

綱要

課程名稱：		開課單位：	土木碩		
(中文) 高科技廠房設施設計		永久課號：	ENCV30076		
(英文) High-tech Facility Design		上課時間/教室：	Tabc-EB117[GF]		
授課教師：					
莊子壽					
學分數：	3.00	必 / 選修：	選修	開課年級：	*
先修科目或先備能力：					
<p>具有應用科學、物理學、工程數學、及工程統計知識的能力。具有設計及執行實驗，以及分析解釋數據的能力。具有辨識、分析規劃及解決工程問題的能力。具有描述各種不同的土木工程範疇的能力。具有善用現代化科技及資訊工具的能力。</p>					
課程概述與目標：					
課程概述					
PURPOSE:					
<p>The purpose of this course is to provide basic design knowledge needed for fabrication facilities that support high-tech manufacturing and R&D. High-Tech includes, not limited to, the advanced technologies applied in the fields of micro-electronics, optoelectronics, precision equipment, telecommunication, nanotech, pharmaceuticals, biotech, medical devices, animal experiment, and Aerospace. The processes undertaken in high-tech manufacturing plants and R&D labs require cleanrooms with extremely stringent environmental control.</p>					
<p>The environmental control includes temperature and humidity requirements, air/water quality, purity of chemicals and gases, noise and vibration degree, electromagnetic and radio frequency interference, electrostatic discharge, materials out-gassing, safe grounding, assurance of personnel health, safety and security and prevention of biohazard.</p>					
<p>The focus of this course is on designing cleanroom and engineering its associated facilities. Students will gain skills needed to meet ever-changing challenge of delivering an ultra-pure</p>					

cleanroom and ultra-pure process utilities. Moreover, this course will strengthen students' understanding and background in constructing high-tech manufacturing fab/plant and research lab. Many advanced topics will be introduced, such as 300mm/12" fab, 3~2 nm manufacturing, IoT (Internet of Things), Green Fab, FinFET (Fin Field-Effect Transistor), LiFi (Light Fidelity), Intelligent Sensing, AMHS (Automated Material Handling System), Waste Recycling and Circular Economy.

SCOPE:

This course is intended to offer to undergraduate Juniors and Seniors, MS, EMBA & PhD students. Students in engineering, science, pharmacy, and life science will be exposed to fundamental theories and their applications in the design/build/certify of the high-tech manufacturing plants and research labs. Academic faculty will teach basic theories and principles. Meanwhile, professional industrial experts will be invited to address the application of theories and principles in the real-world practices. The course contents will include lectures, pop quizzes, home works, a semester team project with an oral presentation and a written report, and/or a final examination. Field trips to visit high-tech plants and research labs, and/or cleanrooms will be arranged. In addition students will have opportunity to observe demonstration of cleanroom testing and hands-on experiences to measure the cleanroom where is the heart of high-tech M&R&D.

This course will be taught in an English friendly environment. Course syllabus, homework assignments, final exam papers and description of semester project will be mostly in English. All three instructors spent many years in the US. They all speak fluent English and Chinese. To enhance student's learning and to facilitate the communication, students are free to use either English or Chinese for asking questions and submitting homework, final exam, field trip report, and semester project report.

課程目標

OBJECTIVES: The course will enable the students to:

1. Differentiate the typical processes in semiconductor, biotech, medical devices, and pharmaceutical manufacturing and R&D.

2. Explain the interdisciplinary nature of high-tech manufacturing and research.
3. Understand architectural design for cleanroom and schematically layout factory.
4. Use the basic theories and principles to design systems for heating, ventilation and air conditioning (HVAC,) water/air treatment, noise and vibration mitigation.
5. Classify cleanrooms in terms of various international standards.
6. Specify the environmental control criteria for cleanroom in terms of temperature and humidity level, air/water quality, purity of chemicals and gases, noise and vibration degree, electromagnetic and radio frequency interference, electrostatic discharge, materials outgassing, airborne molecular contamination (AMC) and safe grounding.
7. Apply the knowledge in testing and commissioning cleanroom and its associated facilities.
8. Establish contamination control programs for constructing, operating, and maintaining the high-tech facilities.
9. Address the issues in circular economy and automatically managing the emergency, safety, and security systems.
10. Link to the information sources for further studies in nano/micro fabrication and research.

教科書 (請註明書名、作者、出版社、出版年等資訊) :

TEXTBOOK:

1. Geng, Hwaiyu, Semiconductor Manufacturing Handbook, McGraw-Hill, New York, 2018.
2. Whyte, W., Cleanroom Design, John Wiley, 2nd ed., New York 1999.
3. McQuiston/Parker/Spitler, Heating, Ventilating, and Air Conditioning, John Wiley, 6th ed., New York 2005.
4. Nishi, Y., Doering, K., and Wooldridge, T., Handbook of Semiconductor Manufacturing Technology, Marcel Dekker, New York, 2000.

REFERENCES:

1. Chang, C.Y., and Sze, S.M., ULSI Technology, McGraw-Hill Company, Inc., International Edition, 1996, New York.
2. Van Zant, Peter, Microchip Fabrication, 5th ed., McGraw-Hill, New York, 2004.

3. Mulhall, D., Our Molecular Future: How Nanotechnology, Robotics, Genetics, and Artificial Intelligence Will Transform Our World, Prometheus Books, Amherst, N.Y., 2002.

