability Measures
- 3.4 Reliability Networks

Chapter 4：Corrective Maintenance (necessary parts 4 hours)
- 4.1 corrective maintenance types
- 4.2 definitions
- 4.3 mathematical models
- 4.4 Failure Rate Equations

Chapter 5：Preventive Maintenance (necessary parts 4 hours)
- 5.1 Preventive maintenance elements
- 5.2 Preventive maintenance measures
- 5.3 Preventive maintenance models.

Chapter 6：Maintenance Steering Group (necessary parts 4 hours)
- 6.1 Aircraft Systems/Powerplant Analysis Procedure
- 6.2 Aircraft Structural Analysis Procedure
- 6.3 Zonal Analysis Procedure,
- 6.4 Lightning/High Intensity Radiated Field (L/HIRF) Analysis

Chapter 7：Maintainability (necessary parts 2 hours)
- 7.1 Maintainability management in system life cycle
- 7.2 Maintainability design characteristics
- 7.3 Maintainability measures and functions

Chapter 8：Maintenance Costing (optional parts 4 hours)
- 8.1 maintenance cost types
- 8.2 maintenance costing and factors influencing maintenance costs
- 8.3 maintenance labor cost estimation.

Chapter 9：Logistics support (optional parts 4 hours)

9.1 Spare part types
9.2 ASD S3000L content
9.3 ASD S3000L procedure

## 3. Experiments

Project1: Method of data analysis（4h，综合性）
The project involves data analysis and question-answer. And the following 4 steps are included:

- The possible states of the equipment should be analyzed, and let students learn how to choose main failure state;
- learn how to derive maintenance time and the interval from the historical examples;
- learn how to fit failure distribution (Exponential Distribution, Normal Distribution and Weibull Distribution)
- Apply Weibull analysis with Matlab to some examples.

Project2: maintenance modeling（4h，综合性）
The project involves an analysis work on the maintenance modeling. And the following 3 steps are included:

- Learn how to estimate maintenance model for a special equipment;
- Research on solving method;
- Program with Matlab and get results.

## 4. Textbooks

(1) Caijing. Modern Maintenance Engineering, NUAA. 2009

## Main Reference Books

(1) Charles E.Ebeling, An introduction to Reliability and maintainability Engineering, Tsinghua University Press 2008

**Written by**：CAI Jing（蔡景）　　**Instructor**：CAI Jing（蔡景）, SU Yan(苏艳).

**Course Code**：6B154003L

**Course Title(Chinese)**：中高层大气动力学

**Course Title(English)**：Dynamics in the Middle and Upper Atmosphere

**College and Department**：Col. of Astronautics
**Semester**：Autumn
**Class Hours**：32
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Space Physics, Environment Engineering
**Assessment Instruments**：Examination
**Pre-requisites**：Mathematics, Thermodynamics

## 1. Course Objective and Requirements

Atmospheric phenomena have been the objects of more serious scientific study for centuries. The basic physical principles of atmospheric processes are well established. Nevertheless, the manner in which these principles are involved in many geophysical phenomena is poorly understood. This is particularly true of the science of the upper atmosphere, first called aeronomy. Aeronomy encompasses the upper atmosphere, a region that is only accessible with rockets, satellites, and radiowaves and is studied mainly on the atomic and molecular scale. Despite the lack of new principles to be discovered, aeronomy has been a very active research field in recent forty years. This activity has been due mainly to great strides in observational techniques (i.e., by use of rockets and spacecraft), and to a lesser extent to developments in the ancillary sciences such as plasma physics and atomic physics. In fact, much of the impetus behind the recent revival of interest in the latter is due to the demands of aeronomy. This is a graduate course on upper atmosphere dyanmics for students with some background in physics, mathematics, or enginerring.

## 2. Course Content and Schedule

Chapter 1 Structure of the atmosphere on the surface of the earth（2h）
- 1.1 Atmospheric layers due to the variation of temperature
- 1.2 Observations and technologies in the upper atmosphere

Chapter 2 An Introduction to Atmospheric Gravity Waves （4h）
- 2.1 Airglow and its mechanism
- 2.2 Remarkable wave-driven refrigerator

Chapter 3 Structure of the static atmosphere （4h）
- 3.1 Hydrostatic state and ideal state
- 3.2 Potential temperature and its physics

Chapter 4 Conservation of mass （4h）
- 4.1 Mathematics of the continuity equation
- 4.2 Physical meaning

Chapter 5 Conservation of momentum （6h）
- 5.1 The fundamental forces
- 5.2 The vectorial form of the Newton's second law
- 5.3 The vectorial form in spherical coordinates

Chapter 6 Conservation of energy（6h）
- 6.1 The thermodynamic energy equation
- 6.2 Acoustic and sound waves
- 6.3 Shallow-water gravity waves

Chapter 7 Advances in upper atmospheric research（6h）
- 7.1 The thermal wind
- 7.2 The seasonal variations of wind and temperature
- 7.3 Internal gravity waves and fluxes

## 3. Textbooks

Holton, J. R. (2004), *An Introduction to Dynamic Meteorology*, 4th Edition, Academic Press, San Diego.

**Written by**：YU Yonghui（余永辉）　　**Instructor**：YU Yonghui（余永辉）

# Electrical and Computer Engineering

| Course type | Course Code | Course Title | Hours | Credits | Semester | College | Remark |
|---|---|---|---|---|---|---|---|
| Compulsory Course | 6A120006L | Chinese | 60 | 4 | Autumn | Col. of Foreign Languages | |
| | 6A080001L | Matrix Theory | 60 | 4 | Autumn | Col. of Science | Compulsory For master students |
| | 6A010001L | Overview of Aeronautics and Astronautics | 30 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 6A030102L<br>6A040102L<br>6A150102L<br>6A160102L | Thesis Proposal and Literature Review | | 1 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | Compulsory For master students |
| | 8A030102L<br>8A030102L<br>8A160102L<br>8A160102L | Thesis Proposal and Literature Review | | 1 | | Col. of Aerospace Engineering<br>Col. of Energy & Power Engineering<br>Col. of Aviation<br>Col. of Astronautics | Compulsory For doctoral students |
| Optional Course | 6B031008L | Digital Control System: Theory and Design | 32 | 2 | Autumn | Col. of Automation Engineering | |
| | 6B041001L | Advanced Electromagnetic Theory | 48 | 3 | Autumn | Col. of Electronic Information Engineering | |
| | 6B041003L | Numerical Methods for Electromagnetic Fields | 48 | 3 | Autumn | Col. of Electronic Information Engineering | |
| | 6B042006L | Digital Communications | 48 | 3 | Autumn | Col. of Electronic Information Engineering | |
| | 8B042003L | Selected Topics in Modern Digital Communications | 48 | 3 | Autumn | Col. of Electronic Information Engineering | |
| | 6B153002L | Satellite and Mobile Communication Engineering | 32 | 2 | Autumn | Col. of Astronautics | |
| | 6B169003L | Combinatorial Mathematics | 48 | 3 | Autumn | Col. of Computer Science & Technology | |

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|---|---|---|---|---|---|---|---|
| | 8B162001L | Advanced Services Engineering | 48 | 3 | Autumn | Col. of Computer Science & Technology | |
| | 8B163001L | Optimization Theory and Application | 48 | 3 | Autumn | Col. of Computer Science & Technology | |
| | 7D161007L | Machine Learning | 32 | 2 | Autumn | Col. of Computer Science & Technology | |
| | 7D161008L | Human-computer Interaction | 32 | 2 | Autumn | Col. of Computer Science & Technology | |
| | 7D161011L | Advanced Artificial Intelligence | 48 | 3 | Autumn | Col. of Computer Science & Technology | |
| | 7D162001L | Software Testing Methods and Techniques | 32 | 2 | Autumn | Col. of Computer Science & Technology | |
| | 7D163003L | Privacy Protection Techniques | 32 | 2 | Autumn | Col. of Computer Science & Technology | |
| Topic | 7D030001L<br>7D040001L<br>7D150001L<br>7D160001L | Topic 1 | 32 | 2 | | Col. of Automation Engineering<br>Col. of Electronic Information Engineering<br>Col. of Astronautics<br>Col. of Computer Science & Technology | |
| | 7D030001L<br>7D040001L<br>7D150001L<br>7D160001L | Topic 2 | 32 | 2 | | Col. of Automation Engineering<br>Col. of Electronic Information Engineering<br>Col. of Astronautics<br>Col. of Computer Science & Technology | |

**Course Code**：6A120006L

**Course Title(Chinese)**：汉语

**Course Title(English)**： Chinese

**College and Department**：Col. of Foreign Languages
**Semester**：Autumn
**Class Hours**：60
**Teaching Methods**：Lecture
**Suitable Majors**: International postgraduates
**Assessment Instruments**：Examination
**Pre-requisites**：Elementary Chinese

## 1.Course Objective and Requirements

To practice spoken Chinese. Students are required to learn some dialogues and sentence pattern in certain situation. Through the classroom learning and some outdoor activities, students are supposed to communicate with Chinese natives and know more about Chinese culture. After taking the course the students should be able to:

1. master several Chinese daily language.
2. communicate with Chinese natives in basic Chinese.
3. know more about Chinese customs and traditions.

## 2.Course Content and Schedule

第一课 你常去图书馆吗（4 小时）
一、课文
（一）你常去图书馆吗
（二）晚上你常做什么
二、语法
（一）时间词语作状语
（二）"还是"和"或者"
第二课 他在做什么呢（4 小时）
一、课文
（一）他在做什么呢
（二）谁教你们语法
二、语法
（一）动作的进行
（二）双宾语句
（三）询问动作行为的方式：怎么+动词
第三课 我去邮局寄包裹（4 小时）
一、课文
（一）我去邮局寄包裹
（二）外贸代表团明天去上海参观四、语法：连动句
第四课 可以试试吗（4 小时）
一、课文
（一）可以试试吗
（二）便宜一点儿吧
二、语法
（一）动词重叠
（二）又……又……
（三）"一点儿"和"有一点儿"
第五课 祝你生日快乐（4 小时）
一、课文
（一）你哪一年大学毕业
（二）祝你生日快乐
二、语法
（一）时间、价格、日期、数量、天气、年龄、籍贯等的表达：名词谓语句
（二）年、月、日
（三）怎么问（6）：疑问语调
第六课 我们明天七点一刻出发（4 小时）
一、课文
（一）我的一天
（二）明天早上七点一刻出发
二、语法：时间的表达
第七课 我打算请老师教我京剧（4 小时）
一、课文：我打算请老师教我京剧

二、语法：兼语句
第八课 学校里边有邮局吗（4 小时）
一、课文
（一）学校里边有邮局吗
（二）从这儿到博物馆有多远
二、语法
（一）方位词
（二）存在的表达
（三）介词"离"、"从"、"往"
第九课 我想学太极拳（4 小时）
一、课文
（一）我想学太极拳
（二）您能不能再说一遍
二、语法
（一）能愿动词
（二）询问原因
第十课 她学得很好（4 小时）
一、课文
（一）她学得很好
（二）她每天都起得很早
二、语法：描写、判断和评价：状态补语（1）：动词+得+形容词
第十一课 田芳去哪儿了（4 小时）
一、课文
（一）田芳去哪儿了
（二）他又来电话了
二、语法
（一）语气助词"了"（1）
（二）"再"和"又"
第十二课 玛丽哭了（4 小时）
一、课文
（一）你怎么了
（二）玛丽哭了
二、语法
（一）动作的完成：动词+了
（二）因为-...一所以.....
第十三课 我吃了早饭就来了（4 小时）
一、课文
（一）我吃了早饭就来了
（二）我早就下班了
二、语法
（一）"就"和"才"
（二）要是.....（的话），就.....
（三）虽然.....但是.....
第十四课 我都做对了（4 小时）
一、课文
（一）我都做对了
（二）看完电影再做作业
二、语法
（一）动作结果的表达：结果补语
（二）结果补语"上"、"成"和"到"
（三）主谓词组作定语
第十五课 我来了两个多月了（4 小时）
一、课文
（一）我来了两个多月了
（二）我每天都练一个小时
二、语法
（一）动作或状态持续时间的表达：时量补语
（二）概数的表达
（三）离合动词

**3.Textbooks**
《汉语教程》 主编 杨寄洲，北京语言大学出版社，2009 年

**Written by**：WANG Zheng (王征)
**Instructor**：LU Hong（陆红）,WANG Zheng（王征）， ZHANG Weidong （张卫东）et al.

**Course Code**：6A080001L

**Course Title(Chinese)**：矩阵论

**Course Title(English)**：Matrix Theory

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：60

**Teaching Methods**：Lecture, Projects, Homework

**Suitable Majors**: Engineering

**Assessment Instruments**：Examination, Projects, Homework

**Pre-requisites**：Linear Algebra, Calculus, Analytic Geometry

## 1. Course Objective and Requirements

Topics include the basic Concepts in Linear Algebra, Linear Space and Inner-product Space, Linear Transformation, Jordan Canonical Form, Matrix Factorization with Applications, Hermitian Matrix and Positive Definite Matrix, Matrix Norm and Matrix Analysis, Generalized Inverse Matrix, Matrix Computation with MATLAB.

Through the course, students learn, practice, and master basic matrix results and techniques that are very useful for applications in various fields such as mathematics, statistics, physics, computer science, and engineering, etc.

It requires that students should master the basic discipline of matrix theory, be able to carry out the classical theory and methods and have the basic knowledge and skills to solve mathematical problems in engineering so that they are prepared with the necessary foundation for their future study and work.

## 2. Course Content and Schedule

Chapter 1 Review and Miscellanea (8h)
- 1.1 Matrix concept and special matrices
- 1.2 Matrix algebra
- 1.3 Eigenvalue and eigenvector
- 1.4 An introduction to MATLAB

Chapter 2 Linear Space and Inner-product Space (8h)
- 2.1 Linear space
- 2.2 Basis and dimension of vector space
- 2.3 Subspace
- 2.4 Inner-product Space

Chapter3 Linear Transformation (6h)
- 3.1 Introduction
- 3.2 Linear transformation with properties
- 3.3 Range and kernel
- 3.4 Matrix Representation of Linear Transformation
- 3.5 Similarity

Chapter 4 Jordan Canonical Form (8h)
- 4.1 Diagonalizability
- 4.2 Jordan block matrix and Jordan form matrix
- 4.3 lambda-matrix and Smith standard form
- 4.4 Jordan Canonical Form
- 4.5 Cayley-Hamilton Theorem and Minimal polynomial

Chapter 5 Matrix Factorization (8h)
- 5.1 Introduction
- 5.2 Full Rank Decomposition
- 5.3 LU Factorization
- 5.4 QR Factorization
- 5.5 Schur Decompisition
- 5.6 Singular value decomposition(SVD)

Chapter 6 Hermitian Matrix and Positive Definite Matrix (6h)
- 6.1 Hermitian matrix
- 6.2 Positive definite matrix

Chapter 7 Matrix Norm and Matrix Analysis (8h)
- 7.1 Introduction
- 7.2 Vector Norm
- 7.3 Matrix Norm

7.4 Matrix sequence, series and function
Chapter 8 The Moore-Penrose Generalized Inverse (4h)
8.1 Introduction
8.2 The Moore-Penrose Generalized Inverse
Matlab Commands for matrix computations (2h)
Reviews and Examination (2h)

**3. Textbooks**

Wang, Z. S. Introduction to Matrix Theory, Science Press, 2015

**Main Reference Books**

(1) 戴华，矩阵论，科学出版社，2001
（2）Steven J. Leon. Linear Algebra with Applications，7th edition. Person Education Asia Limited and China Machine Press.，2007
（3）Roger A. Horn & Charles R. Johnson, Matrix Analysis, 人民邮电出版社， 2005
（4）Zhang F. Matrix Theory: Basic Results and Techniques (Second Edition), 2010, Springer Press.

**Written by**：WANG Zhengsheng（王正盛）
**Instructor**：WANG Zhengsheng（王正盛）, YANG Xi（杨熙）

**Course Code**：6A010001L

**Course Title(Chinese)**：航空航天导论

**Course Title(English)**：Overview of Aeronautics and Astronautics

**College and Department**：Col. of Airspace Engineering
**Semester**：Autumn
**Class Hours**：30
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Any
**Assessment Instruments**：Examination
**Pre-requisites**：None

## 1.Course Objective and Requirements

Overview of Aeronautics and Astronautics provides a comprehensive and overall introduction about aeronautic technology to the international students in China. It is helpful for the students to build the base to learn the related course. This course will discuss all main contents about aeronautic technology including flight history, basic aerodynamic, flight mechanics, aircraft control and stability, propulsion system, aircraft structure and so on.

## 2.Course Content and Schedule

**Chapter 1 Rich History** （6h）
- 1.1 From Wheels to Stars
- 1.2 Myths and Legends
- 1.3 Early Scientific Research
- 1.4 Flight in Balloons
- 1.5 The Era of the Dirigible
- 1.6 Heavier-Than-Air Aircraft Development
- 1.7 Wright Brothers' Flyer I
- 1.8 The Adolescence of Airplane
- 1.9 The Golden Age of Aviation
- 1.10 Airplanes in the World War II
- 1.11 Jet Airplane
- 1.12 Advances in Aeronautics

**Chapter 2 Basic Aerodynamics** （6h）
- 2.1 The Atmosphere
- 2.2 Atmospheric Regions
- 2.3 Continuity Equation
- 2.4 Bernoulli's Principle
- 2.5 About Viscous Flow
- 2.6 About Compressiblity
- 2.7 Measurement of Airspeed
- 2.8 Wind Tunnels

**Chapter 3 Airfoil, Wing and Airplane** （6h）
- 3.1 Introduction
- 3.2 Airfoil Lift
- 3.3 Wing Lift
- 3.4 Airplane Lift
- 3.5 High Lift Devices
- 3.6 Wing and Airplane Drag
- 3.7 Mach Number Effects

**Chapter 4 Elements of Airplane Performance** （2h）
- 4.1 Introduction
- 4.2 Equations of Motion
- 4.3 Drag Curves
- 4.4 Power Curves

4.5 Range and endurance
4.6 Gliding Flight
4.7 Climbs
4.8 Takeoff and Landing
4.9 Turnning Flight
4.10 V-n Diagram

**Chapter 5 Airplanes' Stability and Control** （3h）

5.1 Introduction
5.2 Coordinate System
5.3 Control Surfaces
5.4 Stability Definition
5.5 Longitudinal Control Analysis
5.6 Longitudinal Stability
5.7 Directional Stability and Control
5.8 Lateral Stability and Control

**Chapter 6 Aircraft Propulsion** （3h）

6.1 Introduction
6.2 Airplane Propellers
6.3 Piston Engines
6.4 Turbojet Engines
6.5 Afterburners
6.6 Turbofan Engines
6.7 Turboprop Engine
6.8 Turboshaft Engine
6.9 Ramjets

**Chapter 7 Airplane Structure** （2h）

7.1 Introduction
7.2 Mechanics Conception
7.3 An Airplane's Loads
7.4 Structural Layout
7.5 Component Sizing

**Chapter 8 Airplane Instruments** （2h）

8.1 Introduction
8.2 Early Airplane Instruments
8.3 Instrument Classification
8.4 Typical Instruments
8.5 Navigation Conception

## 3.Textbooks

Caijun Xue. Introduction to aeronautics, National Defense Industry Press, 2015

**Written by**：XUE Caijun（薛彩军） **Instructor**：XUE Caijun（薛彩军）

Course Code：6B031008L

Course Title(Chinese)：数字控制理论与设计

Course Title(English)：Digital Control System: Theory and Design

**College and Department**：Col. of Automation Engineering

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Project, Homework

**Suitable Majors**: Control-related majors

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Principle of Automatic control or Control system engineering, Modern control theory, Digital signal processing, linear algebra

## 1.Course Objective and Requirements

This course is a comprehensive introduction to control system synthesis in which the digital computer plays a major role. The course covers elements of real-time computer architecture; input-output interfaces and data converters; analysis and synthesis of sampled-data control systems using classical and modern (state-space) methods; analysis of trade-offs in control algorithms for computation speed and quantization effects. Laboratory projects emphasize practical digital servo interfacing and implementation problems with timing, noise, and nonlinear devices.

Course objectives: To understand discrete-time system, digital control system, and the problems with implementations, to be able to design sampled-data controllers.

## 2.Course Content and Schedule

Chapter 1 Continuous Control systems: a Review（2h）
- 1.1 Continuous-time models;
- 1.2 Closed-loop systems;
- 1.3 PI and PID controllers

Chapter 2 Computer Control Systems （8h）
- 2.1 Discretization and overview of sampled-data systems;
- 2.2 Discrete-time models; Closed loop discrete-time systems;
- 2.3 Basic principles of modern methods for design of digital controllers;
- 2.4 Analysis of the closed-loop sampled-data systems in the frequency domain.

Chapter 3 Robust Digital Controller Design Methods （10h）
- 3.1 Digital PID controller;
- 3.2 Pole Placement
- 3.3 Tracking and regulation with independent objectives
- 3.4 Internal Model control (Tracking and regulation)
- 3.5 Pole Placement with sensitivity function shaping

Chapter 4 Design of Digital Controller in the presence of random disturbances （6h）
- 4.1 Models for Random disturbances
- 4.2 Minimum variance tracking and regulation
- 4.3 The case of unstable zeros: approximation of the minimum variance tracking and regulation by means of pole placement
- 4.4 Generalized Minimum Variance Tracking and Regulation

Chapter 8 Practical aspects of digital control system （2h+4h experiments）
- 8.1 Implementation of Digital Controllers
- 8.2 Digital Control of an Air Heater
- 8.3 DC Motor Speed Control

## 3. Experiments

Project: The project involves a work on the analysis and design of a digital control system using MATLAB.

## 4.Textbooks

Ioan D. Landau and Gianluca Zito Digital Control Systems: Design, identification and implementation. Springer-Verlag London Limited, 2006.

