Engineering Tripos Part IA, 1P3: Analysis of Circuits and Devices, 2018-19

Lecturers

Prof T D Wilkinson, Dr F Torrisi, Prof F Udrea [1]

Timing and Structure

Weeks 3-8 Michaelmas term and weeks 1-3 Lent term. 22 lectures, (18 on linear circuits (CD), 4 on power flow (FU), 2 lectures/week, in Michaelmas term, 3/week in Lent term.

Aims

The aims of the course are to:

- Teach students how electrical and electronic circuits are analysed, how field effect transistors and amplifiers operate, how real and reactive power flows in a.c. circuits, and to teach basic transformer theory.

Objectives

As specific objectives, by the end of the course students should be able to:

- Know how Ohm's law, the concepts of ideal voltage and current sources, and Thevenin's and Norton's theorems are used by electrical engineers to calculate currents and voltages in d.c. and a.c. circuits. To explain Kirchhoff's voltage and current laws and
- Know how power is transferred from a source to a load and how any network can be represented by a Thevenin or a Norton source. (Lecture 4).
- Understand how semiconductors can be doped to produce p-type and n-type semiconductors, introduce the p-n junction diode. (Lectures 5 & 6).
- Know the principles of operation of the Field Effect Transistor (FET). (Lectures 6 - 8)
- Use complex numbers in the analysis of a.c. circuits and keep track of amplitude and phase simultaneously. Understand the importance of resonance and resonant frequency in electronic circuits. (Lectures 9-12).
- Know how an equivalent circuit for an FET can be used in transistor circuits to determine the small-signal performance of the circuits. (Lectures 13-14).
- Calculate the gain, frequency response, and input and output impedances of amplifier circuits. (Lectures 15-16).
- Introduction to operational amplifiers (Op Amps), and understand how feedback can be used in amplifier circuits to improve frequency response, gain stability and output and input impedances. (Lectures 17-18).
- Understand the concepts of real, reactive and apparent power, and power factor, the importance of power factor correction of a.c. loads, the principles of operation of the transformer, and the development and use of its equivalent circuit.

Content

- Mesh and nodal analysis (1) 34 - 39
- Thevenin's and Norton's theorems, superpositions. (1) 50 - 57
- D.C. characteristics of:
  - Diodes (1) 340 - 348 (2) 36 - 41
  - Field effect transistors (MOSFET) (1) 362 - 367 (2) 62 - 66
  - Operating point, load line and graphical analysis of common source amplifier. (1) 556 - 559 (2) 46 52
Alternating current circuits:
- Techniques, impedance, admittance, phasors, mutual inductance. (1) 151-163 (1) 263-264
- Circuits containing R,L and C. Resonance. (1) 220-231
- Power in resistive loads, r.m.s. quantities. (1) 79
- Amplifiers as building blocks, decibels, mid-band gain, bandwidth, multistage amplifiers and coupling. (1) 630-632 (2) 1-22
- Linearised models of F.E.T. (1) 591-595 (2) 52-54
- Common source amplifier (2) 54-60
- Operational amplifiers, characteristics, feedback, inverting and non-inverting configurations. (1) 518-53 (2) 114-137
- A.C. Power Flow (1) 205-213 (3) 7-12
- Real power (Watts), reactive power (VARs), apparent power, power factor and its correction.
- Use of power and reactive power to solve a.c. circuits.
- Single-phase Transformers (1) 690-710 (3) 67-78
- Principles of operation.
- Development and use of transformer equivalent circuit.

REFERENCES
(1) AHMED, H. & SPREADBURY, P.J. ANALOGUE AND DIGITAL ELECTRONICS FOR ENGINEERS
(2) BRADLEY, D. BASIC ELECTRICAL POWER AND MACHINES
(3) HOROWITZ, P & HILL, W. THE ART OF ELECTRONICS
(4) SMITH, R.J. & DORF, R.C. CIRCUITS, DEVICES AND SYSTEMS
(5) WARNES, L.A.A. ELECTRONICS AND ELECTRICAL ENGINEERING

Examples papers
- 3/1 on Lectures 1-4
- 3/2 on Lectures 5-8
- 3/3 on Lectures 9-12 (lectures 9 & 10 are before Christmas, 11 & 12 are after Christmas)
- 3/4 on Power lectures
- 3/5 on Lectures 13-18

Booklists
Please see the Booklist for Part IA Courses [2] for module references.

Examination Guidelines
Please refer to Form & conduct of the examinations [3].

UK-SPEC
The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

Last modified: 18/05/2018 11:21