4. Scherge, M., Biological Micro- and Nanotribiology: Nature' s Solutions, Springer, New York, 2001.

5. 社團法人日本空氣清淨協會 編，Clean Room Handbook，オーム社，東京，1989。http://www.ohmsha.co.jp/

6. 陳霖新 等編著，潔淨廠房的設計與施工，化學工業出版社，北京，2005。

7. 簡禎富、施義成、林振銘、陳瑞坤編著，半導體製造技術與管理，國立清華大學出版社，2006。

8. 半導體製造技術，Quirk/Serda 著，羅文雄、蔡榮輝 譯，滄海 (2003)

課程大綱		分配時數				備註
單元主題	內容綱要	講授	示範	習作	其他	

教學要點概述：

1.學期作業、考試、評量：

There is one group term project. The group term project tests the student understands of the principal concepts covered in the course within the context of a comprehensive “real-world” problem. It also provides an opportunity to develop skills for working in a project team context and communication skills. The group term project counts 60% of the final grade.

The term project report should conform to good engineering practices and should include, as a minimum, a title page, abstract, table of contents, introduction, theories, real-world practice, comparison between theory and practice, conclusion and references. A good quality report contains well-indicated reference pages and balanced arguments with solid evidences. Individual student' s contribution to the report should be clearly indicated.

A Final Exam is required on December 26, 2023. The Final Exam will be comprehensive and counted as 15% of “Total Grade.”

Another 15% is for homework & class participation. Two unexcused absences will result in a grade of 'Incomplete' or 'Flunk', depending on whether or not the student is considered to be passing in all other aspects at the time of the third absence. Except in emergency, a student must attend the field trip. Unexcused absences will result in a final grade of 'Incomplete.'

Meanwhile, each student will be individually required to take a lecture note on a selected class lecture and a field trip report, illustrated either in Chinese or in English. Then, prepare a maximum 5-page report (10%.) The page limitation imposes an organizational and summarization burden on the student who takes the lecture note and field trip report. The writing must be concise and turn in two weeks after the lecture or field trip. Although figures, tables and graphs often help present useful concepts in less space, the illustrative demonstration of understating on the lecture or field trip will be weighted heavily. Simply download from the provided slides and/or class handouts is not acceptable.

The field trip report should conform to good engineering practices and should include, as a minimum, a title page, abstract, table of contents, introduction, theories behind the lecture, conclusion, and references. The report should be in the student's own words; any citation should be clearly noted and/or referred.

Grading Scale of the Course:

1. Term Project, Group Presentation – 40% (15%, 25%)
2. Term Project, Individual Report – 20%
3. Final Exam – 15%
4. Field Trip Report – 10%
5. Homework, Attendance, and Classroom Participation – 15%

The following deadlines must be observed:

1. October 03, 2023 -- Joining a Group, and Selection of Focus Design Area,
2. November 17, 2023 -- 30% Design Complete
3. December 12, 2023 – Upload Your Field Trip Report
4. December 19, 2023 -- Oral Presentation, Only PowerPoint slides are suitable for the

presentation. The oral presentation should be 20 minutes in length which includes time for questions and discussion.

5. January 09, 2024 – E-mail in Your Individual Term Project Report.

2.教學方法及教學相關配合事項 (如助教、網站或圖書及資料庫等)

CLASS HOURS: Tuesday, 6:30pm-9:20pm

INDUSTRIAL INSTRUCTORS:

- 李若瑟 技術長(漢唐集成)
- 栗正暉 總經理(群策工程顧問)
- 于淳 顧問(台積電廠務技術發展部)
- 鄭昭平 經理(台積電廠務學院)

師生晤談	排定時間	地點	聯絡方式
	By appointment.		Professor Arthur Chuang (莊子壽) Email: tschuang@tsmc.com

每週進度表

週次	上課日期	課程進度、內容、主題	教師授課時數
1	2023-09-12(二)	Course Introduction, Fundamentals of IC Manufacturing Processes	
2	2023-09-19(二)	Fab Economics and High-tech Facilities Overview	
3	2023-09-26(二)	Vibration and EMI, and Mitigation Airborne Molecular Contamination	
4	2023-10-03(二)	Term Project Kickoff and 3D/CAD Introduction	
5	2023-10-10(二)	National Day, No Class	
6	2023-10-17(二)	Site Master Planning and Code Compliance for Semiconductor Facilities	
7	2023-10-24(二)	A Fab Project and Conceptual Design Process	
8	2023-10-31(二)	No Midterm Exam, Substitute with Mandatory Field Trip on 12/02 at Taichung	
9	2023-11-07(二)	30% Design Review	

10	2023-11-14(二)	Fab Layout and Automated Material Handling System	
11	2023-11-21(二)	Cleanroom and MEP System Design	
12	2023-11-28(二)	UPW, Gases and Chemical System Design	
13	2023-12-05(二)	Building and Structure Design	
14	2023-12-12(二)	Circular Economy and Green Manufacturing	
15	2023-12-19(二)	Group Term Project Presentation (Final 100% Design Review)	
16	2023-12-26(二)	Final Exam	

備註：

- 1.請遵守智慧財產權觀念及勿使用不法影印教科書。
- 2.其他欄包含參訪、專題演講等活動。

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