The University Of Sheffield.

Electronic & Electrical Engineering.

EEE123 INTRODUCTION TO ELECTRIC AND ELECTRONIC CIRCUITS

Credits: 20

Course Description including Aims

This module introduces the concepts and analytical tools for predicting the behaviour of combinations of passive circuit elements, resistance, capacitance and inductance driven by ideal voltage and/or current sources which may be ac or dc sources. The ideas involved are important not only from the point of view of modelling real electronic circuits but also because many complicated processes in biology, medicine and mechanical engineering are themselves modelled by electric circuits. The passive ideas are extended to active electronic components; diodes, transistors and operational amplifiers and the circuits in which these devices are used. Transformers, magnetics and dc motors are also covered.

1 outline the behaviour of the basic *R*, *L* and *C* elements in circuits with ac and dc voltages applied
2 define and illustrate the various circuit laws and theorems used to analyse circuits
3 introduce and demonstrate the use of the mathematical concepts (particularly phasors and complex numbers) that aid the solving of ac circuit problems.
4 describe the behaviour of p-n junction diodes in a circuit context.
5 introduce the idea of amplification.
6 show how bias circuits can be analysed and designed.
7 introduce the concept of small signal models and develop and apply a simple small signal model for a BJT.
8 introduce JFET and MOSFET characteristics.
9 show how transistors can be used as switches
10 introduce the ideal op-amp and basic op-amp circuits.
11 show how forces on current carrying conductors in a magnetic field can convert electrical into mechanical energy
12 introduce students to basic electronic engineering measurement equipment and its practical application.

Outline Syllabus

Circuits and Circuit Elements : Concept of a circuit, *V-I* relationships for *R*, *L* and *C*. Series and parallel combinations of elements. Voltage and current sources. Stored energy, power dissipation. **Circuit Laws and Theorems**: Kirchoff's Laws, Superposition theorem, Thevenin, Norton theorems, loop analysis. **Time Varying Signals**: The sinusoid, amplitude, phase, frequency. Response of *L*, *C R* to ac. Phase relationships. **ac Circuits** : Phasor representation. Complex number notation. Analysis of ac circuits. Impedance, admittance, resonance. Power factor and power factor correction. **Transient Response** : First order *R L* and *R C* response. Stored energy. Time constants. **Electric Machines**: Force on a current carrying wire in a magnetic field, equivalent circuit and torque speed relationship of dc machines, torque speed relationship for induction, synchronous and stepper motors. **Basic Diode Behaviour** : large and small signal diode models. **Diode Applications** : Clipping, clamping, voltage doublers, voltage multipliers, rectifiers, simple smoothing, ripple, regulators, zener diode. **Transistors :** BJT, JFET and MOSFET characteristics, similarities and differences. **Switching Applications** : on-state and off-state behaviour, drive considerations for BJT and (power) MOSFET, inductive loads and techniques for controlling back emf, switching AC power, bridge topologies for motor control. **Amplifier Applications** : amplification, biasing, designing dc conditions. Small signal ideas, generation of simple model (g_m based), equivalent circuits,

coupling and decoupling, mid-frequency examples. **Operational Amplifiers** : advantages of - ideal performance. Basic circuit shapes, idea of feedback, follower circuits, virtual earth circuits, effect of finite gains. Use of superposition to handle multiple source amplifiers.

Time Allocation

48 hours lectures + 24 hours problem classes + 12 Hours Laboratory work

Recommended Previous Courses

entry qualifications

Assessment

80% 3 hour exam, answer 4 questions from 6.
20% Labwork assessment

Recommended Books

Robert Spence Introductory Circuits Wiley 2008

Objectives

1 deduce the response of *R*, *L* and *C* to a given standard current or voltage stimulus.
2 evaluate by using several different methods of analysis the currents and voltages in a network driven by dc and/or ac sources.
3 recognise situations where the use of particular circuit theorems will simplify the route to a solution.
4 construct phasor diagrams for combinations of series and parallel circuits.
5 manipulate complex currents and impedances.
6 calculate the transient response of simple first order circuits.
7 perform basic calculations on dc machines, magnetic circuits and transformers
8 use oscilloscopes, multimeters and oscillators to make measurements on circuits.
9 identify under what conditions a diode will conduct and what its effect will be on the behaviour of the circuit as a whole.
10 predict the behaviour of circuits containing resistors, capacitors and diodes such as voltage doublers, peak detectors, rectifiers and simple differentiators.
11 describe the two sensible approaches to the biasing of single stage bipolar transistor circuits, be capable of analysing and synthesising such circuits.
12 apply small signal model ideas and make quantitative estimates of a circuit's small signal performance.
13 demonstrate awareness of the similarities and differences between bipolar junction devices and both types of field effect transistor.
14 design simple transistor switching circuits and appreciate the problems and possibilities associated with switching inductive loads.
15 calculate circuit gain for inverting and non-inverting and multiple input operational amplifier circuits for both ideal operational amplifiers and ones with a finite gain.