About the Course

GEO111 will provide an introduction to computer programming and numerical modelling (with a focus on Earth and Environmental Science problems). It will provide a chance to learn a computer programming language and all the elements that constitute it, including concepts in number bases and types, logical constructs, debugging, etc. The course will develop programming skills step-wise, intertwining them with practical questions and outcomes, such as in data processing and visualization. How complex environmental processes can be encapsulated and approximated, and numerical models thereby constructed, will be illustrated.

The cumulating objectives of the course are to:

1. Provide hands-on training in how computer programs are written and numerical models constructed.
2. Develop both general (transferable) as well as specific numerical and analytical skills applicable to the Earth and Environmental Sciences.
3. Develop an understanding of how computers and the internet work, and how programs are constructed and interfaced, and hence foster a critical understanding of modern technology.

The associated learning goals are firstly; to provide, through hands-on practical exploration, factual knowledge and an understanding of:

- The basic building blocks of computers and computer programs, and how they overall 'work'. (Learning Outcome 2).
- How numerical models are constructed and applied. (Learning Outcomes 1 and 2).
- Basic climate processes. (Learning Outcome 1).
- The use of numerical models in addressing scientific questions and testing hypotheses as well as the limitations of numerical models. (Learning Outcomes 2 and 4).

and provide transferable skills in

- Written communication and presentation. (Learning Outcome 3).
- Problem solving and logical analysis, fault-finding. (Learning Outcomes 4 and 5).
- Computer programming. (Learning Outcomes 2 and 4).

Course logistics

Format

The weekly format of GEO111 is: 1 × 1-hour lecture, together with 1 × 3-hour computer practical session, plus 1 × 2-hour interactive lecture/discussion session of worked problems and examples. The computer practical class is the central element, and will consist of structured exercises leading step-by-step through the components of computer programming and numerical model construction, debugging, and testing, plus applications to common geosciences problems. The lecture starting each week will outline the basics and introduce the key concepts of the week. The purpose of the 2-hour lecture/discussion session ending the week is to ensure all the concepts are understood and misconceptions resolved and will be a mix of presentation and worked-through examples, plus questions and discussion.

In between the Monday and Friday classes, there will be some homework :(This will be assessed and needs to be completed in a timely fashion (i.e. there is a deadline). It will not be unduely time-consuming or difficult. You will be earning valuable genuine marks (towards the final grade).

Finally, to ensure that we keep to schedule and cover all the planned material, please aim to complete work not finished in the Monday lab session prior to Friday, if possible. If stuck, please make use of Office Hours (see below). Friday is scheduled as time available to address problems etc., but you should not count on it as time solely to finish up uncompleted Monday work as additional work will be set and further topics introduced each Friday.

Timetable

The timetabling and overall course structure of GEO111 are given in Table 1.

Assessment

The course will be assessed as follows:

- 8 × weekly micro assessments @ 2.5% each = 20%
- Midterm paper – 30%
- Finals paper – 50%

In the (8) weeks with no UCR Friday holiday, a short (micro) assessment will be set. The hand-in date will be Friday at noon (PST) the same week as the assessment is set. Each micro assessment will

be worth 2.5% of the total marks available for the course. The assessment will be set by noon (PST) on the Monday of that week. The idea is to help reinforce what you should have been learning in the Monday lab. By putting in a modicum of effort, it also enables you to accumulate some marks towards the course and hopefully take a little stress off of the Examinations. Or alternatively, utterly amplifying the stress if you don't bother completing the micro assessment ...

The Mid-term paper will be a written exam, consisting of a mixture of multiple choice and short-answer format questions. Its purpose is to test basic knowledge of computers and programming, plus general concepts and basic commands you have come across in MATLAB. The testable content will comprise the material covered in the lectures and lab sessions (in weeks #1-5). The exam will be 2 hours long. No study aids of any sort will be allowed. The mid-term paper will constitute 30% of the total assessment for the course.

The Finals paper will be an on-line / at computer exam. Answering the questions will require a mixture of: writing short (1 or 2 line) code fragments, completing or debugging provided program code, and writing complete programs. Study aids (course text and handouts, textbooks, lecture notes etc.) plus MATLAB 'help' and on-line documentation are allowed (but no internet!). This will constitute the remaining 50% of the total assessment of the course.

