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

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Prof Jason Xu Zhichuan
Course Author Email	xuzc@ntu.edu.sg
Course Title	Electronic Properties of Materials
Course Code	MS6014
Academic Units	3
Contact Hours	39
Research Experience Components	

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	MS7430 Electronic Materials & Devices
Replacement course to	
Remarks (if any)	Coursework students who have previously completed MS7430 Electronic Materials & Devices will not be allowed to read MS6014 Electronic Properties of Materials.

Course Aims

The aim of this course is to provide you with an understanding of the basic properties of electronic materials, the working principles underlying their applications in devices, and the operation of various electronic devices. At the end of this course, you will be able to analyse the behaviours and applications of various interfaces using energy band theory, understand the working principles of basic electronic devices such as metal-oxide semiconductor capacitors and field-effect transistor as well as energy harvesting and storage devices such as lithium-ion batteries and solar cells. This course will prepare you for exploration in electronic materials and devices development and/or continue higher postgraduate studies.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Analyse the behaviours and applications of various interfaces
ILO 2	Describe the working principles of basic electronic devices
ILO 3	Understand the working principles of energy harvesting and storage devices

Course Content

This course is organized into three modules:

- **Module 1**: Basic principles on energy band theory and various interfaces including metal-metal, metal-semiconductor and semiconductor-semiconductor interfaces.
- **Module 2**: Materials and devices for micro- and nanoelectronics such as metal-oxide semiconductor capacitor and metal-oxide semiconductor field-effect transistor on the basics of dielectric and capacitors.
- **Module 3**: Materials and devices for energy harvesting and storage such as solar cells and lithium-ion batteries.

Reading and References (if applicable)

1. Kasap, S. O. (2005). *Principles of Electronic Materials and Devices,* (3rd ed). Boston : McGraw-Hill.
2. S M Sze, S. M. (2002). *Semiconductor Devices - Physics and Technology*. New York : Wiley.
3. Streetman, B.G. and Banerjee, S. K. (2016). *Solid State Electronic Devices* (7th ed). Boston: Pearson
4. Nelson, J. (2003). *The Physics of Solar Cells*. London: Imperial College Press
5. Wu, Y. (2015). *Lithium-Ion Batteries: Fundamentals and Applications.* London: CRC Press - Taylor & Francis Group

Note: The above listing comprises the foundational readings for the course and more up-to-date relevant readings will be provided when they become available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	History of atomic theory and Energy band theory in brief	1	Kasap, S. O. (2005). Principles of Electronic Materials and Devices, (3rd ed). Boston : McGraw-Hill.	Online	Pre-recorded lecture + Online consultation
2	Metal-metal interface	1	Kasap, S. O. (2005). Principles of Electronic Materials and Devices, (3rd ed). Boston : McGraw-Hill.	Online	Pre-recorded lecture + Online consultation
3	Metal-semiconductor interface: Ohmic and Schottky contact	1	S M Sze, S. M. (2002). Semiconductor Devices - Physics and Technology. New York : Wiley.	Online	Pre-recorded lecture + Online consultation
4	Semiconductor-semiconductor interface: formation of p-n junction	1	S M Sze, S. M. (2002). Semiconductor Devices - Physics and Technology. New York : Wiley.	Online	Pre-recorded lecture + Online consultation
5	Semiconductor-semiconductor interface: properties and applications of p-n junction	1,2	S M Sze, S. M. (2002). Semiconductor Devices - Physics and Technology. New York : Wiley.	Online	Pre-recorded lecture + Online consultation
6	Continual Assessment 1 (CA1): Individual MCQ Quiz	1,2	N/A	Online	Continual Assessment 1 (CA1): Individual MCQ Quiz
7	Dielectric response and capacitor	2	Kasap, S. O. (2005). Principles of Electronic Materials and Devices, (3rd ed). Boston : McGraw-Hill.	Online	Pre-recorded lecture + Online consultation
8	Unique properties of some special dielectric materials	2	Kasap, S. O. (2005). Principles of Electronic Materials and Devices, (3rd ed). Boston : McGraw-Hill.	Online	Pre-recorded lecture + Online consultation

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
9	Metal-oxide semiconductor capacitor	2	Streetman, B.G. and Banerjee, S. K. (2016). Solid State Electronic Devices (7th ed). Boston : Pearson	Online	Pre-recorded lecture + Online consultation
10	Metal-oxide semiconductor field effect transistor	2	Streetman, B.G. and Banerjee, S. K. (2016). Solid State Electronic Devices (7th ed). Boston : Pearson	Online	Pre-recorded lecture + Online consultation
11	Solar cell technologies	3	Nelson, J. (2003). The Physics of Solar Cells. London: Imperial College Press.	Online	Pre-recorded lecture + Online consultation
12	Lithium-ion batteries	3	Wu, Y. (2015). Lithium-Ion Batteries: Fundamentals and Applications. London: CRC Press - Taylor & Francis Group	Online	Pre-recorded lecture + Online consultation
13	Continual Assessment 2 (CA2): Individual MCQ Quiz Submission of Continual Assessment 3 (CA3): Individual Essay	1,2,3	N/A	Online	Continual Assessment 2 (CA2): Individual MCQ Quiz Submission of Continual Assessment 3 (CA3): Individual Essay

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Online lectures	On-line lectures hosted by the Adaptive Teaching and Learning Applications System (ATLAS) are coupled with dynamic learning trees and closed captioning will accelerate learning and allow self-checking of understanding at your own pace with the aid of reference books and other resources. The online lecture discussion sessions engage students in reasoning through complex concepts, helping them connect theory with practical understanding. They also promote deeper learning by clarifying misconceptions, improving retention, and building confidence in scientific communication.
Online assessments	Two continuous assessments will be conducted on-line through the semester. The complexity and weight of CA1 and CA2 increases gradually so you can master the course incrementally without jeopardizing your grade. A project assignment will be conducted at the end for practising problem-solving capabilities using learnt knowledge.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Continual Assessment 1 (CA1): Individual MCQ Quiz)	1,2	N/A	20	MCQ comprises 10 to 15 questions. The duration of the assessment is 1 hour.	Individual	Holistic	Relational
2	Continuous Assessment (CA): Test/Quiz(Continual Assessment 2 (CA2): Individual MCQ Quiz)	2,3	N/A	20	MCQ comprises 10 to 15 questions. The duration of the assessment is 1 hour.	Individual	Holistic	Relational
3	Continuous Assessment (CA): Report/Case study(Continual Assessment 3 (CA3): Individual Essay)	1,2,3	N/A	60	3-5 pages write-up including figures.	Individual	Holistic	Relational

Description of Assessment Components (if applicable)

Formative Feedback

All CAs will measure students' ability to understand the basic concepts and working principles as well as the applications of electronic materials and devices. The students will receive written feedback about the learning progress in the course and the results of assessments. In addition, the students will also receive feedback in lecture discussion sessions.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Creative Thinking	Advanced
Curiosity	Advanced
Problem Solving	Advanced
Design Thinking	Advanced
Systems Thinking	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)

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)

Online 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 online class activities.

Policy (Others, if applicable)

Students may use Generative Artificial Intelligence (GAI) tools for the essay assignment, but the usage shall be restricted to refining syntax and grammar only. Students will be required to submit a declaration form to acknowledge their understanding of this policy when they submit their essays for assessment.

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