Department of Electrical Engineering

Radar Masters Programme

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EEE5108Z MATHEMATICS FOR RADAR AND ELECTRONIC PROTECTION 2015

1 Prerequisites

This course requires students to have a good background in Engineering Mathematics, acquired as part of an Honours Level (4 years of study). The coursework consists of 'pencil and paper' problems, which will require a limited amount of numerical computation in some of their solutions; an acquaintance with Mathematica or Maxima would be useful, but not essential.

2 Course Format and Dates

The formal part of the course is given in a 5 day, intensive format with lectures and tutorials. This is followed by six seminar sessions over the remaining weeks up to the end of the semester, when the examination is held. The dates for the seminar sessions are set during the intensive session, to accommodate as far as possible, student availability.

These follow-on sessions are based on problem sets which the student must attempt in order to gain benefit from the seminars. In addition, students may book appointments with the Course Convener and the Tutor.

The course Calendar is the governing document for planning: please monitor it frequently on the web site:

http://radarmasters.co.za/schedule/

Course interaction is via the UCT Vula System. You will have access to this information once you have registered for the course. It is important that you provide your preferred email address (one that you check frequently) for your Vula registration.

3 Staff

Presenter: Dr. Pieter Uys UCT pieter@edserve.co.za

4 Course description:

This course provides a useful mathematical toolkit for the Radar and Electronic Defence Engineer.; emphasis is on practical calculation and useful 'tricks of the trade' rather than mathematical rigour. The textbook, Advanced Engineering Mathematics, E. Kreyszig (Wiley)(with many editions available but edition 9 preferred) is prescribed. Some notes are also made available to assist the student. Specific course topics include:

4.1 Course Topics (Estimated number of lectures and acronyms shown in brackets)

Ordinary differential equations (7)	(ODE)
Laplace transforms (3)	(LT)
Fourier analysis (3)	(FA)
Partial differential equations (2)	(PDE)
Complex analysis (8)	(CA)

4.2 Revision prerequisites

Students are strongly advised to prepare for the course by revising the material listed at the end of this document (Section 11). This material should all have been covered by students as part of their honours course (4 year degree) and it should be a matter of refreshing ideas rather than new work.

5 Learning outcomes

Having successfully completed this course, students should be able to:

- Understand calculus, linear algebra, special functions and at a level that enables them to access and make use of the radar research literature;
- Carry through detailed calculations based on this material;
- Be able to identify mathematical techniques most appropriate to the analysis of a particular application;

6 Lecture Programme

Table 1: EEE5108Z Mathematics for Radar and Electronic Protection 2014 Programme

Time	Mon 23/3	Tue 24/3	Wed 25/3	Thur 26/3	Fri 27/3
9:00-9:45	*Introduction/ODE*	*ODE*	*FA*	*CA*	*CA*
10:00-10:45	*ODE*	*ODE*	*FA*	*CA*	*CA*
11:00-11:45	*Tut*	*Tut*	*Tut*	*Tut*	*Tut*
12:00-12:45	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
13:00-14:00	*ODE*	*LT*	*FA*	*CA*	*CA*
14:00-14:45	*ODE*	*LT*	*PDE*	*CA*	*CA*
15:00-15:45	*ODE*	*LT*	*PDE*	*Tut*	
16:00-16:45	*Tut*	*Tut*	*Tut*	*Tut*	

The tutorial sessions allow informal discussions of the presented material and provide practice in working together on problems and presenting results. The group breaks up into several subgroups, and attack selected examples from the exercises together and with input from the presenter. These informal sessions also cater for any general issues arising and feedback.

7 Text Book

Advanced Engineering Mathematics. E. Kreyszig. Wiley Ed.8 or 9.

8 Exercises

Students are expected to work through a selection of the exercises that accompany the course, with the aim of consolidating and extending their understanding of the material presented. These exercises are set at the end of each lecture and these should be attempted as soon as possible. Tutorial sessions are scheduled each day during the intensive week and your tutor will be available to assist during these times. During these sessions interaction and discussion with fellow attendees are encouraged, rather than solitary competitiveness. Each session will include a preliminary run through the exercises to highlight their salient features and provide some guidance in their solution. These exercises will have to be completed in your own time as there will not be sufficient time during the intensive week.

Specific questions will be selected from these exercises two weeks before each seminar. The student's solutions to the problems set must be submitted on Vula the day before the start of the seminar. The work submitted is marked and the marks are used to form the class mark.

Model solutions of the exercises will be provided and discussed during the seminar opportunities of about an hour each with the lecturer and tutor; students will be expected to attend seminars, and attendance is only credited if the solutions have been submitted.

The seminars will be carried out with access by Skype for students off campus after the lecture session. For bandwidth reasons, the number of parallel sessions will have to be limited. For example, all students resident in the same city will be expected to attend at a common venue, and students will have to organise their own venue and projection facilities. Within reason, and with prior arrangement, students can approach the tutor / and / or the lecturer for help with problem sets.

9 Course Assessment and Examination

The final assessment of this course is dependent on a three hour, written examination which contributes 60% to the final mark, with the Duly Performed (DP) requirement of 80% of seminars attended. The class mark based on the performance in the work submitted before each seminar contributes 40% of the final mark.

The examination is closed book, i.e. no notes may be brought into the examination venue. However students are not expected to memorise all the formulas: all non-basic formulas and results will be supplied on the examination paper. Students may write the examination in their home location, provided satisfactory supervision of the examination can be arranged in good time.

10 Course Load

Item	Number	hrs/per item	Hours
Revision	1	20	20
Lectures	23	1	23
Tutorials	10	1	10
Lecture assimilation	23	2	46
Seminar Attendance	6	2	12
Seminar Drill Problems	5	9	45
Examination preparation	1	20	20
Examination	1	3	3
TOTAL			179

11 Self-Study Revision

This section outlines mathematical topics that we find necessary for the students to be fully familiar with before attempting the mathematics course offered in the masters in radar program.

11.1 Matrix operations

11.1.1 Basic operations

Matrices. Vectors and dot products. Matrix addition and matrix subtraction. Scalar multiplication and matrix multiplication. Row-echelon form. Elementary row and column operations. Rank.

11.1.2 Square matrices

Diagonals. Elementary matrices. Simultaneous linear equations. Powers of a matrix.

11.1.3 Determinants and Matrix inversion

Determinants. Properties of determinants. The inverse, properties of the inverse.

11.1.4 Vectors

Dimension. Linear dependence and independence. Linear combinations. Properties of Linearly independent vectors. Row rank and column rank.

11.1.5 Eigenvalues and Eigenvectors

Characteristic equation. Properties of eigenvalues and eigenvectors. Linearly independent eigenvectors.

11.2 Complex variables

11.2.1 Complex Numbers

Fundamental operation with complex numbers. Graphical representation of complex numbers. Polar form of complex numbers. De Moivre's Theorem. Euler's Theorem. Vector interpretation of Complex numbers.