

《Additive Manufacturing Technology》

Curriculum Syllabus

By **Prof. Dr.-Ing. Tian Xiaoyong**, School of Mechanical Engineering

1. Basic information

- 1.1. **Course code:** MACH502801
- 1.2. **Course system/category:** specialized optional courses
- 1.3. **Course period/credit:** 40 hours (including 24 hours teaching, experiments 16 hours) / 2 credits
- 1.4. **Prerequisite course:** Material Mechanics, fundamental of thermo-technology, Basis of Materials Engineering, mechanical drawing, Fundamentals of Mechanical Manufacturing Technology, Fundamentals of material forming technology, Numerical Control Technology
- 1.5. **Applicable major:** Major of machinery

2. Course objectives and abilities achieved by students

Additive Manufacturing Technology is an optional course for mechanical specialty in engineering colleges and universities. It plays an important role in cultivating students' creative thinking, engineering innovation and comprehensive practical ability.

The main task of this course is to cultivate students' innovative consciousness and ability as well as comprehensive application ability of mechanical engineering science knowledge through classroom teaching, experimental teaching and project research, so as to enable students to master the basic theory, basic knowledge and basic skills of incremental manufacturing technology. The knowledge of material type, process method and application related to additive manufacturing technology will be introduced in the class. Students' ability of innovative development and application of additive manufacturing technology and equipment will be cultivated to solve practical problems encountered in engineering practice.

The curriculum objectives and competence requirements are as follows:

Course objective 1: To master the basic theory, knowledge and skills of additive manufacturing technology, and to cultivate students' interdisciplinary innovative thinking ability.

Course objective 2: To grasp the general rules of the related knowledge of material types, process methods, equipment and application requirements of additive manufacturing process, and to have the ability of innovative development and application of additive manufacturing process and equipment with the latest frontier progress.

Course objective 3: Through in-class experiments or project research, guide students to adopt additive manufacturing technology to solve practical problems encountered in the process of engineering practice, and cultivate students' innovative ability and comprehensive practical

ability.

Course objective 4: Through the study of professional knowledge and practical operation training, students will be guided to understand the influence of additive manufacturing technology on social production and life mode, and to cultivate students' awareness of serving the society.

Table 1 Supporting relationship between curriculum objectives and graduation requirements

graduation requirements	Graduation Requirements Indicator Point	Supporting relationship
1) Engineering knowledge	Strong and systematic mastery of professional knowledge in mathematics, natural science, engineering foundation and mechanical engineering to solve complex engineering problems in mechanical design, manufacturing and automation.	Course objective 1
2) Problem analysis	Identify and express the complex engineering problems in the field of mechanical design, manufacturing and automation, and analyze the above complex engineering problems through literature.	Course objective 2、3
3) Design/Development Solutions	Corresponding solutions can be designed and developed in view of the complex engineering problems in mechanical design, manufacturing and automation, which can reflect the innovative consciousness under the premise of comprehensive consideration of engineering and social constraints such as law, culture and environment.	Course objective 2、3
4) Research	Complex engineering problems can be investigated by using scientific methods in the process of development and operation management of modern mechanical products and systems, including design tests, analysis and interpretation of data.	Course objective 2、3
5) Using modern tools	Suitable software and hardware tools for complex mechanical engineering problems can be selected, applied and even developed. And apply modern tools and information technology to the whole process of mechanical product and system design, development and operation.	Course objective 3
6) Engineering and society	To understand the interaction between engineering and society, as well as the social responsibility of the scientific and technological workers in mechanical engineering, and to apply relevant knowledge to the whole process of mechanical product design, development and operation.	Course objective 4

