Unit T3: Microelectronics

Unit code:	A/503/7339
QCF level:	6
Credit value:	15

Aim

The aim of this unit is to give learners an understanding of the manufacturing processes for integrated circuits and the purposes and limitations of electronic computer aided design. Learners will also develop skills in analysing integrated circuit components developments in integrated circuit devices packages and their manufacture.

Unit abstract

Microelectronics has been the fastest growing technology for more than three decades. From relatively simple designs involving small numbers of components on a chip, advances in technology and manufacturing processes or micro-fabrication have resulted in complete design solutions on a chip using millions of electronic components.

Learning outcome 1 covers the manufacturing process for integrated circuits (ICs). Learning outcome 2 explores electronic computer aided design (ECAD) software, and learning outcome 3 takes learners through analysis of IC building block circuits and IC systems. The final learning outcome requires learners to investigate the latest IC devices and technology used in IC production.

Learning outcomes

On successful completion of this unit a learner will:

1 understand the manufacturing processes for integrated circuits

2 understand the purposes and limitations of electronic computer aided design software

3 be able to analyse integrated circuits

4 be able to evaluate developments in integrated circuit devices packages and manufacture.

Unit content

1 Understand the manufacturing processes for integrated circuits

Integrated circuit (IC) manufacturing processes: monolithic semiconductor; photolithography; floor planning; register transfer level design; physical design (noise segregation, heat generation, external connections); design for manufacturability

Digital IC devices: microprocessors; Field-programmable Gate Arrays (FGPAs); memories (random access memory (RAM), read only memory (ROM), static random access memory [SRAM], dynamic random access memory (DRAM), flash; Application specific integrated circuits (ASICs)

Analogue IC devices: eg operational amplifiers, linear regulators, phase-locked-loops, oscillators, active filters

2 Understand the purposes and limitations of electronic computer aided design software

Electronic computer aided design (ECAD) processes: schematic capture; hardware description languages; device and circuit modelling; simulation; design synthesis; layout; circuit extraction; verification tests; production tests

ECAD design tools: eg Verilog, PSpice, Mentor Graphics, MATLAB, Simulink

3 Be able to analyse integrated circuits

Circuit analysis: complementary metal–oxide–semiconductor (CMOS) and negative-channel metal-oxide semiconductor (NMOS) circuits (inverter, source follower); cascade stages; low frequency equivalent circuits

System analysis: eg op-amps, linear regulators, phase-locked-loops, oscillators, active filters

4 Be able to evaluate developments in integrated circuits devices, packages and manufacture

Nanofabrication: eg optical, e-beam lithography, active matrix, organic compounds; microelectromechanical systems (MEMS); fables manufacture

Next generation IC challenges: Moore's law; yield verses wafer size; wafer dimensions (diameter, thickness); interconnects; metalisation; copper alloys; polishing; packaging

New devices and applications: eg Micro-Electro-Mechanical Systems (MEMS), opto-electronics

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	**Assessment criteria for pass** The learner can:
LO1 Understand the manufacturing processes for integrated circuits	1.1 Describe in detail integrated circuit manufacturing processes 1.2 Explain in detail the operation of digital integrated circuit devices 1.3 Explain in detail the operation of analogue integrated circuit devices
LO2 Understand the purposes and limitations of electronic computer aided design software	2.1 Explain how electronic computer aided design is used in integrated circuit design 2.2 Critically evaluate electronic computer aided design tools used for integrated circuit design
LO3 Be able to analyse integrated circuits	3.1 Analyse standard complementary metal-oxide semiconductor and negative-channel metal-oxide semiconductor circuits encountered in integrated circuits 3.2 Explain the operation of systems or sub-systems encountered in Integrated Circuits
LO4 Be able to evaluate developments in integrated circuits devices, packages and manufacture	4.1 Describe nanofabrication methods for integrated circuit manufacture 4.2 Critically evaluate challenges for next-generation integrated circuits 4.3 Critically evaluate new integrated circuit devices and applications.

Guidance

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes associated with this unit are closely linked with:

Level 4	Level 5	Level 6
Unit 71: Combinational and Sequential Logic	*Unit 39: Electronic Principles*	*Unit T5: Advanced Manufacturing Processes*
	Unit 73: Principles of Electronic Product Manufacture	*Unit T11: Sustainability in Engineering*

The content of this unit has been designed and mapped against the Engineering Council's current Learning Outcomes for IEng Accreditation. The completion of the learning outcomes for this unit will contribute knowledge, understanding and skills towards the evidence requirements for IEng Registration.

See *Annexe B* for summary of mapping information for IEng Accreditation.

Essential requirements

There are no special requirements needed for this unit.

Delivery

Access to ECAD tools and links/visits to Wafer fabrication facilities would enhance the learner's experience.

Using industrial speakers would enhance delivery.

It is suggested that for learning outcome 4 learners undertake detailed internet searches.

Resources

Books

Grey P R, Hurst P J, Lewis S H, and Mayer R G – *Analysis and Design of Analog Integrated Circuits* (John Wiley & Sons, 2009) ISBN 978-0470398777

Kaeslin H – *Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication* (Cambridge University Press, 2008) ISBN 978-0521882675

Lavagno L, Martin G and Scheffer L – *Electronic Design Automation for Integrated Circuits Handbook* (CRC Press, 2006) ISBN 978-0849330964

Sedra A S and Smith KC – *Microelectronic Circuits* (Oxford University Press, 2009) ISBN 978-0195323030

Website

www.icknowledge.com/misc_technology/IntroToICTechRev4.pdf	This document provides a good introduction and overview on IC design and developments