

## **Annexe A: New/Revised Course Content in OBTL+ Format**

### **Course Overview**

The sections shown on this interface are based on the templates [UG OBTL+](#) or [PG OBTL+](#)

If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to [Data Transformation Status](#) for more information.

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Lew Wen Siang
Course Author Email	wensiang@ntu.edu.sg
Course Title	Fabrication of Micro- and Nano-electronic Devices
Course Code	PH3601
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

## Course Requisites (if applicable)

Pre-requisites	PH2102 Electromagnetism
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

## Course Aims

This course aims to provide comprehensive introduction to you on the fabrication technologies of micro- and nano-structured electronics devices. The fabrication techniques discussed in the course are relevant for micro- and nano-devices in the fields of semiconductor, magnetics, optoelectronics, micro- and nano-electro-mechanical systems (MEMS/NEMS), and biomedical. This course covers essential topics including principles, fabrications and applications. The working principles of each fabrication technique will be explained in detail, and the combination of these techniques as a complete process flow for making different microdevices will be discussed. Specifically, it is also the aim of this course to familiarise you with the semiconductor processing techniques employed in the advanced manufacturing industry so that you can acquire direct applied knowledge before embarking your engineering career in the semiconductor industry.

## Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Identify and describe the basic building block of semiconductor devices
ILO 2	Present a general view of the trend of semiconductor technologies development and its technological ecosystem.
ILO 3	Explain the importance of contamination control and apply the relevant approach in semiconductor processing.
ILO 4	Describe the techniques of optical lithography, resolution enhancement, and the working mechanism of photoresist.
ILO 5	Identify the properties of non-optical lithography techniques, and apply the lithography process in building microfluidics devices.
ILO 6	Describe wet and dry etching and apply the process conditions to achieve lithography minimum feature size.
ILO 7	Explain the physics of doping and able to apply the diffusion or ion implantation conditions.
ILO 8	Design the doping concentration in bulk silicon wafer growth.
ILO 9	Explain vacuum technology and able to design a desired vacuum condition by selecting suitable pump and gauges.
ILO 10	Describe metallic and dielectrics film deposition processes and able to apply suitable tools to grow films.
ILO 11	Use appropriate metallic layers for interconnect metallization process.
ILO 12	Design probing configuration for device electrical measurement techniques.
ILO 13	Describe device packaging process and apply suitable model for manufacturing yield calculation.
ILO 14	Design an integrated process to complete CMOS transistor fabrication.
ILO 15	Search relevant references and review technical topics.
ILO 16	Write a technical review technical reports and give a technical presentation on the surveyed topics.

# Course Content

Lecture 1: Semiconductor Technology and Devices

Lecture 2: Lithography

Lecture 3: Etching and Pattern Transfer

Lecture 4: Impurity Doping

Lecture 5: Semiconductor Wafer and Thermal Oxidation

Lecture 6: Vacuum Science and Technology

Lecture 7: Film Deposition Techniques

Lecture 8: Interconnections and Contacts

Lecture 9: Device Packaging and Yield Models

Lecture 10: Device Fabrication

## Reading and References (if applicable)

1. Fabrication Engineering at Micro- and Nanoscale, The Oxford Series in Electrical and Computer Engineering, 4th edition, Stephen A Campbell, Oxford University Press, USA, 978-0195320176, 2012.
2. Fundamentals of Microfabrication and Nanotechnology, Three-Volume Set: Manufacturing Techniques for Microfabrication and Nanotechnology, 3rd edition, Marc J. Madou, CRC, 978-1420055191, 2011
3. Semiconductor Devices - Physics and Technology, 3rd edition, Simon M. Sze and Ming-Kwei Lee, Wiley, 978-0470537947, 2012.
4. Introduction to Microfabrication, 2nd edition, Sami Franssila, Wiley, 978-0470749838, 2010.

