**Power Engineering and Engineering Thermophysics 0807**

**1.Overview**

The discipline of Power Engineering and Engineering Thermophysics (PEET) is the national first-class key discipline,and it has been ranked as TOP position in engineering thermophysics and energy utilization discipline in China. It has four important research bases, the state key laboratory of multiphase flow in power engineering, the national engineering research center of fluid machinery &compressors, the state laboratory of fluid machinery, the key laboratory of thermo-fluid science and engineering of Ministry of Education, which are also the important human resources for Chinese society in field of energy and power engineering. There are over 200 staffs being engaged in many crucial areas including multiphase flow and heat/mass transfer, fluid mechanics and machinery, turbo machinery, combustion, heat exchangers, CFD/NHT, multiscale and multiphysics transport phenomena, refrigeration andcryogenics, sustainable and new energy, energy and environment, aerospace power and space environment.

**2.Objectives**

The program aims to cultivate talents with comprehensive ability and help them develop morally, intellectually, physically and aesthetically.
Through the training of PhD, students should master solid and broad basic theories, systematic in-depth professional knowledge, have the ability to undertake independent scientific research and teaching, gain innovative achievements in this field, have a rigorous and realistic scientific attitude and work style, and strive to resolve sci-tech difficulties.
For Master students, apart from mastering solid and broad basic theories, systematic in-depth professional knowledge, they have to get familiar with the sci-tech developing trend of the research areas as well as gain the ability to undertake scientific research or special technologies independently.

**3. Research Areas**

a. Thermal Energy Engineering

b. Power Machinery and Engineering

c. Fluid Machinery and Engineering

d. Engineering Thermophysics

e. Refrigeration and Cryogenics Engineering

f. Sustainable Energy and New Energy Technology

g. Energy and Environmental Engineering

h. Aerospace Power and Space Environmental Engineering

**4. Length of Study**

The full-time scheme lasts for two or three years for master students and three to six years for PhD students.

**5. Training Mode**

For PhD candidates, group training mode with supervisor as the top priority should be conducted in the program or united training with other universities, institutes, factories and enterprises can also be adopted to absorb people with high title to participate in the guidance. During the process, based on the demand of the program and students’ personalities, supervisors should make plan and direct PhD candidates in the field of dissertation, document searching, survey, scientific research, thesis writing and defense,strengthening students’ ability of self-study, operation, expression and writing.
For Master students, training mode with supervisors as the top priority should be conducted in the program or united training with other universities, institutes, factories and enterprises can also be adopted to absorb people with high title to participate in the guidance. The process includes course learning and academic dissertation. In accord with the program demand and students’ personalities, supervisors should make plan and direct master students in the field of dissertation, paper work ,thesis writing and defense, strengthening students’ ability of self-study, operation, expression and writing.

**6. Graduate Study**

**Table1** Curriculum structure of Ph.D

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Module** | **Course Code** | **Course Title** | **Credits** | **Minimum Requirement** |
| **Communicaiton** | 272004LITE6102 | Comprehensive Chinese | 2 | 4 |
| 272003LITE6101 | The Outline of China | 2 |
| **Degree Courses** | 031001ENPO6001 | Advanced Fluid Mechanics | 3 | 4 |
| 031002ENPO7001 | Numerical Heat Transfer | 3 |
| 031003ENPO6106 | Practical Guide to English Scientific Writing | 2 |
| 032071ENPO6111 | Advanced Engineering Thermodynamics | 3 |
| 032070ENPO6110 | Advanced Heat Transfer | 3 |
| 032072ENPO6112 | Advanced Combustion Theory | 2 |
| 032049MECH6122 | Flow Dynamics of Multiphase Mixture | 2 |
| 032077MECH6123 | Computational Fluid Dynamics | 2 |
| 032053ENPO7113 | Modern Developments of Combustion Science and Technology | 2 |
| 032057ENPO7116 | Multiphase Flow and Its Advances | 2 |
| 032040ENPO6104 | Tensor Analysis and Application in Engineering | 2 |
| 032012MECH7116 | Recent Progress in Fluid Mechanics Research | 2 |
| 032058ENPO6107 | Modern Control Engineering and Measurement Technology | 2 |
| 032033ENPO8102 | Recent Advances in Computational Heat Transfer | 2 |
| 032069ENPO8105 | Modern Development of Thermodynamics | 2 |
| 032051ENPO7112 | Approaches for the Numerical Simulation of Two-Phase Flows | 2 |
| 032052ENPO6116 | The principle and technology for new energy conversion | 2 |
| 032060ENPO6109 | The Quantitative Analysis Theory of Thermal System and Cogeneration Technology | 2 |
| 032067ENPO7121 | Modern Compressor Theory and Its Application | 3 |
| 032066ENPO7120 | Modern Compressor Theory and Its Application | 2 |
| 032044ENPO7108 | Strength and Vibration Analysis of Power Machinery Structures | 2 |
| **Optional** |  | Students can select any course at the list of Graduate School |  | 4 |
| **Compulsory** | 001999BXHJ8003 | Academic Activities (Lectures) | 2 | 8 |
| 001994BXHJ8001 | Mid-term Assessment | 6 |
| **Thesis** |  |  | 60 | 60 |
| **Total** |  | 80 |

