# 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<br>* Faculty proposing/revising the course | Lau Wai Man |
| Course Author Email | wmlau@ntu.edu.sg |
| Course Title | Advanced Semiconductor Processes |
| Course Code | CB4248 |
| Academic Units | 3 |
| Contact Hours | 39 |
| Research Experience Components | Not Applicable |

## Course Requisites (if applicable)

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

## Course Aims

The semiconductor industry is the backbone of Singapore's electronics manufacturing output, contributing almost 7% of the GDP. In addition, the upcoming Artificial Intelligence (AI) trends will drive an exponential growth in memory and storage semiconductors required to analyze the large amounts of data. The objective of this course is to introduce students to the memory and storage semiconductor industry. By the end of the course, they should understand and be able to describe the critical key processes in a semiconductor manufacturing plant. They will be able to understand how different processes integrate to fabricate the end-product chip. Students will also be able to perform impact assessment to optimize the scalability and cost competitiveness for processes. They will be able to apply Quality Management to meet stringent customer requirements and be introduced to Quality Certifications in the industry. Students will also be exposed to state-of-the-art smart manufacturing technologies employed in the plant. Finally, they will also be informed of sustainable practices employed, and discuss the current and future trends of the industry.

## Course's Intended Learning Outcomes (ILOs)

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

| | |
|---|---|
| ILO 1 | Learn the basic principles of processes involved in semiconductor manufacturing, such as their main purpose, key process parameters to monitor process health, cross process interactions, equipment knowledge, and common defects. |
| ILO 2 | Learn the various methods to ensure high product quality and different industry standards certification and current trend and future challenges. |
| ILO 3 | Develop the ability to apply the process knowledge to identify problem statement, formulate hypothesis to derive root causes, and recommend improvement actions. |

## Course Content

1. NAND Application & R&D – Tech Development
2. Frontend Wafer Fabrication - CVD, Diffusion, Implant
3. Frontend Wafer Fabrication – CMP, Wet Process
4. Frontend Wafer Fabrication – Dry Etch, Lithography
5. Yield & Analysis (include Probe)
6. Ecosystem of Quality & Reliability 1
7. Ecosystem of Quality & Reliability 2
8. Smart Manufacturing Artificial Intelligence / Data Science
9. Advanced Manufacturing Pt 1
10. Advanced Manufacturing Pt 2 / Sustainability

## Reading and References (if applicable)

Supplementary reading materials will be provided before the lessons.

## Planned Schedule

| Week or Session | Topics or Themes | ILO | Readings | Delivery Mode | Activities |
|---|---|---|---|---|---|
| 1 | NAND Introduction, Application and R&D – Tech Development | 1 | Nil | In-person | Lecture |
| 2 | Frontend Wafer Fabrication - CVD, Diffusion, Implant | 1,3 | Nil | In-person | Lecture |
| 3 | Frontend Wafer Fabrication – CMP, Wet Process | 1,3 | Nil | In-person | Lecture |
| 4 | Frontend Wafer Fabrication – Dry Etch, Lithography | 1,3 | Nil | In-person | Lecture |
| 5 | Case Study Problem Introduction | 1,3 | Nil | In-person | Problem-based learning |
| 6 | Yield & Analysis (include Probe) | 2,3 | Nil | In-person | Lecture |
| 7 | Quiz 1 | 1,2,3 | Nil | In-person | Continuous Assessment |
| 8 | Ecosystem of Quality & Reliability 1 | 2,3 | Nil | In-person | Lecture |
| 9 | Ecosystem of Quality & Reliability 2 | 2 | Nil | In-person | Lecture |
| 10 | Smart Manufacturing Artificial Intelligence / Data Science | 2 | Nil | In-person | Lecture |

| Week or Session | Topics or Themes | ILO | Readings | Delivery Mode | Activities |
|---|---|---|---|---|---|
| 11 | Advanced Manufacturing Pt 1 | 2 | Nil | In-person | Lecture |
| 12 | Advanced Manufacturing Pt 2 / Sustainability | 2 | Nil | In-person | Lecture |
| 13 | Quiz 2 | 2,3 | Nil | In-person | Continuous Assessment |