NOTE: The above readings comprise the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

## Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Course Introduction and Lecture 1 (Semiconductor Technology and Devices)	ILO 1-2	Lecture note 1	In-person	
2	Lectures 1 and 2 (Lithography)	ILO 2-3	Lecture notes 1 and 2	In-person	
3	Lecture 2	ILO 4	Lecture note 2	In-person	
4	Lecture 2 and 3 (Etching and Pattern Transfer)	ILO 5-6	Lecture notes 2-3	In-person	Lab Demo
5	Lectures 3 and 4 (Impurity Doping)	ILO 6-7	Lecture notes 3 and 4	In-person	Lab Demo
6	Lectures 4 and 5 (Semiconductor Wafer and Thermal Oxidation)	ILO 7-8	Lecture notes 4 and 5	In-person	Lab Demo
7	Lectures 5 and midterm test 1	ILO 8	Lecture notes 5	In-person	
8	Lecture 6 (Vacuum Science and Technology)	ILO 9	Lecture note 6	In-person	Lab Demo
9	Lecture 7 (Film Deposition Techniques)	ILO 10-11	Lecture note 7	In-person	
10	Lectures 7 and 8 (Interconnections and Contacts)	ILO 10-12	Lecture notes 7 and 8	In-person	

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
11	Lectures 8 and 9 (Device Packaging and Yield Models)	ILO 12-14	Lecture notes 8 and 9	In-person	
12	Lecture 9 and midterm test 2	ILO 14	Lecture note 9	In-person	
13	Lecture 10 (Device Fabrication) and assignment presentation	ILO 15-16	Lecture note 10	In-person	

## Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	In the lecture, student will be first motivated with the relevant technology and processing techniques of electronic devices, followed by lectures that further explains the working principles and physics. Wrap up questions will also be provided.
Tutorials	Discussion on tutorial questions will help to improve the understanding of the main concepts learned in lectures.
Lab Demonstration	Lab demonstration session will be held at the SPMS/PAP Microfabrication Cleanroom Laboratory and student will have the opportunity to firsthand experience of the device microfabrication processes. Demonstration of fabrication techniques, such as photolithography, physical vapour deposition, etching, will be conducted, and student will be encouraged to ask questions so that the field work experience can help to better understand the lecture taught.
Technology-enhanced Learning	Extended learning will be facilitated by online learning video and other materials. This includes recorded lecture and video of techniques & processes.

# Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Summative Assessment (EXAM): Final exam(Final Examination )	All		50	Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Assignment(CA1: Assignment Report and Presentation )	All		20	Individual	Holistic	Extended Abstract
3	Continuous Assessment (CA): Test/Quiz(CA2: Midterm Test 1)	Lectures 1 - 6		15	Individual	Analytic	Multistructural
4	Continuous Assessment (CA): Test/Quiz(CA3: Midterm Test 2)	Lectures 7 - 15		15	Individual	Analytic	Multistructural

## Description of Assessment Components (if applicable)

Assignment (CA1): Do a literature survey on a topic that is relevant to micro- and nano-fabrication, or micro- and nano-electronic devices. You are required to choose one from a list of topics provided. A proposed topic that is relevant to the course objectives is allowed. Write an assignment report for your literature survey and the length should be within 3500 - 20,000 words. A group of 2 students can be formed to review a topic together. However, each student in the group must submit his/her own report and the report from each group member cannot be identical. After report submission, you are required to give a 20 min oral presentation. A joint presentation of a group two students working together on the same topic is allowed and the given time is 30 min.

The rubrics for assignment assessment, both report and presentation, are clearly described in the attached appendix.

Midterm Test 1 (CA2): Restricted open book test covering the lectures taught since the semester start, typically lectures 1-5.

Midterm Test 1 (CA3): Restricted open book test covering the remaining lectures taught, typically lecture 6-10.

Final Exam: Restricted open book exam covering all lectures taught.

## Formative Feedback

You will receive formative feedback through discussion within tutorial lessons.

You will receive both written and/or oral feedback on your report and presentation.

Feedback is also given after each term test on the common mistakes and level of difficulty of the problems. Past exam questions and content of previous examiner's report will be discussed in lecture

## NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Advanced
Creative Thinking	Advanced
Curiosity	Advanced
Problem Solving	Intermediate
Information Literacy	Advanced

# Course Policy

## Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

## Policy (General)

Students are encouraged to attend the lecture from the start of the course. Though lectures are recorded lab demonstrations give opportunity to student to experience the real operation of the system and equipment explained in lectures. Subsequent lecture is largely dependent on the understanding of the course content taught earlier hence it is helpful for student to attend the lecture and lab demo regularly.

## Policy (Absenteeism)

### Absence Due to Medical or Other Reasons

If you are sick and unable to attend your class (particularly the mid-terms), you must:

1. Send an email to the instructor regarding the absence.
2. Submit the original Medical Certificate\* to administrator.

\* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

A make-up test will be conducted only for those absent in both midterm tests with valid reasons (as mentioned above).