**Table2** Curriculum structure of Master

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Module** | **Course Code** | **Course Title** | **Credits** | **Minimum Requirement** |
| **Communicaiton** | 272004LITE6102 | Comprehensive Chinese | 2 | 4 |
| 272003LITE6101 | The Outline of China | 2 |
| **Degree Courses** | 031001ENPO6001 | Advanced Fluid Mechanics | 3 | 6 |
| 031002ENPO7001 | Numerical Heat Transfer | 3 |
| 031003ENPO6106 | Practical Guide to English Scientific Writing | 2 |
| 032071ENPO6111 | Advanced Engineering Thermodynamics | 3 |
| 032070ENPO6110 | Advanced Heat Transfer | 3 |
| 032072ENPO6112 | Advanced Combustion Theory | 2 |
| 032049MECH6122 | Flow Dynamics of Multiphase Mixture | 2 |
| 032077MECH6123 | Computational Fluid Dynamics | 2 |
| 032053ENPO7113 | Modern Developments of Combustion Science and Technology | 2 |
| 032057ENPO7116 | Multiphase Flow and Its Advances | 2 |
| 032040ENPO6104 | Tensor Analysis and Application in Engineering | 2 |
| 032012MECH7116 | Recent Progress in Fluid Mechanics Research | 2 |
| 032058ENPO6107 | Modern Control Engineering and Measurement Technology | 2 |
| 032033ENPO8102 | Recent Advances in Computational Heat Transfer | 2 |
| 032069ENPO8105 | Modern Development of Thermodynamics | 2 |
| 032051ENPO7112 | Approaches for the Numerical Simulation of Two-Phase Flows | 2 |
| 032052ENPO6116 | The principle and technology for new energy conversion | 2 |
| 032060ENPO6109 | The Quantitative Analysis Theory of Thermal System and Cogeneration Technology | 2 |
| 032067ENPO7121 | Modern Compressor Theory and Its Application | 3 |
| 032066ENPO7120 | Compressor design optimization technology | 2 |
| 032044ENPO7108 | Strength and Vibration Analysis of Power Machinery Structures | 2 |
| 031001ENPO6001 | Advanced Fluid Mechanics | 3 |
| **Optional** |  | Students can select any course at the list of Graduate School |  | 12 |
| **Compulsory** | 001997BXHJ6003 | Academic Activities (Lectures) | 1 | 4 |
| 001994 | Mid-term Assessment | 3 |
| **Thesis** |  |  | 25 | 25 |
| **Total** |  | 51 |

**7. Academic Dissertation**

**Master thesis**:Master thesis should be finished independently by students under the guide of supervisors. The thesis, which should be prepared at least 1 year, must be systematic and complete with new insights. The topics should be identified with the help of supervisors and through reading documents and doing investigation.
The thesis should be concise, rigorous and accurate in theoretical guidance and computation. The presentation should be conducted with a pragmatic scientific attitude.