## Main Reference Books

1. Franklin, Gene F., Powell, J. David, & Workman, Michael, Digital Control of Dynamic Systems, 3rd Edition, Addison Wesley Longman Inc., 1997

2. Ogata, Discrete-Time Control Systems, 2nd Ed, 1995
3. 齐瑞云，陆宁云 数字控制系统-设计、辨识和实现. 科学出版社，2014.8.

**Written by**：LU Ningyun（陆宁云）　　**Instructor**：LU Ningyun（陆宁云）

**Course Code**：6B041001L

**Course Title(Chinese)**：高等电磁场理论

**Course Title(English)**：Advanced Electromagnetics Theory

**College and Department**：Col. of Electronic and Information Engineering
**Semester**：Autumn
**Class Hours**：48
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Electronic Science and Technology, Communications Engineering
**Assessment Instruments**：Examination, Project
**Pre-requisites**：Vector Analysis, Electromagnetics, Field Theory

## I. Course Objective and Requirements

This course provides a solid understanding of electromagnetic phenomena related to microwave and millimetre-wave engineering, antenna engineering and wireless technology. Strong emphasis is given to computational electromagnetic techniques, which form the core of contemporary CAA/CAD tools. We adopt a systematic approach in which the complexity and dimension of the explained techniques are increased starting with simple 1D problems. Lectures will cover the following topics:

1. Fundamentals of electromagnetic theory-revision.
2. Electromagnetic properties of matter.
3. Auxiliary vector potentials and construction of solutions.
4. Radiation and scattering.
5. Basic theorems of electromagnetics.
6. Green's functions in electromagnetic equations.
7. Method of Moments (MoM) and applications.
8. Huygen's principle and the time domain Transmission Line Modeling (TLM) method.
9. Variational approaches in electromagnetics and the Finite Element Method (FEM).
10. The Finite Difference Time Domain (FDTD) method.
11. Recent advances in numerical electrodynamics-open discussion

## II. Course Content and Schedule

**1. Time-Varying and Time-Harmonic Electromagnetic Fields** (4h)
- 1.1 Introduction
- 1.2 Maxwell's Equations
  - 1.2.1 Differential Form of Maxwell's Equations
  - 1.2.2 Integral Form of Maxwell's Equations
- 1.3 Constitutive Parameters and Relations
- 1.4 Circuit-Field Relations
  - 1.4.1 Kirchhoff's Voltage Law
  - 1.4.2 Kirchhoff's Current Law
- 1.5 Boundary Conditions
  - 1.5.1 Finite Conductivity Media
  - 1.5.2 Infinite Conductivity Media
  - 1.5.3 Sources along Boundaries
- 1.6 Power and Energy
- 1.7 Time-Harmonic Electromagnetic Field
  - 1.7.1 Maxwell's Equations in Differential and Integral Form
  - 1.7.2 Boundary Condition
  - 1.7.3 Power and Energy

**2. Electrical Properties of Matter** (4h)
- 2.1 Introduction
- 2.2 Dielectrics, Polarization, and Permitivity
- 2.3 Magnetics, Magnetization, and Permeability
- 2.4 Current, Conductors, and Conductivity
  - 2.4.1 Current
  - 2.4.2 Conductors
  - 2.4.3 Conductivity
- 2.5 Semiconductors
- 2.6 Superconductors
- 2.7 Linear, Homogeneous, Isotropic, and Nondispersive Media
- 2.8 A.C. Variations in Matters

2.8.1 Complex Permittvity
2.8.2 Complex Permeability
2.8.3 Ferrites

**3. Wave Equation and Its Solutions** (8h)

3.1 Introduction
3.2 Time-Varying Electromagnetic Fields
3.3 Time-Harmonic Electromagnetic Fields
3.4 Solution to the Wave Equation
3.4.1 Rectangular Coordinate System
A. Source-Free and Lossless Media
B. Source-Free and Lossy Media
3.4.2 Cylindrical Coordinate System
3.4.3 Spherical Coordinate System

**4. Wave Propagation and Polarization** (8h)

4.1 Introduction
4.2 Transverse Electromagnetic Modes
4.2.1 Uniform Plane Wave in an Unbounded Lossless Media-Principal Axis
A. Electric and Magnetic
B. Wave Impedance
C. Phase and Energy (Group) Velocities, Power, and Energy Densities
D. Standing Waves
4.2.2 Uniform Plane Waves in an Unbounded Lossless Medium-Oblique Angle
A. Electric and Magnetic Fields
B. Wave Impedance
C. Phase and Energy (Group) Velocities
D. Power and Energy Densities
4.3 Transverse Electromagnetic Modes in Lossy Media
4.3.1 Uniform Plane Waves in an Unbounded Lossy Medium-Principal Axis
A. Good Dielectrics
B. Good Conductors
4.3.2 Uniform Plane Waves in an Unbounded Lossy Media-Oblique Angle
4.4 Polarization
4.4.1 Linear Polarization
4.4.2 Circular Polarization
A. Right-Hand (Clockwise) Circular Polarization
B. Left-Hand (Counterclockwise) Circular Polarization
4.4.3 Elliptical Polarization
4.4.4 Poincare Sphere

**5. Reflection and Transmission** (8h)

5.1 Introduction
5.2 Normal Incidence-Lossless Media
5.3 Oblique Incidence-Lossless Media
5.3.1 Perpendicular (Horizontal or E) Polarization
5.3.2 Parallel (Vertical or H) Polarization
5.3.3 Total Transmission-Brewster Angle
A. Perpendicular (Horizontal) Polarization
B. Parallel (Vertical) Polarization
5.4 Lossy Media
5.4.1 Normal Incidence: Conductor-Conductor Interface
5.4.2 Oblique Incidence: Dielectric-Conductor Interface
5.4.3 Oblique Incidence: Conductor-Conductor Interface
5.5 Reflection and Transmission of Multiple Interfaces
5.5.1 Reflection Coefficient of a Single Slab Layer
5.5.2 Reflection Coefficient of Multiple Layers
A. Quarter-Wavelength of Multiple Layers
B. Binomial (Maximally Flat) Design
C. Tschebyscheff (Equal-Ripple) Design
D. Oblique-Wave Incidence
5.6 Polarization Characteristics on Reflection

**6. Auxiliary Vector Potentials, Construction of Solution, and Radiation and Scattering Equations** (8h)

6.1 Introduction
6.2 The Vector Potential A
6.3 The Vector Potential F
6.4 The Vector Potential A and F
6.5 Construction of Solution
6.5.1 Transverse Electromagnetic Modes: Source-Free Region

A. Rectangular Coordinate System
B. Cylindrical Coordinate System

6.5.2 Transverse Magnetic Modes: Source-Free Region
A. Rectangular Coordinate System
B. Cylindrical Coordinate System

6.5.3Transverse Electric Modes: Source-Free Region
A. Rectangular Coordinate System
B. Cylindrical Coordinate System

6.6 Solution of the Inhomogenous Vector Potential Wave Equation
6.7 Far-Field Radiation
6.8 Radiation and Scattering Equations
6.8.1 Near Field
6.8.2 Far Field
A. Rectangular Coordinate System
B. Cylindrical Coordinate System

**7. Electromagnetic Theorems and Principles** (6h)
7.1 Introduction
7.2 Duality Theorem
7.3 Uniqueness Theorem
7.4 Image Theory
7.4.1 Vertical Electric Dipole
7.4.2 Horizontal Electric Dipole
7.5 Reciprocity Theorem
7.6 Reaction Theorem
7.7 Volume Equivalence Theorem
7.8 Surface Equivalence Theorem: Huygenes's Principle
7.9 Induction Theorem (Induction Equivalent)
7.10 Physical Equivalent and Physical Optical Equivalent
7.11 Induction and Physical Equivalent Approximations

## III. Examination (2h)

## IV. Textbook

C.A. Balanis, *Advanced Engineering Electromagnetics*, John Wiley & Sons, 2012, Springer

**Written by**：CAO Qunsheng（曹群生） **Instructor**： CAO Qunsheng（曹群生）

**Course Code**：6B041003L

**Course Title(Chinese)**：电磁场的数值方法

**Course Title(English)**：Numerical Methods for Electromagnetic Fields

**College and Department**：Col. of Electronic Information Engineering

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Electronic Science and Technology, Communications Engineering

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Advanced Engineering Electromagnetics，Microwave Technology, Matlab

## 1. Course Objective and Requirements

This is an introductory (2nd semester) graduate level electromagnetic course related to the area of approximate solution of boundary value problems by the use of digital computers. Students will be exposed to various aspects of numerical solution of EM equations in the frequency domain, including:

- Intro to CEM;
- Numerical integration;
- Iterative and direct solvers;
- Finite difference method;
- Integral equation methods - Method of Moments;
- Finite element method.

Goal:

To develop a foundation level necessary for successful use of available CEM tools (programs) and research in the area of numerical and applied electromagnetics.

## 2. Course Content and Schedule

1. Introduction (6h)
   - 1.1 Computational Electromagnetics
   - 1.2 Maxwell's Equations
     - 1.2.1 Boundary Conditions
     - 1.2.2 Energy Relations
     - 1.2.3 Time Evolution
     - 1.2.4 Low-Frequency Approximation
     - 1.2.5 Integral Formulation Power and Energy
2. Convergence (2h)
   - 2.1 Extrapolation to Zero Cell Size
     - 2.1.1 A Singular Problem
   - 2.2 Practical Procedures
3. Finite Differences (4h)
   - 3.1 A 2D Capacitance Problem
     - 3.1.1 Iterative Solution of Laplace's Equation
     - 3.1.2 Computing the Capacitance
     - 3.1.3 MATLAB: Capacitance of Coaxial Cable
   - 3.2 Finite Difference Derivatives of Complex Exponentials
     - 3.2.1 First-Order Derivative
     - 3.2.2 Spurious Solutions and Staggered Grids
     - 3.2.3 Second-Order Derivative
4. Eigenvalues (4h)
   - 4.1 Maxwell's Equations
   - 4.2 Model Problems
   - 4.3 Frequency-Domain Eigenvalue Calculation
     - 4.3.1 MATLAB: The 1D Helmholtz Equation
   - 4.4 Time-Domain Eigenvalue Calculation
     - 4.4.1 Stability Analysis
     - 4.4.2 MATLAB: The 1D Wave Equation
     - 4.4.3 Extracting the Eigenfrequencies
     - 4.4.4 MATLAB: Pad′e Approximation
5. The Finite-Difference Time-Domain Method (8h)
   - 5.1 The 1D Wave Equation
     - 5.1.1 Dispersion and Stability
   - 5.2 The FDTD Method: Staggered Grids
     - 5.2.1 One Space Dimension
     - 5.2.2 Three Space Dimensions
     - 5.2.3 MATLAB: Cubical Cavity Integral
     - 5.2.4 Interpretation of the FDTD Method
     - 5.2.5 Dispersion Analysis in Three Dim
   - 5.3 Boundary Conditions for Open Regions
   - 5.4 The Perfectly Matched Layer
   - 5.5 Near-to-Far-Field Transformation

6. The Finite Element Method (14h)
   6.1 General Recipe
   6.2 1D Finite Element Analysis
   6.3 2D Finite Element Analysis
      6.3.1 The Assembling Procedure
      6.3.2 Unstructured Meshes in Practice
      6.3.3 MATLAB: 2D FEM Using Nodal Basis Functions
   6.4 Adaptivity
   6.5 Vector Equations
      6.5.1 Mixed-Order FEM for Systems of First-Order Equations
      6.5.2 The Curl-Curl Equation and Edge Elements
      6.5.3 Edge Elements on Cartesian Grids
      6.5.4 Eigenfrequencies of a Rectangular Cavity
      6.5.5 Edge Elements on Triangles
      6.5.6 Edge Elements in Practice
      6.5.7 MATLAB: FEM with Triangular Edge Elements
      6.5.8 Time-Dependent Problems
   6.6 Magnetostatics and Eddy Current Problems
      6.6.1 2D Formulation
      6.6.2 A 2D Application Problem
      6.6.3 3D Eddy Current Calculations
   6.7 Variational Methods
      6.7.1 Relation Between Linear Differential Equations and Quadratic Forms
      6.7.2 Rayleigh Ritz Method
      6.7.3 Galerkin's Method
      6.7.4 A Variational Method for Maxwell's Equations
7. The Method of Moments (10h)
   7.1 Integral Formulation of Electrostatics
      7.1.1 Green's Function
      7.1.2 General Formulation
      7.1.3 FEM Solution
   7.2 Capacitance Problem in an Unbounded 2D Region
      7.2.1 Integration
      7.2.2 MATLAB: MoM for General, 2D Geometries
      7.2.3 Charge Distribution
      7.2.4 Adaptivity
      7.2.5 Numerical Integration
   7.3 Electromagnetic Scattering
      7.3.1 Representation by Potentials and a Lorentz Gauge 
      7.3.2 Green's Function for the Vector Potential
      7.3.3 The Electric Field Integral Equation
      7.3.4 The Magnetic Field Integral Equation.
      7.3.5 The Combined Field Integral Equation
   7.4 Scattering on Thin Wires
      7.4.1 Hall′en's Equation
      7.4.2 Valid Approximation for the 1D Kernel
      7.4.3 Numerical Solution

**3. Examination** (2h)

**4. Textbook**

Anders Bondeson, Thomas Rylander, Par Ingelstrom, Computational Electromagnetics, Springer Science+Business Media, Inc. , 2005

**Written by**：CAO Qunsheng（曹群生） **Instructor**： CAO Qunsheng（曹群生）.

**Course Code**：6B042006L

**Course Title (Chinese)**：数字通信

**Course Title (English)**：Digital Communications

**College and Department**：Col. of Electronic Information Engineering

**Semester:** Autumn

**Lecturing Hours:** 48

**Teaching Methods:** Lecturing, Interactive discussion

**Suitable Majors:** Information Engineering, Automatic Control

**Assessment Instruments:** Open books exam

**Pre-requisites:** Matrix Theory, Stochastic process, Digital Signal Process (DSP)

## 1. Course Objectives and Requirements

The course "Digital Communication" treats the transport of bit streams from one geographical location to another over various physical media, such as wire pairs, coaxial cable, optical fiber, and radio. It also treats multiple-access channels, where there are potentially multiple transmitters and receivers sharing a common medium.

The general approach of this course is to extract the common principles underlying a range of media and applications and present them in a unified framework. It is relevant to the design of a variety of systems, including voice and video digital telephone, digital CATV distribution, wireless LANs, digital subscriber loop, metallic Ethernet, voiceband data modems, and satellite communication systems.

The course is intended for designers and would-be designers of digital communication systems. We have been selected in topics covered and in the depth of coverage. For example, the coverage of advanced information, coding, and detection theory is limited to those aspects directly relevant to the design of digital communication systems. This emphasis on topics important to designers results in more detailed treatment of some topics than is traditional in academic textbooks, for example in our coverage of synchronization (timing and carrier recovery).

This course is suitable for first-year graduate students, and should also be of interest to many industry professionals. The lecturer attempted to make the course attractive to both audiences through the inclusion of many practical examples and a practical flavor in the choice of topics. This course has increased the readability by relegating many of the more detailed derivations to appendices and exercise solutions, both of which are included in the book.

Finally, the lecturers are always keen to hope that this course will be very much useful to the students who will attend the course and appreciate any valuable comments and suggestions from the readers.

## 2. Course Contents and Schedule

**Ch 1. Fundamentals of Shannon Theory (6 h)**

**1.1. Laws of Large Numbers**

1.1.1. Indicator Function

1.1.2. Chernoff Bound and Its Properties

1.1.3. Introduction to Convex and Concave Functions

1.1.4. Properties of Chernoff exponent

1.1.5. Chernoff Bound for Functions of Random Variables

**1.2 Fundamental Theorem of Large-Deviation Theory**

1.2.1. Relative entropy (Kullback-Leibler divergence/ distance)

1.2.2. An $\varepsilon$ -typical sequence with log-likelihood ratio $\lambda(x) = \log[p(x)/q(x)]$

1.2.3. Fundamental of large-deviation theory

**1.3 Proof of the Capacity Theorem (Random Coding) for an AWGN Channel**

1.3.1. Shannon's random code and decision rule for decoder

1.3.2. Probability of decoding error for Shannon's random codes over noisy channels

1.3.3. Capacity of AWGN channel and relations with the Shannon's random codes

**1.4 Geometric Interpretation for the Capacity Theorem of AWGN Channel**

1.4.1. Real Euclidean $N$ -space $\mathbf{R}^N$

1.4.2. Applying Real Euclidean $N$-space $\mathbf{R}^N$ to AWGN channel

1.4.3. Further Discussions

**Ch 2. Pulse-Amplitude Modulation (8 h)**

**2.1. Baseband PAM**
- 2.1.1. Nyquist Pulse Shape
- 2.1.2. The Impact of Filtering on PAM
- 2.1.3. ISI and Eye Diagrams
- 2.1.4. Bit Rate and Spectral Efficiency

**2.2. Passband PAM**
- 2.2.1. Three Representations of Passband PAM
- 2.2.2. Constellations
- 2.2.3. Spectral Efficiency

**2.3. The One-Shot Minimum-Distance Receiver**
- 2.3.1. The Minimum-Distance Criterion
- 2.3.2. Properties of the Matched Filter
- 2.3.3. Matched Filter and ISI
- 2.3.4. Passband PAM Receivers
- 2.3.5. More Elaborate PAM Receivers: A Preview

**2.4. Minimum-Distance Sequence Detection**
- 2.4.1. The Minimum-Distance Sequence Detector and the Folded Spectrum
- 2.4.2. Minimizing Distance in Discrete-Time
- 2.4.3. The Whitened-Matched Filter
- 2.4.4. The Viterbi Algorithm

**2.5 Error Performance of PAM System**
- 2.5.1. Probability of Symbol Error
- 2.5.2. Bandwidth and SNR Requirements of Passband PAM
- 2.5.3. Further Reading

**Ch 3. Advanced Modulation (6 h)**

**3.1. M-ary Modulation**
- 3.1.1. Baseband Equivalent Model
- 3.1.2. One-Shot Minimum-Distance Detection
- 3.1.3. One-Shot Minimum-Distance Detection

**3.2. Probability of Error**
- 3.2.1. Performance in AWGN

**3.3. Orthogonal Modulation**
- 3.3.1. The Minimum-Distance Receiver for Orthogonal Modulation
- 3.3.2. Error Probability for Orthogonal Modulations
- 3.3.3. Examples of Orthogonal Modulation
- 3.3.4. The Generalized Nyquist Criterion
- 3.3.5. Noise Immunity and Spectral Efficiency of Orthogonal Modulation
- 3.3.6. Practical-Shift Keying

**3.4. Orthogonal Pulse-Amplitude Modulation (OPAM)**
- 3.4.1. OPAM: Combined PAM and Orthogonal Modulation
- 3.4.2. Multicarrier Modulation
- 3.4.3. Spread Spectrum
- 3.4.4. Coded-Division Multiplexing

**3.5. Modulation with Memory**
- 3.5.1. Continuous-phase Modulation
- 3.5.2. Detection of CPM
- 3.5.3. Differential Encoding and DPSK

**3.6. Bandwidth and Signal Dimensionality**
- 3.6.1. Landau-Pollak Theorem
- 3.6.2. Relation to the Generalized Nyquist Criterion
- 3.6.3. Impact of Signal Bandwidth on the Isolated Pulse
- 3.6.4. Communication Link in a Network Context

**3.7. Capacity and Modulation**
- 3.7.1. Error Probability of PAM
- 3.7.2. Capacity of the ideal Gaussian Channel
- 3.7.3. Using Normalized SNR in Comparisons

**3.8. Further Reading**

**Ch 4. Probabilistic Detection (6 h)**

**4.1. Introduction**

**4.2. Detection of a Signal Real-Value Symbol**
- 4.2.1 Discrete-Value Observation
- 4.2.2 Continuous-Valued Observation

**4.3. Detection of a Signal Vector**
- 4.3.1 ML Detection
- 4.3.2 MAP Detector
- 4.3.3 Probability of Error for BSC ML Detector

**4.4. Known Signals in Gaussian Noise**
4.4.1 Discrete-Time Received Signal
4.4.2 Continuous-Time Reception
4.4.3 Sufficient Statistics
4.4.4 Optimal Detection for PAM with ISI
**4.5. ML Sequence Detection with the Viterbi Algorithm**
**4.6. A Posteriori Probability Detection with BCJR**
4.6.1. Special Case: Binary Alphabet
4.6.2. Normalization
**4.7. Symbol-Error Probability for MLSD**
4.7.1. Error Events
4.7.2. Calculating the Minimum-Distance for ISI
**4.8. Incoherent Detection**
**4.9. Shot Noise Signal with Known Intensity**
**Ch. 5 Error Control Coding (8h)**
**5.1. Introduction**
**5.2. The Capacity Penalty of Binary Coding**
**5.2. Binary Linear Block Codes**
5.2.1. Performance of Soft Decoders
5.2.2. Performance of Hard Decoders
5.2.3. Parity-Check Matrix
5.2.4. Hamming Codes
**5.3. Convolutional Codes**
5.3.1. Performance of Soft Decoders
5.3.2. Performance of Hard Decoders
**5.4. Algebraic Concepts**
5.4.1. Fundamental Definitions
5.4.2. Primitive Element
5.4.3. Extension Fields $GF(q)$
**5.5. General Cyclic Codes**
**5.6. BCH Codes**
5.6.1 Introduction
5.6.2 Binary BCH Codes
5.6.3 Reed-Solomon (RS) Codes
**5.7 Decoding of BCH and Reed-Solomon Codes**
5.7.1 $q$ -Ary Linear Block Codes
5.7.2. Primitive BCH Codes Over $GF(q)$
5.7.3. Reed-Solomon Codes
5.7.4. Decoding of Nonbinary BCH and RS Codes: The Berlekamp Algorithm
5.7.5. Decoding of Nonbinary BCH and RS Codes: The Euclidean Algorithm
**Ch. 6 Carrier and Timing Recovery (6 h)**
**6.1 Decision-Directed Carrier Recovery**
**6.2 Power of N Carrier Recovery**
**6.3 Timing Recovery Performance**
**6.4 Spectral-Line Methods**
**6.5 MMSE Timing Recovery and Approximations**
**6.6 Baud-Rate Timing Recovery**
**6.7 Accumulation of Timing Jitter**
**Ch. 7 Multiple Access Alternatives (6 h)**
**7.1 Medium Topology for Multiple Access**
**7.2 Multiple Access by Time Division**
**7.3 Multiple Access by Frequency Division**
**7.4 Multiple Access by Code Division**
**7.5 The Cellular Concept**

## 3. Textbook

John R. Barry, Edward A. Lee and David G. Messerschmitt, Digital Communication, 3rd edition, Kluwer G. Messerschmitt, 2006, Boston, Dordrecht, London, Kluwer Academic Publishers.

## Bibliography

[1] J. H. Van Lint, Introduction to Coding Theory, 3rd Edition, Spring-Verlag, Heideberg, New York, 2006.
[2] Steven Roman, Coding and Information Theory, Springer-Verlag, Spring-Verlag, Berlin, Heideberg, New York, 2005.

[3] John G. Prokais, Digital Communications, 4th Edition, McGraw-Hill, Inc. 2001.
[4] M. B. Pursley, Introduction to Digital Communications, Prentice Hall, 2005.
[5] Mohinder Jankiraman, Space-Time Codes and MIMO Systems, Aretech House Inc. 2004.
[6] Kamilo Feher, Advanced Digital Communications: Systems and Signal Processing Techniques, Prentice Hall, Inc. 1987.
[7] Kamilo Feher, Digital Communications: Satellite/Earth Station Engineering, Noble Publishing Corporation, Atlantic, 1997.

**Written by:** YANG Fengfan（仰枫帆）

**Principal Lecturer:** YANG Fengfan（仰枫帆）

**Co-lecturer:** ZONG Peng (宗鹏)

**Course Code：** 8B042003L

**Course Title (Chinese)：** 现代数字通信专题

**Course Title (English)：** Selected Topics on Modern Digital Communications

**Department/College:** Col. of Electronics and Information Engineering
**Semester:** Autumn
**Lecturing Hours:** 48
**Teaching Methods:** Lecturing, Interactive discussion
**Suitable Majors:** Information Engineering, Automatic Control
**Assessment Instruments:** Open books exam
**Pre-requisites:** Matrix Theory, Stochastic process, Digital Signal Process (DSP)

## 1. Course Objectives and Requirements

The course is promoted by two main developments in wireless communication in the past decade. First is the huge surge of research activities in physical-layer communication theory. While this has been a subject of the study since sixties, recent developments such as opportunistic and multiple input multiple output (MIMO) communication techniques have brought completely new perspectives on how to communicate over wireless channels. Second is the rapid evolution of wireless systems, particularly cellular networks, which embody communication concepts of increasing sophistication. This evolution started with second-generation digital standards, particularly the IS-95 Code Division Multiple Access standard, continuing to more recent third-generation system focusing on data applications.

Finally, the lecturers are always keen to hope that this course will be very much useful to the students who will attend the course and appreciate any valuable comments and suggestions from the readers.

## 2. Course Contents and Schedule

**Chapter 1. Prerequisites and Preliminaries (5h)**
- 1.1 Logic, Sets and Classes
- 1.2. Relations and Partitions
- 1.3. Products and Functions
- 1.4. Brouwer Fixed Point Theorem
- 1.5. Categories and Functions
- Bibliographies

**Chapter 2. Fundamental Mathematics in Communications (8h)**
- 2.1. Group
  - 2.1.1 Semigroups, Monoids and Groups
  - 2.1.2 Homomorphisms and Subgroups
  - 2.1.3 Cyclic Groups
  - 2.1.4 Cosets and Counting
  - 2.1.5 Normality, Quotient Groups and Homomorphisms
- 2.2 Ring
  - 2.2.1 Rings and Homomorphisms
  - 2.2.2 Ideals
  - 2.2.3 Factorization in Commutative Rings
  - 2.2.4 Rings of Polynomials and Formal Power Series
- 2.3 Modules
  - 2.3.1 Modules, Homomorphisms and Exact Sequences
  - 2.3.2 Free Modules and Vector Spaces
  - 2.3.3 Projective and Injective Modules
  - 2.3.4 Tensor Products
- 2.4 Fields and Galois Fields
  - 2.4.1 Field Extensions
  - 2.4.2 The Fundamental Theorem
  - 2.4.3 Splitting Fields, Algebraic Closure and Normality
  - 2.4.4 The Galois Group of a Polynomial
  - 2.4.5 Finite Fields
  - 2.4.6 Separability
  - 2.4.7 Cyclic Extensions
- Bibliographies

**Chapter 3. The Wireless Channel (5h)**
- 3.1 Physical Modeling for Wireless Channels

3.2 Input/Output Model of Wireless Channel
3.3 Time and Frequency Coherence
3.4 Statistical Channel Models
Bibliographies

**Chapter 4 Point-to-Point Communication: Detection, Diversity and Channel Uncertainty (5h)**

4.1 Detection in a Rayleigh Fading Channel
4.1.1 Non-Coherent Detection
4.1.2 Coherent Detection
4.2 Time Diversity
4.3 Antenna Diversity
4.4 Frequency Diversity
4.5 Impact of Channel Uncertainty
Bibliographies

**Chapter 5. Cellular System: Multiple Access and Interference Management (5h)**

5.1 Introduction
5.2 Narrowband Cellular Systems
5.2.1 Narrowband Allocations: GSM System
5.2.2 Impact on Network and System Design
5.3 Wideband Systems: OFDM
5.4.1 Allocation Design Principles
5.4.2 Hopping Pattern
5.4.3 Signal Characteristic and Receiver Design
5.4.4 Sectorization
Bibliographies

**Chapter 6 Capacity of Wireless Channels (5h)**

6.1 AWGN Channel Capacity
6.1.1 Repetition Coding
6.1.2 Packing Spheres
6.2 Resources of the AWGN Channel
6.3 Linear Time-Invariant Gaussian Channels
6.3.1 Single Input Multiple Output (SIMO) Channel
6.3.2 Multiple Input Single Output (MISO) Channel
6.3.3 Frequency-Selective Channel
6.4 Capacity of Fading Channels
6.4.1 Slow Fading Channel
6.4.2 Receive Diversity
6.4.3 Time and Frequency Diversity
6.4.4 Fast Fading Channel
6.4.5 Transmitter Side Information
6.4.6 Frequency-Selective Fading Channels
Bibliographies

**Chapter 7 Multiuse Capacity and Opportunistic Communications (5h)**

7.1 Uplink Fading Channel
7.2 Downlink Fading Channel
7.3 Frequency-Selective Fading Channel
7.4 Multiuser Diversity
7.5 Multiuser Diversity: System Aspect
Bibliographies

**Chapter 8. Capacity and Multiplexing Architectures (5h)**

8.1 The V-BLAST Architecture
8.2 Fast Fading MIMO Channel
8.3 Receiver Architecture
8.4 Slow Fading MIMO Channel
8.5 D-BLAST: An Outage-Optimal Architecture
Bibliographies

**Chapter 9. Diversity-Multiplexing Tradeoff and Universal Space-Time Codes (5h)**

9.1 Diversity-Multiplexing Tradeoff
9.2 Universal Code Design for Optimal Diversity-Multiplexing Tradeoff
9.2.1 QAM is approximately universal for scalar channels
9.2.2 Universal Code Design for Parallel Channels
9.2.3 Universal Code Design for MIMO Channels
Bibliographies

## 3. Textbook

David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press

2008. Cambridge, New York, Melbourne, Madrid, Cape Town Singapore, Sao Paulo.

## Bibliography

[1] J. H. Van Lint, Introduction to Coding Theory, 3rd Edition, Spring-Verlag, Heideberg, New York, 2006.
[2] Steven Roman, Coding and Information Theory, Springer-Verlag, Spring-Verlag, Berlin, Heideberg, New York, 2005.
[3] John G. Prokais, Digital Communications, 4th Edition, McGraw-Hill, Inc. 2001.
[4] M. B. Pursley, Introduction to Digital Communications, Prentice Hall, 2005.
[5] Mohinder Jankiraman, Space-Time Codes and MIMO Systems, Aretech House Inc. 2004.
[6] Kamilo Feher, Advanced Digital Communications: Systems and Signal Processing Techniques, Prentice Hall, Inc. 1987.
[7] Kamilo Feher, Digital Communications: Satellite/Earth Station Engineering, Noble Publishing Corporation, Atlantic, 1997.

