The University Of Sheffield.

Electronic & Electrical Engineering.

EEE117 ELECTRICAL CIRCUITS AND NETWORKS

Credits: 20

Course Description including Aims

This module introduces the basic principles underlying electric circuits. The idea of a circuit, and the concepts of voltage, current and power are introduced for both alternating and direct sources. The interaction between electrical circuits and magnetic circuits is discussed and the idea of mutual coupling and transformers is introduced. Formal analysis methods such as nodal, loop and superposition are introduced in the context of dc and ac circuits and the complex notation for ac quantities applied to the latter. The calculation of power in a range of contexts is discussed extensively.

The module aims to:

1. Outline the behaviour of the basic *R*, *L* and *C* elements in circuits with AC amd DC voltages applied.
2. Define and illustrate the various circuit laws and theorems used to analyse circuits.
3. Introduce and demonstrate the use of mathematical concepts (phasors and complex numbers) to aid the solving of AC circuits.
4. Use the concepts of frequency response and phase relationships to study filters.
5. To develop the general principles for the calculation of energy and power flow in electrical networks.
6. To demonstrate the circumstances in which the concept of a magnetic circuit is valid and to develop analytical procedures.
7. To derive circuit models of self and mutual inductance from the magnetic coupling of electric circuits, to extend this to transformer action and show the advantages and use of equivalent circuit models.
8. To demonstrate the main features and operation of a power supply network.

Outline Syllabus

Basic Circuit Elements : *V-I* relationships for *R*, *L* and *C*. Time response. Voltage and current sources. **Circuit Laws and Theorems** : Kirchoff's Laws, Superposition, Thevenin, Norton theorems, loop and node 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 using laws and theorems. **Transient Response** : First order *R L* and *R C* response. Time constants. **Frequency Response** : Filters. Amplitude and phase response. Bode plots. Resonance, *Q* factor, bandwidth. **Magnetic Circuits :** the concept and justification of a circuit model compared to a field model, circuit laws, magnetic materials and their properties. **Time-Varying Fields :** Faraday's Law, self- and mutual-inductance, voltage fed and current fed magnetic devices, effect of circuit resistance, and calculation of phasor relationships. **Closely Coupled Circuits :** Transformer action and equivalent circuits. Types of transformer in terms of performance requirements (e.g. power, audio, instrumentation) and main performance criteria (amplitude and phase changes, efficiency, frequency response). **Energy Storage and Power Flow:** Storage in *L* and *C* and dissipation in *R* under sinusoidal and non-sinusoidal conditions. Concepts of instantaneous, average and rms values, VA, VAR and watts, and power factor. **Power Supply Networks :** Description of the UK network. Three-phase systems, power measurement, power factor correction and tariffs. Safety issues.

Time Allocation

48 lectures, 24 problem classes and 124 hours of independent study

Recommended Previous Courses

entry qualifications

Assessment

mid term test (January) - 10%, exam (June) answer 4 questions from 6 in 3 hours - 90%

Recommended Books

Objectives

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

1. demonstrate familiarity with standard circuit diagram symbols and conventions and use the diagram to identify interconnections between the various components in the network concerned.
2. deduce the *v* or *i* response of *R*, *L* or *C* for a given *v* or *i* stimulus.
3. solve for the currents and voltages in a DC or AC network by applying several different formal analysis techniques.
4. recognise situations where the circuit theorems can be used to simplify the route to a solution.
5. manipulate complex currents and impedances.
6. calculate the step response of first order circuits.
7. recognise first order low pass and high pass filter circuits and sketch Bode plots to describe their amplitude and phase responses.
8. carry out magnetic circuit calculations including circuit reluctance, mmf requirements, flux, flux density and field strength.
9. calculate the instantaneous and average power and energy in electric circuits - containing elements of *R*, *L* and *C*.
10. recognise where rms quantities can be used in power calculations.
11. use rms phasor notation for sine wave excited systems and to calculate the active and reactive components of the apparent power.
12. calculate self- and mutual-inductance in terms of magnetic circuit dimensions and materials.
13. calculate the important performance parameters of power transformers and instrument transformers.
14. recognise the important structure and provisions of a power supply system and carry out calculations on balanced three-phase networks.