

**NEW ZEALAND INSTITUTES OF TECHNOLOGY AND POLYTECHNIC
QUALIFICATIONS IN INFORMATION & COMMUNICATIONS TECHNOLOGY**

PRESCRIPTION: BS500 SEMICONDUCTOR THEORY

AIM OF MODULE:	Students will gain an understanding of the structure of semiconductor materials and the construction, characteristics and operational principles of semiconductor devices.
CREDITS:	14
STUDENT LEARNING HOURS:	140
CONTENT REVISED:	2010
PRESCRIPTION EXPIRY DATE:	November 2013

Level and Assessment Schedule

TOPICS	Highest Skill Level				Suggested Assessment Percentage
	R	C	A	P	
1. Semiconductor Materials		*			10
2. Diodes		*			15
3. Bipolar Transistors		*			25
4. Unipolar Transistors		*			25
5. Thyristor family of semiconductors		*			25
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LEARNING OUTCOMES

The student will:

- C 1 Describe the atomic structure of semiconductor materials, differentiate between conductors, insulators and semiconductors and explain the principles associated with the production of semiconductor materials
- C 2 Explain the construction, characteristics and principles of operation of diodes
- C 3 Explain the construction, characteristics and principles of operation of bipolar transistors
- C 4 Explain the construction, characteristics and principles of operation of unipolar transistors
- C 5 Explain the construction, characteristics and principles of operation of thyristor family of semiconductors including SCRs, diacs, sidacs and triacs

Content

1 Semiconductor Materials

- Describing the atomic structure of semiconductor materials, differentiating between conductors, insulators and semiconductors and explaining the principles associated with the production of semiconductor materials includes:
 - Resistivity of conductors, insulators and semi-conductors
 - Variations in conductivity due to changes in temperature
 - Silicon and germanium semi-conductor materials
 - Doping of semi-conductor materials
 - P and N type materials

2 Diodes

- Explaining the construction, characteristics and principles of operation of diodes includes:
 - Circuit symbol and polarity
 - Conventional and electron current flow
 - Properties related to construction materials (silicon and germanium)
 - Forward voltage drop
 - Leakage current
 - Junction capacitance
 - Peak inverse voltage (PIV)
 - Characteristic curves

3 Bipolar Junction Transistors

- Explaining the construction, characteristics and principles of operation of bipolar junction transistors includes:
 - Schematic symbols of NPN and PNP
 - Forward biased base-emitter junction and reversed biased base-collector junction
 - Electron flow and characteristic family of curves for NPN and PNP
 - Effects of leakage current
 - Common base, common emitter, and common collector (emitter follower) configurations

4 Unipolar Transistors

- Explaining the construction, characteristics and principles of operation of unipolar transistors includes:
 - Schematic symbols of JFETs and MOSFETs
 - JFET and MOSFET construction
 - Cross section of a CMOS integrated circuit
 - Physical structure of the enhancement type of NMOS transistor
 - JFET and MOSFET enhancement and depletion modes
 - Characteristics of junction field-effect transistors

5 Thyristor Family of Semiconductors

- Explaining the construction, characteristics and principles of operation of thyristors, including silicon controlled rectifiers (SCRs), diacs, sidacs, and triacs, will involve:
 - Thyristor terms, symbols and definitions
 - Schematic symbols of SCRs, diacs, sidacs, and triacs
 - Block construction of SCRs
 - Basic operation and geometric construction (cross-sectional view) of;
 - An SCR
 - A diac
 - A sidac
 - A triac
 - Thyristor electrical characteristic curves
 - Thyristor switching methods

Note:

- The characteristics of the devices should be demonstrated by laboratory experiments.

Reading/Reference List:

Electronics Fundamentals: Circuits, Devices & Applications (8th Edition) Thomas L. Floyd & David M. Buchla. ISBN-13: 978-0135072950 (Prentice Hall; 8 edition July 3, 2009)

- Web links:
 - **Semiconductor Materials** http://www.science-campus.com/engineering/electronics/semiconductor_theory/ (Accessed August 2010)
 - **Diodes** http://www.allaboutcircuits.com/vol_3/chpt_2/6.html & http://www.electronics-radio.com/articles/electronic_components/diode/pn-junction-diode.php (Accessed August 2010)
 - **Bipolar Junction Transistors** http://en.wikipedia.org/wiki/Bipolar_junction_transistor (Accessed August 2010)
 - **Unipolar Transistors** <http://www.ece.uvic.ca/~btill/uvatt/discrete/review.pdf> (Accessed August 2010)
 - **Thyristor Family of Semiconductors** <http://www.educylopedia.be/electronics/composetriac.htm> & http://www.littelfuse.com/data/en/Application_Notes/AN1001.pdf (Accessed August 2010)