**Written by:** YANG Fengfan（仰枫帆）

**Principal Lecturer:** YANG Fengfan（仰枫帆）

**Co-lecturer:** ZONG Peng （宗鹏）

**Course Code**：6B153002L

**Course Title(Chinese)**：卫星移动通信工程

**Course Title(English)**：Satellite and Mobile Communication Engineering

**College and Department**：Col. of Astronautics

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Report Homework

**Suitable Majors**: Telecommunication Engineering

**Assessment Instruments**：Design, Project

**Pre-requisites**：Signal and system, Electromagnetic, Telecommunication Theory

## 1.Course Objective and Requirements

Mobile satellite communication becomes more and more important and presents a brilliant trend of future mobile communications. Satellite communication has to take reference of the mature techniques of ground mobile communication because the application of ground cellular achieves today's significant success. The course is mainly concerned by mobile and satellite communication principle, fundamental techniques and system design. It consists of traffic analysis, cellular fundamental, radio propagation, link budget, and satellite orbit and constellation design... It amalgamates mobile cellular technology and satellite communication with constellation communication technology. The objective of this course is to help student acquiring ability to solve the practical engineering problem by using basic technology. Meanwhile, it improves the student's ability of synthesizing and self learning

## 2.Course Content and Schedule

Chapter 1 Fundamental of Mobile Communication （2h）
- 1.1 Concept of cellular and planning
- 1.2 Frequency reuse and mobility management
- 1.3 Multiple Access

Chapter 2 Radio resource management （2h）
- 2.1 Channel capacity
- 2.2 Admission/ Access control
- 2.3 Resource management
- 2.4 Handover control
- 2.5 WCDMA radio network control

Chapter 3 The Propagation of Mobile communication （2h）
- 3.1 Propagation Mechanisms
- 3.2 Free-space Path Loss, line-of-sight
- 3.3 The models of Path Loss
- 3.4 The characteristics of fading channel

Chapter 4 The technology of Digital Mobile Communication （4h）
- 4.1 Communication system
- 4.2 Digital Modulation and Detection
- 4.3 Coding for Wireless Channels
- 4.4 Transform function of mobile channel
- 4.5 The new techniques applied in digital mobile communication

Chapter 5 The Engineering of GSM System （4h）
- 5.1 GSM and other 2G systems
- 5.2 GSM System network Architecture GSM
- 5.3 GSM system Control and Management
- 5.4 GSM system design

Chapter 6 The Engineering of 3G System （4h）
- 6.1 Evolution From 2G to 3G
- 6.2 3G 3.5G and UP
- 6.3 Network Architecture of WCDMA/UMTS, and CDMA2000, TD-CDMA
- 6.4 The 3G channels
- 6.5 Link budget of WCDMA

Chapter 7 The Fundamental of Mobile Satellite Communication（4h）
- 7.1 The brief of satellite communications
- 7.2 The Orbital Mechanics and geometry, looking angle, distance and coverage
- 7.3 Mobile Satellite Communication channel

Chapter 8 The Design of Mobile Satellite System （6h）

8.1 The design process
8.2 The Constellation Design of Mobile Satellite System
8.3 Dynamic coverage analysis of the constellation
8.4 The link attenuation calculation
8.5 Link Budget Examples

Chapter 9 The typical mobile satellite systems （4h）
9.1 Inmarsat (GEO GMSC) System
9.2 Iridium (Non-GEO GMSC) Systems
9.3 Globalstar (Non-GEO GMSC) Systems
9.4 Global Stratospheric Platform Systems
9.5 Advance in mobile satellite communications

## 3.**Textbooks**

[1] Global Mobile Satellite Communications For Maritime, Land and Aeronautical Applications, STOJCE DIMOV ILCEV, Springer, ISBN 1-4020-7767-X
[2] WIRELESS COMMUNICATIONS, Andrea Goldsmith，Cambridge University Press，2005

## **Main Reference Books**

[1] DIGITAL SATELLITE COMMUNICATIONS，Giovanni E. Corazza, 2007 Springer Science, ISBN 0-387-25634-2
[2] Satellite communication engineering，2002 by Marcel Dekker, Inc.，ISBN: 0-8247-0777-X
[3] Mobile and Wireless Communication Networks, Springer Science, ISBN: 0-387-23148-X

**Written by**：ZONG Peng（宗鹏）　　**Instructor**：ZONG Peng（宗鹏）

**Course Code**：6B169003L

**Course Title(Chinese)**：组合数学

**Course Title(English)**：Combinatorial Mathematics

**College and Department**：Col. of Computer Science & Technology

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Computer Science and Technology

**Assessment Instruments**：Examination or Project

**Pre-requisites**： Calculus, linear algebra, abstract algebra

## 1.Course Objective and Requirements

The course content of combinatorial mathematics is a strong theoretical application of the wider curriculum. Therefore, through this course, students can be familiar with the basic principles and of combination count of the basic method of count combination to master, can transfer a combination of a difficult problem into an easier to count a combination of problems, further improve the ability of combination count. And also it could enable students with the viewpoints and methods of modern mathematics, and grasp the construction thinking and count methods of the combination count. At the same time, it can train students the ability of abstract thinking and summary, so it can enable students to develop professional with good quality and use of theoretical knowledge to analyze and solve practical problems.

## 2.Course Content and Schedule

Chapter 1 what is combinatorics?（1h）

Chapter 2permutations and combinations（3h）

1．four basic counting principles
2．permutations of sets
3．combinations (subsets) of sets
4．permutations of multisets
5．combinations of multisets
6．finite probability

Chapter 3 the pigeonhole principle（4h）

1．pigeonhole principle: simple form
2．pigeonhole principle: strong form
3．a theorem of ramsey

Chapter 4generating permutations and combinations（4h）

1．generating permutations
2．inversions in permutations
3．generating combinations
4．generating r-subsets
5．partial orders and equivalence relations

Chapter 5 the binomial coefficients（4h）

1．pascal's triangle
2．the binomial theorem
3．unimodality of binomial coefficients
4．the multinomial theorem
5．newton's binomial theorem
6．more on partially ordered sets

Chapter 6 the inclusion-exclusion principle and applications（8h）

1. the inclusion-exclusion principle
2. combinations with repetition
3. derangements
4. permutations with forbidden positions
5. another forbidden position problem

Chapter 7 recurrence relations and generating functions （8h）

1．some number sequences
2．generating functions
3．exponential generating functions
4．solving linear homogeneous recurrence relations
5．nonhomogeneous recurrence relations

6．a geometry example

Chapter 10　combinatorial .designs （8h）

1. modular arithmetic
2. block designs
3. steiner triple systems
4. latin squares

Chapter 14　polya counting （8h）

1. permutation and symmetry groups
2. burnside's theorem
3. polya's counting formula

## 3.Textbooks

1．Richard A. Brualdi. Introductory Combinatorics, Fifth Edition. Machinery Industry Press. 2009.

## Main Reference Books

1. J.H. van Lint and R.M. Wilson， A course in combinatorics，Machinery Industry Press, 2004.
2. Miklos Bona. Introduction to Enumerative Combinatorics，Tsinghua university press. 2009

**Written by**：　XU Min (徐敏)　　**Instructor**：XU Min (徐敏)

**Course Code**： 8B162001L

**Course Title(Chinese)**：高级服务工程

**Course Title(English)**：Advanced Services Engineering

**College and Department**：Col. of Computer Science & Technology

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Software Engineering and Compute Science & Techonolgy

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Software Engineering, Service Computing

## 1. Course Objectives and Requirements

Software Engineering is a discipline approved by the Ministry of Education, which includes Software Engineering Theory, Software Engineering Technology, Software Engineering Management, and Software Service Engineering. Software Service Engineering is a sub- discipline based on Software Engineering Theory to provide Domain- and Application-Oriented services by using software engineering technology, methodology, and tools.

The basic theory, method and some applications of Software Service Engineering will be introduced, which focused on the theory, method, technology, and applications of Software Service, Software process services and Service-Oriented Computing, Trust service computing, and technology of service platform. It is for advance the abstract thinking and logical reasoning ability with scientific literacies. After course study, the students will master the basic theory and meothdology of software service engineering, and software domain engineering knowledge for science research and engineering application of software industry.

## 2.Course Content and Schedule

Chapter 1 An Introduction to Software service engineering（4h）
- 1.1 Software service and software service engineering
- 1.2 Software engineering development process
- 1.3 Software service engineering architecture
- 1.4 Prospect for software service engineering

Chapter 2 Service Science and Engineering Services（6h）
- 2.1 Service Science, Management and Engineering
- 2.2 Software service engineering
- 2.3 IT Service Management
- 2.4 ITIL Service Providing Workflow
- 2.5 ITIL ITIL Service Suporting Workflow
- 2.6 Software service engineering method, Platform, and tools

Chapter 3 Software quality and standardization of services（4h）
- 3.1 Management of Software Service Quality
- 3.2 Software service providers ontology and Service Credit
- 3.3 Software Service trust and credibility
- 3.4 Standard Archetecture for Software Service Quality
- 3.5 Software Service Verification

Chapter 4 Modeling Software Services（6h）
- 4.1 Software service modeling principles
- 4.2 Hierarchical process modeling method
- 4.3 Dynamic Enterprise Modeling
- 4.4 Process-driven integrated modeling method for complex enterprise systems
- 4.5 Cross-organizational trusted software service modeling
- 4.6 Complex systems integration and service engineering modeling

Chapter 5 Service Computing and simulation analysis（4h）
- 5.1 introducation to Service Computing
- 5.2 Service Computing and Operations Research
- 5.3 Discrete event and continuous streaming service
- 5.4 Services Computing Technology and Distributed Computing
- 5.5 Simulation and Analysis for Services

Chapter 6 Software service reliability and credibility measure（4h）
- 6.1 Cross-organizational services Workflow Overview
- 6.2 Cross-organizational service workflow model
- 6.3 Reliable service computing model for Cross-organizational workflow

6.4 Service reliability evaluation model and optimization
Chapter 7 Optimal combination of software services（4h）
7.1 Service Composition and Rules
7.2 Service-Oriented Architecture
7.3 SOA-Based Service combination
7.4 Backward tree-based Service Portfolio
Chapter 8 Software and service outsourcing partner selection method （4h）
8.1 Social collaborative computing model
8.2 Task-based social network division
8.3 Service Discovery
8.4 Service Outsourcing Partner Selection Method
8.5 Collaborative computing social workflow optimization algorithm

## 3. Experiments

Project1: The operation of the service process scheduling and forecasting（4h，演示性）
The project involves an analysis work on the complete FEM simulation of a Workflow system scheduling Technical and Cross-organizational dynamic Service Portfolio and emergency services mechanism.

Project2: Recommended software services（4h，综合性）
The project involves an analysis work on the complete Service identification, Trusted Service Recommended Model and Users credibility evaluation simulation of a Recommended software service system.

Project3: Trusted Service Platform（4h，设计性）
The project involves an analysis work on the complete SOA-Based Cross-organizational business collaboration service system simulation of a Trusted service platform technology framework.

## 4. Textbooks

1. LiangJie Zhang, Jia Zhang, Hong Cai, Services Computing, Springer Berlin Heidelberg New York, 2007, ISBN 978-3-540-38281-2
2. Rundan Zhang, Xiaomin Zhu, Introduction to Service Science, Electronic Industry Press, 2009. (张润彤，朱晓敏，服务科学概论， 电子工业出版社，2009 年)
3. Yunshun Fan, Information management strategy and methods, Tsinghua University Press, 2008(范玉顺，信息化管理战略与方法，清华大学出版社，2008 年)
4. Zhaohui Wu, Shuiguang Deng, Jian Wu. Services Computing and Technology, Zhejiang University Press,2009 (吴朝晖，邓水光，吴健，服务计算与技术，浙江大学出版社，2009 年)
5. Yunshun Fan, Integrated Enterprise Modeling Method and System, China Electric Power Press, 2006 (范玉顺，集成化企业建模方法与系统，中国电力出版社，2006 年)
6. Mike Papazoglou, Klaus Pohl, Michael Parkin, Andreas Metzger (Eds.), Service Research Challenges and Solutions for the Future Internet, Lecture Notes in Computer Science 6500, Springer-Verlag Berlin Heidelberg 2010, ISBN-10 3-642-17598-8

**Written by**：TAN Wenan (谭文安) **Instructor**：TAN Wenan (谭文安) etal.

**Course Code**：8B163001L

**Course Title(Chinese)**：最优化理论与应用

**Course Title(English)**：Optimization Theory and Application

**College and Department**：Col. of Computer Science & Technology
**Semester**：Autumn
**Class Hours**：48
**Teaching Methods**：Lecture, Reading session, Experiment
**Suitable Majors**: Master students in engineering
**Assessment Instruments**：Paper, Homework
**Pre-requisites**：Linear Algebra, Real Analysis

## 1.Course Objective and Requirements

Optimization is a discipline for studying how to choose certain actions for achieving the optimal objective under certain constraints. Optimization has been widely applied in different areas in computer science. In this course, the topics of linear programming, nonlinear programming, integer programming, and the use of Matlab optimization toolbox will be covered. The objective is to help students understand the concepts, theory, and models of optimization, and have the ability to apply optimization theory for practical research problems in their areas.

## 2.Course Content and Schedule

Chapter 1 Introduction to Optimization（2h）
- 1.1 Optimization methods and model
- 1.2 Introduction to Matlab optimization toolbox
- 1.3 Mathematical models and classifications of optimization problems
- 1.4 Solution methods for optimization problems

Chapter 2 Linear Programming （8h）
- 2.1 Basic concepts and properties
- 2.2 Simplex method
- 2.3 Interior point method
- 2.5 Application examples of linear programming

Chapter 3 Integer Programming （6h）
- 3.1 Mathematical model
- 3.2 The cutting planning method
- 3.3 Branch and bound method
- 3.4 Knapsack problem
- 3.5 Application examples of integer programming

Chapter 4 Nonlinear Programming （8h）
- 4.1 Basics of nonlinear programming
- 4.2 Non-constrained nonlinear programming problem
- 4.3 Constrained nonlinear programming problem
- 4.4 Convex optimization
- 4.5 Application examples of nonlinear programming

Chapter 5 One-dimensional search techniques for numerical optimization （6h）
- 5.1 Golden section method
- 5.2 Fibonacci method
- 5.3 Netwon's method

Chapter 6 Global search method（6h）
- 6.1 Simulated annealing method
- 6.2 Genetic algorithm
- 6.3 Particle swarm optimization

## 3.Experiments

Project1: Use Matlab optimization toolbox (2h)
Project2: Reading session (10h)

## 4.Textbooks

(1) E. K. P. Chong, An introduction to optimization, Wiley Publication, 2013,
(2) Joge Nocedal and Stephen J. Wright, Numerical optimization, Springer, 2006.

**Written by**：ZHU Kun（朱琨）　　**Instructor**：ZHU Kun（朱琨）

**Course Code**：7D161007L
**Course Title(Chinese)**：机器学习
**Course Title(English)**：Machine Learning

**College and Department**：Col. of Computer Science & Technology
**Semester**：Autumn
**Course hours**：32
**Teaching methods**：Lecture, Homework
**Suitable majors:** Computer Science, Engineering, Statistics, Social Sciences
**Assessment instruments**：Examination, Project
**Pre-requisites**：Advanced Mathematics, Linear Algebra

## 1.Course objective and Requirements

The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience. The goal of this course is to present the key algorithms and theory that from the core of machine learning. Machine learning draws on concepts and results from many fields, including statistics, artificial intelligence, philosophy, information theory, biology, cognitive science, computational complexity, and control theory. The primary goal of this course is to provide a broad-based single source introduction to the field. Because of the interdisciplinary nature of the material, this course makes few assumptions about the background of the students. Instead, it introduces basic concepts from statistics, artificial intelligence, information theory, and other disciplines as the need arises, focusing on just those concepts most relevant to machine learning.

## 2.Course contents and Schedule

Lecture 1 Introduction (2h)
- 1.1 Course information
- 1.2 Introduction to basic concepts in machine learning
- 1.3 Example applications of machine learning

Lecture 2 Supervised Learning (4h)
- 2.1 Introduction to supervised learning
- 2.2 K-nearest neighbors
- 2.3 Decision tree
- 2.4 Support vector machine

Lecture 3 Probabilistic Modeling （4h）
- 3.1 Introduction to probabilistic inference
- 3.2 Justification of maximum likelihood from Bayesian perspective
- 3.3 MAP and full Bayesian parameter estimation
- 3.4 Bayesian and traditional methods for model selection

Lecture 4 Unsupervised Learning （2h）
- 4.1 Multi-dimensional Gaussians and the Gaussian mixture model
- 4.2 The likelihood function and maximum likelihood parameter estimation
- 4.3 EM-algorithm for mixtures and a derivation for the general case
- 4.4 K-means clustering

Lecture 5Sampling Methods（4h）
- 5.1 Basic Sampling Algorithms
- 5.2 Markov Chain Monte Carlo (MCMC)
- 5.3 Gibbs Sampling

Lecture 6 Sequence Data and Markov Chains （4h）
- 6.1 The simplest sequence model
- 6.2 Pseudo-count priors
- 6.3 1$^{st}$ order Markov chains
- 6.4 Extension to hidden Markov models

Lecture 7 Hidden Markov Models （2h）
- 7.1 A hidden Markov model
- 7.2 Inference in HMMs
- 7.3 Maximum likelihood learning in an HMM

Lecture 8 Ensemble Methods (2h)
- 8.1 Parallel ensemble: bagging
- 8.2 Sequential ensemble: boosting
- 8.3 Applications

Lecture 9 Principles of Learning (2h)

9.1 Generalization and overfitting
9.2 Bias-variance dilemma
9.3 PAC-learning theory
Lecture 10 Experimental Evaluation (2h)
10.1 Experiments design
10.2 Performance metrics
10.3 Evaluation and comparison
Lecture 11 Advanced Topics (4h)
11.1 Large scale learning
11.2 Active learning
11.3 Multi-label learning

## 3.Textbooks

Tom M. Mitchell. Machine Learning, McGraw-Hill, 1997.

## Main reference books

(1) Hastie, T., Tibshirani, R., Fridman, J., The Elements of Statistical Learning, Springer, 2nd edition, 2009.
(2) Bishop, C. M. Pattern Recognition and Machine Learning, Springer, 2006.
(3) Mackay, D. Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003.
(4) 周志华，机器学习，清华大学出版社, 2016.

**Written by**：LIU Xuejun（刘学军）， HUANG Sheng-Jun（黄圣君）
**Instructor**：LIU Xuejun（刘学军）， HUANG Sheng-Jun（黄圣君）

**Course Code：7D161008L**

**Course Title(Chinese)：人机交互**

**Course Title(English)：**Human-computer Interaction

**College and Department：**Col. of Computer Science & Technology

**Semester：**Autumn

**Class Hours：**32

**Teaching Methods：**Lecture, Experiment, Presentation

**Suitable Majors**: Computer Science and Technology

**Assessment Instruments：**Examination, Project

**Pre-requisites：**Computer Graphics, High-level Programming Language

## 1. Course Objective and Requirements

Human computer interaction (HCI) is an interdisciplinary field in which computer scientists, engineers, psychologists, social scientists, and design professionals play important roles. The goal of HCI is to solve real problems in the design and use of technology, making computer-based systems easier to use and more effective for people and organizations. Ease of use and effectiveness are critical to the success of any systems that interact with people, including software systems, home, office and factory appliances, and web and phone applications.

This course provides an overview and introduction to the field of human-computer interaction, with a focus on interaction techniques and models. Specifically, this course will introduce pen-based interaction, touch-based interaction, gesture-based interaction, eye-based interaction and gesture models. Particular emphasis will be placed on what HCI methods and HCI-trained specialists can bring to design and development teams. The course will introduce students to proven tools and methods for designing and analysing user interfaces. Students at the end of the course will have learned some useful techniques and an understanding of systematic procedures for creating usable and useful designs and systems. Prior knowledge on computer graphics and high-level programming language is required to take this course.

## 2. Course Content and Schedule

Chapter 1 HCI Introduction（2h）
- 1.1 Basic concepts
- 1.2 The history of HCI, including important academic events, famous researchers, representative commercial products

Chapter 2 Pen-based Interaction（4h）
- 2.1 The history of pen-based interaction
- 2.2 Pen interaction properties
- 2.3 Pen-based interaction framework
- 2.4 Pen-based interaction applications

Chapter 3 Touch-based Interaction（4h）
- 3.1 The history of touch-based interaction
- 3.2 Touch interaction properties
- 3.3 Touch-based interaction framework
- 3.4 Touch-based interaction applications

Chapter 4 Gesture-based Interaction（4h）
- 4.1 The history of gesture-based interaction
- 4.2 Gesture interaction properties
- 4.3 Gesture-based interaction framework
- 4.4 Gesture-based interaction applications

Chapter 5 Eye-based Interaction（4h）
- 5.1 The history of eye-based interaction
- 5.2 Eye interaction properties
- 5.3 Eye-based interaction framework
- 5.4 Eye-based interaction applications

Chapter 6 HCI Models（4h）
- 6.1 Fitts' Model
- 6.2 Steering Model
- 6.3 CLC Model
- 6.4 GOMS Model
- 6.5 Keystroke-level Model

Chapter 7 Experiment Design and Data Analysis（2h）
- 7.1 The importance of experiment design

7.2 Experiment design
7.3 Data analysis with SPSS

## 3. **Experiments**

Phase 1: Interaction Technique Design（2h）
Based on theoretical courses, design interaction techniques to select small targets on touchscreen devices
Phase 2: Experiment Design（4h）
Implement designed interaction techniques, design HCI experiment and conduct experiment
Phase 3: Data Analysis and Result Report（2h）
Use SPSS software to analyze experiment data collected in Phase 2, report the experiment results

## **4. Textbooks**

(1) Bill Buxton, Human Input to Computer Systems: Theories, Techniques and Technology. http://www.billbuxton.com
(2) Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004
(3) Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009.
(4) Bill Buxton, Sketching User Experiences: Getting the Design Right and the Right Design (Interactive Technologies), Elsevier, 2007.