## Learning and Teaching Approach

| Approach | How does this approach support you in achieving the learning outcomes? |
|---|---|
| Lecture and case studies are incorporated together | Lectures are used to provide the fundamental background of the semiconductor industry and case studies are supplementing the understanding to solve real life problems. |

## 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 | Continuous Assessment (CA): Test/Quiz(Quiz) | 1,2,3 | a, b, c | 30 | Individual | Analytic | Multistructural |
| 2 | Continuous Assessment (CA): Test/Quiz(Quiz) | 2,3 | a, b, c | 30 | Individual | Analytic | Multistructural |
| 3 | Continuous Assessment (CA): Project(Case study project) | 1,3 | a, b, c, d, h, i | 40 | Team | Holistic | Multistructural |

Description of Assessment Components (if applicable)

The case study projects involve the examination of problems provided by industry. Basic tools for problem solving will be applied to
critically analyze the case study problems and determine the root cause of the incidents. The technical findings will be presented in either technical report or presentation format.

Formative Feedback

Marker's report on overall examination performance will be uploaded to NTUlearn; Quiz answers will be discussed in class.

## NTU Graduate Attributes/Competency Mapping

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

| Attributes/Competency | Level |
|---|---|
| Communication | Intermediate |
| Critical Thinking | Intermediate |
| Systems Thinking | Intermediate |

# 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)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

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Last Updated By: Lai Ru Ying

Appendix 1: Assessment Rubric

Case Study Project

| Criteria | Exceed Expectations (75-100%) | Meet Expectations (50-74%) | Meet Baseline Expectations (25-49%) | Below Expectations (0-24%) | Points |
|---|---|---|---|---|---|
| Apply basic concepts of root cause analysis in problem solving | Demonstrates very deep interest and a wider understanding of root cause analysis and applications in a certain industry | Demonstrates reasonable interest and understanding of root cause analysis and applications in a certain industry. | Demonstrates shallow interest and understanding of root cause analysis and applications in a certain industry. | Shows no interest and understanding of root cause analysis and applications in a certain industry. | 40 |
| Identify the basic tools used for problem solving and critically analyze and examine problems of different nature. | The results were interpreted clearly and conclusion drawn was supported by strong evidence. | The results were interpreted correctly but the conclusion was not fully supported by evidence. | The result interpretation was acceptable but the conclusion was not supported by clear evidence. | No result and/or interpretation to showcase. | 40 |
| Write technical report and present technical findings. | Reports and presentations are concise, coherent, well-organized and well-structured. The format is consistent throughout. | Reports and presentations are coherent and organized. The format is consistent throughout. | Reports and presentations are organized but the format is inconsistent. | Reports and presentations are unorganized and difficult to comprehend. | 20 |

Peer evaluation is built into Case Study Project score as modifying factor:
Individual Case Study Project Score = Group Case Study Project Score * Peer Score/Max Peer Score

E.g. Group 1 has a Group Case Study Project score of 70%
Member A has peer score of 9/10; Members B has a peer score of 8/10 and Member C has a peer score of 5/10
Member A will then get 70% * 9/9; Member B will get 70% * 8/9; Member C will get 70% * 5/9

# Peer Evaluation for Case Study Project 1 - 2025

1. What is your full name?

2. For a scale of 0-5, 0 represents No Contribution and 5 represents full contribution, how would you rate your own contribution to the project relative to your other members?

☆ ☆ ☆ ☆ ☆

3. Any remark on your contribution to the project can be put here.

4. What is the full name of member 1 in your team?

5. For a scale of 0-5, 0 represents no contribution and 5 represents full contribution, how would you rate member 1's contribution to the project relative to yourself and other members?

☆ ☆ ☆ ☆ ☆

6. Any remark on member 1's contribution to the project can be put here.

7. What is the full name of member 2 in your team?

8. For a scale of 0-5, 0 represents no contribution and 5 represents full contribution, how would you rate member 2's contribution to the project relative to yourself and other members?

☆ ☆ ☆ ☆ ☆

9. Any remark on member 2's contribution to the project can be put here.

10. What is the full name of member 3 in your team?

11. For a scale of 0-5, 0 represents no contribution and 5 represents full contribution, how would you rate member 3's contribution to the project relative to yourself and other members?