3. Teaching Content and Time Allocation

No	Teaching content	Teaching requirement	Period	Teaching Method	Objective
1	1、 Introduction to the course and Additive Manufacturing technologies	1. Understanding the object and content of this course research; 2. Understanding the basic concepts and terminology of additive manufacturing technology; 3. Understand the application and development status of additive manufacturing technology.	2	Lecture	1
2	Experiment 01--Visiting the Lab State Key Lab ---Qujiang Camps SL lab, LENS, FDM, SLS etc	1. Understanding the basic structure and operation characteristics of various processes and equipment; 2. Understand the application cases of various processes.	2	Experiment	1
3	2、 Fundamental AM processes	1. Grasp the basic information of the classification and terminology of additive manufacturing process; 2. Grasp the basic technological characteristics, materials and application fields of various kinds of additive manufacturing processes.	4	Lecture	1、 2
4	Experiment 02 -Basic operations of Materials extrusion additive manufacturing equipment	1 Grasp the basic operation method of material extrusion process equipment	3	Experiment	2
5	Homework 01 Prepare a five to ten-minute review presentation to introduce one AM process or one kind of application	1.Deeply understand the details of a process method or process application	0	Homework	3
6	3、 Geometric model data preparation	1. Grasp the file format type and characteristics used in additive manufacturing; 2. Grasp the basic method of process planning for additive manufacturing technology.	2	Lecture	1、 2
7	Experiment 03 Basic operation of SLS additive manufacturing equipment	1. Grasp the basic operation method of powder bed fusion process equipment	3	Experiment	2
8	4、 Interaction between energy and materials	1. Understanding the basic energy sources in the process of additive manufacturing; 2. Grasp the law of interaction between materials and energy.	4	Lecture	1、 2、 3
9	Experiment 04 Basic operations of model processing software and printing the designed part	1. Grasp the basic process of model processing, such as parts orientation selection, support addition, slicing, etc. 2 Grasp the basic setting method of process parameters; 3. Printing experiments of parts by additive manufacturing process.	2	Experiment	1、 2、 3

10	5、 Comment and Summarize the presentations from the Homework 01	1. Grasp the English expression of the related content of the additive manufacturing technology; 2. Proficiency in using professional English for academic exchanges	2	Interactive classroom	1、 3
11	6、 Processes optimization	1. Understanding the basic optimization methods of the additive manufacturing processes; 2. Grasp the optimization strategy of the additive manufacturing process performance.	2	Lecture	1、 2
12	Project research 01 Using AM process and equipment to solve an industrial problem.	1. Grasp the basic design method of three-dimensional parts; 2. Master the data processing flow of the additive manufacturing process; 3. Ability to operate additive manufacturing equipment skillfully.	6	Experiment	1、 2、 3、 4
13	7、 Design for AM (topological optimization)	1. Understanding the structural requirements of the parts fabricated by additive manufacturing technology; 2. Understand the optimization method of parts structure oriented to additive manufacturing technology.	4	Lecture	1、 2
14	9、 Applications of AM: Bio-medical, Aeronautical, Automotive, Information Technologies etc	1. Understanding the latest application of cutting-edge technology in additive manufacturing technology; 2. Exploring the Development Direction of additive manufacturing and its applications	2	Lecture	1、 2
15	10、 The influence of 3D printing on the fabrication modes	1. Understand the influence of additive manufacturing technology on social life and production mode;	2	Lecture	4
16	8、 Comment and Summarize results from experiment 05 - Design and Additive manufacturing	1. Understanding the basic feature evaluation methods of additive manufactured parts; 2. Master the manufacturing process of parts.	2	Interactive classroom	1、 2、 3

4. Teaching methods

4.1. Lecture

1. Use heuristic teaching to stimulate students' interest in active learning, cultivate students' ability to think independently, analyze and solve problems, and guide students to actively acquire the knowledge they want to learn through practice and self-study.

2. In the teaching content, we systematically teach the basic principles and classification of the process methods of additive manufacturing, and focus on the data processing, process planning and process optimization in the process. Students can systematically grasp the basic process methods of additive manufacturing, and introduce the application of the cutting-edge technology of additive manufacturing, and systematically analyze the influence of additive manufacturing technology on society production and lifestyle.

3. Use electronic teaching plan, CAI courseware, multimedia teaching and traditional blackboard teaching, teaching aids to improve the amount of classroom teaching information, enhance the intuition of teaching.

4. Develop interactive classroom links, encourage students to actively participate in the classroom teaching process, exercise their teamwork ability, problem analysis ability and expression ability, and explore interactive teaching methods.

4.2. Experiments

Through the development of experimental activities, we can improve the students' operational ability, deepen the understanding of theoretical knowledge, improve the ability of integrating theory with practice, and solve engineering problems.