**Written by**：TU Huawei（涂华伟）　　**Instructor**：TU Huawei（涂华伟）

**Course Code**：7D161011L

**Course Title(Chinese)**：高级人工智能

**Course Title(English)**：Advanced Artificial Intelligence

**College and Department**：Col. of Computer Science & Technology

**Semester**：Autumn

**Class Hours**：48(14 hours for the experiment)

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Computer Science and Technology

**Assessment Instruments**：Examination or Project

**Pre-requisites**：Calculus, linear algebra, Data Structure, Probability Theory, Discrete Math.

## 1. Course Objective and Requirements

Artificial Intelligence (AI) is a field that has a long history but is still constantly and actively growing and changing. In this course, you'll learn the basics of modern AI as well as some of the representative applications of AI. Along the way, we also hope to excite students about the numerous applications and huge possibilities in the field of AI, which continues to expand human capability beyond our imagination.

## 2. Course Content and Schedule

Chapter 1 Introduction (2 hours)
- 1.1what is al?
- 1.2the foundations of artificial intelligence
- 1.3the history of artificial intelligence
- 1.4the state of the art
- 1.5summary, bibliographical and historical notes, exercises

Chapter 2 Intelligent agents (2 hours)
- 2.1agents and environments
- 2.2good behavior: the concept of rationality
- 2.3the nature of environments
- 2.4the structure of agents
- 2.5summary, bibliographical and historical notes, exercises

Chapter 3 Solving problems by searching (2 hours)
- 3.1problem-solving agents
- 3.2example problems
- 3.3searching for solutions
- 3.4uninformed search strategies
- 3.5informed (heuristic) search strategies
- 3.6heuristic functions
- 3.7summary, bibliographical and historical notes, exercises

4 beyond classical search (2 hours)
- 4.1local search algorithms and optimization problems
- 4.2local search in continuous spaces
- 4.3searching with nondeterministic actions
- 4.4searching with partial observations
- 4.5online search agents and unknown environments
- 4.6summary, bibliographical and historical notes, exercises

5 games (2 hours)
- 5.1optimal decisions in games
- 5.2alpha-beta pruning
- 5.3imperfect real-time decisions
- 5.4stochastic games
- 5.5partially observable games
- 5.6state-of-the-art game programs
- 5.7alternative approaches
- 5.8summary, bibliographical and historical notes, exercises

6 constraint satisfaction problems (2 hours)
- 6.1defining constraint satisfaction problems
- 6.2constraint propagation: inference in csps
- 6.3backtracking search for csps
- 6.4local search for csps
- 6.5the structure of problems
- 6.6summary, bibliographical and historical notes, exercises

7 logical agents (2 hours)
- 7.1knowledge-based agents
- 7.2the wumpus world
- 7.3logic
- 7.4propositional logic: a very simple logic
- 7.5propositional theorem proving
- 7.6effective propositional model checking
- 7.7agents based on propositional logic
- 7.8summary, bibliographical and historical notes, exercises

8 first-order logic (2 hours)
- 8.1representation revisited
- 8.2syntax and semantics of first-order logic
- 8.3using first-order logic
- 8.4knowledge engineering in first-order logic
- 8.5summary, bibliographical and historical notes, exercises

9 inference in first-order logic (4 hours)
- 9.1propositional vs. first-order inference
- 9.2unification and lifting
- 9.3forward chaining
- 9.4backward chaining
- 9.5resolution
- 9.6summary, bibliographical and historical notes, exercises

10 classical planning (2 hours)
- 10.1 definition of classical planning
- 10.2 algorithms for planning as state-space search
- 10.3 planning graphs
- 10.4 other classical planning approaches
- 10.5 analysis of planning approaches
- 10.6 summary, bibliographical and historical notes, exercises

11 planning and acting in the real world (4 hours)
- 11.1 time, schedules, and resources
- 11.2 hierarchical planning
- 11.3 planning and acting in nondeterministic domains
- 11.4 multiagent planning
- 11.5 summary, bibliographical and historical notes, exercises

12 knowledge representation (option)
- 12.1 ontological engineering
- 12.2 categories and objects
- 12.3 events
- 12.4 mental events and mental objects
- 12.5 reasoning systems for categories
- 12.6 reasoning with default information
- 12.7 the intemet shopping world
- 12.8 summary, bibliographical and historical notes, exercises

13 quantifying uncertainty (4 hours)
- 13.1 acting under uncertainty
- 13.2 basic probability notation
- 13.3 inference using full joint distributions
- 13.4 independence
- 13.5 bayes' rule and its use
- 13.6 the wumpus world revisited
- 13.7 summary, bibliographical and historical notes, exercises

14 probabilistic reasoning (4 hours)
- 14.1 representing knowledge in an uncertain domain
- 14.2 the semantics of bayesian networks
- 14.3 efficient representation of conditional distributions
- 14.4 exact inference in bayesian networks
- 14.5 approximate inference in bayesian networks
- 14.6 relational and first-order probability models
- 14.7 other approaches to uncertain reasoning
- 14.8 summary, bibliographical and historical notes, exercises

15 probabilistic reasoning over time (option)
- 15.1 time and uncertainty
- 15.2 inference in temporal models
- 15.3 hidden markov models
- 15.4 kalman filters

15.5 dynamic bayesian networks
15.6 keeping track of many objects
15.7 summary, bibliographical and historical notes, exercises
16 making simple decisions (option)
16.1 combining beliefs and desires under uncertainty
16.2 the basis of utility theory
16.3 utility functions
16.4 multiattribute utility functions
16.5 decision networks
16.6 the value of information
16.7 decision-theoretic expert systems
16.8 summary, bibliographical and historical notes, exercises
17 making complex decisions (option)
17.1 sequential decision problems
17.2 value iteration
17.3 policy iteration
17.4 partially observable mdps
17.5 decisions with multiple agents: game theory
17.6 mechanism design
17.7 summary, bibliographical and historical notes, exercises

## 3.**Experiments**

Project1: Application of A* Algorithm（7hours，演示性）
The project involves how to apply A* Algorithm to solve a problem.
Project2: implementation of a expert system（7 hours，综合性）
The project involves to how construct an expert system and apply it to solve a practical problem.

## 4.Textbooks

1．Stuart J.Russell, Peter Norvig. Artificial Intelligence: A Modern Approach. 3rd Edition. Peterson. 2011.

## Main Reference Books

1. Nils J. Nilsson， Artificial Intelligence: A New Synthesis. Springer Press, 1998.
2. Nils J. Nilsson. The Quest for Artificial Intelligence. The Cambridge University press. 2009.

**Written by：** XU Min (徐敏)　　**Instructor：** XU Min (徐敏)

**Course Code**：7D162001L

**Course Title(Chinese)**：软件测试方法与技术

**Course Title(English)**：Software Testing Methods and Techniques

**College and Department**：Col. of Computer Science & Technology

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Experiment, Discussion, Homework

**Suitable Majors**: Computer Science and Technology, Software Engineering

**Assessment Instruments**：Course Report

**Pre-requisites**：Object-Oriented Programming Language, Software Engineering

## 1.Course Objective and Requirements

Software testing is a key technique toward software quality assurance. This course systematically introduces the principles, techniques, and tools about software testing as well as software reliability. Its topics cover black-box testing, white-box testing, integration and system testing, object-oriented software testing, test automation, software testing and debugging, software reliability analysis, and etc. The objective is to help graduate students build a better understanding of the software quality problems and develop skills to improve software quality. In addition to the principles and techniques, the course will also introduce modern software testing tools to students. Students can learn how to use tools to solve real problems as well as how to build new software testing tool during course projects. Students are required to demonstrate good understanding of software testing and reliability after the course. They are also required to have the ability in conducting testing processes for real software.

## 2.Course Content and Schedule

Chapter 1 Introduction to Software Testing（4h）
- 1.1 Software Quality Problem
- 1.2 Concepts and Basic Problems of Software Testing
- 1.3 Software Testing Process

Chapter 2 Black-Box Testing （4h）
- 2.1 Concept of Black-Box Testing
- 2.2 Basic Techniques for Black-Box Testing
- 2.3 Key Challenges in Black-Box Testing and Their Solutions
- 2.4 Tools for Black-Box Testing

Chapter 3 White-Box Testing （4h）
- 3.1 Concept of White-Box Testing
- 3.2 The Abstraction and Representation of Programs
- 3.3 Coverage-Based Testing
- 3.4 Automated Test Generation
- 3.5 Automated Code Review
- 3.6 Tools for White-Box Testing

Chapter 4 Unit Testing and Integration Testing （4h）
- 4.1 Introduction to Unit Testing
- 4.2 Techniques for Integration Testing

Chapter 5 System Testing （4h）
- 5.1 Basic Concepts and Problems in System Testing
- 5.2 Performance Testing
- 5.3 Compatibility Testing
- 5.4 Testing Security Problems
- 5.5 Testing Techniques for Special Software

Chapter 6 Automated Software Testing（4h）
- 6.1 The concept and meaning of automated software testing
- 6.2 Techniques in automated software testing
- 6.3 Building an automated software testing system
- 6.4 Testing tools
- 6.5 The challenges in automated software testing

Chapter 7 Software Testing and Debugging（3h）
- 7.1 Testing and Debugging
- 7.2 Techniques for Software Debugging
- 7.3 Automated Debugging based on Testing
- 7.4 Tools for Software Debugging

Chapter 9 The Future of Software Testing （1h）

## 3.Experiments

Project1: Black-Box Testing Project（2h，演示性）

1.1 Using test scripts to do GUI testing

1.2 Using tools for performance testing;

Project2: White-Box Testing Project（2h，演示性）

2.1 Unit testing with JUnit

2.2 White-box testing with static analysis tools.

## 4.Textbooks

(1) Ron Patton. Software Testing (2ed), Sams Publishing, 2005.5

## Main Reference Books

(1) Glenford J. Myers. The Art of Software Testing. 1979.
(2) P. C. Jorgensen. Software Testing – A Craftsman's Approach. Auerbach Publications, 3 ed., 2008.
(3) A. Zeller. Why Programs Fail - A Guide to Systematic Debugging. Morgan Kaufmann. 2005.
(4) D. A. Peled, Software Reliability Methods, Springer-Verlag, New York, Inc., 1st ed., 2001.
(5) 郑人杰. 计算机软件测试技术. 清华大学出版社. 1992.
(6) 孙志安, 裴晓黎, 宋昕, 戴忠健. 软件可靠性工程. 北京航空航天大学, 2008.

**Written by**：QIAN Ju（钱巨）　　**Instructor**：QIAN Ju（钱巨）

**Course Code**：7D163003L

**Course Title(Chinese)**：隐私保护技术

**Course Title(English)**：Privacy protection Techniques

**College and Department**：Col. of Computer Science & Technology
**Semester**：Autumn
**Class Hours**：32
**Teaching Methods**：Lecture, Student Presentation, Homework
**Suitable Majors**: Information security, Computer Science and related majors
**Assessment Instruments**：Presentation and Project
**Pre-requisites**：Cryptography, Mathematical Foundations in Information Security, Database

## 1. Course Objective and Requirements

This course will mainly introduce various types of privacy-preserving technologies and their applications. Concretely speaking, in this course, we will introduce the concept and main methods of the following privacy-preserving technologies: secure multi-party computation protocols, homomorphic encryption system, secret sharing, data perturbation, and negative database, differential privacy, and various anonymization techniques. Then, we will require each student to read some recent papers on one of the above topics, present them, and discuss the research work proposed in the papers. After this course, the students are expected to know the basic concept of the above privacy-preserving technologies, and understand one method in depth, such as how it work and what it can be applied to.

## 2. Course Content and Schedule

Chapter 1 Homomorphic encryption system and Secret sharing（6h）
- 1.1 Basic Concept
- 1.2 Homomorphic encryption system
- 1.3 Secret sharing

Chapter 2 Secure multi-party computation （8h）
- 2.1 Basic Concept
- 2.2 Millionaires protocol
- 2.3 Secure scalar product protocol
- 2.4 Secure sum protocol
- 2.5 Incentive compatible secure multiparty protocol

Chapter 3 Data perturbation （4h）
- 3.1 Introduction
- 3.2 Applications of data perturbation

Chapter 4 Negative database （6h）
- 4.1 Introduction
- 4.2 Negative database generation methods
- 4.3 Applications

Chapter 5 Differential privacy and anonymization （8h）
- 5.1 Differential privacy
- 5.2 Anonymization

## 3. Textbooks

No.

## Main Reference Books

1．Jaideep Vaidya, Chris Clifton, Michael Zhu. Privacy Preserving Data Mining, Springer Science+Business Media, 2006.
2．Charu C. Aggarwal, Philip S. Yu. Privacy-Preserving Data Mining: Models and Algorithms, Springer Science+Business Media, 2008.
3．Josep Domingo-Ferrer, David Sánchez, Jordi Soria-Comas. Database Anonymization Privacy: Models, Data Utility, and Microaggregation-based Inter-model Connections, Morgan&Claypool Publishers, 2016.

**Written by**：ZHU Youwen（朱友文）　　**Instructor**：ZHU Youwen（朱友文）

# Mechanical and Material Engineering

| Course type | Course Code | Course Title | Hours | Credits | Semester | College | Remark |
|---|---|---|---|---|---|---|---|
| Compulsory Course | 6A120006L | Chinese | 60 | 4 | Autumn | Col. of Foreign Languages | |
| | 6A080001L | Matrix Theory | 60 | 4 | Autumn | Col. of Science | Compulsory For master students |
| | 6A010001L | Overview of Aeronautics and Astronautics | 30 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 6A050102L 6A060102L | Thesis Proposal and Literature Review | | 1 | | Col. of Mechanical & Electronic Engineering Col. of Material Science & Technology | Compulsory For master students |
| | 8A050102L 8A060102L | Thesis Proposal and Literature Review | | 1 | | Col. of Mechanical & Electronic Engineering Col. of Material Science & Technology | Compulsory For doctoral students |
| Optional Course | 6B052003L | Non-traditional Machining | 48 | 3 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 6B054002L | Principles of Metal Forming | 48 | 3 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 7D052005L | Modern Physical and Chemical Analysis Technology | 40 | 2.5 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 7D054017L | Mechanics and Dynamics of NC Cutting | 40 | 2.5 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 6B061005L | Polymer Science | 48 | 3 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 8B061003L | Functional Materials | 32 | 2 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 7D061003L | Composites Material Engineering | 32 | 2 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 7D061028L | Synthesis, Characterization and Application of Functional Coatings | 32 | 2 | Autumn | Col. of Mechanical & Electronic Engineering | |
| | 7D062009L | Nanomaterials and Nanotechnology | 32 | 2 | Autumn | Col. of Mechanical & Electronic Engineering | |
| Topic | 7D050001L 7D060001L | Topic 1 | 32 | 2 | | Col. of Mechanical & Electronic Engineering | |
| | 7D050002L 7D060002L | Topic 2 | 32 | 2 | | Col. of Mechanical & Electronic Engineering | |

**Course Code**：6A120006L

**Course Title(Chinese)**：汉语

**Course Title(English)**： Chinese

**College and Department**：Col. of Foreign Languages
**Semester**：Autumn
**Class Hours**：60
**Teaching Methods**：Lecture
**Suitable Majors**: International postgraduates
**Assessment Instruments**：Examination
**Pre-requisites**：Elementary Chinese

## 1.Course Objective and Requirements

To practice spoken Chinese. Students are required to learn some dialogues and sentence pattern in certain situation. Through the classroom learning and some outdoor activities, students are supposed to communicate with Chinese natives and know more about Chinese culture. After taking the course the students should be able to:

1. master several Chinese daily language.
2. communicate with Chinese natives in basic Chinese.
3. know more about Chinese customs and traditions.

## 2.Course Content and Schedule

第一课 你常去图书馆吗（4 小时）
一、课文
（一）你常去图书馆吗
（二）晚上你常做什么
二、语法
（一）时间词语作状语
（二）"还是"和"或者"
第二课 他在做什么呢（4 小时）
一、课文
（一）他在做什么呢
（二）谁教你们语法
二、语法
（一）动作的进行
（二）双宾语句
（三）询问动作行为的方式：怎么+动词
第三课 我去邮局寄包裹（4 小时）
一、课文
（一）我去邮局寄包裹
（二）外贸代表团明天去上海参观四、语法：连动句
第四课 可以试试吗（4 小时）
一、课文
（一）可以试试吗
（二）便宜一点儿吧
二、语法
（一）动词重叠
（二）又……又……
（三）"一点儿"和"有一点儿"
第五课 祝你生日快乐（4 小时）
一、课文
（一）你哪一年大学毕业
（二）祝你生日快乐
二、语法
（一）时间、价格、日期、数量、天气、年龄、籍贯等的表达：名词谓语句
（二）年、月、日
（三）怎么问（6）：疑问语调
第六课 我们明天七点一刻出发（4 小时）
一、课文
（一）我的一天
（二）明天早上七点一刻出发
二、语法：时间的表达
第七课 我打算请老师教我京剧（4 小时）
一、课文：我打算请老师教我京剧

二、语法：兼语句
第八课 学校里边有邮局吗（4 小时）
一、课文
（一）学校里边有邮局吗
（二）从这儿到博物馆有多远
二、语法
（一）方位词
（二）存在的表达
（三）介词"离"、"从"、"往"
第九课 我想学太极拳（4 小时）
一、课文
（一）我想学太极拳
（二）您能不能再说一遍
二、语法
（一）能愿动词
（二）询问原因
第十课 她学得很好（4 小时）
一、课文
（一）她学得很好
（二）她每天都起得很早
二、语法：描写、判断和评价：状态补语（1）：动词+得+形容词
第十一课 田芳去哪儿了（4 小时）
一、课文
（一）田芳去哪儿了
（二）他又来电话了
二、语法
（一）语气助词"了"（1）
（二）"再"和"又"
第十二课 玛丽哭了（4 小时）
一、课文
（一）你怎么了
（二）玛丽哭了
二、语法
（一）动作的完成：动词+了
（二）因为-...一所以.....
第十三课 我吃了早饭就来了（4 小时）
一、课文
（一）我吃了早饭就来了
（二）我早就下班了
二、语法
（一）"就"和"才"
（二）要是.....（的话），就.....
（三）虽然.....但是.....
第十四课 我都做对了（4 小时）
一、课文
（一）我都做对了
（二）看完电影再做作业
二、语法
（一）动作结果的表达：结果补语
（二）结果补语"上"、"成"和"到"
（三）主谓词组作定语
第十五课 我来了两个多月了（4 小时）
一、课文
（一）我来了两个多月了
（二）我每天都练一个小时
二、语法
（一）动作或状态持续时间的表达：时量补语
（二）概数的表达
（三）离合动词

**3.Textbooks**
《汉语教程》 主编 杨寄洲，北京语言大学出版社，2009 年

**Written by**：WANG Zheng (王征)
**Instructor**：LU Hong（陆红）,WANG Zheng（王征）， ZHANG Weidong （张卫东）et al.

**Course Code**：6A080001L

**Course Title(Chinese)**：矩阵论

**Course Title(English)**：Matrix Theory

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：60

**Teaching Methods**：Lecture, Projects, Homework

**Suitable Majors**: Engineering

**Assessment Instruments**：Examination, Projects, Homework

**Pre-requisites**：Linear Algebra, Calculus, Analytic Geometry

## 1. Course Objective and Requirements

Topics include the basic Concepts in Linear Algebra, Linear Space and Inner-product Space, Linear Transformation, Jordan Canonical Form, Matrix Factorization with Applications, Hermitian Matrix and Positive Definite Matrix, Matrix Norm and Matrix Analysis, Generalized Inverse Matrix, Matrix Computation with MATLAB.

Through the course, students learn, practice, and master basic matrix results and techniques that are very useful for applications in various fields such as mathematics, statistics, physics, computer science, and engineering, etc.

It requires that students should master the basic discipline of matrix theory, be able to carry out the classical theory and methods and have the basic knowledge and skills to solve mathematical problems in engineering so that they are prepared with the necessary foundation for their future study and work.

## 2. Course Content and Schedule

Chapter 1 Review and Miscellanea (8h)
- 1.1 Matrix concept and special matrices
- 1.2 Matrix algebra
- 1.3 Eigenvalue and eigenvector
- 1.4 An introduction to MATLAB

Chapter 2 Linear Space and Inner-product Space (8h)
- 2.1 Linear space
- 2.2 Basis and dimension of vector space
- 2.3 Subspace
- 2.4 Inner-product Space

Chapter3 Linear Transformation (6h)
- 3.1 Introduction
- 3.2 Linear transformation with properties
- 3.3 Range and kernel
- 3.4 Matrix Representation of Linear Transformation
- 3.5 Similarity

Chapter 4 Jordan Canonical Form (8h)
- 4.1 Diagonalizability
- 4.2 Jordan block matrix and Jordan form matrix
- 4.3 lambda-matrix and Smith standard form
- 4.4 Jordan Canonical Form
- 4.5 Cayley-Hamilton Theorem and Minimal polynomial

Chapter 5 Matrix Factorization (8h)
- 5.1 Introduction
- 5.2 Full Rank Decomposition
- 5.3 LU Factorization
- 5.4 QR Factorization
- 5.5 Schur Decompisition
- 5.6 Singular value decomposition(SVD)

Chapter 6 Hermitian Matrix and Positive Definite Matrix (6h)
- 6.1 Hermitian matrix
- 6.2 Positive definite matrix

Chapter 7 Matrix Norm and Matrix Analysis (8h)
- 7.1 Introduction
- 7.2 Vector Norm
- 7.3 Matrix Norm

7.4 Matrix sequence, series and function
Chapter 8 The Moore-Penrose Generalized Inverse (4h)
8.1 Introduction
8.2 The Moore-Penrose Generalized Inverse
Matlab Commands for matrix computations (2h)
Reviews and Examination (2h)

**3. Textbooks**

Wang, Z. S. Introduction to Matrix Theory, Science Press, 2015

**Main Reference Books**

(1) 戴华，矩阵论，科学出版社，2001
（2）Steven J. Leon. Linear Algebra with Applications，7th edition. Person Education Asia Limited and China Machine Press.，2007
（3）Roger A. Horn & Charles R. Johnson, Matrix Analysis, 人民邮电出版社， 2005
（4）Zhang F. Matrix Theory: Basic Results and Techniques (Second Edition), 2010, Springer Press.

**Written by**：WANG Zhengsheng（王正盛）
**Instructor**：WANG Zhengsheng（王正盛）, YANG Xi（杨熙）

**Course Code**：6A010001L

**Course Title(Chinese)**：航空航天导论

**Course Title(English)**：Overview of Aeronautics and Astronautics

**College and Department**：Col. of Airspace Engineering
**Semester**：Autumn
**Class Hours**：30
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Any
**Assessment Instruments**：Examination
**Pre-requisites**：None

## 1.Course Objective and Requirements

Overview of Aeronautics and Astronautics provides a comprehensive and overall introduction about aeronautic technology to the international students in China. It is helpful for the students to build the base to learn the related course. This course will discuss all main contents about aeronautic technology including flight history, basic aerodynamic, flight mechanics, aircraft control and stability, propulsion system, aircraft structure and so on.

