MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF ARMENIA

STATE ENGINEERING UNIVERSITY OF ARMENIA

CONFIRMED BY

EXECUTIVE DIRECTOR OF

"SYNOPSYS ARMENIA" CJSC SG

H. MUSAYELYAN

"____" _____2005

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VICE RECTOR OF STATE ENGENEERING

UNIVERSITY OF ARMENIA

R. AGHGASHYAN

"____" _____2005

VLSI DESIGN

COURSE PROGRAM

INDEX: **MIM-3.20**

SPECIALIZATION **"VLSI DESIGN"**

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The program has been discussed and approved by:

- At the sitting of the SEUA interdepartmental Chair of **"Microelectronic Circuits and Systems"** acting on the basis of "SYNOPSYS ARMENIA" CJSC SG
  Protocol No. 5 of. 22.02.2005

Head of Chair V.Sh. Melikyan
"Microelectronic Circuits and Systems",
Associate Professor, PhD

INTRODUCTION

Course program on "**VLSI Design**" is assigned for postgraduate education on "**VLSI Design"** specialization and is taught on the 3 semesters (2 year's 1 semesters).

The course duration is 136 hours, lectures volume is 68 hours, practical works are 34 hours, and laboratory works are 34 hours, and course work (2 year's 1st semester).

COURSE GOALS AND OBJECTIVES

The goal of the course is to teach the peculiarities, principles and methods of contemporary VLSI design and analysis to the future designers of microelectronic circuits and systems.

The main objectives of the course are:

The study of different types of VLSI and their design procedures with methods applied in different stages of design, and algorithms used in each stage of design. The understanding of the course will help students to apply their knowledge in practice.

At the practice classes connected with different stages of VLSI design are reviewed during the practical works. These works are aimed at practical usage of different design methods.

In the process of the laboratory work it is necessary to study the problems related to various levels and stages of VLSI design.

SYLLABUS

1. LECTURES (34 hours)

1.1. VLSI design basic principles (8 hours).

Applications of VLSI. Full-Custom and Semi-Custom VLSI design methods. Standard-Cell-Based VLSI. Gate-Array-Based VLSI. Channeled and Channel-less Gate Array. Structured Gate Array. Programmable Logic Devices. Decomposition of VLSI. VLSI - PCB correlation.

Switching energy of interconnections. Operating speed of interconnections. Ratio of logical elements and interconnections areas. Routing ability of basic matrix crystal. The degree of VLSI integration limit.

Design and technological factors influencing on VLSI cost. Design, production and maintenance expenses and their components. Changes in the market and their impact on design. Comparative analysis of different design methods.

1.2. VLSI libraries design (6 hours).

The peculiarities of VLSI design by standard cells library method. Organization of library design. The standard cells library structure.

Typical sizes of cells. Standard cells library design peculiarities.

The parasitic connections existing in standard cells, the noise caused by them and the noise control. The parasitic connections existing in the CMOS transistors - resistance, capacitance and inductance and methods of their description.

The difference between Gate-Array Macros, Standard Cells, Data path Cells and features of their Design.

1.3. Programmable VLSI (6 hours).

Programmable logic cells, their structure, design peculiarities.

Programmable storage devices. Programmable permanent and random access storage devices. Read only (ROM) and erasable- programmable (EPROM) organization technologies.

Programmable logic arrays and their variety. Partially programmable logical matrixes. Multi-stage logical arrays.

Classification, peculiarities, basic characteristics, implementation methods and programming tools summary of leading companies' programmable VLSI.

1.4. System-on-a-chip design (4 hours).

Microsystems and circuit Modules. System-on-a-chip (SoC) design methodology. SoC design flow.

1.5. Multichip modules design (4 hours).

Multichip modules (MCM) technologies. MCM design cycle. Chip array based approach. Full custom approach. Partitioning, placement and routing problem of MCM design.

1.6. Ensuring reliability of VLSI during the design (4 hours).

The factors affecting the reliability of VLSI. VLSI fault analysis and way of increasing the reliability. Reliability modeling and calculation methods.

Test of VLSI as a way of increasing reliability. Fault modeling types.

Modeling and calculation of VLSI thermal effects.

Modeling and calculation of VLSI mechanical effects.

1.7. VLSI automated design systems (2 hours).

VLSI automated design system's building methodology. The requirements to the VLSI automated design systems and the principles of their building. The design flow in the VLSI automated design system. Summary of CAD structure, design technologies, programming means and tools of leading companies.

2. PRACTICE CLASSES (34 hours)

2.1. The calculation of ratio of logical elements interconnections areas (6 hours).

2.2. Calculation and selection of basic matrix crystals' sizes (6 hours).

2.3. Calculation of basic matrix crystal's routing capacitance (6 hours).

2.4. The calculation of VLSI thermal regime (8 hours).

2.5. Research of methods for reliability modeling and calculation (8 hours).

3. LABORATRY WORKS (34 hours)

Tools used during laboratory works: Cosmos, HSPICE, NanoSim, DC Expert, DC Ultra, DC FPGA, Module Compiler, Physical Compiler, DFT Compiler, Power Compiler, PrimePower, Astro, Astro-Xtalk, Encore, Star-RCXT, Hercules, PathMill, PrimeTime, PrimeTime SI, RailMill, Milkyway, System Studio, VCS, VCS MX, Magellan, Formality ESP.

3.1. The development of logical circuits (6 hours).

3.2. The development of VLSI sample unit (6 hours).

3.3. Modeling of electronic circuit (6 hours).

3.4. Design of VLSI sample units by using electrical logic cells library (6 hours).

3.5. Development of VLSI layout (6 hours).

3.6. VLSI post- layout verification (4 hours).

4. COURSE WORK

The themes for Course Work, intended in 2nd year 1st semester, are related to VLSI libraries design, programmable VLSI design, system-on-a-chip design and multichip modules design.

METHODIC PROVISION OF THE COURSE

To study the course the necessary list of references is given below.

The course program is compiled taking into account that the following courses had been studied beforehand:

- “IC Design Introduction”
- “Digital Integrated Circuits”
- “Analog Integrated Circuits”
- “RF Circuits and Systems”
- “Semiconductor Technology”
- “PCB Design”

Understanding of the course is the basis for the further specialized subjects destined by the educational plan of “VLSI Design” specialization.

REFERENCIES

Main

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2. Rajsuman R., System-on-a-Chip: Design and Test, Artech, 2001.
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4. Naveed A. Sherwani. Algorithms for VLSI Physical Design Automation, Kluwer Academic Publishers, 1999.

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5. Baker, R. Jacob, CMOS Circuit Design, Layout and Simulation, IEEE Press, 1997.
6. J.M. Rabaey, A. Chandrakasan, B. Nikolic. Digital Integrated Circuits - A Design Perspective, Prentice Hall, 2003.