At least two paper reviewers with senior titles who get familiar with the paper are needed. The other should come from other departments. For instance, if the paper focuses on software design or development, one of the reviewers should be familiar with it and do the acceptance. The defence can only be conducted with the agreement of the reviewers. If one reviewer disagrees, another one should be employed; if two reviewers reject, the defence can only be conducted after reapplying through revising the paper.
Thesis need review and defence. When presenting an oral defense, graduates are supposed to answer questions related to the thesis, including professional basic theory and specialized knowledge.
**PhD Dissertation**: PhD dissertation should be completed under the guidance of supervisors and research topic and scope need to be identified through document reading and investigation. Candidates should take the advantage of strong points of their supervisors and themselves, combining the scientific task to make creative achievements.
Students should prepare materials at the beginning of the second semester and identify the preliminary topic at the end of it. The proposal report must be finished and read out at the conference of teaching and research section so as to seek for opinions. At the beginning of the third semester, final topic and paper work plan should be identified and worked out including main contents in different periods, requirements and completion deadlines, etc.
During the process of scientific research which costs nearly one semester, PhD candidates should present a progress report on the meeting organized by different departments.

**8. Research Centers**

**1)The State Key Laboratory of Multiphase Flow in Power Engineering**

The State Key Laboratory of Multiphase Flow in Power Engineering was ratified to establish by State Planning Commission in February 1990, and completed in December 1992. Now the director is Prof. GuoLiejin, assigned by the Education Ministry's "Yangzi River Scholars Rewarding Programme", from Xi'an Jiaotong University, and the chairman of Academic Committee is academician of CAS ( Chinese Academy of Science) XuJianzhong from Tsinghua University . In March 1997, the Laboratory was appraised as the top one of engineering thermo-physics and energy utilization subject in material and engineering field during the national evaluation organized by the MOST (Ministry of Science and Technology) and NSFC (National Natural Science Foundation of China). In March 2003, the Laboratory was ranked as the first place again, appraised as the top one among the total 29 State Key Laboratories and got the "First-class" State Key Laboratory (A). The present main academic fields are focused on: High pressure steam-water two-phase flow and its heat and mass transfer; Multiphase flow theory and measurement technique in petroleum engineering; Multiphase flow and energy and mass transfer in chemical processes, natural resource exploiting, and environmental protection; Multiphase flow in clean combustion and emission control; New energy conversion and high technology, etc..

**2)The National Engineering Research Center of Fluid Machinery & Compressors**

The National Engineering Research Center of Fluid Machinery & Compressors is one of the NERC approved by the State Developing Planning Committee in 1995 and based at Xi'an Jiaotong University, and also a sub-project of science & technology development of World Bank. Its total investments are USD $3.5 millions from World Bank Loan and 10.0 millions Yuan RMB from domestic resource. The main task of the center is to research and develop key technologies, to implement "technology transfer" through integration of production, teaching and research in the area of fluid machinery & compressors, and to provide enterprises with advanced technologies, i.e. carries out R & D and system integration for the products having marketing prospects. The Center, therefore, is also intermediary experimental base from research to production.

**3)The state laboratory of fluid machinery (SLFM)**

The state laboratory of fluid machinery (SLFM) was ratified to establish by State Planning Commission in 1990 and completed in 1993. It was supported in financial by the World Bank Loan in 1998. Now the director of SLFM is Prof. Xi Guang from Xi'an Jiaotong University, and the chairman of Academic Committee is academician of XuJianzhong from Chinese Academy of Science. Major Research Fields include: Theoretical and experimental studies of fluid machinery; Design method and applied technology for centrifugal compressor and general fluid machinery; Fluid engineering for Ecological environment and biologic technology; Information fluid engineering and control technology; Fluid-structure coupling noise control technique; Theoretical and experimental studies of gas-solid, liquid-solid two-phase flows in fluid machinery; Optimal design and computer aided design of fluid machinery, the study on high quality fluid machinery and the components.

**4)The Key Laboratory of Thermo-Fluid Science and Engineering of Ministry of Education**

The Key Laboratory of Thermo-Fluid Science and Engineering of Ministry of Education was officially approved by the State Ministry of Education in November 2010 for preparing the establishment. This Laboratory is aimed at conducting a series of foresight and strategic systematic researches related to the basic scientific issues originated from the processes of energy transport and utilization. The research activities of the Laboratory are focused on four areas: mechanism and technology in heat and mass transfer enhancement; thermophysical properties of fluids and new working fluids for energy-saving and environment-protection; numerical simulation in thermo-fluid science and complex fluid transport; applications of thermo-fluid fundamentals in new energy, energy saving, and emission reduction. The Laboratory is expected to be a comprehensive interdisciplinary creative research center and a base in the fields of energy transport and utilization, a teaching center for the courses of fluid mechanics, thermodynamics and heat transfer, and an education center for the talents of energy and power engineering. The researches executed in the Laboratory are characterized by their fundamental, comprehensive and international features, with attention being paid on the intersecting of disciplines.

