**NORMANDALE COMMUNITY COLLEGE**
**COMMON COURSE OUTLINE**
**VACT 2294 and NANO 2294, Semiconductor Processing**

## I. EFFECTIVE DATE OF OUTLINE

Fall Semester, 2012. To be reviewed by the department annually.

## II. CATALOG DESCRIPTION

A. VACT 2294 and NANO 2294
B. Semiconductor Processing
C. 4 Credits
D. Offered Spring Semester
E. Prerequisites: VACT 2297 or concurrent enrollment
F. Semiconductor processing refers to categories of manufacturing processes associated with fabricating an integrated circuit, a type of electrical component manufactured by the semiconductor industry. This course provides an overview explaining these special processes and how they are sequenced to produce the integrated circuit. Vacuum systems technology plays a critical role in making several of the underlying fabrication processes possible.

## III. RECOMMENDED ENTRY SKILLS/KNOWLEDGE

A. Students are expected to possess intermediate knowledge and skills related to the composition, functions and operation of vacuum-based systems (completion of VACT 2293 or NANO 2293) and some familiarity with applications which utilize vacuum systems technology in support of processes to manufacture specific end-products (completion of VACT 2297 or NANO 2297 or concurrent enrollment) commensurate with a readiness for this second-year, post-secondary level course.
B. Students should possess intermediate skills in the use of the following Microsoft Office applications: Word and Excel. Examples of intermediate skills in the use of these software applications are creating mathematical functions to analyze data, creating appropriate charts to represent tabled data, adding a chart to a lab report and creating a report according to stated layout criteria.
C. Students should be familiar with the college online course site and be prepared to use the online site to access information about the class including downloads of file-type information, post homework and interact with the instructor and class peers through the online site.
D. Students should also have an intermediate knowledge of how to perform searches for information on the Internet.

## IV. OUTLINE OF MAJOR CONTENT AREAS

A. Integrated Circuit (IC)
B. Semiconductor industry
C. Semiconductor processing workplace environment
D. Wafer substrate
    a. Properties and characteristics of semiconductor materials
    b. Wafer formation
E. Wafer processing steps
    a. Modification of electrical properties
    b. Deposition
    c. Patterning
    d. Material Removal
F. Fabricating an IC
    a. Front-end-of-line (FEOL) processing
    b. Back-end-of-line (BEOL) processing
G. Wafer and device testing
H. Die preparation
I. IC packaging

## V. LEARNING OUTCOMES

Upon successful completion of VACT 2294 or NANO 2294, students will have demonstrated ability to:

A. Explain the function of a basic transistor component and its relationship to the implementation of Boolean functions or logic operations in electronic devices.
B. Define an integrated circuit (IC) as a singular electronic component which itself consists of a complete electronic circuit.
C. Describe the origins of the IC and significant developments in the evolution of IC technology and the key contributors to these developments.
D. Identify some of the largest current day semiconductor manufacturers which produce IC components, the types of components they produce and the volume of components produced.
E. Describe the function and features of a modern semiconductor fabrication foundry.
F. Differentiate between monocrystalline, polycrystalline and amorphous silicon materials.
G. Describe the characteristics of a typical silicon wafer substrate used in IC manufacturing and identify the steps associated with creating the wafer.
H. Explain the purpose associated with modifying the electrical properties to form an IC, describe the chemical and physical reactions involved with this type of process, identify the technologies and the essential input materials and parameters required to execute this process, and describe the expected outcomes of the process.
I. Explain the purpose associated with depositing materials to form an IC, describe the chemical and physical reactions involved with this type of process, identify the technologies and the essential input materials and parameters required to execute this process, and describe the expected outcomes of the process.
J. Explain the purpose associated with setting a pattern to form an IC, describe the chemical and physical reactions involved with this type of process, identify the technologies and the essential input materials and parameters required to execute this process, and describe the expected outcomes of the process.
K. Explain the purpose associated with removing material to form an IC, describe the chemical and physical reactions involved with this type of process, identify the technologies and the essential input materials and parameters required to execute this process, and describe the expected outcomes of the process.
L. Synthesize the sequence of wafer processing steps to form the transistor.
M. Synthesize the sequence of wafer processing steps to produce the IC.
N. Describe the wafer testing techniques used to confirm an IC functions properly and perform some of these testing techniques.
O. Describe the processes by which an IC die is extracted from the wafer.
P. Differentiate the IC packaging options.
Q. Explain the operations of the IC packaging process and identify the technologies and the essential input materials and parameters used to execute these operations.
R. Recognize and interpret basic chemical equations which express IC formation process outcomes properly and use these equations correctly.
S. Use appropriate algebra-based formulas to calculate certain IC formation process outcomes.
T. Practice appropriate safety techniques and procedures when performing lab activities.
U. Create advanced lab reports which convey information about lab activities including the purpose and objective, background reference, procedure, summary of results, analysis, conclusion and appendix of data tables and graphs.

## VI. METHODS USED FOR EVALUATION OF STUDENT LEARNING

Students will be evaluated on the following categories of course work: (1) assignment work involving both written descriptive answers and mathematical based problem solving; (2) lab reports; (3) demonstration of laboratory competence including but not limited to practices in (a) safety, (b) equipment operation, (c) collecting and documenting data, (d) maintaining a lab notebook; and (4) mid-term and final end-of-course exams.

The final grade will be determined by some appropriate weighting of the course assignments, lab work and exam results.

## VII. SPECIAL INFORMATION

A. Students will need access to a model vacuum-based system to conduct lab activities. The vacuum-based system will be available for student use in the classroom.
B. Students will need access to equipment to perform characterization measurements as part of lab activities. The measurement equipment will be available for student use in the classroom.
C. Students will need access to appropriate safety gear. The safety gear will be available for student use in the classroom.
D. Normandale Community College students who complete certain pre-requisite coursework may consider as an alternative to VACT 2294, completing courses MT 3111 "Elements of Microelectronic Manufacturing" and MT 3112 "Elements of Micro and Nano Manufacturing Lab" at the University of Minnesota. Students should consult with the Vacuum and Thin Film Technology department chair and Normandale academic advisors to understand their eligibility to pursue this option as well as other potential implications.