Department of Mechanical Engineering, Academic Year 2026 2nd Semester Syllabus (EN)

<table>
<tr><td colspan="5">Course title：(Chinese) 材料分析與檢測
(English) Materials Analysis and Characterization</td><td>Dept.</td><td>Mech. Engrg.</td></tr>
<tr><td colspan="5"></td><td>Code</td><td>4208354</td></tr>
<tr><td>Lecture</td><td>.Jong-Ning Aoh</td><td>credits</td><td>3</td><td>optional</td><td>Class</td><td>Graduate/senior</td></tr>
<tr><td>English as Medium of Instruction</td><td colspan="6">■Yes □No</td></tr>
<tr><td colspan="7">Preliminary course required: Physics, Chemistry, Engineering Materials, Strength of Materials,</td></tr>
<tr><td colspan="7">Description: This course provides students with fundamental understanding on principles and techniques of modern materials analysis and characterization with emphasis on analysis of metallic and electronic materials. Fundamental knowledge on crystal structures of materials and microstrucutres of materials will be reviewed. Principles, instruments and techniques on optical microscopy, transmission and scanning electron-microscopy (SEM/TEM), X-ray diffraction (XRD), energy-dispersive spectroscopy (EDS), electron beam spectral diffraction (EBSD), and Raman spectroscopy are explained in details.
THIS COURSE IS AN EMI COURSE AND IS TAUGHT IN ENGLISH.

Goal: The purpose of this course is to equip students with basic ability to carry out materials analysis using modern instruments.</td></tr>
<tr><td>Textbooks /References</td><td colspan="6">Reference books:
1. 材料分析(2nd. Ed.)，汪建民主編，中國材料科學學會 2014
2. Wachtman, J.B. Characterization of Materials. Boston: Butterworth Heinemann, 1993.
3. S. K. Sharma (Ed), Handbook of Materials Characterization, Springer Verlag, 2018
4.W. Callister; D. Rethwisch, Materials Science and Engineeering, Wiley & Sons, 10th ed. 2020</td></tr>
<tr><td colspan="7">教學要點概述</td></tr>
<tr><td>教材編選
Teaching materials</td><td colspan="6">■ Lecture presentation(ppt) ■Handout □Instructor’s Textbook
□ Teaching program ■Lecture video ■Textbook</td></tr>
<tr><td>教學方法
Teaching methods</td><td colspan="6">■Instruction □Group Discussion ■Oral presentation by Students
■Problem based learning □Case study □Miscellaneous</td></tr>
<tr><td>評量工具
Evaluation tools</td><td colspan="6">■Midterm exams ■Final exam □Quiz □In-class work
■Homework □Midterm report □Final report ■Topic report
□Miscellaneous</td></tr>
<tr><td>教學資源
Teaching resources</td><td colspan="6">■e-course 2 ■Handout for download ■Practice website</td></tr>
<tr><td>教師相關訊息
Instructor’s information</td><td colspan="6"></td></tr>
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Outline		course hour				Established Core competence
Subjects	Contents	Lecture	Demo	Exercise	Misc.	
Fundamental Crystallography	1.Crystal systems 2.Miller/Bravais indices 3.Crystallographic directions and plane	9				D1-D9
Fundamental Metallography	1.Defects in materials 2. Phase diagrams 3. Optical Microscopy	6				D1-D9
Principle of X-Ray diffraction	1.Bragg's law 2. X-ray diffraction analysis on elements 3. Stereographic projections	9				D1-D9
Electron Microscopy	1. Scanning Electron Microscopy (SEM) 2. Transmission Electron Microscopy (TEM) 3. Ewald sphere and reciprocal lattice 4. Selected area diffraction pattern SADP	7	1	1		D1-D9
Electron beam and energy beam techniques	1. Energy-dispersive spectroscopy (EDS), 2. Electron beam spectral diffraction (EBSD) 3. Raman spectroscopy	9	1	1		D1-D9
Nano-analysis	1.Scanning Probe Microscopy (SPM) 2.Nano-indentation	7	1	1		D1-D9

Core Competence of Graduate Program		**Index for achieving Core Competence**
D1	Well established professional knowledge in mechanical and materials engineering	Mastering professional knowledge in engineering materials and materials analysis
D2	Competence in planning and conducting research and development projects in mechanical and materials integrated engineering and related disciplines	Using appropriate analytical methods for materials research topics
D3	Proficiency at professional writing papers in mechanical and materials engineering	Mastering the ability in write research reports or papers by using appropriate vocabulary and analytical logic

D4	Capacity of innovative thinking and independent problem solving for mechanical and materials engineering challenges	Innovative thinking and independent problem solving by mastering and applying the professional knowledge and skills of materials analysis
D5	Effectiveness in communication and coordination in multi-disciplinary environments	Ability in communicating with people in different disciplines using multi-disciplinary terminology and thinking
D6	Well-balanced global vision	Well-balanced competence in communication and comprehension of professional knowledge and information in English
D7	Capability of leadership, planning, and management	Capability of leadership, planning, and management of materials related projects
D8	Engagement to lifelong learning	Life-long learning through acquiring materials analysis related knowledge from professional articles and medium
D9	Understand the importance of engineering ethics, social responsibility and sustainable development	Good conduct complying engineering ethics and social responsibility. Considering sustainable development in every aspect

Course Content

Time	Class	Evaluation	Office hour	Evaluation of course quality
Monday, 0910-1200	Mechanical Engineering R 215R	HW 20% Midterm 35% Final term 35% Practice 5% Attendance 5%	Monday 14:00~15:00 pm Rm. 424, Tel: 2720411 ext. 33304 E-mail: imejna @ccu.edu.tw	Questionnaire on Core Competence

Week	Contents	Remarks
1	Crystal systems, crystallographic directions and Miller/Bravais indices	
2	Crystal systems, crystallographic planes and Miller/Bravais indices	Homework I
3	.Defects in materials and phase diagrams	
4	Optical Microscopy and metallography	
5	Bragg’s law and X-ray diffraction analysis (XRD)	Homework II
6	Stereographic projectins (I)	
7	Stereographic projectins (II)	Homework III
8	Midterm exam	

9	Scanning Electron Microscopy (SEM) and Energy-dispersive spectroscopy (EDS)	
10	Practice in Scanning Electron Microscopy and EDS	
11	Transmission Electron Microscopy (TEM) and Ewald sphere and reciprocal lattice	Homework IV
12	TEM and selected area diffraction pattern (SADP)	
13	Electron beam spectral diffraction (EBSD)	Homework V
14	Raman spectroscopy	
15	Scanning Probe Microscopy (SPM) and practice	
16	Nano-indentation and practice	
17	Final review	
18	Final exam	