**9. Description of Courses**

**(1)032012 Recent Progress in Fluid Mechanics Research**

**Credits：2**

**Prerequisites:**

**The Principle of Impeller Machinery**

**Higher Fluid Dynamics**

**Numerical Method**

The course is offered to Master and PhD students of power engineering and thermophysics.In the course, the most up-to-date science and technology on the numerical method in the fluid flow is lectured. Some recent study progress on finite difference method, finite element method and mesh-free particle method are introduced.It includes unstructured mesh, high accuracy difference scheme, slide surface method in unsteady flow and modern measurement technology for complex flow. The optimal design theory including deduced optimal method, respond surface method and multi-parameter optimal method is also introduced. Some advanced numerical method used in micro-fluid flow and large eddy simulation are presented in the course. According to different claim, the selected subject and worked method are provided for Master and PhD students.

**(2)032040Tensor Analysis and Application in Engineering**

**Credits：2**

**Prerequisites:**

**Advanced Mathematics**

**Fluid Mechanics**

**Solid Mechanics**

**Continuum Mechanics**

The tensor analysis method was widely applied in various science branches and engineering areas. The tensor analysis method, as applied to describe and study the mathematical model for engineering problems, has several advantages such as clear meanings, solid foundations and flexible expressions. The main contents of this course are: brief introduction to tensor analysis, tensor analysis in Cartesian coordinates, arbitrary curvature coordinates and curvature surfaces, application of tensor analysis in fluid mechanics, fluid machinery and solid mechanics. The essentials of this course are not only to teach the basic theory and operators of tensor analysis, but also to teach the engineering background and physical meaning of tensor analysis; the latter is quite important for the students in engineering university to grasp easily and deeply the mathematical tools such as tensor analysis.

**(3)032044 Strength and Vibration Analysis of Power Machinery Structures**

**Credits：2**

**Prerequisites:**

**Theoretic Mechanics**

**MaterialMechanics**

**Vibration Mechanics**

This course will introduce the structure stress, vibration analysis and reasonable structure design and material selection of blade, disk, rotor, casing and diaphragm in turbomachinery. It is high technique engineering subject and should be taken for part of Thermal Power Engineering students. It will help the students for the further career of working in the Power Plant, Turbine Manufacturing Company in turbine design, operation and maintenance ability.

From studying this course, you can get more knowledge and do some strength calculation and verification about the main components of turbomachinery. eg. blade, disk, rotor and casing. You will also know how to design a blade, disk, rotor and keep them in the safety position. You will learn how to get the natural frequency of a real blade and critical speed of rotor by experiment.

**(4)032066Compressor design optimization technology**

**Credits：2**

**Prerequisites:**

**Engineering thermodynamics**

**Fluid mechanics**

**Heat transfer**

**Mechanical design**

**Calculation method**

This course mainly introduces compressor optimization design concept, method and the mathematical model of optimization design, its content includes: compressor optimization design content, research ideas and research methods. All kinds of commonly used optimization design methods. The mathematical simulation of the commonly used compressor working process. The commercial CFD software in the application of the compressor flow field analysis.

**(5)032070 Advanced Heat Transfer**

**Credits：3**

**Prerequisites:**

**Heat Transfer**

**Fluid Dynamics**

**Engineering Thermodynamics**

The Advance Heat Transfer mainly describes the mechanism for heat conduction, heat convection, radiation and enhanced heat transfer. This course focuses on the fundamental equations and solving methods for the fluid flow and heat transfer problems. The content mainly includes three parts: heat conduction (describing the basic principles and mathematic formulations for heat conduction, variable separation method, Duhamel theorem method, and Green function method), heat convection (describing basic mathematic equations for heat convection, boundary layer equations, laminar heat transfer for external boundary layer, laminar forced convection in ducts, natural convection, brief introduction to turbulent fluid flow and heat transfer, and phase change heat transfer), and radiation (describing surface radiation characteristics, solid angle, radiation heat transfer for random surface, radiation heat transfer combined other heat transfer modes, and radiation heat transfer for absorptive media)

**(6)032071 Advanced Engineering Thermodynamics**

**Credits：3**

**Prerequisites:**

**Advanced math**

**Basic Physics**

**Computing method**

**Engineering thermodynamics**

**Heat transfer; Fluid mechanics**

Advanced Engineering Thermodynamics is the prolongation and development of Engineering Thermodynamics. Its content includes: Microscopic explanation of basic concept and principle in classical thermodynamics, EOS of real gas and calculation of induced thermodynamic properties, fundamentals of solution thermodynamics, vapor- liquid phase equilibrium and its calculation, exergy analysis of energy system and its application, statistical thermodynamics fundamentals and its application etc..