## 2.Course Content and Schedule

**Chapter 1 Rich History** （6h）
- 1.1 From Wheels to Stars
- 1.2 Myths and Legends
- 1.3 Early Scientific Research
- 1.4 Flight in Balloons
- 1.5 The Era of the Dirigible
- 1.6 Heavier-Than-Air Aircraft Development
- 1.7 Wright Brothers' Flyer I
- 1.8 The Adolescence of Airplane
- 1.9 The Golden Age of Aviation
- 1.10 Airplanes in the World War II
- 1.11 Jet Airplane
- 1.12 Advances in Aeronautics

**Chapter 2 Basic Aerodynamics** （6h）
- 2.1 The Atmosphere
- 2.2 Atmospheric Regions
- 2.3 Continuity Equation
- 2.4 Bernoulli's Principle
- 2.5 About Viscous Flow
- 2.6 About Compressiblity
- 2.7 Measurement of Airspeed
- 2.8 Wind Tunnels

**Chapter 3 Airfoil, Wing and Airplane** （6h）
- 3.1 Introduction
- 3.2 Airfoil Lift
- 3.3 Wing Lift
- 3.4 Airplane Lift
- 3.5 High Lift Devices
- 3.6 Wing and Airplane Drag
- 3.7 Mach Number Effects

**Chapter 4 Elements of Airplane Performance** （2h）
- 4.1 Introduction
- 4.2 Equations of Motion
- 4.3 Drag Curves
- 4.4 Power Curves

4.5 Range and endurance
4.6 Gliding Flight
4.7 Climbs
4.8 Takeoff and Landing
4.9 Turnning Flight
4.10 V-n Diagram

**Chapter 5 Airplanes' Stability and Control** （3h）

5.1 Introduction
5.2 Coordinate System
5.3 Control Surfaces
5.4 Stability Definition
5.5 Longitudinal Control Analysis
5.6 Longitudinal Stability
5.7 Directional Stability and Control
5.8 Lateral Stability and Control

**Chapter 6 Aircraft Propulsion** （3h）

6.1 Introduction
6.2 Airplane Propellers
6.3 Piston Engines
6.4 Turbojet Engines
6.5 Afterburners
6.6 Turbofan Engines
6.7 Turboprop Engine
6.8 Turboshaft Engine
6.9 Ramjets

**Chapter 7 Airplane Structure** （2h）

7.1 Introduction
7.2 Mechanics Conception
7.3 An Airplane's Loads
7.4 Structural Layout
7.5 Component Sizing

**Chapter 8 Airplane Instruments** （2h）

8.1 Introduction
8.2 Early Airplane Instruments
8.3 Instrument Classification
8.4 Typical Instruments
8.5 Navigation Conception

## 3.Textbooks

Caijun Xue. Introduction to aeronautics, National Defense Industry Press, 2015

**Written by**：XUE Caijun（薛彩军） **Instructor**：XUE Caijun（薛彩军）

**Course Code**：6B052003L

**Course Title(Chinese)**：特种加工

**Course Title(English)**：Non-traditional Machining

**College and department**：Col. of Mechanical & Electrical Engineering

**Semester**： Autumn

**Class hours**：48

**Teaching methods**：Lecture

**Suitable majors:** Mechanical Engineering

**Assessment instruments**：Examination, Project

**Pre-requisites**：Mechanical manufacturing technology, Electrotechnics

## 1. Course objective and Requirements

In this course, the brief introduction of Non-Traditional Machining are given, then the three main processing methods of non-traditional machining, EDM, ECM and LMP, are relatively, comprehensively, and systematically introduced. Under the broad category of EDM, the basic principle of EDM, EDM forming processing, Wire-cut EDM, EDM surface modification, and EDM of non-conductive and semi-conductive material are emphatically introduced. Likewise, under ECM, the basic principle and theory of ECM, the ECM system, shaping law and process characteristics selection of ECM, applications and development of ECM, EF, ECG and other processes of composite electrochemical machining are emphatically introduced. In the third part, laser material processing technology will be introduced. That includes the principle of laser, laser processing equipment, laser cutting and welding, and laser 3D printing.

Through interpreting the basic principles, types and applications of the three most common non-traditional machining, the graduate will deeply understand the development background, types, process, equipment of these non-traditional machining technologies.

## 2. Course content and Schedule

Chapter 0 Introduction of Non-Traditional Machining(NTM) (2h)
- 0.1 Classification of the mechanical processing
- 0.2 Beginning and Development of NTM
- 0.3 Classification of NTM
- 0.4 Typical Processes in NTM
- 0.5 NTM effect on manufacturing process and technology

**Part 1: Electrical Discharge Machining (20h)**

Chapter 1 Description and Development of Electrical Discharge Machining (EDM) (2 h)
- 1.1Definition of EDM
- 1.2 Development of EDM
- 1.3 The development of wire-cut EDM
- 1.4 Comparison of die-sinker and wire cut machines
- 1.5 Acceptance of the EDM process and developing tendency

Chapter 2 The EDM System (2h)
- 2.1 Summary of EDM
- 2.2 The structure of servo head
- 2.3 EDM assemblies
- 2.4 Summary of Wire-cut EDM

Chapter 3 The EDM Process (2h)
- 3.1Ionization
- 3.2 The microcosmic process of discharge
- 3.3 Polarity effect
- 3.4 The material removal

Chapter 4 The EDM Sparking System (2h)
- 4.1 EDM-DC-POWER source
- 4.2 Typical EDM-power supplies
- 4.3 Spark energy transmission
- 4.4 Electrode servo systems
- 4.5 EDM dielectric systems

Chapter 5 Electrode Polarity & Chips (4h)
- 5.1 Type of electrode materials
- 5.2 Ionization and electrode wear
- 5.3 Low wear machining methods
- 5.4 Wire cut EDM electrodes (LSWEDM)
- 5.5 EDM chips
- 5.6 Side sparking and sidewall taper

Chapter 6 The EDM Workpiece Surface (2h)
- 6.1 Workpiece's surface quality
- 6.2 Mirror finishing and diffused discharge machining
- 6.3 DC arcing

Chapter 7 Special Types of EDM (2h)
- 7.1 Different types of EDM
- 7.2 EDM on nonconductive material
- 7.3 EDM in gas
- 7.4 WEDM for semi-conductive materials
- 7.5 Small hole EDM drilling
- 7.6 Micro electrode discharge machining

Chapter 8 Wire-cut EDM controlling function, cutting technique & accuracy testing (4h)

8.1 Assemblies of WEDM 8.2 Function of process control
8.3 Technological problems processing 8.4 Skim cutting
8.5 Precision acceptance of WEDM 8.6 Extended application for wire cutting technology

**Part 2: Electrochemical Machining (ECM) (14h)**

Chapter 1 Description and Development of Electrochemical Machining (ECM) (2h)
1.1 Principle of ECM 1.2 Development of ECM
1.3 Acceptance of the ECM Process

Chapter 2 Basic Theory of ECM (2h)
2.1 Electrolysis 2.2 Electric field
2.3 Flow field

Chapter 3 The ECM Process (2h)
3.1 Process characteristics 3.2 Material removal
3.3 Accuracy and dimensional control

Chapter 4 The ECM System (2h)
4.1 Electrolyte 4.2 ECM tools
4.3 DC Power supply

Chapter 5 Applications of ECM (2h)
5.1 Electrolytic cavity machining 5.2 Hole drilling
5.3 Deburring 5.4 Electrolytic cutting
5.5 Electrolytic turing 5.6 Electrolytic milling
5.7 Electro-stream drilling 5.8 Electrolytic polishing
5.9 Electrolytic trepanning 5.10 Electrolytic marking

Chapter 6 Electroforming (EF) and Electric Brush-plating (2h)
8.1 Principle of EF 8.2 Process characteristics of EF
8.3 Equipment of EF 8.4 Applications of EF

Chapter 7 Electrochemical Micro-Machining (2h)

**Part 3: Laser material processing (LMP) (12h)**

Chapter 1 Background to Laser Design and General Applications (4h)
1.1 Basic Principles of Lasers 1.2 Laser Construction Concepts
1.3 Types of Laser 1.4 Applications of Lasers

Chapter 2 Basic Laser Optics (2h)
2.1 The Nature of Electromagnetic Radiation
2.2 Interaction of Electromagnetic Radiation with Matter
2.3 Reflection or Absorption 2.4 Refraction
2.5 Laser Beam Characteristics 2.6 Focusing with a Single Lens
2.7 Optical Components

Chapter 3 Laser Cutting, Drilling and Piercing (2h)
3.1 Introduction 3.2 The Process
3.3 LaserDrilling and Piercing 3.4 Methods of Cutting
3.5 Examples of Applications of Laser Cutting

Chapter 4 Laser Welding (2h)
4.1 Introduction 4.2 Process Arrangement
4.3 Process Mechanisms 4.4 Operating Characteristics
4.5 Process Variations

Chapter 5 Rapid Prototyping and Low-volume Manufacture (2h)
5.1 Introduction 5.2 Range of Processes
5.3 Computer Aided Design File Manipulation 5.4 Layered Manufacturing Issues
5.5 Individual Processes 5.6 Rapid Manufacturing Technologies

## 3. Textbooks

(1) Elman C. Jameson. electrical discharge machining. SME 2001.
(2) Carl Sommer and Steve Sommer M.E., complete EDM handbook, advance publishing, Inc.2005
(3) V. K. Jain, electrochemical machining, ELV, 2007.
(4) A.E. DE BARR. Electrochemical Machining, american elsevier publishing company, Inc.1968.
(5) William M. Steen，Jyotirmoy Mazumder, Laser material processing, springer, 2010

## Main Reference Books

(1) 刘志东主编, 特种加工, 北京大学出版社, 2013 年
(2) 赵万生著, 先进电火花加工技术, 国防工业出版社, 2003 年
(3) 刘志东、高长水编著，电火花加工工艺及应用，国防工业出版社, 2011 年
(4) 徐家文、云乃彰等编著，电化学加工技术，国防工业出版社，2008 年
(5) 范植坚等编著，电解加工与复合电解加工，国防工业出版社，2008

**Written by**：LIU Zhidong (刘志东)，LIU Zhuang (刘壮)
**Instructor**：LIU Zhidong (刘志东)，LIU Zhuang (刘壮)，ZHU Zengwei (朱增伟)

**Course Code**：6B054002Y/6B054002L

**Course Title(Chinese)**：金属塑性成形原理

**Course Title(English)**：Principles of Metal Forming

**College and department:** Col. of Mechanical & Electrical Engineering
**Semester:** Autumn
**Class hours:** 48
**Teaching methods:** Lecture, Homework
**Suitable majors:** Aerospace Manufacturing Engineering, Mechanical Engineering
**Assessment instruments:** Examination, Report
**Pre-requisites:** Materials Mechanics, Engineering Materials, Metal Forming Technology

## 1.Course objective and Requirements

This course is designed to help students establish the knowledge structure of the principles of metal forming – both the mechanics of forming processes and how the properties of metals interact with the processes. The first section of the course is devoted to fundamentals of mechanics in metal forming; the middle section to the introduction of the methods used in forming process analysis such as work balance, slab analysis, and slip line field method; and the last section covers sheet forming processes and metal formability. A chapter has been devoted to sheet metal anisotropy, including how the sheet anisotropy influences the metal formability; final chapter introduces metallic deformation microstructure and the interaction between microstructure and mechanical properties. Not only is the knowledge required to be established for the students, but also the application ability of the knowledge.

## 2.Course content and Schedule

**Chapter 1 Scope of the course (2h)**
- 1.1 Content of the course
- 1.2 Aim of the course
- 1.3 Major advantages of plastic forming
- 1.4 Characteristics of the subject
- 1.5 Typical metal forming processes

**Chapter 2 Stress analysis (6h)**
- 2.1 Stress state at a point
- 2.2 Stress on a oblique plane
- 2.3 Principle stress
- 2.4 Principle shear stress
- 2.5 Equilibrium equations
- 2.6 Spherical and deviator stress tensors
- 2.7 Equivalent stress
- 2.8 Mohr's circle and stress transformation

**Chapter 3 Strain analysis (6h)**
- 3.1 Deformation and displacement
- 3.2 Normal strain and shear strain for small displacement
- 3.3 Infinitesimal strains as a function of displacement
- 3.4 Volume constancy condition
- 3.5 Incremental strain and strain rate
- 3.6 Large strain and true strain
- 3.7 Mohr circle for strain
- 3.8 Isotropic elasticity
- 3.9 Force and moment balances

**Chapter 4 Yield criteria (4h)**
- 4.1 Yield and yield criteria
- 4.2 Yield criteria on $\pi$ plane
- 4.3 Tresca yield criterion
- 4.4 Von Mises yield criterion
- 4.5 Characteristics of yield locus
- 4.6 Yield surface-principal stress space representation of yield criterion
- 4.7 Application of yield criteria to forming

**Chapter 5 Stress strain relation (4h)**
- 5.1 Flow theory
- 5.2 Typical material models
- 5.3 A power-law expression
- 5.4 Instability
- 5.5 Bulge testing

5.6 Behavior during necking
5.7 Factors affect the resistance force of deformation

**Chapter 6 Plastic anisotropy (4h)**

6.1 Anisotropy formation mechanism
6.2 Texture and plasticity relation
6.3 R
6.4 Hill's anisotropic plasticity theory
6.5 Calculation of anisotropy from crystallographic consideration
6.6 Earring

**Chapter 7 Strain rate and temperature (4h)**

7.1 Strain rate and strain rate sensitivity
7.2 Temperature dependence of flow stress
7.3 Superplasticity
7.4 Deformation mechanism
7.5 Hot-working
7.6 Precision forging process design
7.7 Forgeability of metals
7.8 Formability criterion-Crack formation criterion

**Chapter 8 Work balance method (2h)**

8.1 Work in plastic forming
8.2 Plastic work
8.3 Basic equation of work balance
8.4 Three examples using work balance method

**Chapter 9 Slab method (2h)**

9.1 What is Slab method
9.2 Three examples using slab method
9.2.1 Uniaxial pressure
9.2.2 Pulling
9.2.3 Deep drawing

**Chapter 10 Slip-Line method (4h)**

10.1 Characteristics of plane strain deformation
10.2 Basic concepts in slip line method
10.3 The Hencky Equation
10.4 Geometric characteristics of slip line field
10.5 Stress boundary condition
10.6 Applications

**Chapter 11 Sheet metal forming (4h)**

11.1 Cupping and bulging
11.2 Sheet metal formability
11.2.1 Drawing properties
11.2.2 Grain orientation
11.2.3 Grain size
11.2.4 Bulging properties
11.3 Forming limiting diagram
11.3.1 Plastic instability: Localized necking
11.3.2 Experimental methods to determine FLD

**Chapter 12 Friction and lubricants in metal forming (2h)**

12.1 Friction in metal forming
12.2 Types of friction in metal forming
12.3 Friction criterion
12.4 How to determine the values of $m$ and $u$?

**Chapter 13 Plasticity and microstructure (4h)**

13.1 Crystal structure of metal
13.2 Defect in actual metal
13.3 Theory of dislocation
13.4 Plastic deformation in single crystalline and polycrystalline
13.5 Severe plastic deformation
13.6 Work hardening behavior
13.7 Recovery and recrystallization

## 3. Textbooks

(1) Hosford, W. F. and Caddell R. M.: The Metal Forming-Mechanics and Metallurgy, 3th edition, Cambridge University Press, 2007

## Main reference books

(1) Humphreys F. J. and Hatherly M.: Recrystallization and Related Annealing Phenomena, 2th edition, Elsevier Press, 2004.

(2) 汪大年，金属塑性成形原理，机械工业出版社，1998.
Wang Danian, Principles of Metal Forming, Machinery Industry Press, 1988.
(3) 董湘怀，金属塑性成形原理，机械工业出版社，2011.
Dong Xianghuai, Principles of Metal Forming, Machinery Industry Press, 2011.

**Written by**：ZHOU Qing(周清)　　**Instructor**：ZHOU Qing (周清),　LU Shihong (鲁世红)

**Course Code**：7D052005L

**Course Title(Chinese)**：现代理化分析技术

**Course Title(English)**：Modern Physical and Chemical Analysis Technology

**College and Department**：Col. of Mechanical Engineering

**Semester**：Autumn

**Class Hours**：40

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Mechanical Engineering

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Material Mechanics, Metal Material Science, Metal Material & Heat Treatment

## 1.Course Objective and Requirements

The Modern physical and chemical analysis technology is a very impotant methed and powerful analytical tool for mechanical engineering. The course covers the theory, fundamental operating principles, and specimen preparation techniques of scanning electron microscopy (SEM), transmission electron microscope (TEM), X-ray Diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), Raman Spectroscopy (Raman), et al. The course provides a series of analysis work on metal or crystal material using SEM, AFM, XRD and Raman. Course objectives: develop comprehensive basic theory, basic knowledge and basic skills in the modern physical and chemical analysis technique; know how to analyse physical and chemical characteristic of metal or crystal materials; develop and exercise critical thinking in interpreting results from modern physical and chemical analysis. The course is available to graduate students and upper level undergraduates.

## 2.Course Content and Schedule

Chapter 1 An Introduction to Modern Physical and Chemical Analysis Techniques （2h）
- 1.1 History of Physical and Chemical Analysis Techniques
- 1.2 Development of Physical and Chemical Analysis Techniques
- 1.3 Application of Physical and Chemical Analysis Techniques

Chapter 2 Sample Preparation （4h）
- 2.1 Initial Preparation of Samples
- 2.2 Mounting
- 2.3 Polishing
- 2.4 Etching
- 2.5 Coating
- 2.6 Marking Specimens
- 2.7 Specimen Handling and Storage

Chapter 3 Scanning Electron Microscopy (SEM) （8h）
- 3.1 Introduction
- 3.2 Magnification and Resolution
- 3.3 Focussing
- 3.4 Topographic Images
- 3.5 Compositional Images
- 3.6 Image Defects
- 3.7 Image Enhancement
- 3.8 Applications

Chapter 4 Transmission Electron Microscopy (TEM) （4h）
- 4.1 Introduction
- 4.2 Comparison of Optical and Electron Microscopes
- 4.3 The Electron Wavelength
- 4.4 Lens Aberration and Practical Limit of Resolution
- 4.5 Defects of Focus
- 4.6 Modes of Operation
- 4.7 Applications

Chapter 5 X-ray Diffraction (XRD) （8h）
- 5.1 Introduction
- 5.2 Theoretical Considerations
- 5.3 Samples
- 5.4 Goniometer
- 5.5 Diffractometer Slit System
- 5.6 Diffraction Spectra

5.7 ICDD Data Base
5.8 Preferred Orientation
5.9 Applications

Chapter 6 X-ray Photoelectron Spectroscopy (XPS) （4h）
6.1 Introduction
6.2 Photoelectric Effect
6.3 Information Depth
6.4 Chemical Shifts
6.5 Analytical Methods
6.6 Small Area Analysis and Imaging
6.7 Applications

Chapter 7 Scanning Probe Microscopy (SPM) （6h）
7.1 Introduction
7.2 Atomic Force Microscopy
7.3 Scanning Tunneling Microscopy and Spectroscopy
7.4 Related Techniques
7.5 Applications

Chapter 8 Raman Spectroscopy (Raman) （4h）
8.1 Introduction
8.2 Theory of Raman Spectra
8.3 Mechanism of Raman Scattering
8.4 Solid State Raman Spectroscopy
8.5 Data Conversion
8.6 Applications

## 3.**Experiments**

Project: The project involves a series of analysis work on metal or crystal materials using SEM, AFM, XRD and Raman.

## **4.Textbooks**

(1) S.J.B.Reed. Electron microprobe analysis and scanning electron microscopy in geology, Cambridge University Press, 2005.
(2) A.Guinier. X-Ray Diffraction: In crystals, imperfect crystals, and amorphous bodies, Dover Publications,1994.
(3) L.V.Mironov. Fundamental of scanning probe microscopy, Butterworth-Heinemann, Nizhniy Novgorod,2004.
(4) Conners,E.Terrance,Banerjee,E.Sukit. Surface analysis of paper. Boca Raton, FL:CRC Press, 1995.
(5) R.Davis. Mass Spectrometry/Analytical Chemistry by Open Learning; Wiley: New York, 1987.
(6) R.F.Egerton. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM. Springer Science Business Media, Inc., 2005.

## **Main reference books**

(1) L.Reimer. Scanning electron microscopy: physics of image formation and microanalysis. Berlin; New York: Springer-Verlag,1985.
(2) E.T.Whittaker. Modern analysis. Cambridge University Press, 4th ed, 2008.
(3) 陆家和,陈长彦. 现代分析技术. 北京:清华大学出版社,1995.

**Written by**：LU Wenzhuang（卢文壮）
**Instructor**：LU Wenzhuang（卢文壮）, XU Feng（徐锋）et al.

**Course Code**：7D054017Y/7D054017L

**Course Title(Chinese)**：数控加工力学和动力学

**Course Title(English)**：Mechanics and Dynamics of NC Cutting

**College and Department**：Col. of Mechanical & Electrical Engineering

**Semester**：Autumn

**Class Hours**：40

**Teaching Methods**：Lecture, Experiment, Homework

**Suitable Majors**: Mechanical Engineering

**Assessment Instruments**：Evaluation, Project

**Pre-requisites**：Metal cutting, Mechanical Vibration

## 1.Course Objective and Requirements

NC Metal cutting is one of the most widely used methods of producing the final shape of manufactured products. This course treats the scientific principles of metal cutting and their practical application to producing manufactured products. It begins with the fundamentals of NC metal cutting mechanics and features in-depth coverage of chatter vibrations, a common problem in manufacturing. The essential topics from mechanics to dynamics of cutting are fully discussed using mathematics, physics, computers, software, and instrumentation as integration tools in analyzing machine implements and manufacturing processes. Each chapter includes examples drawn from industry, design projects, and homework problems. Graduate students, as well as advanced undergraduate and practising engineers, will find this course a clear and thorough way to learn the engineering principles of metal cutting mechanics and dynamics.

## 2.Course Content and Schedule

Chapter 1 Orthogonal Cutting（4h）
- 1.1 Mechanics of Orthogonal Cutting
- 1.2 Model of Cutting Force
- 1.3 Theoretical Prediction of Shearing

Chapter 2 Oblique Cutting（6h）
- 2.1 Geometrical Relation of Oblique Cutting
- 2.2 Cutting Coefficient of Oblique Cutting
- 2.3 The Calculation of Cutting Force

Chapter 3 Mechanics of Lathe Cutting（2h）

Chapter 4 Mechanics of Milling Cutting（2h）

Chapter 5 Mechanics of Drilling （2h）

Chapter 6 Static and dynamic deformations in machining（2h）

Chapter 7 The Basis of Mechanical Vibration（6h）
- 7.1 Laplace transforms
- 7.2 Vibration of a Single Degree of Freedom System
- 7.3 Vibration of a Multiple Degree of Freedom System
- 7.4 Model Analysis

Chapter 8 Vibration of Orthogonal Cutting（2h）

Chapter 9 Vibration of Milling（6h）
- 9.1 Dynamics Model of Milling
- 9.2 Stability Lobes

## 3.Experiments

Project1: The Measurement of Cutting Coefficient（2h，综合性）

The project involves the measurement of cutting coefficient which is the basis of cutting force calculation.

Project2: The Measurement of Cutting Force （2h，综合性）

The project involves the measurement of cutting force which is fundamentals of NC metal cutting mechanics.

Project3: Hammer Test and Model Analysis（2h，设计性）

The project involves hammer test and model analysis, and model analysis is fundamentals of NC metal cutting dynamics.

Project4: Stability Analysis of Milling（2h，综合性）

The project involves stability analysis which is a common problem in manufacturing.

## 4.Textbooks

Altintas Yusuf，Manufacturing automation : metal cutting mechanics, machine tool vibrations & CNC

design，Cambridge University Press，2000

**Main Reference Books**

1．J Tlusty，Manufacturing processes and equipment，Prentice Hall，2000
2．S．Graham Kelly，Mechanical Vibrations，McGraw Hill Inc，1996
3．刘强，数控铣削加工过程仿真与优化-建模.算法与工程应用，中航书苑文化传媒（北京）有限公司，2011 年
4．黄翔，数控编程理论、技术与应用，清华大学出版社，2006

**Written by**：HUANG Xiang（黄翔）　　**Instructor**： HUANG Xiang（黄翔）

**Course Code**：6B061005L

**Course Title(Chinese)**：聚合物科学

**Course Title(English)**：Polymer Science

**College and Department**：Col. of Materials Science & Technology

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Homework，Final project report/presentation

**Suitable Majors**: Material Processing Engineering，Material Science & Engineering，polymer engineering, composite material

**Assessment Instruments**：Homework, Project

**Pre-requisites**：Fundations of Materials Science and Engineering, Organic Chemistry, Polymer Chemistry, Mechanics of material ,etc..

## 1.Course Objective and Requirements

The masters programme in Polymer Materials Science is a multi-disciplinary taught programme which examines in-depth the wide range of issues relating to structural and functional polymers.

This course provides Chemists, Materials Scientists and Engineers with a rich understanding of both traditional commodity plastics and speciality polymers with increasing applications in the biomedical and pharmaceutical fields, and in electronics and nanotechnology. The full range of issues, from fundamental polymer science, through polymer processing, to manufacturing are all covered.

## 2.Course Content and Schedule

Chapter 1 Introduction to Polymer Science (4h)
- 1.1. From Little Molecules to Big Molecules.
- 1.2. Molecular Weight and Molecular Weight Distributions.
- 1.3. Major Polymer Transitions.
- 1.4. Polymer Synthesis and Structure.
- 1.5. Cross-Linking, Plasticizers, and Fillers.
- 1.6. The Macromolecular Hypothesis.

Chapter 2 Chain Structure and Configuration（4h）
- 2.1. Examples of Configurations and Conformations.
- 2.2. Theory and Instruments.
- 2.3. Stereochemistry of Repeating Units.
- 2.4. Repeating Unit Isomerism.
- 2.5. Common Types of Copolymers.

Chapter 3 Dilute Solution Thermodynamics, Molecular Weights, and Sizes(4h)
- 3.1. Introduction.
- 3.2. The Solubility Parameter.
- 3.3. Thermodynamics of Mixing.
- 3.4. Molecular Weight Averages.
- 3.5. Determination of the Number-Average Molecular Weight.
- 3.6. Weight-Average Molecular Weights and Radii of Gyration.
- 3.7. Molecular Weights of Polymers.
- 3.8. Intrinsic Viscosity.

Chapter 4 Concentrated Solutions, Phase Separation Behavior, and Diffusion(4h)
- 4.1. Phase Separation and Fractionation.
- 4.2. Regions of the Polymer-Solvent Phase Diagram.
- 4.3. Polymer-Polymer Phase Separation.
- 4.4. Diffusion and Permeability in Polymers.
- 4.5. Latexes and Suspensions.
- 4.6. Multicomponent and Multiphase Materials.

