Faculty of Engineering and the Built Environment

Department of Electrical Engineering

2023 Course Handout: EEE3089F

Course Name:	EEE3089F Electromagnetic Engineering
SAQA Credits:	16
Pre-requisites:	PHY2010S, MAM2083/FS
Co-requisites:	None

Course convenor:	Dr Francois Schonken
Email address:	francois.schonken@uct.ac.za
Office location:	7th floor
Consultation hours:	Weekdays by prior arrangement
Course lecturers:	Dr Francois Schonken and Dr Gideon Wiid (gideon.wiid@uct.ac.za)
Teaching assistant:	none

Lecture venue:	LS1A
Lecture days and time:	Mondays and Tuesdays, 11:00 – 13:00
Tutorial venue:	EM7
Tutorial days and times:	Tuesdays, 16:00 – 18:00

Course objectives

We focus on the dynamic behaviour of EM fields in various practical situations electrical engineers will encounter. It provides the background to the mechanism of radio communication, radar, radio astronomy, high and low frequency transmission lines, EM interference, considerations for high speed digital circuits and solving EM problems using computational electromagnetics. All of these can only be fully understood with the solid background provided here. Computer graphical visualisation practical sessions are used to supplement the theoretical analyses and clarify the mathematical concepts to students.

Learning outcomes

Students successfully completing this course will have the following:	Exit level	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9	LO10	LO11
A. Knowledge (Information plus Understanding)												
Students will (1) understand how antennas radiate and appreciate the difference between near and far fields of a radiator, (2) be able to describe and represent mathematically the radiated fields of basic antenna arrays, (3) be aware of the public safety standards for radiation from antennas and (4) be able to design very basic antennas.	N											
Students will understand why plane wave theory is useful and the applications of it, for example the concepts of the skin effect for lossy conductors and the penetration of microwave signals into human tissue. Guided waves: students will be able to determine whether a transmission line is electromagnetically long or short. Students will be able to construct circuit models for long lines and briefly explain how this would simplify for short lines. Students will learn the basic properties of a selection of waveguides and be able to describe the modes that may be supported by each. For each example the student will be able to verify that the modes satisfy the electromagnetic boundary conditions.	N											
Computational Electromagnetics: students will appreciate the difference between Time domain and Frequency domain methods. Students will be able to use computational software with more awareness of the accuracy as determined by appropriate discretisation, realistic geometric and material property modelling.	N											

B. Skills (Application of Knowledge)												
Generates and formulates field expressions for antenna near and far fields, high frequency transmission line 1D models and waveguide modes. Be able to implement a 1D FDTD code.	N		7									
Using concepts of superposition, describe the radiation pattern of a two-element antenna array.	N		7									
Choose transmission line equations or Smith Chart graphical solutions to solving transmission line problems	N	7										
Formulates and presents all solutions in an appropriate and correct format.	N						6					
C. Values and Attitudes												
Apply the understanding of dynamic behaviour of EM fields in the following practical situations electrical engineers may typically encounter: radio communication, radar, radio astronomy, high and low frequency transmission lines, EM interference, considerations for high speed digital circuits and solving EM problems using computational electromagnetics, to make appropriate engineering decisions where these contexts are relevant to their engineering work and project management.	N											

Detailed course content

Maxwell's equations for wave propagation, Electromagnetic potentials and why we need these, how do antennas produce radiation, plane wave reflection and transmission and practical implications for engineers: for example safe exposure to fields, 1D transmission lines supporting wave propagation and guided wave structures: why this is important to understand, Computational Electromagnetics: how to solve EM problems using software, given that most practical EM problems are very hard or impossible to solve using only pen and paper. A detailed week by week planning grid, with relevant textbook material, is available on Vula when the course starts.

TEST DATES:

TBD

Knowledge areas

Maths Sciences	Natural Sciences	Eng Sciences	Design & Synthesis	Complm Studies
		100%		

Learning environment

Lectures and Tutorials

Suggested time allocation

Learning Activity	**No./ week**	**Time in hours**	**Contact time Multiplier**	**Total no of hours**
Number of lectures ***per week***	**2**	**1.5**	**2**	**72**
Number of tutorials ***per week***	**1**	**2**	**2**	**48**
Total practical/lab periods	**0**			**0**
Total other contact periods	**0**			**0**
Total assignment non-contact ***hours***	**---**	**15**	**1**	**15**
Assessment hours (Tests, Exam)	**---**	**5**	**5**	**25**
Number of weeks the course lasts	**12**	**---**	**---**	**---**
Total hours	**---**	**---**	**---**	**160**

General assessment strategy

Assessment Task	**%**	**The following DP rules apply:**
Assignments		Completion of all assignments.
Tutorials (tut tests)	30	
Labs		
Project		
Tests	20	

Exam	50	
Total	**100**	

Books/Reading Materials/Notes

- **Prescribed**: Fundamentals of Applied Electromagnetics. Fawwaz T. Ulaby and Umberto Ravaioli. Pearson Education Limited 2015. 7th edition.
- Additional material made available on Vula.

Absence: The continuous assessment marks will be adjusted to allow for absence only on the following grounds:

- A medical certificate for absence of 3 or more consecutive days or any day with a class test or exam
- Death of an immediate family member (parent or sibling)
- Pre-arranged absence to represent a University, provincial or national team.

Tut test marks: The final mark for the tut test component of the class mark will be calculated by taking the average of the best (N - 2) tut test marks for each student, where N is the total number of tut tests for the semester. This will most likely be the best 8 out of 10 tut tests, depending on access to campus. Students who miss a tut test do not have to provide any reasons, it will simply be marked as 0. This means that students can potentially miss up to 2 tut tests without any adverse effect on their class mark.

Academic dishonesty: Plagiarism is a very serious offence and usually leads to disciplinary action that could include expulsion from the university. Therefore, recognise the work of others in any submission. Details of referencing methods are widely available on the Web. A non-plagiarism declaration must be submitted with all work submitted for marking.