**(7)032072 Advanced Combustion Theory**

**Credits：2**

**Prerequisites:**

**Fundamental Chemistry**

**Fundamental Thermodynamics**

Why is it useful to study combustion? One motivation is that this source contributes with more than 85% of all the energy supply throughout the world, and the energy usage increases globally by 3% per year. Another motivation is that knowledge in combustion is important for the modern engineer or scientist to be able to make combustion processes more efficient and to develop them to produce less pollutants, such as hydrocarbons, particles and nitrogen oxides. Thus, we need to study combustion processes. Research on alternative fuels also enables a transition to a future sustainable society.

This course aims at providing the basics for understanding combustion phenomena. This includes thermodynamics, chemical kinetics, ignition, fluid dynamics and the formation of pollutants. From the knowledge in these areas it is possible to reach an understanding for energy related and environmental problems connected to real life combustion.

**(8)031001 Advanced Fluid Mechanics**

**Credits：3**

**Prerequisites:**

**Advanced Mathematics**

**Complex Functions**

**Equations of Mathematical Physics**

**Fluid Mechanics**

**Engineering Thermodynamics**

The first-year graduate students of science and technology are encouraged to enroll in this course, which covers the basis of advanced fluid mechanics. The fundamental concepts, principles and equations of fluid mechanics can be better understood through this study, and the capacities of theoretical analysis and practical applications are therefore obtained. According to priority order, the content of this course, such as basic concepts and equations of fluid mechanics, characteristics of ideal flow, two-dimensional potential flow, axisymmetric potential flows, vortical motion of ideal fluid, exact solutions ofincompressible viscous flow, low Reynolds number flow, boundary layer flow in laminar regime, turbulent flow, one-dimensional unsteady flow and planar flow of compressible ideal fluid, are introduced sequentially.

**(9)031002 Numerical Heat Transfer**

**Credits：3**

**Prerequisites:**

**Fluid mechanics**

**Heat transfer**

**Numerical methods**

Heat transfer and fluid flow problems are governed by a set of partial different equations. Because of the complexity of the governing equations, analytical solutions are only allowed for very simple cases, making it necessary to use numerical techniques and computers for most problems of practical interest. During the past four decades, numerical or computational heat transfer and fluid dynamics have emerged as important tool for both scientific research and engineering design. And with the fast development of computer hardware and solution techniques, their importance will become more and more obvious.

In this course the fundamental theories, methods and engineering applications of computational fluid dynamics and computational heat/mass transfer are comprehensively and systematically introduced. It has two parts, one is the basic theory and the other is a two-dimensional general computer program. Through the introductions of the principles of finite volume method（FVM）,its implementation and application examples about diffusion (heat conduction) and convective heat/mass transfer, the students can not only grasp the principles of FVM and but also know the details of their implementations well. The two-dimensional general computer program can be used for solving the problems of heat/mass conduction/diffusion and convection of incompressible fluid in three two-dimensional orthogonal coordinate systems. Through modification of user's subroutine source code, this program can also be used for solving many technical problems in engineering. The teaching of this course puts emphasis on applying physical concepts in the development of numerical methods , revealing the physical background of numerical methods, and training the ability of postgraduates for solving real engineering problems by using numerical methods. Through the learning of this course the students will have a sound background for understanding and applying related commercial software.

**(10)032033 Recent Advances in Computational Heat Transfer**

**Credits：2**

**Prerequisites:**

**Fluid mechanics**

**AdvancedHeat transfer**

**Numerical methods**

**Numerical heat transfer**

Graduates should learn to discern the recent research advances of numerical techniques based on the finite volume method (FVM) in computational heat transfer and fluid flow, grasp at least one newly numerical method by their computational practice and solve the engineering problems, develop the codes to predict the relevant fluid flow and heat transfer processes. They should peruse some published papers on the research fronts of the relevant speciality, propose a course report, give a short speech and discuss with professors and classmates.