Chapter 5 The Amorphous State(4h)
- 5.1. The Amorphous Polymer State.
- 5.2. Experimental Evidence Regarding Amorphous Polymers.
- 5.3. Conformation of the Polymer Chain.
- 5.4. Macromolecular Dynamics.

Chapter 6 The Crystalline State(4h)
- 6.1. General Considerations.
- 6.2. Methods of Determining Crystal Structure.
- 6.3. The Unit Cell of Crystalline Polymers.

6.4. Structure of Crystalline Polymers.
6.5. Crystallization from the Melt.
6.6. Kinetics of Crystallization.

Chapter 7 Polymers in the Liquid Crystalline State(4h)
7.1. Definition of a Liquid Crystal.
7.2. Rod-Shaped Chemical Structures.
7.3. Liquid Crystalline Mesophases.
7.4. Liquid Crystal Classification.
7.5. Thermodynamics and Phase Diagrams.
7.6. Mesophase Identification in Thermotropic Polymers.

Chapter 8 Glass-Rubber Transition Behavior(4h)
8.1. Simple Mechanical Relationships.
8.2. Five Regions of Viscoelastic Behavior.
8.3. Methods of Measuring Transitions in Polymers.
8.4. Other Transitions and Relaxations.
8.5. Time and Frequency Effects on Relaxation Processes.
8.6. Theories of the Glass Transition.
8.7. Effect of Molecular Weight on TG.
8.8. Effect of Copolymerization on TG.
8.9. Effect of Crystallinity on TG.
8.10. Dependence of TG on Chemical Structure.
8.11. Effect of Pressure on TG.
8.12. Damping and Dynamic Mechanical Behavior.

Chapter 9 Cross-linked Polymers and Rubber Elasticity(4h)
9.1. Cross-links and Networks.
9.2. Historical Development of Rubber.
9.3. Rubber Network Structure.
9.4. Rubber Elasticity Concepts.
9.5. Thermodynamic Equation of State.
9.6. Equation of State for Gases.
9.7. Statistical Thermodynamics of Rubber Elasticity.

Chapter 10 Polymer Viscoelasticity and Rheology(4h)
10.1. Stress Relaxation and Creep.
10.2. Relaxation and Retardation Times.
10.3. The Time-Temperature Superposition Principle.
10.4. Polymer Melt Viscosity.
10.5. Polymer Rheology.
10.6. Overview of Viscoelasticity and Rheology.

Chapter 11 Mechanical Behavior of Polymers. (4h)
11.1. An Energy Balance for Deformation and Fracture
11.2. Deformation and Fracture in Polymers.
11.3. Crack Growth.
11.4. Cyclic Deformations.
11.5. Molecular Aspects of Fracture and Healing in Polymers.
11.6. Friction and Wear in Polymers.
11.7. Mechanical Behavior of Biomedical Polymers.
11.8. Summary.

Chapter 12 Polymer Surfaces and Interfaces(4h)
12.1. Polymer Surfaces.
12.2. Thermodynamics of Surfaces and Interfaces.
12.3. Instrumental Methods of Characterization.
12.4. Conformation of Polymer Chains in a Polymer Blend Interphase.
12.5. The Dilute Solution-Solid Interface.
12.6. Instrumental Methods for Analyzing Polymer Solution Interfaces.
12.7. Theoretical aspects of the Organization of Chains at Walls.
12.8. Adhesion at Interfaces.
12.9. Interfaces of Polymeric Biomaterials with Living Organisms.
12.10. Overview of Polymer Surface and Interface Science.

## 3.**Textbooks**

(1) Fundamentals of Polymer Science, Second Edition, By Paul C Painter
(2) Essentials of polymer Science and Engineering, By Paul C Painter

## **Main Reference Books**

(1) The elements of polymer science and engineering, By Alfred Rudin, University of Waterloo

**Written by**：LI Shuqin（李淑琴）
**Instructor**：LI Shuqin（李淑琴）, WANG JingWen（王经文）etal.

**Course Code**：8B061003L

**Course Title(Chinese)**：功能材料学

**Course Title(English)**：Functional Materials

**College and Department**：Col. of Material Science & Technology

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Material Science and Engineering and relevant major

**Assessment Instruments**：Examination

**Pre-requisites**：Fundamentals of Material Science & Engineering, Physical Properties of Materials

## 1.Course Objective and Requirements

Course objectives: The development of functional materials is at the heart of technological needs and the forefront of materials research. This course provides a comprehensive and up-to-date treatment of functional materials, by which the students can grasp the new development of materials in electrical, dielectric, electromagnetic, optical, and magnetic applications. The textbook features hundreds of illustrations to help explain concepts and provide quantitative information. Topics include electrical conduction behavior, dielectric behavior, electromagnetic behavior, optical behavior and magnetic behavior of functional materials and their applications.

## 2.Course Content and Schedule

**Chapter 1 Introduction to Functional Materials and their applications（2h）**

1.1 Types of materials
1.2 Composite materials
1.3 Carbon
1.4 Smart structures
1.5 Intrinsic smartness
1.6 Extrinsic smartness
1.7 Functional applications

**Chapter 2 Electrical Conduction Behavior （8h）**

2.1 Origin of electrical conduction
2.2 Volume electrical resistivity
2.3 Resistivity-density product
2.4 Sheet resistance
2.5 Surface resistance
2.6 Contact electrical resistivity
2.7 Electric power and resistance heating
2.8 Effect of temperature on the electrical resistivity
2.9 Electrical conduction evaluation methods
2.10 Effect of strain on the electrical resistivity
2.11 Seebeck effect
2.12 Semiconductors and their junctions

**Chapter 3 Dielectric Behavior （8h）**

3.1 Relative dielectric constant
3.2 Calculation of relative dielectric constant of a composite
3.3 Origin of dielectric behavior
3.4 Lossy capacitor
3.5 Dielectric material evaluation
3.6 Electrical insulation
3.7 Conversion between mechanical energy and electrical energy
3.8 Electrets
3.9 Piezoelectric effect
3.10Pyroelectric effect
3.11Electrostrictive behavior
3.12Electrorheology
3.13Solids electrolytes
3.14Composite materials for dielectric applications

**Chapter 4 Electromagnetic Behavior （3h）**

4.1 Electromagnetic applications
4.2 Electromagnetic radiation

4.3Applications of Faraday's Law and Lenz's Law
4.4 Electromagnetic shielding
4.5Low observability
4.6composite materials for electromagnetic functions

**Chapter 5 Optical Behavior（3h）**

5.1 Optical behavior of materials
5.2 Reflection and refraction
5.3 Optical fiber
5.4 Light sources
5.5 Light detection and photocopying
5.6 Liquid crystal display
5.7 Thermal emission
5.8 Compact disc
5.9 Composite materials for optical applications

**Chapter 6 Magnetic Behavior（8h）**

6.1 Force generated by the interaction of a magnetic field with moving charged particles
6.2 Magnetic moment
6.3 Ferromagnetic behavior
6.4Paramagnetic behavior
6.5 Ferrimagnetic behavior
6.6 Antiferromagnetic behavior
6.7 Hard and soft magnets
6.8 Magnetic shielding
6.9 Composite material with a magnetic filler and a non-magnetic matrix
6.10Diamagnetic behavior
6.11Magnetostriction and Villari effect
6.12Ferromagnetic shape memory effect
6.13Magnetoresistance and magnetic multilayer
6.14Magnetorheology
6.15Nondestructive evaluation using magnetic particles
6.16Composites for magnetic applications

## 3.Textbooks

(1) Deborah D. L. Chung Functional materials: electrical, dielectric, electromagnetic, optical and magnetic applications (with companion solution manual), World Scientific, 2010, ISBN: 9814287156, 9789814287159

## Main Reference Books

**Written by**：FENG Xiaomei（冯晓梅）

**Instructor**：FENG Xiaomei（冯晓梅），SHEN Honglie(沈鸿烈)

**Course Code**：7D061003L

**Course Title(Chinese)**：复合材料工程

**Course Title(English)**：Composites Material Engineering

**College and Department**：Col. of Material Science & Technology

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture

**Suitable Majors**: Material Science and Engineering

**Assessment Instruments**：Project

**Pre-requisites**：Engineering Material,Material Science

## 1.Course Objective and Requirements

The subject of composite materials is truly an inter- and multidisciplinary one. People working in fields such as metallurgy and materials science and engineering, chemistry and chemical engineering, solid mechanics, and fracture mechanics have made important contributions to the field of composite materials. Topics include introduction; fabrication and properties of the various types of reinforcement ;the main types of matrix materials; the interface in composites; the important types of composites; metal matrix composites; ceramic composites; carbon fiber composites; multifilamentary superconducting composites; the micromechanics and macromechanics of composites.

Course objectives: obtaining an understanding of composite properties (e.g., mechanical, physical, and thermal) as controlled by their structure at micro- and macro-levels.

Course requirements: This involves a knowledge of the properties of the individual constituents that form the composite system, the role of interface between the components, the consequences of joining together, say, a fiber and matrix material to form a unit composite ply, and the consequences of joining together these unit composites or plies to form a macrocomposite, a macroscopic engineering component as per some optimum engineering specifications.

## 2.Course Content and Schedule

Chapter 1 Introduction(1h)
Chapter 2 Reinforcements (3h)
- 2.1 Introduction
- 2.2 Glass Fibers
- 2.3 Boron Fibers
- 2.4 Carbon Fibers
- 2.5 Organic Fibers
- 2.6 Ceramic Fibers
- 2.7 Whiskers
- 2.8 Other Nonoxide Reinforcements
- 2.9 Effect of High-Temperature Exposure on the Strength of Ceramic Fibers
- 2.10 Comparison of Fibers

Chapter 3 Matrix Materials(3h)
- 3.1 Polymers
- 3.2 Metals
- 3.3 Ceramic Matrix Materials

Chapter 4 Interfaces(3h)
- 4.1 Wettability
- 4.2 Crystallographic Nature of Interface
- 4.3 Interactions at the Interface
- 4.4 Types of Bonding at the Interface
- 4.5 Optimum Interfacial Bond Strength
- 4.6 Tests for Measuring Interfacial Strength

Chapter 5 Polymer Matrix Composites (4h)
- 5.1 Processing of PMCs
- 5.2 Interface in PMCs
- 5.3 Structure and Properties of PMCs
- 5.4 Applications
- 5.5 Recycling of PMCs

Chapter 6 Metal Matrix Composites (4h)
- 6.1 Types of Metal Matrix Composites
- 6.2 Important Metallic Matrices

6.3 Processing
6.4 Interfaces in Metal Matrix Composites
6.5 Properties
6.6 Applications
Chapter 7 Ceramic Matrix Composites (4h)
7.1 Processing of CMCs
7.2 Interface in CMCs
7.3 Properties of CMCs
7.4 Toughness of CMCs
7.5 Thermal Shock Resistance
7.6 Applications of CMCs
Chapter 8 Carbon Fiber/Carbon Matrix Composites (4h)
8.1 Processing of Carbon/Carbon Composites
8.2 Oxidation Protection of Carbon/Carbon Composites
8.3 Properties of Carbon/Carbon Composites
8.4 Applications of Carbon/Carbon Composites
Chapter 9 Micromechanics of Composites (2h)
9.1 Density
9.2 Mechanical Properties
9.3 Thermal Properties
9.4 Mechanics of Load Transfer from Matrix to Fiber
9.5 Load Transfer in Particulate Composites
Chapter 10 Monotonic Strength and Fracture (2h)
10.1 Tensile Strength of Unidirectional Fiber Composites
10.2 Compressive Strength of Unidirectional Fiber Composites
10.3 Fracture Modes in Composites
10.4 Effect of Variability of Fiber Strength
10.5 Strength of an Orthotropic Lamina
10.5.1 Maximum Stress Theory
Chapter 11 Fatigue and Creep (2h)
11.1 Fatigue
11.2 Creep
11.3 Closure

## 3.Textbooks

K K. Chawla ,Composite Materials Science and Engineering, 3th edition, Springer Science+Business Media New York,2012.

## Main Reference Books

(1) G. Brooks, Composites : mechanical, physical and other properties, NY Research Press, 2015.
(2) D. Gay ,Composite materials:design and applications, Taylor & Francis Group, 2015.
(3) F.L. Matthews , R.D. Rawlings, Composite materials : engineering and science, Woodhead Pub., 1999.

**Written by**：PAN Lei（潘蕾） **Instructor**：PAN Lei（潘蕾）

**Course Code**：7D061028L

**Course Title(Chinese)**：功能涂层的制备、 表征及应用

**Course Title(English)**：Synthesis, Characterization and Applications of Functional Coatings

**Course Unit:** Col.of Materials Science and Technology

**Semester:** Autumn

**Class Hours:** 32

**Teaching Method:** Lecture and experiment

**Applicable Profession and Level:** Professional Engineering Master Degree

**Examination/Evaluation Method:** Based on assignment and practical work

**Prerequisite Course:** Material Science and Technology, Semiconductors

## 1. Course Objective and Requirements

The lectures of this course will be given in English. The theme of this course is to foster and develop a sound foundation of basis and advanced research in functional coatings for industrial applications. In fact, functional coatings is an interdisciplinary engineering research field that addresses many issues in material science, physics, chemistry, biology, environmental science and other engineering subjects. The focus of this course is to provide the understanding of the fundamentals of functional coatings fabrication technologies, their characteristics (such as crystal structure (XRD), microstructure (SEM), chemical composition (EDS/XPS) and electrical transport properties) and associated applications. The course also discusses the synthesis of advanced functional nano-materials and their applications. Moreover, the students will be asked to apply gained knowledge to evaluate semiconductor electrical characteristics, e.g. current-voltage curves, temperature dependent conductivity, sensor dynamic response, reaction times, estimate activation energy and etc., of some practically performed measurements. By the end of this course, the students will be able to explain the fundamental reactions occurring at the surface of chemical sensors and their applicability in various industries. In addition, students will be able to apply this knowledge to adopt their research field in the direction of smart future gas sensors.

## 2. Course Content and Schedule

Chapter 1: Functional Coatings: fundamentals, classification and applications (6h)

- 1.1 Introduction to functional coatings processes.
- 1.2 Applications of functional coatings
- 1.3 Fundamentals of vacuum science and technology.
- 1.4 Basics of sputtering method.
- 1.5 Sol-gel methods.
- 1.6 Basics of Chemical (CVD) and Physical Vapor deposition (PVD).
- 1.7 Thermally oxidized and sprayed coatings.

Chapter 2: Characterization of functional coatings (6h)

- 1.1 Key issues and optimization of the processes.
- 1.2 Effect of synthesis parameters on the properties of the coatings e.g. sputtering method.
- 1.3 Crystal structure analysis by XRD.
- 1.4 Morphology of the functional coatings by SEM.
- 1.5 Chemical composition by EDS and GDOES.
- 1.6 Other techniques such as XPS, STM, AFM and etc.

Chapter 3: Advanced and nanostructured sensing materials (6h)

- 3.1 Synthesis of metal oxide nanotubes and nanowires.
- 3.2 Effect of synthesis parameters on the morphology of these structures.
- 3.3 TiO2, SnO2, ZnO, WO3 and other metal oxide gas sensing materials.
- 3.4 Variation in the sensing properties and classification.
- 3.5 Conduction mechanism.
- 3.6 Adsorption and desorption at the surface.
- 3.7 Surface reaction kinetics.

Chapter 4: Conductivity of metal oxide semiconducting coatings (4h)

- 4.1 Resistive gas sensors based on metal oxide.
- 4.2 Type of the conductivity, n- or p-type.
- 4.3 Gas interaction with the surface.
- 4.4 Receptor and transducer function.
- 4.5 Basic characteristics of a gas sensor.
- 4.6 Current issues.

Chapter 5: Doping and defect chemistry of functional coatings (4h)

5.1 Surface chemistry of metal oxide coatings.
5.2 Oxygen vacancies and other defects.
5.3 Effect of annealing on the defect chemistry.
5.4 Effect of synthesis parameters on various properties.
5.5 Metal-Semiconductor interface.
5.6 Effect of electrode materials for conductivity measurements.

Chapter 6: Analysis of electrical characterization (6h with practicals)

6.1 Electrical properties of bulk semiconductors.
6.2 Temperature dependent conductivity measurements.
6.3 DC and AC electrical properties and grain boundaries.
6.4 Practical 1: Understanding the electrical behavior of semiconductors under some gas exposure.
6.5 Practical 2: Studying the resistance vs. temperature plot and estimation of activation energy.
6.6 Practical 3: Impedance measurements and analysis.

## 3. Teaching materials:

The electric versions and power point files of lecture materials will be available.

Main reference books:

Sam Zhang *Nanostructured Thin Films and Coatings: Functional Properties* CRC Press; 1st edition (2010)

G. Eranna *Metal oxide nanostructures as gas sensing device* CRC Press; 1stedition (2011)

Written by: Azhar Ali Haidry

Instructor: Azhar Ali Haidry

**Course Code**：7D062009L

**Course Title (Chinese)**：纳米材料与纳米技术

**Course Title (English)**: Nanomaterials and Nanotechnologies

**College and Department**：Col. of Materials Science & Technology
**Semester**：Autumn
**Class Hours**：32
**Teaching Methods**：Lecture, Assignments
**Suitable Majors**: Physical Chemistry of Materials, Physical Chemistry
**Assessment Instruments**：Examination, Project
**Pre-requisites**：Material Science Foundation, Physical Chemistry, Materials Test Technology

## 1. Course Objective and Requirements

This subject contains two complementary strands. The first deals with methods for producing nanostructures, nanostructured materials and nanoscale devices, using deposition, growth and self-assembling processes. The second uses real-world examples to demonstrate how the unique properties of these materials can be tailored for a wide range of applications from novel building materials and medical prothestics to the next generation of electronic devices.
Upon successful completion of this subject students should be able to:

(1) be aware of the importance and impact that nanoscale science has to the engineering of materials and processes for the 21st century
(2) be aware of the latest development of the nanomaterials in commercial and industrial applications
(3) acquire fundamental knowledge in materials science in association with nanomaterials and nanotechnology
(4) be familiar with the scientific issues that underpin the nanoscale properties of materials, nanotechnology in nature and biology, biomimetics and nanoscale measurement and analysis

## 2. Course Content and Schedule

Chapter 1. Nanomaterials
1.1 Introduction (4h)
- 1.1.1 Introduction to nanomaterials and Nanotechnology
- 1.1.2 Size effects, scaling laws, surface area; Current perspectives of Nanotechnology
- 1.1.3 Colloids and nanocrystals
- 1.1.4 fluorescent nanocrystals
- 1.1.5 Quantum dots
- 1.1.6 Biomaterials and implants

1.2. Carbon Nanomaterials (8h)
- 1.2.1 Carbon. I. General. Industrial carbon products
- 1.2.2 Carbon II. Fullerenes
- 1.2.3 Carbon III. Nano-diamonds
- 1.2.4 Carbon IV. Carbon nanotubes
- 1.2.5 Carbon V. Graphene

1.3. Nanomaterials for Batteries (12h)
- 1.3.1 Nanomaterials for batteries I: introduction
- 1.3.2 Nanomaterials for batteries II: Li-ion batteries
- 1.3.3 Nanomaterials for batteries III: Cathode materials
- 1.3.4 Nanomaterials for batteries IV: Anode materials
- 1.3.5 Nanomaterials for batteries V: electrochemical performance
- 1.3.6 Nanomaterials for batteries VI: Strategy to improve the performance
- 1.3.7 Nanomaterials for batteries VII: Strategy to improve the performance
- 1.3.8 Nanomaterials for batteries VIII: Strategy to improve the performance
- 1.3.9 Nanomaterials for batteries IX: Na-ion batteries
- 1.3.10 Nanomaterials for batteries X: Li-$O_2$ batteries
- 1.3.11 Nanomaterials for batteries XI: Li-S batteries

Chapter 2. Nanotechnology (8h)
- 2.1 Nanocoatings made by physical means
- 2.2 Self-assembled nanostructures
- 2.3 Structural characterization
- 2.4 Nanofabrication
- 2.5 Precious metal nanotechnology
- 2.6 Composite materials

## 3. Textbooks

(1) Poole, C.P. and Owens F.J. (2003). "Introduction to Nanotechnology", Wiley-Interscience.
(2) Hoch HC, Jelinski LW, Craighead HG (1996). "Nanofabrication and biosystems: integrating materials science, engineering and biology", Cambridge, CUP (660.6 HOCH)
(3) Lorenz WJ, Plieth W (1998). "Electrochemical nanotechnology: in-situ local probe techniques at electrochemical interfaces", Weinheim, Wiley (547.37 LORE)

## Main Reference Books

### 1. General

(1) Bard AJ (1994). "Integrated chemical systems: a chemical approach to nanotechnology", NY, Wiley (660.297 BARD) Gardner JW, Hingle (1991). "From instrumentation to nanotechnology", Philadelphia, Gordon & Breach (681.2 GARD)
(2) Nalwa HS (2000). "Handbook of nanostructured materials and nanotechnology". San Diego, Academic Press (620.5 NALW [1-5])
(3) Regis E (1995). "Nano: the emerging science of nanotechnology: remaking the world – molecule by molecule", Boston, Little Brown (620.4 REGI)
(4) Rietman EA (2001). "Molecular engineering of nanosystems", NY, Springer (620.5 RIET)

### 2. Nanostructured Materials & Coatings

(1) Dresselhaus MS, Dresselhaus G (2001). "Carbon nanotubes: synthesis, structure, properties, and applications", Berlin, Springer (620.193 DREE)
(2) Ebbesen TW (1997). "Carbon nanotubes: preparation and properties", Boca Raton, CRC (620.193 EBBE) Edelstein AS, Cammarata RC (1998). "Nanomaterials: synthesis, properties, and applications", Bristol, Institute Physics (620.11 EDEL)
(3) Harris PJF (1999). "Carbon nanotubes and related structures: new materials for the 21st century", Cambridge, CUP (620.193 HARR)
(4) Hodes G (2000). "Electrochemistry of nanomaterials". Weinheim, Wiley (620.11297 HODE)
(5) Inoue A, Hashimoto K (2001). "Amorphous and nanocrystalline materials: preparation, properties, and applications", Berlin, Springer (621.11 INOU)
(6) Koch CC (2002). "Nanostructured material: processing, properties and potential applications", Norwich NY, Noyes (620.11 KOCH)
(7) Markel VA, George TF (2001). "Optics of nanostructured materials", NY, Wiley (621.36 MARK)
(8) Morris DG (1998). "Mechanical behaviour of nanostructured materials", Zurich, Trans Tech (620.5 MORR)

### 3. Nanomachines, Sensors & MEMs

(1) Grattarola M, Massobrio G (1998). "MOSFETS, biosensors, and neurons", NY, McGraw-Hill (621.3815 MASS)
(2) Gross M (1999). "Travels to the nanoworld: miniature machinery in nature and technology", NY, Plenum (620.5 GROS)
(3) Sienicki K (1993). "Molecular electronics and molecular electronic devices", Boca Raton, CRC (621.381/369 [2])

### 4. Web Resources

www.foresight.org
www.vjnano.org
www.micromachines.com
www.nanopore.com
www.nano.org.uk
www.nnun.org
www.ho.seas.ucla.edu/mainflash.html

**Written by**：WANG Guoxiu（汪国秀）　　**Instructor**：WANG Guoxiu（汪国秀）

# Science

| Course type | Course Code | Course Title | Hours | Credits | Semester | College | Remark |
|---|---|---|---|---|---|---|---|
| Compulsory Course | 6A120006L | Chinese | 60 | 4 | Autumn | Col. of Foreign Languages | |
| | 6A080001L | Matrix Theory | 60 | 4 | Autumn | Col. of Science | Compulsory For master students |
| | 6A010001L | Overview of Aeronautics and Astronautics | 30 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 6A080102L | Thesis Proposal and Literature Review | | 1 | | Col. of Science | Compulsory For master students |
| | 8A080102L | Thesis Proposal and Literature Review | | 1 | | Col. of Science | Compulsory For doctoral students |
| Optional Course | 6B081001L | Functional Analysis | 48 | 3 | Autumn | Col. of Science | |
| | 6B081010L | Numerical Analysis | 40 | 2.5 | Autumn | Col. of Science | |
| | 6B082001L | Advanced Quantum Mechanics | 48 | 3 | Autumn | Col. of Science | |
| | 8B081003L | Advanced Numerical Analysis | 48 | 3 | Autumn | Col. of Science | |
| Topic | 7D080001L | Topic 1 | 32 | 2 | | Col. of Science | |
| | 7D080002L | Topic 2 | 32 | 2 | | Col. of Science | |

**Course Code**：6A120006L

**Course Title(Chinese)**：汉语

**Course Title(English)**： Chinese

**College and Department**：Col. of Foreign Languages
**Semester**：Autumn
**Class Hours**：60
**Teaching Methods**：Lecture
**Suitable Majors**: International postgraduates
**Assessment Instruments**：Examination
**Pre-requisites**：Elementary Chinese

## 1.Course Objective and Requirements

To practice spoken Chinese. Students are required to learn some dialogues and sentence pattern in certain situation. Through the classroom learning and some outdoor activities, students are supposed to communicate with Chinese natives and know more about Chinese culture. After taking the course the students should be able to:

1. master several Chinese daily language.
2. communicate with Chinese natives in basic Chinese.
3. know more about Chinese customs and traditions.

