

Engineering Tripos Part IB, 2P5: Analysis of Circuits and Devices, 2018-19

Lecturers

[Prof Tim Wilkinson](#) [1]

Timing and Structure

10 lectures, 2 lectures/week weeks 1-5

Aims

The aims of the course are to:

- Understand the operation of the bipolar transistor as a linear amplifier.
- Understand the principle of negative feedback and the effects of its application.
- Understand the concept and practical realization of an operational amplifier and be familiar with the use of operational amplifiers in feedback circuits.
- Appreciate the special considerations involved in output stages which are required to supply appreciable power.
- Understand how oscillators can be realized using linear circuits and other means.

Objectives

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

- Know how to bias a bipolar transistor to a suitable operating point for linear amplification and how to construct a load line through the operating point.
- Be familiar with the small signal equivalent circuit for the bipolar transistor and be able to use it to determine gain, bandwidth and input and output impedances for the common emitter and emitter follower (common collector) circuit configurations.
- Be able to analyse the long-tailed pair circuit and to understand its importance in practical differential and operational amplifiers.
- Know how to apply negative feedback to an operational amplifier and calculate the effects on gain, bandwidth and input and output impedances.
- Be able to relate the departures from ideality of practical operational amplifiers to the use of the long-tailed pair circuit.
- Know how to use operational amplifiers to make simple circuit elements, namely difference amplifiers, adders, integrators and differentiators.
- Be able to configure a simple oscillator using a linear amplifier and a feedback network.
- Understand how a hysteresis switch and a timing network can be used to make a relaxation oscillator.
- Be able to set up a basic complementary emitter follower, or source follower, output stage for a power amplifier
- Know the conditions for class A, AB and B operation of a power amplifiers, and the effect on efficiency and linearity.

Content

Bipolar Transistor - Device & Circuits (2L)

- Biasing & load lines. (1) 83-91 (2) 560-565

- Small signal equivalent circuit. (1) 91-100 (2) 600-601
- Emitter (source) follower. (1) 100-104, 60-62 (2) 642-644
- Input & output impedance of CE and CC configurations. (1) 96-98, 100-104

Operational Amplifier Circuits (5L)

- The long-tailed pair as an input circuit to an OpAmp (both FET and BJT)
- Differential gain and common mode rejection ratio (long-tailed pair). (1) 140-146 (2) 536-538
- Negative feedback theory, gain = $A/(1+AB)$. (1) 164-181 (2) 636-641
- Input & output impedance with & without feedback. (1) 121-126 (2) 528-529
- Stabilisation of gain, increasing bandwidth and reducing distortion.
- Revision of Ideal operational amplifiers (1) 114-128, 526 (2) 518-520
- Effects of input bias and offset currents, offset voltages. (1) 146-151 (2) 528-539
- The non-ideal OpAmp
- Voltage follower, adding, integrating & differentiating amplifiers. (1) 128-132 (2) 526-529

Oscillators (1.5L)

- Instability, $AB = -1$, positive feedback.
- Oscillators using linear circuits. (2) 574-576
- Relaxation oscillators

Power Amplifier Stages (1.5L)

- Emitter or source follower, power output and efficiency. (2) 574-576
- Complementary transistor output stage.
- Classes A, AB and B.

REFERENCES

- (1) AHMED, H. & SPREADBURY, P.J. ANALOGUE AND DIGITAL ELECTRONICS FOR ENGINEERS
(2) SMITH, R.J. & DORF, R.C. CIRCUITS, DEVICES AND SYSTEMS

Booklists

Please see the [Booklist for Part IB Courses](#) [2] for references for this module.

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.

Source URL (modified on 17-05-18): <http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-ib-2p5-analysis-circuits-and-devices-2018-19>

Links

[1] <mailto:tdw13@cam.ac.uk>

[2] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364081&chapterid=43731>

[3] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[4] <http://www.engc.org.uk/ukspec.aspx>

[5] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>

[6] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>