**(11)032057 Multiphase Flow and Its Advances**

**Credits：2**

**Prerequisites:**

**Fluid mechanics**

**Heat transfer**

Introduction (6hrs); Basic equations of multiphase flow and major describing parameters (4hrs); Dynamics of bubble and particle (4hrs); Multiphase flow in pipelines (6hrs); Multiphase flow over tubes (4hrs); Separation and distribution of multiphase flow (6hrs); Multiphase flow in turbomachinery (3 hrs); Numerical simulation of multiphase flow (5 hrs); Specific topics (2hrs)

**(12)032053 Progresson Combustion Science and Technology**

**Credits：2**

**Prerequisites:**

**Combustion Theory**

This course is set for the graduated students conducting research on combustion progress in the departments of Thermal Engineering, Power Engineering and Chemical Engineering. It mainly demonstrates the latest development in the area of combustion science and technology. The content in this course mainly includes the progress of coal combustion, internal combustion engine, biomass combustion, micro-scale combustion, microgravity combustion, combustion synthesis, pollutant control in combustion, combustion modeling and combustion diagnose.

**(12)032060** **Poly-Generation Technology and Its Progress**

**Credits：2**

**Prerequisites:**

**Engineering Thermodynamics**

**Heat Transfer**

**Thermal System and Equipment of Power Plant**

The technology of combined heat and power generation had been developed rapidly since 1911 in Europe and USA, which was the firstclimax phase for the development of combined heat and power generation. Some global crises have appeared, including energy crisis, greenhouse effect and the shortage of fresh water, since 1970s. The scientific problem on efficient utilization of existing energy sources becomes a hot topic. The heating, cooling, electricity generation, freshwater production and chemical products production are combined in poly-generation technology, with which the sustainable development of energies, resources and environment could be realized.

In this course, different kinds of poly-generation system and analysis models on economy, environmental, energy efficiency characteristics will be introduced. Furthermore, the development situation and recent progress will be reviewed. The main contents include basic methods and progress of the seawater desalination, basic methods and progress of the cogeneration, energy consumption characteristics of poly-generation system, the thermo-economic evaluation method of poly-generation system, and the development of poly-generation system.

**(13)032067 Modern Refrigeration and Air conditioning theory and Computer Simulation Technology**

**Credits：3**

**Prerequisites:**

**Principle of Refrigeration Technology**

**Refrigeration and Air Conditioning apparatus**

**Air Conditioning Technology**

This course is for graduate students of refrigeration and cryogenic engineeringspecialty. This professional courseprovides the advanced knowledge about the basic thermophysic process of refrigeration & air-conditioning systems as well asthe computer simulation techniques for vapor-compression refrigeration systems. The main content of this course is involved in the analyses of vapor-compression refrigeration systems, dual evaporator refrigeration systems, analysis of air-source heat pump, dynamic characteristics of vapor-compression refrigeration systems, new technology and appliances in the refrigeration & air-conditioning field, heat transfer enhanced technology for the heat exchangers applied in refrigeration & air-conditioning appliances, introduction of computer simulation techniques, basic simulation methodology for vapor-compression refrigeration systems, the models for evaporator, condenser, compressor,capillary tube as well as the simulation algorithm and software.

**(14)032077 Computational Fluid Dynamics**

**Credits：2**

**Prerequisites:**

**advanced mathematics**

**computational methods**

**university physics**

**fluid dynamics**

**heat transfer**

**thermodynamics**

Recently, CFD (Computational Fluid Dynamics) method has been widely employed in the engineering field which involves with flow, heat transfer, condensation, combustion, etc. On the basis of NS (Navier-Stokes) equations solution, the flow field in the apparatus or components can be numerically obtained. Therefore, CFD is becoming a general research and design (R&D) tool in power engineering, meteorology, oceanography, oil recovery, environmental engineering, biological engineering, and also in architecture. As the flow field is usually important part of the multi-physic fields, many numerical techniques developed for CFD are also used in the solutions of FSI (Fluid-Structure Interaction) problem or Maxwell equations (for example, fluid-magnetic-heat transfer coupled problem). Hence, CFD is now commonly accepted in engineering and research fields. With this tool, it can effectively reduce the design cycle, costs and also improve the overall performance of the products before manufacture. However, it would be completely wrong to think that CFD has been a mature technology now. There are still many open questions like turbulence and combustion modeling, efficient solution techniques for viscous flow, heat transfer, robust and accurate discretization methods, etc. Therefore, many strategies have to be adopted and carefully validated in the numerical simulations to ensure the stability and accuracy. In this course, these commonly used strategies will be introduced in detail.