## 2.Course Content and Schedule

第一课 你常去图书馆吗（4 小时）
一、课文
（一）你常去图书馆吗
（二）晚上你常做什么
二、语法
（一）时间词语作状语
（二）"还是"和"或者"
第二课 他在做什么呢（4 小时）
一、课文
（一）他在做什么呢
（二）谁教你们语法
二、语法
（一）动作的进行
（二）双宾语句
（三）询问动作行为的方式：怎么+动词
第三课 我去邮局寄包裹（4 小时）
一、课文
（一）我去邮局寄包裹
（二）外贸代表团明天去上海参观四、语法：连动句
第四课 可以试试吗（4 小时）
一、课文
（一）可以试试吗
（二）便宜一点儿吧
二、语法
（一）动词重叠
（二）又……又……
（三）"一点儿"和"有一点儿"
第五课 祝你生日快乐（4 小时）
一、课文
（一）你哪一年大学毕业
（二）祝你生日快乐
二、语法
（一）时间、价格、日期、数量、天气、年龄、籍贯等的表达：名词谓语句
（二）年、月、日
（三）怎么问（6）：疑问语调
第六课 我们明天七点一刻出发（4 小时）
一、课文
（一）我的一天
（二）明天早上七点一刻出发
二、语法：时间的表达
第七课 我打算请老师教我京剧（4 小时）
一、课文：我打算请老师教我京剧

二、语法：兼语句
第八课 学校里边有邮局吗（4 小时）
一、课文
（一）学校里边有邮局吗
（二）从这儿到博物馆有多远
二、语法
（一）方位词
（二）存在的表达
（三）介词"离"、"从"、"往"
第九课 我想学太极拳（4 小时）
一、课文
（一）我想学太极拳
（二）您能不能再说一遍
二、语法
（一）能愿动词
（二）询问原因
第十课 她学得很好（4 小时）
一、课文
（一）她学得很好
（二）她每天都起得很早
二、语法：描写、判断和评价：状态补语（1）：动词+得+形容词
第十一课 田芳去哪儿了（4 小时）
一、课文
（一）田芳去哪儿了
（二）他又来电话了
二、语法
（一）语气助词"了"（1）
（二）"再"和"又"
第十二课 玛丽哭了（4 小时）
一、课文
（一）你怎么了
（二）玛丽哭了
二、语法
（一）动作的完成：动词+了
（二）因为-...一所以.....
第十三课 我吃了早饭就来了（4 小时）
一、课文
（一）我吃了早饭就来了
（二）我早就下班了
二、语法
（一）"就"和"才"
（二）要是.....（的话），就.....
（三）虽然.....但是.....
第十四课 我都做对了（4 小时）
一、课文
（一）我都做对了
（二）看完电影再做作业
二、语法
（一）动作结果的表达：结果补语
（二）结果补语"上"、"成"和"到"
（三）主谓词组作定语
第十五课 我来了两个多月了（4 小时）
一、课文
（一）我来了两个多月了
（二）我每天都练一个小时
二、语法
（一）动作或状态持续时间的表达：时量补语
（二）概数的表达
（三）离合动词

**3.Textbooks**
《汉语教程》 主编 杨寄洲，北京语言大学出版社，2009 年

**Written by**：WANG Zheng (王征)
**Instructor**：LU Hong（陆红）,WANG Zheng（王征）， ZHANG Weidong （张卫东）et al.

**Course Code**：6A080001L

**Course Title(Chinese)**：矩阵论

**Course Title(English)**：Matrix Theory

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：60

**Teaching Methods**：Lecture, Projects, Homework

**Suitable Majors**: Engineering

**Assessment Instruments**：Examination, Projects, Homework

**Pre-requisites**：Linear Algebra, Calculus, Analytic Geometry

## 1. Course Objective and Requirements

Topics include the basic Concepts in Linear Algebra, Linear Space and Inner-product Space, Linear Transformation, Jordan Canonical Form, Matrix Factorization with Applications, Hermitian Matrix and Positive Definite Matrix, Matrix Norm and Matrix Analysis, Generalized Inverse Matrix, Matrix Computation with MATLAB.

Through the course, students learn, practice, and master basic matrix results and techniques that are very useful for applications in various fields such as mathematics, statistics, physics, computer science, and engineering, etc.

It requires that students should master the basic discipline of matrix theory, be able to carry out the classical theory and methods and have the basic knowledge and skills to solve mathematical problems in engineering so that they are prepared with the necessary foundation for their future study and work.

## 2. Course Content and Schedule

Chapter 1 Review and Miscellanea (8h)
- 1.1 Matrix concept and special matrices
- 1.2 Matrix algebra
- 1.3 Eigenvalue and eigenvector
- 1.4 An introduction to MATLAB

Chapter 2 Linear Space and Inner-product Space (8h)
- 2.1 Linear space
- 2.2 Basis and dimension of vector space
- 2.3 Subspace
- 2.4 Inner-product Space

Chapter3 Linear Transformation (6h)
- 3.1 Introduction
- 3.2 Linear transformation with properties
- 3.3 Range and kernel
- 3.4 Matrix Representation of Linear Transformation
- 3.5 Similarity

Chapter 4 Jordan Canonical Form (8h)
- 4.1 Diagonalizability
- 4.2 Jordan block matrix and Jordan form matrix
- 4.3 lambda-matrix and Smith standard form
- 4.4 Jordan Canonical Form
- 4.5 Cayley-Hamilton Theorem and Minimal polynomial

Chapter 5 Matrix Factorization (8h)
- 5.1 Introduction
- 5.2 Full Rank Decomposition
- 5.3 LU Factorization
- 5.4 QR Factorization
- 5.5 Schur Decompisition
- 5.6 Singular value decomposition(SVD)

Chapter 6 Hermitian Matrix and Positive Definite Matrix (6h)
- 6.1 Hermitian matrix
- 6.2 Positive definite matrix

Chapter 7 Matrix Norm and Matrix Analysis (8h)
- 7.1 Introduction
- 7.2 Vector Norm
- 7.3 Matrix Norm

7.4 Matrix sequence, series and function
Chapter 8 The Moore-Penrose Generalized Inverse (4h)
8.1 Introduction
8.2 The Moore-Penrose Generalized Inverse
Matlab Commands for matrix computations (2h)
Reviews and Examination (2h)

**3. Textbooks**

Wang, Z. S. Introduction to Matrix Theory, Science Press, 2015

**Main Reference Books**

(1) 戴华，矩阵论，科学出版社，2001
（2）Steven J. Leon. Linear Algebra with Applications，7th edition. Person Education Asia Limited and China Machine Press.，2007
（3）Roger A. Horn & Charles R. Johnson, Matrix Analysis, 人民邮电出版社， 2005
（4）Zhang F. Matrix Theory: Basic Results and Techniques (Second Edition), 2010, Springer Press.

**Written by**：WANG Zhengsheng（王正盛）
**Instructor**：WANG Zhengsheng（王正盛）, YANG Xi（杨熙）

**Course Code**：6A010001L

**Course Title(Chinese)**：航空航天导论

**Course Title(English)**：Overview of Aeronautics and Astronautics

**College and Department**：Col. of Airspace Engineering
**Semester**：Autumn
**Class Hours**：30
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Any
**Assessment Instruments**：Examination
**Pre-requisites**：None

## 1.Course Objective and Requirements

Overview of Aeronautics and Astronautics provides a comprehensive and overall introduction about aeronautic technology to the international students in China. It is helpful for the students to build the base to learn the related course. This course will discuss all main contents about aeronautic technology including flight history, basic aerodynamic, flight mechanics, aircraft control and stability, propulsion system, aircraft structure and so on.

## 2.Course Content and Schedule

**Chapter 1 Rich History** （6h）
- 1.1 From Wheels to Stars
- 1.2 Myths and Legends
- 1.3 Early Scientific Research
- 1.4 Flight in Balloons
- 1.5 The Era of the Dirigible
- 1.6 Heavier-Than-Air Aircraft Development
- 1.7 Wright Brothers' Flyer I
- 1.8 The Adolescence of Airplane
- 1.9 The Golden Age of Aviation
- 1.10 Airplanes in the World War II
- 1.11 Jet Airplane
- 1.12 Advances in Aeronautics

**Chapter 2 Basic Aerodynamics** （6h）
- 2.1 The Atmosphere
- 2.2 Atmospheric Regions
- 2.3 Continuity Equation
- 2.4 Bernoulli's Principle
- 2.5 About Viscous Flow
- 2.6 About Compressiblity
- 2.7 Measurement of Airspeed
- 2.8 Wind Tunnels

**Chapter 3 Airfoil, Wing and Airplane** （6h）
- 3.1 Introduction
- 3.2 Airfoil Lift
- 3.3 Wing Lift
- 3.4 Airplane Lift
- 3.5 High Lift Devices
- 3.6 Wing and Airplane Drag
- 3.7 Mach Number Effects

**Chapter 4 Elements of Airplane Performance** （2h）
- 4.1 Introduction
- 4.2 Equations of Motion
- 4.3 Drag Curves
- 4.4 Power Curves

4.5 Range and endurance
4.6 Gliding Flight
4.7 Climbs
4.8 Takeoff and Landing
4.9 Turnning Flight
4.10 V-n Diagram

**Chapter 5 Airplanes' Stability and Control** （3h）

5.1 Introduction
5.2 Coordinate System
5.3 Control Surfaces
5.4 Stability Definition
5.5 Longitudinal Control Analysis
5.6 Longitudinal Stability
5.7 Directional Stability and Control
5.8 Lateral Stability and Control

**Chapter 6 Aircraft Propulsion** （3h）

6.1 Introduction
6.2 Airplane Propellers
6.3 Piston Engines
6.4 Turbojet Engines
6.5 Afterburners
6.6 Turbofan Engines
6.7 Turboprop Engine
6.8 Turboshaft Engine
6.9 Ramjets

**Chapter 7 Airplane Structure** （2h）

7.1 Introduction
7.2 Mechanics Conception
7.3 An Airplane's Loads
7.4 Structural Layout
7.5 Component Sizing

**Chapter 8 Airplane Instruments** （2h）

8.1 Introduction
8.2 Early Airplane Instruments
8.3 Instrument Classification
8.4 Typical Instruments
8.5 Navigation Conception

## 3.Textbooks

Caijun Xue. Introduction to aeronautics, National Defense Industry Press, 2015

**Written by**：XUE Caijun（薛彩军） **Instructor**：XUE Caijun（薛彩军）

**Course Code**：6B081001L

**Course Title(Chinese)**：泛函分析

**Course Title(English)**：Functional Analysis

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture , Homework

**Suitable Majors**: Mathematics

**Assessment Instruments**：Examination

**Pre-requisites**：Real analysis

## 1.Course Objective and Requirements

Course objective: This course contains two parts: functional analysis (FA) and partial differential equations (PDE). The first part deals with abstract results in FA and operator theory. The second part concerns the study the study of spaces of functions (of one or more real variables) having specific differentiability properties: the celebrated Sobolev spaces, which lie at the heart of the modern theory of PDEs. This course is aimed to show the elegance of FA and how the abstract results from FA can be applied to solve PDEs.

Requirements: A solid foundation in differential and integral calculus, real analysis

## 2.Course Content and Schedule

Chapter 1 The Hahn—Banach Theorems. Introduction to the Theory of Conjugate Convex Functions (4h)

1.1 The Analytic Form of the Hahn—Banach Theorem： Extension of Linear Functionals

1.2 The Geometric Forms of the Hahn—Banach Theorem： Separation of Convex Sets

1.3 The Bidual $E^{**}$.Orthogonality Relations

Exercises for Chapter 1

Chapter 2 The Uniform Boundedness Principle and the Closed Graph Theorem (10h)

2.1 The Baire Category Theorem

2.2 The Uniform Boundedness Principle

2.3 The Open Mapping Theorem and the Closed Graph Theorem

2.4 Complementary Subspaces.Right and Left Invertibility of Linear Operators

2.5 Orthogonality Revisited

2.6 An Introduction to Unbounded Linear Operators.Definition of the Adjoint

2.7 A Characterization of Operators with Closed Range.A Characterization of Surjective Operators

Exercises for Chapter 2

Chapter 3 Weak Topologies.Reflexive Spaces.Separable Spaces.Uniform Convexity (10h)

3.1 The Coarsest Topology for Which a Collection of Maps Becomes Continuous

3.2 Definition and Elementary Properties of the Weak Topology

3.3 Weak Topology， Convex Sets， and Linear Operators

3.4 The Weak* Topology

3.5 Reflexive Spaces

3.6 Separable Spaces

3.7 Uniformly Convex Spaces

Exercises for Chapter 3

Chapter 4 $L^p$ Spaces (6h)

4.1 Some Results about Integration That Everyone Must Know

4.2 Definition and Elementary Properties of $L^p$ Spaces

4.3 Reflexivity.Separability. Dual of $L^p$

4.4 Convolution and regularization

4.5 Criterion for Strong Compactness in $L^p$

Exercises for Chapter 4

Chapter 5 Hilbert Spaces (6h)

5.1 Definitions and Elementary Properties.Projection onto a Closed Convex Set

5.2 The Dual Space of a Hilbert Space

5.3 The Theorems of Stampacchia and Lax—Milgram
5.4 Hilbert Sums.Orthonormal Bases
Exercises for Chapter 5
Chapter 6 Compact Operators.Spectral Decomposition of Self—Adjoint Compact Operators (6h)
6.1 Definitions.Elementary Properties.Adjoint
6.2 The Riesz—Fredholm Theory
6.3 The Spectrum of a Compact Operator
6.4 Spectral Decomposition of Self—Adjoint Compact Operators
Exercises for Chapter 6
Chapter 7 The Hille—Yosida Theorem (6h)
7.1 Definition and Elementary Properties of Maximal Monotone Operators
7.2 Solution of the Evolution Problem. Existence and uniqueness
7.3 Regularity
7.4 The Self Adjoint Case
Exercises for Chapter 7

## 4.Textbooks

(1) Haim Brezis，Functional Analysis, Sobolev Spaces and Partial Differential Equations，Springer，2011.

## Main Reference Books

(1) Haim Brezis，Functional Analysis, Sobolev Spaces and Partial Differential Equations，Springer，2011.
(2) Douglas Farenick, Foudamental of Functional Analysis, Springer, 2016

**Written by**：GONG Rongfang（龚荣芳） **Instructor**：GONG Rongfang（龚荣芳）

**Course Code**：6B081010L

**Course Title(Chinese)**：数值分析

**Course Title(English)**：Numerical Analysis

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：40

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Mathematics

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Differential and integral calculus, linear algebra

## 1. Course Objective and Requirements

Course objective: Numerical analysis is concerned with the development and investigation of constructive methods for the numerical solution of mathematical problems. No applied mathematician can be properly trained without some basic understanding of numerical analysis. This course aims at go provide insight into numerical analysis rather than merely to provide numerical recipes. After the study of the course, the students have fundamental knowledge on the basic tools for solving applied problems as well as on the challenging and rewarding part of mathematics.

Requirements: A solid foundation in differential and integral calculus, linear algebra

## 2. Course Content and Schedule

Chapter 1 Calculation of functions (2h)

1.1 Taylor polynomial approximations

1.2 Evaluating a polynomial

Exercises for Chapter 1

Chapter 2 Error and precision (2h)

2.1 Floating point numbers and the machine epsilon

2.2 Introduction of different kinds of errors

2.3 Propagation of error

Exercises for Chapter 2

Chapter 3 Rootfing of nonlinear equation (6h)

3.1 The bisection method

3.2 Newton' method

3.3 The secant method

3.4 Fixed point iteration

3.5 Multiple roots

Exercises for Chapter 3

Chapter 4 Interpolation (8h)

4.1 Lagrange's formula for the interpolation polynomial

4.2 Newtion's formula for the interpolation polynomial

4.3 Interpolation error analysis

4.4 Piecewise polynomial interpolation

4.5 Best Approximation

4.6 Chebyshev polynomials

4.7 A near-minimax approximation method

4.8 Least squares approximation

Exercises for Chapter 4

Chapter 5 Numerical integration and differentiation (6h)

5.1 Trapezoidal method and Simpson's rule

5.2 Error formula for Trapezoidal method and Simpson's rule

5.3 Numerical integration: another approach

5.4 Numerical differentiation

Exercises for Chapter 5

Chapter 6 Linear systems (6h)

6.1 Introduction to linear systems and matrices

6.2 Direct methods

6.3 Error analysis

6.4 Iteration method and convergence

Exercises for Chapter 6

Chapter 7 Least squares data fitting (2h)

7.1 Least squares data fitting

Exercises for Chapter 7

Chapter 8 Differential equations (8h)

8.1 Well-posedness of differential equations

8.2 Euler's method and numerical integration

8.3 Error analysis

8.4 The backward Euler method and trapezoidal method

8.5 Runge-Kutta methods

Exercises for Chapter 8

## 4. Textbooks

(1) 袁东锦，Numerical Analysis (数值分析英文版)， 东南大学出版社，2005.

## Main Reference Books

(1) 袁东锦，Numerical Analysis (数值分析英文版)， 东南大学出版社，2005.
(2) R. Kress, Numerical Analysis, Springer-Verlag, 1998.
(3) D.F. Griffiths and G.A. Watson, Numerical Analysis， World Scientific, 1996.

**Written by**：Gong Rongfang（龚荣芳） **Instructor**：Gong Rongfang (龚荣芳)

**Course Code**：6B082001L

**Course Title(Chinese)**：高等量子力学

**Course Title(English)**：Advanced Quantum Mechanics

**College and Department**：Col. of Science

**Semester**：Autum

**Class Hours**：48

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Physics, nano-science

**Assessment Instruments**：Examination

**Pre-requisites**：Matrix, Quantum Mechanics

## 1.Course Objective and Requirements

This course deals with advanced topics in the field of quantum mechanics, material which is usually encountered in graduate student level. The course is taught in such a way as to attach importance to a rigorous presentation while, at the same time, requiring no prior knowledge, except in the field of basic quantum mechanics. The inclusion of all mathematical steps and full presentation of intermediate calculations ensures ease of understanding. A number of problems are included at the end of each chapter. Sections or parts thereof that can be omitted in a first reading are marked with a star.

## 2.Course Content and Schedule

Chapter 1 Mathematical Tools of Quantum Mechanics (10h)

1.1 The Hilbert Space 1.2 Dual Spaces and the Dirac Notation
1.3 Operators 1.4 Self-Adjoint Operators and Eigen-problem
1.5 Representation in Discrete Bases
1.6 Representation in Continues Bases
1.7 Matrix and Wave Function
1.8 Direct Product and Direct Sum
1.9 Exercises

Chapter 2 Fundamentals of Quantum Mechanics (10h)

2.1 The Basic Postulates of Quantum Mechanics
2.2 The State of a System
2.3 Observables and Operators
2.4 Measurement in Quantum Mechanics
2.5 Time Evolution of the System's State
2.6 Symmetries and Conservation Laws
2.7 State Operator
2.8 Three Pictures of Quantum Mechanics
2.9 Connecting Quantum to Classical Mechanics
2.10 Approximation Methods I . The Variational Method
2.11 Approximation Methods II . The WKB Method
2.12 Exercises

Chapter 3 Second Quantization (10h)

3.1 Many-Particle States and Permutation Symmetry
3.2 Bosons
3.3 Fermions
3.4 Field Theory
3.5 Momentum Representation
3.6 Noninteracting Fermions
3.7 Ground State Energy and Elementary Theory of the Electron Gas
3.8 .Hartree.Fock Equations for Atoms
3.9 Free Bosons
3.10 .Weakly Interacting, Dilute Bose Gas
3.11 Exercises

Chapter 4 Coherent States and Squeezed States (10h)

4.1 Four Representations of Quantum States
4.2 Coherent States
4.3 The quasi.classical interpretation of coherent states
4.4 Coordinate representation in terms of displacement operator
4.5 Coherent states vector algebra
4.6 Squeezed States

4.7 Exercises

Chapter 5 Green's Functions and Scattering Theory (8h)

5.1 Time-Independent Green's Functions
5.2 Time-Dependent Green's Functions
5.3 Green's Functions and Perturbation Theory
5.4 Scattering Theory I.Scattering Operators
5.5 Scattering Theory II.Partial Wave
5.6 Green's Functions for Tight-Binding Hamiltonians
5.7 Exercises

3. **Textbooks**

1， Advanced Quantum Mechanics, Jinbin Li，science press，2015

**Main Reference Books**

1．Sakurai, Modern Quantum Mechanics, Addison-Wesley Publishing Company, Revised Version,1994
2．Shankar, Principles of quantum mechanics_2ed, PLENUM PRESS, 1994
3．Daniel R. Bes, Quantum Mechanics_A Modern and Concise Introductory Course, Second, Revised Edition, Spinger, 2006
4．Lesile E. Ballentine, Quantum Mechanics A Modern Development, 2000

**Written by**：LI Jinbin（李晋斌） **Instructor**：LI Jinbin（李晋斌）

**Course Code**：8B081003L

**Course Title(Chinese)**：高等数值分析

**Course Title(English)**：Advanced Numerical Analysis

**College and Department**：Col. of Science

**Semester**：Autumn

**Class Hours**：48

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Student abroad

**Assessment Instruments**：Examination

**Pre-requisites**： Mathematical analysis, higher algebra, functional analysis, ordinary differential equations , partial differential equation, differential equation numerical solution

## 1. Course Objective and Requirements

The basic contents of this course include numerical approximation and interpolation, numerical integration, numerical solutions of linear equations in matrix eigenvalue calculation, etc. Considering the science students' needs for the training of scientific computing and for the purpose of improving the quality of mathematics, the course is basic in the textbooks and the contents of scientific computing in practical methods and other new methods, mainly focuses itself on basic principles of numerical calculations and expounds the basic thoughts of various methods. Through the scientific study, students abroad should master the basic theories and methods narrated in this course and learn the subsequent courses as a basis for performing scientific research in the future.

## 2. Course Content and Schedule

Chapter 1. Introduction （4h）

1.1 Overview　　1.2 Error estimation

1.3 Significant figure　　1.4 Numerical stability

Chapter 2. Numerical solution of nonlinear equation（8h）

2.1 Overview　　2.2 Simple iterative method

2.3 Newton tangent method

Chapter 3. Numerical method for linear algebraic equations（8h）

3.1 Solution to equations　　3.2 Direct decomposition of a matrix

3.3 Equations of state and error analysis　　3.4 Iterative method

Chapter 4. The interpolation and approximation（8h）

4.1 Polynomial interpolation　　4.2 Equidistant node polynomial interpolation

4.3 Hermite polynomial interpolation　　4.4 Spline interpolation

4.5 Best uniform approximation　　4.6 Best square approximation

Chapter 5. Numerical integration and numerical differentiation（8h）

5.1 Equidistant node quadrature formula　　5.2 Romberg quadrature formula

5.3 Gauss type quadrature formula

Chapter 6. Numerical method for differential equation（12h）

6.1 Euler method　　6.2 Runge-Kutta method

6.3 Convergence and stability of single step method　　6.4 Linear multistep method

## 3. Textbooks

1. David Dincaid, Ward Cheney, Numerical Analysis, 机械工业出版社, 2005.

2．J. Douglas Faires, Richard L Burden, Numerical Analysis, Brooks Cole, 2005.

**Main Reference Books**

1．黄友谦，李岳生，数值逼近，高等教育出版社，1987.