☆ ☆ ☆ ☆ ☆

12. Any remark on member 3's contribution to the project can be put here.

13. What is the full name of member 4 in your team? (If you don't have member 4, you can pull down "NA")

14. For a scale of 0-5, 0 represents no contribution and 5 represents full contribution, how would you rate member 4's contribution to the project relative to yourself and other members? (If you do not have member 4, you can choose any star rating.

☆ ☆ ☆ ☆ ☆

15. Any remark on member 4's contribution to the project can be put here.

16. What is the full name of member 5 in your team? (If you don't have member 5, you can pull down "NA")

17. For a scale of 0-5, 0 represents no contribution and 5 represents full contribution, how would you rate member 5's contribution to the project relative to yourself and other members? (If you do not have member 5, you can choose any star rating.

☆ ☆ ☆ ☆ ☆

18. Any remark on member 5's contribution to the project can be put here.

19. Any feedback on the case study problem statement, flow of the sessions and other comments can be put here.

## Mapping of Course ILOs to EAB Graduate Attributes

| | |
|---|---|
| **Course Code & Title** | CB4248 Advanced Semiconductor Processes |
| **Course Type** | MPE/BDE |

| **Overview** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) | ● | (b) | ● | (c) | ● | (d) | ● | (e) | | (f) | ◐ |
| (g) | | (h) | ◐ | (i) | ◐ | (j) | | (k) | ◐ | | |

Legend:

| | |
|---|---|
| ● | Fully consistent (contributes to more than 75% of Student Learning Outcome) |
| ◐ | Partially consistent (contributes to about 50% of Student Learning Outcome) |
| O | Weakly consistent (contributes to about 25% of Student Learning Outcome) |
| Blank | Not related to Student Learning Outcome |

| | **Course ILOs** | **EAB Graduate Attributes** |
|---|---|---|
| 1) | Learn the basic principles of processes involved in semiconductor manufacturing, such as their main purpose, key process parameters to monitor process health, cross process interactions, equipment knowledge, and common defects. | a, b, c, d |
| 2) | Learn the various methods to ensure high product quality and different industry standards certification and current trend and future challenges. | a, b, c, d |
| 3) | Develop the ability to apply the process knowledge to identify problem statement, formulate hypothesis to derive root causes, and recommend improvement actions. | a, b, c, d, f, h, i, k |
| 4) | | |
| 5) | | |
| 6) | | |
| 7) | | |
| 8) | | |
| 9) | | |
| 10) | | |

**EAB GRADUATE ATTRIBUTES**

a) **Engineering Knowledge**: Apply the knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively to the solution of complex engineering problems.

b) **Problem Analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences with holistic considerations for sustainable development. (WK1 to WK4)

c) **Design / Development of Solutions**: Design creative solutions for complex engineering problems and design systems, components or processes that meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required. (WK5)

d) **Investigation**: Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) **Modern Tool Usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering problems, with an understanding of the limitations. (WK2 and WK6)

f) **The Engineer and the World**: When solving complex engineering problems, analyse and evaluate sustainable development impacts to: society, the economy, sustainability, health and safety, legal frameworks and the environment (WK1, WK5, and WK7).

g) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK9).

h) **Individual and Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multidisciplinary, face-to-face, remote and distributed settings (WK9).

i) **Communication**: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions, taking into account cultural, language, and learning differences.

j) **Project Management and Finance**: Demonstrate knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

k) **Life-long Learning**: Recognise the need for, and have the preparation and ability to (i) engage in independent and life-long learning, and (ii) adapt to new and emerging technologies, and (iii) think critically, in the broadest context of technological change (WK8).

**KNOWLEDGE PROFILE**

**WK1** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

**WK2** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

**WK3** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

**WK4** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

**WK5** Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts that supports engineering design and operations in a practice area.

**WK6** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

**WK7** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline such as the professional responsibility of an engineer to public safety and sustainable development.

**WK8** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

**WK9** Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc with mutual understanding and respect, and of inclusive attitudes.

Reference: EAB Accreditation Manual