The objective of this course is to provide graduate students (including PhD candidate) with a solid foundation for understanding the numerical methods employed in today’s CFD and to familiarize them with modern CFD software and codes experiences. This course is also aiming at teaching the future engineers and scientists who are applying CFD codes to deal with flow involved problems.

The contents of this course are as follows:

(1) Introduction of Computational Fluid Dynamics

(2) Basic principles of fluid dynamics

(3) Characteristics of partial equations in CFD solutions

(4) Methods of discretization

(5) Grid generation technologies

(6) Brief introduction to finite volume method and its solution

(7) Turbulence flow solution

(8) Boundary conditions

(9) Accuracy and validation

(10) CFD applications

**(15)032051 Approaches for Numerical Simulation of Two-Phase Flows**

**Credits：2**

**Prerequisites:**

**Computational methods**

**Two-phase flow dynamics**

**Two phase flow and boiling heat transfer**

**Numerical heat transfer**

**Numerical fluid dynamics**

Fundamental theories, basic models and basic equations, some key issues and basic simulation methods will be addressed in this course, to generally meet the demand of students for applying numerical simulation methods in their study of two-phase or multiphase flows, and as well, to lay some basic foundations for students to properly use numerical simulation technologies in related engineering applications.

Specifically, the following topics will be covered in this course: categorization of numerical methods used in study of two-phase flows (gas-liquid two-phase flows, even three phase flows); general considerations, developments, applications, merits and shortcomings, and latest advances of the main numerical methods used in study of two-phase flows; the principals, basic equations, related computational methods, numerical implementation procedures and practical applications of the Level Set method; the principals, basic equations, related computational methods, numerical implementation procedures and practical applications of the Volume of Fluid (VOF) method. Some topics related to the meshless methods and smooth particle hydrodynamics method will also be introduced.

Based on the study of this course, the students are hoped to generally understand the basic theory for numerical simulation of two-phase even multiphase flows, and to gain the basic capability to use the numerical technologies in studies of two-phase or multiphase flow phenomena. This course can also be considered as a basis for students who wish to learn further and improve their capabilities to use different numerical methods and models in the study of complicated two-phase or multiphase flows coupled possibly with moving boundaries, heat transfer, phase change, turbulence transportation or porous media, and so on.

**(16)032058 Modern Control Engineering and Measurement Techniques**

**Credits：2**

**Prerequisites:**

**Complex Function,Linear Algebra**

**Integral Transform, Statistics**

**Principle of Automatic Control**

An overview of the modern control engineering and measurements including: the rudiments of MATLAB,differential equation, transfer function, state space model, Z- transfer function model and difference equation model, along with their reciprocal transformations, time domain analysis and frequency domain analysis of a control system, discrete-time approximation of the continuous-time state differential equation,performance analysis of a control system,cascade compensation, root locus compensation and frequency method compensation of a control system,the designs of a discrete control system and its state space,the rationale of dynamic test, fourier transform and algorithm, linear system analysis, power spectrum estimation and data preprocessing, system modeling and parameter identification, dynamictesting technology, signal analysis, error analysis and uncertainty assessment for measurement, measurement system, sensors, data acquisition, virtual instrumentation, fieldbus, multiple statistics process data analysis, soft-sensing.

**(17)032069 Recent Advances in Engineering Thermodynamics**

**Credits：2**

**Prerequisites:**

**EngineeringThermodynamics**

**Fluidmechanics Heattransfer**

**Fundamental chemistry**

The research progress for non-equilibrium thermodynamics, the development of refrigerants and nano-refrigerant, thermodynamic system for variable mass and its applications and electrochemical thermodynamics are introduced. Graduates should have a general understanding for the four aspects, understand the basic concepts and theories, and grasp the ideas and methods of the research. They should peruse some published papers on the research fronts of the relevant aspects, and their ability for analysis and solve problems should be further developed.