**Written by**：ZHU Jun（朱君）　　**Instructor**：ZHU Jun（朱君）

# Economics and Management

| Course type | Course Code | Course Title | Hours | Credits | Semester | College | Remark |
|---|---|---|---|---|---|---|---|
| Compulsory Course | 6A120006L | Chinese | 60 | 4 | Autumn | Col. of Foreign Languages | |
| | 6A010001L | Overview of Aeronautics and Astronautics | 30 | 2 | Autumn | Col. of Aerospace Engineering | |
| | 6A090102L | Thesis Proposal and Literature Review | | 1 | | Col. of Economics and Management | Compulsory For master students |
| | 8A090102L | Thesis Proposal and Literature Review | | 1 | | Col. of Economics and Management | Compulsory For doctoral students |
| Optional Course | 6B091002L | Advanced Operational Research | 56 | 3.5 | Autumn | Col. of Economics and Management | |
| | 6B091006L | Advanced Statistics | 32 | 2 | Autumn | Col. of Economics and Management | |
| | 6B092002L | Advanced Management | 32 | 2 | Autumn | Col. of Economics and Management | |
| | 6B093009L | International Finance Management | 32 | 2 | Autumn | Col. of Economics and Management | |
| Topic | 7D090001L | Topic 1 | 32 | 2 | | Col. of Economics and Management | |
| | 7D090002L | Topic 2 | 32 | 2 | | Col. of Economics and Management | |

**Course Code**：6A120006L

**Course Title(Chinese)**：汉语

**Course Title(English)**： Chinese

**College and Department**：Col. of Foreign Languages
**Semester**：Autumn
**Class Hours**：60
**Teaching Methods**：Lecture
**Suitable Majors**: International postgraduates
**Assessment Instruments**：Examination
**Pre-requisites**：Elementary Chinese

## 1.Course Objective and Requirements

To practice spoken Chinese. Students are required to learn some dialogues and sentence pattern in certain situation. Through the classroom learning and some outdoor activities, students are supposed to communicate with Chinese natives and know more about Chinese culture. After taking the course the students should be able to:

1. master several Chinese daily language.
2. communicate with Chinese natives in basic Chinese.
3. know more about Chinese customs and traditions.

## 2.Course Content and Schedule

第一课 你常去图书馆吗（4 小时）
一、课文
（一）你常去图书馆吗
（二）晚上你常做什么
二、语法
（一）时间词语作状语
（二）"还是"和"或者"
第二课 他在做什么呢（4 小时）
一、课文
（一）他在做什么呢
（二）谁教你们语法
二、语法
（一）动作的进行
（二）双宾语句
（三）询问动作行为的方式：怎么+动词
第三课 我去邮局寄包裹（4 小时）
一、课文
（一）我去邮局寄包裹
（二）外贸代表团明天去上海参观四、语法：连动句
第四课 可以试试吗（4 小时）
一、课文
（一）可以试试吗
（二）便宜一点儿吧
二、语法
（一）动词重叠
（二）又……又……
（三）"一点儿"和"有一点儿"
第五课 祝你生日快乐（4 小时）
一、课文
（一）你哪一年大学毕业
（二）祝你生日快乐
二、语法
（一）时间、价格、日期、数量、天气、年龄、籍贯等的表达：名词谓语句
（二）年、月、日
（三）怎么问（6）：疑问语调
第六课 我们明天七点一刻出发（4 小时）
一、课文
（一）我的一天
（二）明天早上七点一刻出发
二、语法：时间的表达
第七课 我打算请老师教我京剧（4 小时）
一、课文：我打算请老师教我京剧

二、语法：兼语句
第八课 学校里边有邮局吗（4 小时）
一、课文
（一）学校里边有邮局吗
（二）从这儿到博物馆有多远
二、语法
（一）方位词
（二）存在的表达
（三）介词"离"、"从"、"往"
第九课 我想学太极拳（4 小时）
一、课文
（一）我想学太极拳
（二）您能不能再说一遍
二、语法
（一）能愿动词
（二）询问原因
第十课 她学得很好（4 小时）
一、课文
（一）她学得很好
（二）她每天都起得很早
二、语法：描写、判断和评价：状态补语（1）：动词+得+形容词
第十一课 田芳去哪儿了（4 小时）
一、课文
（一）田芳去哪儿了
（二）他又来电话了
二、语法
（一）语气助词"了"（1）
（二）"再"和"又"
第十二课 玛丽哭了（4 小时）
一、课文
（一）你怎么了
（二）玛丽哭了
二、语法
（一）动作的完成：动词+了
（二）因为-...一所以.....
第十三课 我吃了早饭就来了（4 小时）
一、课文
（一）我吃了早饭就来了
（二）我早就下班了
二、语法
（一）"就"和"才"
（二）要是.....（的话），就.....
（三）虽然.....但是.....
第十四课 我都做对了（4 小时）
一、课文
（一）我都做对了
（二）看完电影再做作业
二、语法
（一）动作结果的表达：结果补语
（二）结果补语"上"、"成"和"到"
（三）主谓词组作定语
第十五课 我来了两个多月了（4 小时）
一、课文
（一）我来了两个多月了
（二）我每天都练一个小时
二、语法
（一）动作或状态持续时间的表达：时量补语
（二）概数的表达
（三）离合动词

**3.Textbooks**
《汉语教程》 主编 杨寄洲，北京语言大学出版社，2009 年

**Written by**：WANG Zheng (王征)
**Instructor**：LU Hong（陆红）,WANG Zheng（王征）， ZHANG Weidong （张卫东）et a

**Course Code**：6A010001L

**Course Title(Chinese)**：航空航天导论

**Course Title(English)**：Overview of Aeronautics and Astronautics

**College and Department**：Col. of Airspace Engineering
**Semester**：Autumn
**Class Hours**：30
**Teaching Methods**：Lecture, Homework
**Suitable Majors**: Any
**Assessment Instruments**：Examination
**Pre-requisites**：None

## 1.Course Objective and Requirements

Overview of Aeronautics and Astronautics provides a comprehensive and overall introduction about aeronautic technology to the international students in China. It is helpful for the students to build the base to learn the related course. This course will discuss all main contents about aeronautic technology including flight history, basic aerodynamic, flight mechanics, aircraft control and stability, propulsion system, aircraft structure and so on.

## 2.Course Content and Schedule

**Chapter 1 Rich History** （6h）

1.1 From Wheels to Stars
1.2 Myths and Legends
1.3 Early Scientific Research
1.4 Flight in Balloons
1.5 The Era of the Dirigible
1.6 Heavier-Than-Air Aircraft Development
1.7 Wright Brothers' Flyer I
1.8 The Adolescence of Airplane
1.9 The Golden Age of Aviation
1.10 Airplanes in the World War II
1.11 Jet Airplane
1.12 Advances in Aeronautics

**Chapter 2 Basic Aerodynamics** （6h）

2.1 The Atmosphere
2.2 Atmospheric Regions
2.3 Continuity Equation
2.4 Bernoulli's Principle
2.5 About Viscous Flow
2.6 About Compressiblity
2.7 Measurement of Airspeed
2.8 Wind Tunnels

**Chapter 3 Airfoil, Wing and Airplane** （6h）

3.1 Introduction
3.2 Airfoil Lift
3.3 Wing Lift
3.4 Airplane Lift
3.5 High Lift Devices
3.6 Wing and Airplane Drag
3.7 Mach Number Effects

**Chapter 4 Elements of Airplane Performance** （2h）

4.1 Introduction
4.2 Equations of Motion
4.3 Drag Curves
4.4 Power Curves

4.5 Range and endurance
4.6 Gliding Flight
4.7 Climbs
4.8 Takeoff and Landing
4.9 Turnning Flight
4.10 V-n Diagram

**Chapter 5 Airplanes' Stability and Control** （3h）

5.1 Introduction
5.2 Coordinate System
5.3 Control Surfaces
5.4 Stability Definition
5.5 Longitudinal Control Analysis
5.6 Longitudinal Stability
5.7 Directional Stability and Control
5.8 Lateral Stability and Control

**Chapter 6 Aircraft Propulsion** （3h）

6.1 Introduction
6.2 Airplane Propellers
6.3 Piston Engines
6.4 Turbojet Engines
6.5 Afterburners
6.6 Turbofan Engines
6.7 Turboprop Engine
6.8 Turboshaft Engine
6.9 Ramjets

**Chapter 7 Airplane Structure** （2h）

7.1 Introduction
7.2 Mechanics Conception
7.3 An Airplane's Loads
7.4 Structural Layout
7.5 Component Sizing

**Chapter 8 Airplane Instruments** （2h）

8.1 Introduction
8.2 Early Airplane Instruments
8.3 Instrument Classification
8.4 Typical Instruments
8.5 Navigation Conception

## 3.Textbooks

Caijun Xue. Introduction to aeronautics, National Defense Industry Press, 2015

**Written by**：XUE Caijun（薛彩军） **Instructor**：XUE Caijun（薛彩军）

**Course Code**：6B091002L

**Course Title(Chinese)**：高等运筹学

**Course Title(English)**：Advanced Operations Research

**College and Department**：Col. of Economics and Management
**Semester**：Autumn
**Class Hours**：56
**Teaching Methods**：Lecture, Case Study, Homework
**Suitable Majors**: Management Science and Engineering
**Assessment Instruments**：Examination 50%, Presentation 30%, Class Performance 20%
**Pre-requisites**：Matrix, Elasticity Mechanics, Mechanical Vibration

## 1. Course Objective and Requirements

The Advanced Operations Research is an effective and efficient tool for optimal operation at the strategic, operational and tactical levels. It is practiced widely by analysts and decision makers in industry, government, and other organizations. In this course, the concept and principle and application are introduced. The objective of this course is to educate students in the fundamental theory and practice of operations research for the understanding, structuring, and improvement of decision making, leading to improved performance of complex defense and non-defense operations and systems. Topics covered include linear & non-linear programming, queuing theory, simulation, decision analysis and multiple attribute decision making, with emphasis on the development and manipulation of mathematical and computer models of complex organizational and operational systems. Examples will be drawn from the areas of resource allocation, logistics, force composition, human resources, operational planning & scheduling, etc.

## 2.Course Content and Schedule

Chapter 1 What Is Operations Research?（4h）
1.1 Operations Research Models
1.2 Solving the OR Model
1.3 Queuing and Simulation Models

1.4 Art of Modeling
1.5 More Than Just Mathematics
1.6 Phases of an OR Study
1.7 About This Book
Chapter 2 Introduction to Linear Programming（4h）
2.1 Two-Variable LP Model
2.2 Graphical LP Solution
2.3 Graphical Sensitivity Analysis
2.4 Computer Solution of LP Problems
2.5 Analysis of Selected LP Models
Chapter 3 The Simplex Method（4h）
3.1 LP Solution Space in Equation Form
3.2 Transition from Graphical to Algebraic Solution
3.3 The Simplex Method
3.4 Artificial Starting Solution
3.5 Special Cases in the Simplex Method
Chapter 4 Duality and Sensitivity Analysis（4h）
4.1 Definition of the Dual Problem
4.2 Primal-Dual Relationships
4.3 Economic Interpretation of Duality
4.4 Additional Simplex Algorithms for LP
4.5 Postoptimal or sensitivity Analysis
Chapter 5 Advanced Linear Programming（4h）
5.1 Simplex Method Fundamentals
5.2 Revised Simplex Method
5.3 Bounded-Variables Algorithm
5.4 Decomposition Algorithm
5.5 Duality
5.6 Parametric Linear Programming
5.7 Karmarkar Interior-Point Method
Chapter 6 Goal Programming（4h）
6.1 A Goal Programming Formulation
6.2 Goal Programming Algorithms
Chapter 7 Integer Linear Programming（4h）
7.1 Illustrative Applications
7.2 Integer Programming Algorithms
7.3 Solution of the Traveling Salesperson Problem (TSP)
Chapter 8 Deterministic Dynamic Programming（4h）
8.1 Recursive Nature of Computations in DP
8.2 Forward and Backward Recursion
8.3 Selected DP Applications
8.4 Problem of Dimensionality
Chapter 9 Forecasting Models（4h）
9.1 Moving Average Technique
9.2 Exponential Smoothing
9.3 Regression
Chapter 10 Decision Analysis and Games（4h）
10.1 Decision Making under Certainty-Analytic Hierarchy Process (AHP)
10.2 Decision Making under Risk
10.3 Decision under Uncertainty
10.4 Game Theory
Chapter 11 Queuing Systems（4h）
11.1 Why Study queues?
11.2 Elements of a Queueing Model
11.3 Role of Exponential Distribution
11.4 Pure Birth and Death Models (Relationship between the Exponential and Poisson Distributions)
11.5 Generalized Poisson Queuing Model
11.6 Specialized Poisson Queues
Chapter 12 Simulation Modeling（4h）
12.1 Monte Carlo Simulation
12.2 Types of Simulation
12.3 Elements of Discrete Event Simulation
12.4 Generation of Random Numbers
12.5 Mechanics of Discrete Simulation
12.6 Methods for Gathering Statistical Observations
12.7 Simulation Language
Chapter 13 Classical Optimization Theory（4h）
13.1 Unconstrained Problems
13.2 Constrained Problems
Chapter 14 Nonlinear Programming Algorithms（4h）
14.1 Unconstrained Algorithms
14.2 Constrained Algorithms

## 3. Case Study

There will be a case where students will have the opportunity to identify, model and solve a sufficiently realistic real-world problem using the various operations research methodologies and software covered in this course. The case will be drawn up by the team and solved by the team members together. All the teams will introduce the selected subjects, ideas and progress.

## 4. Textbooks

(1) Hamdy A. Taha. Operations Research: An Introduction, 9th edition, Prentice Hall, Inc., 2010.

## Main Reference Books

(1) F.S. Hillier and G.J. Lieberman. Introduction of Operations Research, 8th Edition. McGraw Hill. 2005
(2) E.H. Forman and M.A.Selly. Decision by Objectives: How to convince others that you are right, World Scientific, 2001. (electronic version)

**Written by**：ZHOU Peng（周鹏）　　**Instructor**：ZHOU Peng（周鹏）

**Course Code：6B091006L**

**Course Title(Chinese)：高等统计学**

**Course Title(English)：**Advanced Statistics

**College and Department：**Col. of Economics and Management

**Semester：**Autumn

**Class Hours：**32

**Teaching Methods：**Lecture, Homework

**Suitable Majors**: All relevant majors in Economics and Management areas

**Assessment Instruments：**Examination, Project

**Pre-requisites：**Calculus, Probability theory

## 1.Course Objective and Requirements

The course is designed for graduate students majored in management areas include International Business, Industrial Engineering, Marketing, etc. The course provides students advanced statistics with an abundance of real data in the examples, applications, and exercises. Considering the background of students, the course has an increased emphasis on interpreting results, rather than simply obtaining answers, helps students develop statistical literacy and, where appropriate, arrive at practical conclusions.

The course focuses on how students can use theories and model to analyze the data from real cases. Specifically, the following points are expected to learn for students:

- ✓ Grasp statistical ideas, techniques, formulas, and calculations;
- ✓ Interpret and critique graphs and charts, determine probability, and work with confidence intervals;
- ✓ Critique and analyze data from polls, surveys and experiments

## 2.Course Content and Schedule

The overall of the course structure include the following chapters:

1. Introduction to Statistics (1h)
   - 1-1 Overview
   - 1-2 Types of Data
   - 1-3 Critical Thinking
   - 1-4 Design of Experiments
2. Summarizing and Graphing Data (1h)
   - 2-1 Overview
   - 2-2 Frequency Distributions
   - 2-3 Histograms
   - 2-4 Statistical Graphics
3. Statistics for Describing, Exploring, and Comparing Data (2h)
   - 3-1 Overview
   - 3-2 Measures of Center
   - 3-3 Measures of Variation
   - 3-4 Measures of Relative Standing
   - 3-5 Exploratory Data Analysis (EDA)
4. Probability (2h)
   - 4-1 Overview
   - 4-2 Fundamentals
   - 4-3 Addition Rule
   - 4-4 Multiplication Rule: Basics
   - 4-5 Multiplication Rule: Complements and Conditional Probability
   - 4-6 Probabilities Through Simulations
   - 4-7 Counting
5. Probability Distributions (2h)
   - 5-1 Overview
   - 5-2 Random Variables
   - 5-3 Binomial Probability Distributions
   - 5-4 Mean, Variance, and Standard Deviation for the Binomial Distribution
   - 5-5 The Poisson Distribution
6. Normal Probability Distributions (3h)
   - 6-1 Overview
   - 6-2 The Standard Normal Distribution
   - 6-3 Applications of Normal Distributions
   - 6-4 Sampling Distributions and Estimators
   - 6-5 The Central Limit Theorem
   - 6-6 Normal as Approximation to Binomial
   - 6-7 Assessing Normality
7. Estimates and Sample Sizes (3h)
   - 7-1 Overview
   - 7-2 Estimating a Population Proportion
   - 7-3 Estimating a Population Mean: σ Known
   - 7-4 Estimating a Population Mean: σ Not Known
   - 7-5 Estimating a Population Variance
8. Hypothesis Testing (4h)
   - 8-1 Overview
   - 8-2 Basics of Hypothesis Testing
   - 8-3 Testing a Claim about a Proportion
   - 8-4 Testing a Claim about a Mean: σ Known
   - 8-5 Testing a Claim about a Mean: σ Not Known
   - 8-6 Testing a Claim about Variation

9. Inferences from Two Samples (3h)
9-1 Overview 9-2 Inferences about Two Proportions
9-3 Inferences about Two Means: Independent Samples
9-4 Inferences from Matched Pairs 9-5 Comparing Variation in Two Samples
10. Correlation and Regression (3h)
10-1 Overview 10-2 Correlation
10-3 Regression 10-4 Variation and Prediction Intervals
10-5 Multiple Regression 10-6 Modeling
11. Multinomial Experiments and Contingency Tables (3h)
11-1 Overview 11-2 Multinomial Experiments: Goodness-of-Fit
11-3 Contingency Tables: Independence and Homogeneity
11-4 McNemar's Test for Matched Pairs
12. Analysis of Variance (3h)
12-1 Overview 12-2 One-Way ANOVA
12-3 Two-Way ANOVA
13. Statistical Process Control (1h)
14-1 Overview 14-2 Control Charts for Variation and Mean
14-3 Control Charts for Attributes
15. Projects, Procedures, Perspectives (1h)
15-1 Projects 15-2 Procedure
15-3 Perspective

## 3.Textbooks

Elementary Statistics, 10 edition, Mario Triola, Pearson Education, Tsinghua University Press, ISBN:978-7-302-17441-7

## Main Reference Books

[1] Tijms, Henk (2004). Understanding Probability: Chance Rules in Everyday life. Cambridge University Press.
[2] Dodge, Y. (2003) The Oxford Dictionary of Statistical Terms, OUP. ISBN 0-19-920613-9.

**Written by**：CHEN Ye（陈晔） **Instructor**：CHEN Ye（陈晔）,GUO Xu（郭旭）.

**Course Code**：6B092002L

**Course Title(Chinese)**：高级管理学

**Course Title(English)**： Advanced Management

**College and Department**：Col. of Economics & Management

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Homework

**Suitable Majors**: Management Science and Engineering

**Assessment Instruments**：Examination, Project

**Pre-requisites**：Matrix, Elasticity Mechanics, Mechanical Vibration

## 1. Course Objective and Requirements

The Advance Management is introduced systematically about the status quo of management theory and applications. Topics include the history and development trends of management; definitions and characteristics of management theories; uncertainty of decision making; contingency theories of leadership; behavioral theories of leadership; theoretical basis of motivation and their applications; and fundamentals of control theory. Through the theories and cases study, the course provides some experience with attainment and consciousness of management. The students can be advanced their capability of solving problems with knowledge of management science based on the theories and cases study.

## 2.Course Content and Schedule

Chapter 1 **Introduction to Management and Organizations**（4h）
- 1.1 Who Are Managers
- 1.2 What Is Management
- 1.3 What Do Managers Do
- 1.4 What Is An Organization
- 1.5Why Study Management?

Chapter 2 **Management History**（4h）
- 2.1 Historical Background Of Management
- 2.2 Classical Approach
- 2.3 Quantitative Approach
- 2.4 Behavioral approach
- 2.5Contemporary Approach?

Chapter 3 **Managers as Decision Makers**（6h）
- 3.1 The Decision-Making Process
- 3.2 Managers Making Decisions
- 3.3 Types Of Decisions and Decision-Making Conditions
- 3.4 Decision-Making Styles
- 3.5 Effective Decision Making In Today’s World

Chapter 4 **Managing Human Resources** （6h）
- 4.1 The Human Resource Management Process
- 4.2 Identifying and Selecting Competent Employees
- 4.3 Providing Employees with Needed Skills and Knowledge
- 4.4 Retaining Competent, High Performing Employees
- 4.5 Contemporary Issues in Managing Human Resources

Chapter 5 **Motivating Employees**（4h）
- 5.1 What Is Motivation
- 5.2 Early Theories of Motivation
- 5.3 Contemporary Theories of Motivation
- 5.4 Current Issues in Motivation

Chapter 6 Managers As Leaders（4h）
- 4.1 Who Are Leaders and What Is Leadership
- 4.2 Early Leadership Theories
- 4.3 Contingency Theories of Leadership
- 4.4 Contemporary Views of Leadership
- 4.5 Leadership Issues in the Twenty-First Century

Chapter 7 Introduction to Controlling（4h）
- 7.1 What Is Control and Why Is It Important?
- 7.2 The Control Process
- 7.3 Controlling Organizational Performance

7.4 Tools for Measuring Organizational Performance
7.5 Contemporary Issues in Control

## 4.Textbooks

(1) Rao, S. S. The Finite Element Method in Engineering, 4th edition, Elsevier Inc., 2005
(2)Cook, R. D., Malkus, D. S., Plesha, M. E., & Witt, R. J. Concepts and Applications of Finite Element Analysis. (4th edition) John Wiley & Sons. 2002.
(3)Liu, G. R., Quek, S. S., The Finite Element Method:A Practical Course, Butterworth-Heinemann, 2003

## Main Reference Books

1．S. P. Robbins &M. Coulter，Management，Tsinghua University Press（Tenth Edition）
2．Stephen P.Robbins，Mary Coulter，Management science，China Renmin University Press（Ninth Edition），2008.
3．Samuel C. Certo, Modern Management – Diversity, Quality, Ethics and the Global Environment, Prentics Hall, 2004.
4．Charles W.L.Hill, Steven L. Mcshane, Principles of Management，China Machine Press，2009.

**Written by**：ZHANG Ling（章玲）　　**Instructor**：ZHANG Ling（章玲） et al.

**Course Code**：6B093009L

**Course Title(Chinese)**：国际金融管理

**Course Title(English)**：International Finance Management

**College and Department**：Col. of Economics & Management

**Semester**：Autumn

**Class Hours**：32

**Teaching Methods**：Lecture, Discussion, Presentation, Homework

**Suitable Majors**: Majors in Applied Economics

**Assessment Instruments**：Examination, Presentation, Daily performance

**Pre-requisites**：Economics, Money and Banking, Accounting

## 1. Course Objective and Requirements

International Finance is an advanced and elective course for Finance majors and recommended for students who want to pursue careers in multinational corporate finance, currency trading, global banking, global asset management or risk management industry. This course provides a rigorous introduction to the fundamental principles of international financial management and investment. The main focus of the course is on foreign exchange and international capital markets. To this end, we develop the theories and quantitative tools that are necessary for global asset management and investment. Topics to be discussed include foreign exchange and Eurocurrency markets, financial instruments, international parity propositions, currency risk exposure and hedging, cross border capital budgeting.

Good skills in finance, accounting, macroeconomics, and statistics are required. Students should understand the concepts of no-arbitrage relations, discount rate, risk premium, expected return and risk, CAPM, prior to taking International Finance.

## 2. Course Content and Schedule

Lecture 1: Preface and global finance environment（4h）
- Overview of the course
- Integration of the world market
- Balance of payments (BOP)
- International investment position (IIP)

Lecture 2: Global finance environment Ⅱ （4h）
- Foreign Exchange Markets
- Government policies toward Fx market
- International monetary system

Lecture 3: Foreign exchange rate determinative theory （4h）
- The asset market approach
- Purchasing power parity (PPP)
- The monetary approach
- Exchange rate overshooting

Lecture 4: Derivatives for currency Risk Management （4h）
- Currency Futures
- Currency Options
- Currency Swaps

Lecture 5: Managing the Risks of Multinational Operations I （4h）
- The Rationale for Hedging Currency Risk
- Multinational treasury management

Lecture 6: Managing the Risks of Multinational Operations II （4h）
- Managing Transaction Exposure,
- Managing Operating Exposure,
- Managing Translation Exposure to Currency Risk

Lecture 7: Valuation and the structure of multinational operations（4h）
- Cross border capital budgeting
- Multinational capital structure and cost of capital
- Risk options and cross border investment
- Corporate governance and the international market for corporate control

Lecture 8 Presentations and examination by students （4h）

## 3.Textbooks

(1) Michael H. Moffett, *fundamentals of multinational finance, the third edition, China machine press*
迈克尔. 莫菲特等，国际金融， 第三版， 机械工业出版社，2010。 注：此书为英文原版精编版

**Main Reference Books**

(1) Kirt C. Butler, *Multinational Finance*, most recent Edition, South-Western College Publishing.

国际金融（multinatinational finance），科特. C. 巴特勒 （Kirt C. Butler）著， 张成思 译注，东北财经大学出版社

(2) *International finance (14 edition)* 中国人民大学出版社 Thomas A. Pugel 2009 35 CNY

**Written by：** LI Jie (李杰)

**Instructor：**LI Jie（李杰）**,** Wang Ying（王英）, Xiao Longjie（肖龙阶）