The experimental teaching of additive manufacturing technology is an important part of this course. Through visiting laboratories, operating additive manufacturing equipment, three-dimensional design, data processing and other practical activities, the aim is to cultivate students' ability to use additive manufacturing technology to solve the design and manufacturing problems of complex structural parts. Four experiments are required in the course. Each experiment is completed independently or in groups according to the requirements of the experimental instruction, and the experimental report is submitted.

4.3. Projects research based on team work

Using problem-driven approach, guide students to carry out experimental project research, three people in a group, condense the project theme, and complete project reports. Cultivate students' ability to find problems, propose solutions, adopt additive manufacturing technology to solve practical engineering or life problems.

5. Assessment and self-assessment method

5.1. Assessment

The main purpose of the course assessment is to assess the achievement of students' ability training objectives. The main content is to check the students' mastery and application ability of each knowledge point, including homework, experiment, and oral examination. The total score is 100% and the proportion of points in each assessment item can be adjusted according to the specific situation. The recommended values and detailed rules of assessment are as follows.

Items	Percentage	Detailed rules	Objectives
Homework	30	(1) It mainly examines the students' understanding and mastery of additive manufacturing. (2) Innovative abilities for processes and applications of additive manufacturing.	1、 2、 3
Project research	30	(1) According to the performance of the students' team in selecting topics, proposing solutions and implementing them, the assessment is made. (2) Evaluate project research results, such as in-kind, research reports, etc. Comprehensive evaluation, give the results of experimental research projects;	1、 2、 3、 4
Oral examination	40	(1) Student's comprehensive ability is examined by answering professional questions face to face. (2) According to understanding and expression of professional knowledge,the level of mastery will be evaluated.	1、 2、 3、 4

5.2. Evaluation of Achievement Degree of Curriculum Objectives

The evaluation of the achievement degree of curriculum objectives includes the evaluation of the achievement degree of curriculum sub-objectives and the evaluation of the achievement degree of curriculum general objectives. Specific instructions and examples for calculating the evaluation value of the degree of achievement are shown in the table below. The letters A_0 (25), B_0 (25) and E_0 (50) denote the target scores of assignments, experiments and project studies in the overall assessment scores respectively, while A , B and E denote the actual average scores of assignments, experiments and project studies in the overall assessment scores respectively. And the summation of them are 100, expressed by the equation: $A_0 + B_0 + E_0 = 100$.

Objective	Support items	Target score	Average scores of students	Calculation of AD
Course objective 1	Homework	A_{10} (10)	A_1	$AD_{ofobjective1} = \frac{A_1 + B_1 + E_1}{A_{10} + B_{10} + E_{10}}$
	Project research	B_{10} (5)	B_1	
	Oral examination	E_{10} (10)	E_1	
Course objective 2	Homework	A_{20} (10)	A_2	$AD_{ofobjective2} = \frac{A_2 + B_2 + E_2}{A_{20} + B_{20} + E_{20}}$
	Project research	B_{20} (10)	B_2	
	Oral examination	E_{20} (10)	E_2	
Course objective 3	Homework	A_{30} (10)	A_3	$AD_{ofobjective3} = \frac{A_3 + B_3 + E_3}{A_{30} + B_{30} + E_{30}}$
	Project research	B_{30} (10)	B_3	
	Oral examination	E_{30} (10)	E_3	
Course objective 4	Project research	B_{40} (5)	B_4	$AD_{ofobjective4} = \frac{B_4 + E_4}{B_{40} + E_{40}}$
	Oral examination	E_{40} (10)	E_4	
Total objective	Final scores	100	$A_{1, 2, 3} + B_{1, 2, 3} + E_{1, 2, 3, 4}$	$AD = \frac{A_{1,2,3} + B_{1,2,3} + E_{1,2,3,4}}{A_0 + B_0 + E_0}$

6. Relationship and allocation of this course and other courses

6.1. Prerequisite courses

Material Mechanics, Thermal Basis, Engineering Material Basis, Mechanical Drawing, Mechanical Manufacturing Technology Basis, Material Forming Technology Basis, CNC Technology

6.2. Follow-up courses

CDIO innovative design, graduation design and other links.

7. Suggested Textbooks and Teaching Reference Books

Wohlers T. Wohlers report 2020 executive summary. America: Wohlers Associates, Inc, 2020.

Writer: Tian Xiaoyong

Professional Officer:

Course Officer:

Approved Dean: