NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Reg. No. 200604393R

New Course Code and Title	**MS7430: Electronic Materials**
Instructor	Jason Xu Zhichuan
Details of Course	**Rationale for introducing this course** This is a specialization course focusing on electronic materials and devices. Electronic materials are a core component of many high value added, cutting edge, and functional devices. The applications include microprocessors, memory devices, displays, energy harvesting, energy storage, etc. Electronic industry forms an important part of Singapore's gross domestic products and a significant numbers of our graduates are employed by these companies.
	Aims and objectives The aim of this course is to equip the students with an understanding of the basic properties of electronic materials, the fundamental principle underlying their applications in devices, and the processing/operation of various electronic devices. At the end of this course the students will be able to 1. Understand and explain the basic properties of electronic materials and their roles in modern technological applications. 2. understand and explain the fundamental principles underlying the operation of various electronic devices. 3. describe the processing of electronic devices and their integration into systems. 4. analyse and predict future directions in the use of electronic materials and design of electronic devices.
	Course Syllabus (Refer to Page 2 and 3) MODULE 1: BASIC PRINCIPLES OF ELECTRONIC MATERIALS & DEVICES MODULE 2: MATERIALS & DEVICES FOR MICRO/NANOELECTRONIC APPLICATIONS MODULE 3: MATERIALS AND DEVICES FOR ENERGY HARVESTING AND STORAGE
Assessment	Components are assessed Individually 2 x Continuous Assessment (MCQ) — *60%* 1 x Essay — *40%* Total: 100 %

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To be offered with effect from (state Academic Year and Semester)	*AY2018/19 Semester 2*	
Any Duplication of Course	*NIL*	
Cross Listing (if applicable)	*N/A*	
Prerequisites (if applicable)	*N/A*	
Preclusions (if applicable)	*N/A*	
Mode of Teaching & Learning (Lectures, regular tests, Q&A, problem-based learning)	Lectures, tutorials, peer discussion, assessments, project	
Basic Reading List • **Compulsory Reading** • **Supplementary Reading**	**Supplementary Reading** 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.	
Maximum Class Size	*30*	
Hours of Contact/Academic Units	39 hours/ 3 AUs	
Workload Per Week (The workload for a 3-AU course must add up to 39 hours of contact hours)	Lecture hours per week Tutorial hours per week	*3 hours*
	Total hours	*39 hours*

Course Syllabus

The following topics will be covered:

MODULE 1: BASIC PRINCIPLES OF ELECTRONIC MATERIALS & DEVICES

1.1 Energy band theory in brief: metal, semiconductor and insulator
1.2 Metal-metal interface: Seebeck effect and thermocouple
1.3 Metal-semiconductor interface: Ohmic contact, Schottky barrier and their applications
1.4 Semiconductor-semiconductor interface (*pn* junction): basics of extrinsic semiconductors, space charge region, forward and reverse bias, current-voltage characteristics, etc.

MODULE 2: MATERIALS & DEVICES FOR MICRO/NANOELECTRONIC APPLICATIONS

2.1 Capacitor and Metal-Oxide-Semiconductor (MOS) capacitor: Dielectric response and capacitor, ideal MOS capacitor, operation of MOS capacitor, etc.
2.2 MOS-field effect transistor (MOSFET): Structure and properties of MOSFET, Field effect and threshold voltage, ON/OFF states of MOSFET, etc.

2.3 Advanced MOSFET: Scaling of MOSFETs, Moore's law, gate oxide scaling, low k dielectric, metal interconnect scaling, etc.

2.4 Overview of microelectronic packaging: introduction of flip chip, wire bonding, encapsulation, etc.

2.5 Other relevant devices: Memory devices-floating gate FET (FLASH), DRAM (1T1C), Materials for displays application-LEDs, electrochromic, etc., Latest Advances in Materials for Micro/Nanoelectronic applications-organic polymer and small molecules for printed electronic, etc.

MODULE 3: MATERIALS AND DEVICES FOR ENERGY HARVESTING AND STORAGE

3.1 Silicon based solar cells: single crystal, thin film, modules, and applications etc.

3.2 Alternative solar cell technologies: dye sensitized cells-working principles, hybrid perovskites solar cells, materials selection & design, etc.

3.3 Thermoelectric materials & devices: working principles, materials selection, etc.

3.4 Energy storage: rechargeable battery, supercapacitor etc.

3.5 Other energy related technologies: fuel cells, etc.