The University Of Sheffield.

Electronic & Electrical Engineering.

EEE225 ANALOGUE AND DIGITAL ELECTRONICS

Credits: 20

Course Description including Aims

This module brings together the underlying physical principles of BJT, JFET and MOSFET devices to show how structural decisions in device design affect performance as a circuit element. Basic circuit topologies such as long - tailed pairs, Darlington transistors and current mirrors are described as a precursor to exploring the internal design of a typical op-amp. Common applications of op-amps are discussed. The relationship between device structure and performance in simple CMOS circuits is explored and applied to real digital circuit applications. Digital system design strategies are introduced with examples drawn from everyday embedded digital systems.

The specific aims of the unit are . .

1 Give students an understanding of common transistor device structures and of the way that their design affects the application areas for which a device is useful.

2 Provide foundation knowledge of the operating principles of LEDs, lasers and photo-voltaics.

3 Introduce multi transistor circuit blocks that together can be used to form an operational amplifier.

4 Explore a wide range of linear and non-linear op-amp applications

5 Introduce the concept of noise in analogue circuits and systems.

6 Introduce multi transistor circuit blocks that are the basis of the majority of the logic gates that together form complex VLSI digital systems.

7 Outline the differences between various digital logic families with reference to their input/output properties, speed and power consumption. Highlight currently popular families.

8 Review the area of finite state machines and their relationship to programmable systems and extend the discussion to programmable logic and FPGAs.

9 Explore the anatomy of a simple microcontroller system including memory organisation, hardware/software trade-off and speed and present some everyday examples of embedded controller systems.

Outline Syllabus

Band model of materials, metals, insulators and semiconductors. Intrinsic and doped semiconductors, p-n junction diode, BJT and MOSFET device structures and internal operation, modelling for analogue and digital applications, Electrons as waves, LEDs, lasers and solar cells. Noise. Digital circuit organisation. Microcontrollers and embedded systems, practical system organisation and interfacing. Software - hardware trade-offs, power consumption. Introduction to packaging and reliability.

Time Allocation

48 hours of lectures (inc case studies), 24 hours problem classes, 125 hours of guided independent study.

Recommended Previous Courses

Knowledge equivalent to first year EEE117, EEE118 and EEE119.

Assessment

three hour examination answer 4 questions from 6 in three hours

Recommended Books

Edwards-Shea, L.	The Essence of Solid-State Electronics	Prentice-Hall
Streetman & Bannerjee	Solid State Electronic Devices	Prentice-Hall
J. Crowe & B. Hayes-Gill	Introduction to Digital Electronics	Prentice Hall
T. L. Floyd	Digital Fundamentals	Prentice Hall
D. D. Gajski	Principles of Digital Design	Prentice Hall
M Morris Mano	Digital Design 3rd ed.	Prentice Hall
Sedra A S & Smith K C	Microelectronic Circuits	Oxford
Horowitz and Hill	The Art of Electronics	Cambridge
Smith, R.J.	Circuits Devices and Systems	Wiley

Objectives

"By the end of the unit, a candidate will be able to"

1 Use basic device relationships to predict the performance of some common semiconductor devices in the analogue, digital and optical arenas.

2 Explain the key issues in device packaging and appreciate the effects of electrical and thermal stress on device reliability.

3 Write down equivalent circuit representations of diodes, BJTs and MOSFETs and use these to predict device behaviour in a circuit context.

4 Recognise the circuit diagrams of and make simple quantitative performance predictions for a number of multi-transistor circuit blocks in both the analogue and digital domains.

5 Design linear and non-linear op-amp circuits for conditions well inside the amplifiers performance envelope.

6 Understand the nature of electronic noise and make quantitative predictions of noise magnitudes and of system noise parameters such as S/N and noise factor.

7 Discuss the merits and disadvantages associated with a number of logic families and be able to design using open collector (drain) logic devices and comparators.

8 Design at high level a simple embedded system and demonstrate awareness of key issues such as speed, power consumption, environment and hardware/software trade-off.