

# Introduction to System-on-Chip and its Applications

(系統晶片應用簡介)

**(3 units) (Elective, for senior and graduate students)**

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## Course Description

This course introduces what is System-on-Chip (SoC), benefits of using SoC, system architecture, design methodology and its applications. It uses several SoC designs, such as computer chip sets, cell phone IC, multimedia ICs, wireless communication ICs, information appliances and interface ICs, as examples to illustrate the top-down IC design flow, Intellectual Property(IP), system platform design and their market applications. The computer chip sets covers personal computer architectures, memory and peripheral I/O interface chip design. The cell phone IC covers heterogeneous multi-processor (HMP). The wireless communication includes CDMA, OFDM and LTE 4G chip designs. The multimedia ICs covers audio, still image, and video ICs. The biomedical ICs covers Gene chip, Lab on a chip, and Ink-jet microarray.

## Course Objective

This course is intended for students to understand the SoC current status, existing SoC systems and their applications.

## Pre-requisite

-none

## Textbook

- ppt lectures

## Course Outline and Schedule

### ■ I. SoC 簡介

- 1. Introduction to Integrated Circuit/SoC
- 2. SoC architecture and platform
- 3. SoC Semiconductor Process

### ■ II. Computer SoC Systems and its Applications

- 1. Introduction to Computer SoC
- 2. CISC Architecture and Intel CPU
- 3. RISC Architecture and ARM CPU
- 4. Server CPU

### ■ III. Memory

- 1. Introduction to memory (SRAM/DRAM/Harddisk)
- 2. Flash Memory (NOR/NAND Flash)
- 3. New generation nonvolatile memory (RRAM/MRAM)
- 4. In-Memory Computing

### ■ IV. Display technologies

- 1. Liquid Crystal Display (LCD)/
- 2. Light Emitting Diode (LED)
- 3. Organic LED (OLED)

- 4. Quantum Dot LED (QLED)
  - 5. Mini-LED and Micro-LED
  - 6. Touch Panel
- **V. Interface (Interconnect IC)**
  - 1. PCI-E (Peripheral Component Interconnect-Express)
  - 2. USB (Universal Serial Bus)
  - 3. DP (Display Port)
  - 4. HDMI (High Definition Multimedia Interface)
- **VI. Multimedia SoC**
  - 1. Video CODEC
  - 2. H.265/HEVC Video Decoder (VP9)
  - 3. H.266 (VVC) (Versatile Video Coding)
  - 4. Video Streaming
  - 5. Speech CODEC
  - 6. High Dynamic Range (HDR)
  - 7. 3D Video IC
  - 8. 360 degree video IC
- **VII. Graphic SoC**
  - 1. Computer Graphic
  - 2. Graphic Processor (GPU) Architecture
  - 3. Nvidia GPU (2080 Ti)
  - 4. GPU for Deep Learning
- **VIII. Video Game SoC**
  - 1. Microsoft XBOX
  - 2. PlayStation (PS5)
  - 3. Nintendo Switch
- **IX. Augmented Reality/Virtual Reality**
  - 1. HTC VR
  - 2. Microsoft HoloLens (holographic VR)
  - 3. Oculus SLAM
  - 4. AR/VR glass
- **X. Wireless Data Transmission (Modem IC/Cellphone)**
  - 1 LTE
  - 2 5G
  - 3 Qualcomm 5G IC
  - 4 MediaTek
  - 5. Cellphone System
- **XI. Wireless Interface (Interconnect IC)**
  - 1 Bluetooth
  - 2 RFID (Radio Frequency Identification)
  - 3 USB (Universal Serial Bus)
  - 4 NFC (Near Field Communication)
  - 5 Zigbee
- **XII Wearable Devices**
  - 1. Sensors

- 2. Apple watch
- 3. Exercise monitor
- 4. Bio-condition monitor
- **XIII Application Systems**
  - 1. Social Network
  - 2. Apps on mobile or Tablet devices
  - 3. Internet of Things
  - 4. Drone
  - 5. Self-Driving Cars
  - 6. Biometric Recognition System (fingerprint, iris, face, gait, etc)
  - 7. 3D Sensing
  - 8. Blockchain

#### Individual Projects:

Each student selects a topic from provided System\_on\_chip technologies list, provides deep core technologies, and market analysis, then give a presentation and a written report.

#### Individual Project

1. Select a topic from the SoC list
2. Project must cover
  - Definition of the technology/Devices/SoC
  - Applications
  - System Architecture
  - Core Module Technology (based on a technical paper)
  - SoC Architecture
  - Market Analysis
3. Oral presentation in English - ppt 25min
4. Written report in English –pdf

#### Final Projects

Divide students into groups by fourth week.

Proposal -seventh week

Final presentation – last two weeks

Final Report

- Innovative SoC Systems and Applications
- Project must cover
  - ◆ Definition of the technology/Devices/SoC
  - ◆ Applications
  - ◆ System Architecture
  - ◆ Core Module Technology (based on a technical paper)
  - ◆ SoC Architecture
  - ◆ Market Analysis
- Oral presentation in English - ppt 25min
- Written report in English –pdf

**Grading**

- Group project 30%
- individual project 35%
- Exam 30%
- Participation-5%

Lecture website: <https://eeclass.nthu.edu.tw/>