

## Engineering Tripos Part IIB, 4B24: Radio Frequency Systems, 2022-23

### Module Leader

[Dr M J Crisp](#) [1]

### Lecturer

Dr M J Crisp

### Timing and Structure

Lent term. 75% exam / 25% coursework

### Prerequisites

3B1 (Assumed)

### Aims

The aims of the course are to:

- Provide a system level overview of RF and Microwave, so that system performance can be predicted and optimised to meet a specification

### Objectives

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

- Be able to apply network analysis to an RF system
- Understand the effects of noise, linearity and gain in cascaded RF systems
- Be able to optimise impedance match of an amplifier as a tradeoff of noise, linearity, bandwidth and stability
- Understand the operation of passive RF networks (Couplers, splitters, attenuators) and limits on their performance
- Have a knowledge of range of methods to improve amplifier performance
- Understand a range of RF system applications and their performance requirements

### Content

It is proposed that this module will focus on the *system* aspects of RF design (as opposed to circuits). Therefore the overall aim is that circuits (amplifiers etc) can be reduced to a blocks with a minimum number of parameters from which the system performance can be estimated.

### Preliminary Syllabus

#### 1. Network Analysis

- 2-port and multi-port devices
- Impedance, Scattering and Transmission parameters, their relationships and uses

- Signal Flow Graphs
- Two port power gains

## 2. Noise and Distortion

- Noise sources in RF systems
- Noise figure
- Noise in passive networks
- Noise of mismatched devices
- Effects of Distortion
- Measures of distortion and intermodulation
- Dynamic range
- Noise and distortion of cascaded devices

## 3. Impedance Matching Methods

- Limits on achievable matches
- Distributed Impedance matching methods
- Broadband matching

## 4. Amplifier Design

- Stability
- Conjugate matching
- Design for low noise
- Design for high power and low distortion

## 5. RF System Architecture

- Zero IF
- Software Defined Radio

## 6. RF System Applications

- Radar
- Passive RFID
- Radio regulations

## Coursework

Coursework	Format	Due date & marks
<p><b>CAD Amplifier design</b></p> <p>Using industry standard software, the performance of a microwave low noise amplifier will be investigated to maximize performance.</p> <p>A brief getting started demonstration will be given in lectures and a drop in session organised for software trouble shooting</p> <p><u>Learning objective:</u></p> <ul style="list-style-type: none"><li>• Familiarisation with microwave simulation capabilities</li><li>• Design for an amplifier to meet specifications.</li></ul>	<p>Individual</p> <p>Report</p> <p>anonymously marked</p>	<p>Weds week 9</p> <p>[15/60]</p>

## Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [2].

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[1] <mailto:mjc87@cam.ac.uk>

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