MICROWAVE DESIGN TECHNIQUES - 2024/5

Module code: EEEM064

Module Overview

Expected prior learning: EEE3033–RF and Microwave Fundamentals, or equivalent learning.

Module purpose: At Gigahertz frequencies the operating wavelength is small. Devices operating in the Gigahertz frequency range are therefore electrically large compared to the operating wavelength. In such cases, it is no longer appropriate to use traditional lumped element circuit components. The passive devices used at Gigahertz frequencies thus have to be made either using printed transmission lines (e.g. microstrip, coplanar waveguide) or waveguide. This module will present microwave design and analysis concepts for a range of commonly used passive circuits using both microstrip lines and waveguides, including: transmission lines, coupling networks, antennas and filters. This module will revisit and build on the use of the Smith chart also introduced in EEE3033 RF and Microwave Fundamentals and use it for further design applications of microstrip circuits. It is complementary to module EEEM044 RF Systems and Circuit Design and EEEM006 Antennas and Propagation.

Module provider

Computer Science and Electronic Eng

Module Leader

XIAO Pei (CS & EE)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 7

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 46

Seminar Hours: 9

Tutorial Hours: 10

Laboratory Hours: 5

Guided Learning: 20

Captured Content: 60

Module Availability

Semester 2

Prerequisites / Co-requisites

None.

Module content

Indicative content includes the following.

- Revision of prerequisite background material, including: S-parameters, decibels, transmission line theory, smith charts.
- Common transmission line technologies: waveguide, micro strip lines, and coplanar waveguides
- Waveguide structures, propagation within waveguides.
- Applications of waveguides, including: couplers, tee junctions, slots, horn antennas
- Microwave network analysis
- Printed micro strip devices, including: splitters, couplers
- Impedance matching
- Microwave filters

Assessment pattern

Assessment type	Unit of assessment	Weighting
Examination	EXAMINATION - 2 HOURS	100

Alternative Assessment

N/A

Assessment Strategy

Assessment Strategy

The **assessment strategy** for this module is designed to provide students with the opportunity to demonstrate the competence in the design and analysis of passive microwave circuits. The written examination is designed to test the students' ability to design and analyse circuits as well as communicate their understanding of the microwave principles presented in class.

Thus, the **summative assessment** for this module consists of the following.

- Written examination, in which students have a choice of three questions out of four available questions.

Formative assessment and feedback

For the module, students will receive formative assessment/feedback in the following ways.

- During seminars and tutorials, by question and answer sessions.
- During seminars and tutorials, by peer instruction (subject to a large enough class size).
- During revision classes.

Module aims

- To provide a foundation of knowledge and understanding in the area of passive microwave circuit and systems design.
- The module also aims to provide opportunities for students to learn about the Surrey Pillars listed below.

Learning outcomes

		Attributes Developed	
Ref			
001	Explain the propagation of waves through microstrip lines and waveguides and the mathematics behind it.	KC	M1, M2
002	Recognise the electromagnetic properties of microstrip and waveguide based passive components commonly used in microwave engineering.	K	M1
003	Design and analyse waveguide and microstrip based passive devices most commonly used in microwave engineering.	KCPT	M3, M5
004	Apply S-parameters as well as the Smith chart in the analysis and design of passive microwave circuits.	KCPT	M3, M6

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to have the students develop an understanding of each of the items listed in the module content. The teaching strategy is to present these topics through formal lectures, with interactive in-class problem solving and through additional tutorial sessions. Students will take the concepts formed relevant to both microstrip and waveguide circuits and from that be able to form design techniques for passive microwave devices and some active switch systems. These will formulate the students' ability to aid in designing low cost and sustainable microwave devices as well as their ability to test and measure their properties with full understanding of the associated parameters. They will also gain some hands on experience of such designs using computer aided design (CAD) simulations as a formative activity.

Learning and teaching methods include the following:

EEEM064 – Short Course Version

Learning and teaching methods include the following.

- Short course delivered as a continuing professional development course.
- Distance learning material for self study provided after the course to enable learning of the material in a professional setting.
- Tutorials can be arranged either in person or online with the module leader ad-hoc in order to enable dialogue on what has been learned.

EEEM064 – Main Version

Learning and teaching methods include the following.

- Delivery of online material to provide learning set into separate tasks.
- Seminars, with the purpose to provide narrative to the work learned online.
- Tutorials, to provide formative feedback on knowledge and problem solving.
- Laboratory demonstrations, with practical demonstrations of material learned in the final week of study.

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: EEEM064

Other information

The following of the Five Pillars of the Surrey Curriculum Framework are embodied by this module:

Sustainability – Designing of compact microwave passive devices is crucial to forming low cost, and low volume of materials that are robust and long lasting to enable sustainability of mass produced RF and microwave consumer electronics. Students will learn about the design of devices with microstrip lines and waveguide devices that will be of minimal cost to mass production but also of recyclable materials.

Digital capabilities – As part of the formative learning, students will experiment with electromagnetic simulation tools including Computer Simulation Technology (CST) to form visual animated results to improve their learning while also gaining hands on experience of a state of the art simulation tool in microwave engineering.

Employability – Fundamental design skills and use of key parameters in microwave design techniques including those of scattering parameters and Smith charts will be crucial to such employability skills in the given area of RF and microwave engineering. Assessment will form the testing and assurance of design skills in passive devices that are readily used in connecting active and passive microwave devices together on a circuit board.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Electrical and Electronic Engineering MEng	2	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering MEng	2	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering MSc	2	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Nanotechnology MEng	2	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Space Systems MEng	2	Optional	A weighted aggregate mark of 50% is required to pass the module
RF and Microwave Engineering MSc	2	Compulsory	A weighted aggregate mark of 50% is required to pass the module
Satellite Communications Engineering MSc	2	Optional	A weighted aggregate mark of 50% is required to pass the module