**COURSE DESCRIPTION**

**name** **Design for manufacturing of microsystems**

**shortname**/**abbr**. **DFM**

**course objectives see in syllabus (Knowledge, Skills, Competences)**

**description** **see in syllabus**

**target students bachelor, master, Ph.D. students**

**intro** **see in syllabus**

**developed** **by**  **POLITEHNICA University of Bucharest, Center for Technological Electronics and Interconnection Techniques (UPB-CETTI)**

**evaluation**  **see in syllabus**

# Syllabus "Design for manufacturing of microsystems"

## Course topic

A practice oriented course for understanding Electronic Design Automation (EDA) and manufacturing principles oriented to design for manufacturing of microsystems and electronic modules.

## Number of credits

3 ECTS

## *Course responsible*

POLITEHNICA University of Bucharest

Prof. Norocel Codreanu

## *Course lecturers*

Prof. Norocel Codreanu

Prof. Ciprian Ionescu

Assoc. Prof. Ioan Plotog

## *Prerequisites*

Knowledge of basic electronics design, passive and active electronic components and circuits, modelling, simulation, and materials for electronics; basic knowledge of microelectronics, technologies and electronic packaging.

## *Learning outcomes*

Knowledge: Advanced knowledge in the field of Design For Manufacturing (DFM) of microsystems and modules, involving deep understanding Electronic Design Automation (EDA) theories and manufacturing principles based on optimum design solutions.

Skills: Ability to design specific electronic modules which contain microsystems using the Cadence design environment and ability to solve Design For Manufacturing (DFM) problems based on pre-layout and post-layout simulation.

Competences: Demonstration of advanced ability to use engineering knowledge, skills, innovation, autonomy and methodological abilities in the design for manufacturing of specific electronic modules, including research and development in this field; ability to manage and design custom modules with microsystems.

## Abstract

The course introduces students to modern manufacturing, with the main focus to design for manufacturing. Design plays a critical role in the success or failure of manufacturing and assembling. The course exposes students to integration of engineering design activities oriented to manufacturing and volume production. Labs are integral parts of the course, and expose students to various practical design and manufacturing issues and problems. This course provides students with the opportunity to develop and demonstrate an understanding of product design and manufacturing processes fundamentals, offering design for manufacturing and assembling techniques, which are used to minimize product cost through design and process improvements. Computer aided design (CAD) and computer aided manufacturing (CAM) principles are introduced in the development of microsystems and modules. This part will introduce students to the use of modern production methods, including printed circuit board (PCB) layout and computer numerical control (CNC) drilling and milling. It will also enable students to experience the full cycle of design, manufacture and testing of microsystems and modules. Additionally, students will execute a practical project, while obtaining feedback from industry concerning the introduction in production. Finally, attendees will have a unique opportunity to obtain first-hand information on design issues that impact both manufacturability and testability.

## Content

1. Basics of Electronic Design Automation (EDA), manufacturing and Design for Manufacturing (DFM)

1.1 Intro to EDA and DFM

1.2 International standards used in industry

1.3 Overview of DFM issues and problems

1. Modelling, simulation and design of interconnection structures for microsystems and modules

2.1 Introduction

2.2 Meshing and cells

2.3 Layer stack-up and thickness

2.4 Practical modelling and simulation of microsystems interconnection structures/elements

1. Computer Aided Design of microsystems structures and elements

3.1 Introduction

3.2 Software tools for CAD and DFM

3.3 Beam design

3.4 Mirror design

3.4.1 Simple mirror design

3.4.2 Four-layer optical mirror

3.4.3 Thermally-actuated pop-up mirror

1. Design rules and guidelines for DFM

4.1 DFM rules and guidelines

4.2 DFM examples from industry

1. New trends in microsystems design for manufacturing

5.1 The present and the future of DFM

5.2 New trends in microsystems design

## *Teaching methods*

The theoretical part of the course is presented with PowerPoint slides, practical examples/projects and problem-based learning. Based on the MECA Knowledge Alliance project, a Moodle learning environment in the form of HTML tutorials is also considered, in partnership with Giga Electronic International, Romania. The laboratory is based on interactive design and simulation activities using the Lite version of the Cadence/OrCAD 16.6-2015 design environment and other various CAD-CAM tools. Additionally, during the lab students solve practical problems found in various electronic projects, addressing the design for manufacturing of microsystems and modules.

## Evaluation/Assessment

The evaluation is based on the examination of concepts acquired in the course and consists of the following components:

40% - Final report targeting various problems and issues, according to those solved during the lectures and the labs;

60% - Final design project of a small complexity electronic circuit.

## Recommended reading

* Deiter G. E., McGraw Hill - *Engineering Design - Material & Processing Approach*, 2nd ed., 2000;
* Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight - *Product Design for Manufacturing and Assembly*, CRC Press, 2010;
* Kalpakjian, S. and Schmid, S. R. - *Manufacturing Engineering and Technology*, 4th ed., Prendice-Hall, N.J., 2001;
* Linbeck, J. R. - *Product Design and Manufacture*, Prendice-Hall, N.J., 1995;
* Singh, N. - *Systems Approach to Computer-integrated Design and Manufacturing*, John-Wiley, 1996;
* Jin Y., Wang Z., Chen J., *Introduction to Microsystem Packaging Technology*, CRC Press, Boca Raton, 2011, ISBN 978-143981910-4;
* Harper C. A., *Electronic packaging and interconnection handbook*, McGraw-Hill, 2000;
* Coombs C. F., Jr., *Printed circuits handbook*, 6th ed., McGraw Hill Professional, 2007, ISBN 978-0071510790;
* J. Lau, C. P. Wong, J. L. Prince, W. Nakayama, *Electronic Packaging – Design, Materials, Process and Reliability*, McGraw-Hill, 1998;
* Fitzpatrick D., *Analog Design and Simulation using OrCAD Capture and PSpice*, Newnes/Elsevier, Oxford,  2012, ISBN 978-0-08-097095-0.