

# E3111 Electronics 1 - 2013

An introduction to analogue electronics using a device-based approach. The course starts with basic nomenclature and the ideal amplifier model concept. Semiconductor diodes, BJTs and MOSFETs are then introduced followed by how these devices can be used to implement single-stage small-signal amplifiers. To compliment this overall analog approach, the use of both BJTs and MOSFETs in digital logic gates is also covered which in turn introduces the concept of noise margins.

## 1 Introduction

- Outline - Definitions, model, symbols, voltage sources, phases
- Large and small signals
- Basic amplifiers models

## 2 Operational Amplifiers

- Ideal amplifiers
- Feedback
- Virtual earth approximation
- Circuits      Non inverting amplifier
- Infinite gain approximation
- Formal analysis
- Inverting amplifier
- Input/Output impedance
- Instrumentation Amplifier
- Frequency and Feedback, filters, low, high, bandpass

## 3 Semiconductors

- Intrinsic/Extrinsic
- Current flow
- Biasing - forward and reverse
- Capacitance

## 4 Diodes

- Ideal
- Rectifier
- Diode logic
- Real Characteristic
- Analysis - Simple, graphical, iterative, Small signal
- Voltage regulator
- Voltage references

Zener diode  
Rectifier circuits - Half, Full, Active

## **5 Bipolar Junction Transistors**

Structure, modes of operation & base current  
Large signal models  
Biasing and operating point  
Small signal T and  $\pi$  models

## **6 BJT Applications**

Common emitter amplifier  
Feedback  
Common base amplifier  
Common collector amplifier  
Output voltage swing and review  
Noise margins and ideal inverter  
BJT inverter

## **7 MOSFET – metal oxide FET**

Structure & basic operation  
Terminal characteristics & modes of operation  
Derivation of  $I_D$ - $V_{DS}$  curves  
Small signal transconductance & BJT comparison

## **8 CMOS Logic Circuits**

Basic CMOS inverter operation  
Derivation of noise margins  
Power consumption & logic synthesis  
Device sizing  
MOS switch & transmission gate

## **Book**

Sedra and Smith

Microelectronic Circuits - Oxford University Press - ISBN 978-0-19-532303-0

Latest version is the 6th Edition, but 4th or 5th are similar. Earlier versions should also suffice.

Chapters 1, 2, 3, 4, 5, 6 and 13

*Ignore sections on PSPICE*

5th Edition

Chapters 1, 2, 3, 4, 5 and 10 (sections 1-3)

4th Edition

Chapters 1, 2, 3, 4, 5 and 13 (similar but not identical)

## **Marks**

There are four components to this course for which marks will be assigned. The overall grade will be based on a weighted sum of these components as shown below:

Problem sheets	15%
Mid-term tests	20% - Conducted in class, date TBA
Laboratory work	15%
Final exam	50%

In-term tests and the final are all closed book exams. Lab work is mandatory and must be completed. In addition, a grade of C or better must be obtained on the final exam in order to pass this course.

## **Problem Sheets**

There are five Problem Sheets scheduled for the course during the term. They will be set during the Wednesday lecture period and are due on the following Wednesday at 4.00pm, ie. ONE week after issue. Your answers may be submitted for marking at the end of the following Wednesday lecture or using the boxes located outside the ECE Departmental Office (D-level).

## **Mid term tests and exams**

There will be a mid-term tests which will take place in a regular lecture period. The final exam will be scheduled by the registrar. Please note that both the tests and the final exam are both “closed book” and no notes will be allowed.

Please ensure you have visited the washroom before entering the exam room as no bathroom breaks will be allowed unless prior permission has been given by the instructor. This will only be granted on advanced submission of a dated medical certificate signed by a physician.

## **Additional Requirements**

a) Late assignments will NOT be accepted unless supported by medical evidence supplied by a physician. (ie. death certificate or similar). Late formal lab reports will be accepted as evidence for compliance with the lab requirements but will only have a maximum mark of 50% towards the final assessment.

b) Un-authored manuscripts will NOT be marked under any circumstances. (ie. put your name on any scripts for which marking is required).

c) An additional part of the requirement of this course is that a passing grade (C or better) must be attained on the final exam. Any student that does not meet this standard will be automatically graded D or F (dependent on final exam mark), independent of any other marks gained during the term.

d) Students are strongly advised to review Part IV of the University Regulations that deals with class attendance. As stated earlier, the laboratory part of the course is mandatory and all students should be aware of the consequences.

e) Students are also strongly recommended to review Part VII of the University Regulations that deals with academic offences.

# Schedule

<b>September</b>				
	5th	Term begins		
	18th		Problem sheet 1	
	25/26			Lab 1
	25th		Hand in Problem sheet 1	
<b>October</b>				
	4th	NO LECTURE		
	9/10			Lab 2
	9th		Problem sheet 2	
	14th	Canadian Thanksgiving		
	16th		Hand in Problem sheet 2	
	23/24			Lab 3
	25th	MID TERM		
	30th		Problem sheet 3	
<b>November</b>				
	6/7			Lab 4
	6th		Hand in Problem sheet 3	
	11th	Remembrance Day		
	13th		Problem sheet 4	
	20/21			Lab 5
	20th		Hand in Problem sheet 4	
	27th		Problem sheet 5	
<b>December</b>				
	4th		Hand in Problem sheet 5	
	4th	Term Ends		