## Policy (Others, if applicable)

### Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science. It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

## Appendix 1: Assessment Rubrics for Assignment Report

Criteria Description	Assessment					Score (Max)
	Poor (0-2)	Below Average (3-4)	Adequate (5-6)	Good (7-8)	Excellent (9-10)	
<b>QUALITY OF WRITE-UP</b> Consider good effort have been made on the content of the literature review. Good English with minimal grammatical errors and spellings.	Work quality presented is questionable or severely poor.	Work presented is of subpar quality	Work quality presented is marginally acceptable.	Good quality of work presented.	Excellent Work Quality	10
<b>STRUCTURE AND ORGANISATION</b> Consider use of proper report structure, i.e., a clear and concise summary/abstract followed by logical sequences on the chapters.	No or negligible effort in organizing the report is shown.	Report is poorly organized	Report is adequately organized.	Report is well organized.	Report is excellently organized	10
<b>QUALITY OF INFORMATION GATHERING &amp; REFERENCES</b> Consider the degree of preparation on the information gathered related to the work and choices of references. Proper citations have been made to external statements, picture, table and plots.	No or negligible effort in information gathering is shown.	Insufficient information gathering, or substantial use info from unreliable sources	Only minimal effort of information gathering is shown.	Good effort of information gathering is presented.	Excellent information gathering is presented	10
<b>SURVEYED INFORMATION PRESENTATION AND DISCUSSION</b> Consider if interpretation and discussion of results are put into context, main points picked for discussion, understanding of underlying assumptions and limitation while being rationale to various approaches.	No or negligible effort of discussion is shown. Clear trace of paragraphs plagiarism.	Poor discussion	Only minimal discussion is presented.	Good discussion with in-depth analysis.	Excellent discussion and new ideas is presented	10
<b>LOGICAL ANALYSIS AND CONCLUSION</b> Consider if interpretation and discussion of results are put into context, main points picked for discussion, understanding of underlying assumptions and limitation while being rationale to various approaches.	No or negligible effort of logical analysis and conclusion is shown.	Poor analysis and conclusion	Only minimal analysis and conclusion is presented.	Good analysis and logical conclusion is presented.	Excellent analysis and new ideas is presented.	10
<b>Total</b>						<b>50</b>

## Appendix 2: Assessment Rubrics for Assignment Presentation

Criteria Description	Assessment					Score (Max)
	Poor (0-2)	Below Average (3-4)	Adequate (5-6)	Good (7-8)	Excellent (9-10)	
<b>QUALITY OF WORK PRESENTED</b> Consider the originality, correctness and importance of the work presented.	Work quality presented is questionable or severely poor.	Work presented is of subpar quality.	Quality of work presented is marginally acceptable.	Good work quality is presented.	Excellent work quality is presented.	10
<b>ABILITY OF GIVING EXPLANATION</b> Consider the student's ability to explain the technical knowledge learnt, specifically from the physics viewpoint; consider the coherence between the presentation and the contents of the final report submitted.	Completely fails to demonstrate the relevant technical understanding.	Struggling to provide decent technical explanations of the work presented	Able to demonstrate the relevant technical understanding.	Demonstrate good understanding of the technical knowledge.	Demonstrate excellent understanding and strong command of the technical knowledge.	10
<b>QUALITY OF PRESENTATION MATERIALS</b> Consider the degree of preparation of the presentation materials – informative, and appropriateness on the topics discussed; consider the clarity and context of the slides.	No effort shown in preparing the presentation materials, or complete plagiarism without proper source citing.	Materials were poorly prepared and visuals were not helpful to audience.	Ideas were vaguely presented and visuals were marginally helpful to audience.	Ideas were presented clearly and visuals were helpful to audience.	Exceptional presentation skills with highly informative materials.	10
<b>CLARITY, LANGUAGE USE AND ACCURACY</b> Consider the student's ability to give a clear and concise presentation – appropriate choice of words, understandable, minimal stoppage, proper pace and good timing.	Very poor verbal and communication skills.	Reading from notes all the time during presentation.	Able to communicate ideas and relates to others.	Communicates and explains ideas clearly and concisely.	Communicates in a highly convincing and persuasive manner.	10
<b>QUESTIONS AND ANSWERS</b> Consider the student's ability to explain his/her work in the Q&A session – able to provide unambiguous and logical answers confidently.	Unable to provide logical answers to any of the questions raised.	Struggling in answering any of the questions raised.	Limited capability in answering some of the questions.	Able to answer most queries raised.	Confidently respond to all queries raised and able to provide new ideas.	10
<b>Total</b>						<b>50</b>