Office Hours

There are no specific Office Hours, but rather an open invitation to drop by[1] (excluding Thursdays) and/or email[2] questions. Wednesdays (almost any time) would be your best chance of finding me (and not busy).

Note that a large part of the purpose of the lecture/discussion/lab session on Fridays is to provide an opportunity for further clarification of the course material and to go through worked examples. So please feel free to treat the Friday class as a kind of group tutorial session.

Please note that programming may be completely new to almost everypony in the class. It may well be something unlike anything you have taken classes in before and hence how to go about 'learning' it may not be obvious. So please do not hold back on questions – no question is too stupid[3]! Or rather, given the likely newness to you and total weirdness of programming, you are not stupid and so no question you could ask can be stupid.[4]

[1] My office is in the Geology building, room 464 (basement floor).

[2] andy@sea02.org

[3] In the context of MATLAB and programming that is. The current political situation gives rise to questions at a level of stupidity completely off the scale.

[4] Instead, some of the programming syntax in MATLAB is genuinely stupid.

Course text

There is no one (or even two, between them) commercial (published) course texts that covers both basic computer programming and numerical modelling at a suitable introductory level, and certainly not in the context of MATLAB. Hence the reason for this *e*-book – to provide a 1-stop shop for a range of information and practical tutorials in useful and commonly used data manipulation and visualization, numerical techniques, and programming methodologies.

Note that I will be revising the text as we go, and the revised chapters will only be posted immediately prior to each class. These will appear (PDF format) on my teaching webpage[5]. However, a copy of the complete course text used in 2016/17 will be made available and will serve you as a fair guide to the 2017/18 year content.

[5] http://www.sea02.info/teaching.html

In conjunction with the course text (this document), if you were to work through any commercial textbook, I would recommended (but remember it is **not** required): *Matlab (Third Edition): A Practical Introduction to Programming and Problem Solving*[6], which provides a good general introduction to MATLAB and covers a similar range of material to much of the course.

[6] Stormy Attaway. *Matlab (Third Edition): A Practical Introduction to Programming and Problem Solving*. Butterworth-Heinemann, 2013

For additional reading (on both MATLAB and numerical modelling), you might also try:

- *The Climate Modelling Primer (4th Edition)*, by Kendal McGuffie and Ann Henderson-Sellers. Wiley-Blackwell (2014). ISBN: 978-1-119-94336-5.
- *Introduction to MATLAB (3rd Edition)*, by Delores M. Etter. Prentice Hall (2014). ISBN: 978-0133770018.
- *Mathematical Modelling of Earth's Dynamical Systems, A Primer*, by Rudy Slingerland and Lee Kump. Princeton (2011). ISBN: 978-0-691-14514-3.

Table 1: Schedule of GEO111

Week #	**Monday lecture**	**Monday LAB**	***micro assessment***	**Friday LAB**
01 (10/02)	Introduction to the course & MATLAB.	Elements of MATLAB and data visualization.	1. Practice in math and using arrays in MATLAB.	(CONTINUED)
02 (10/09)	Fundamentals of computer programming I.	Scripts and functions in MATLAB. Loops and conditionals.	2. Writing a simple text-based program.	Further programming / elements and structures.
03 (10/16)	Fundamentals of computer programming II.	Further MATLAB and data visualization.	3. Plotting exercise.	(CONTINUED)
04 (10/23)	Algorithms and problem-solving.	Further programming tricks and techniques in MATLAB.	4. Data processing exercise.	(CONTINUED)
05 (10/30)	How computers work.	Statistics in MATLAB.	5. Fun with number bases.	**Mid-term**
06 (11/06)	Introduction to numerical modelling.	Basic (zero-D) numerical modelling.	NONE	UCR HOLIDAY
07 (11/13)	Further numerical modelling – techniques and applications.	'Daisy World'.	6. Experiments with the Fate of the Earth.	'Daisy World'.
08 (11/20)	Computer program Graphical User Interfaces(GUIs) and GUI-ing in MATLAB.	Basic GUI creation in MATLAB.	NONE	UCR HOLIDAY
09 (11/27)	Time-stepping in numerical models.	Dynamic (time-stepping) modelling – ballistics 101.	7. The 'boiling kettle' model(!)	Dynamic modelling CONTINUED – climate change.
10 (12/02)	Computer networks and the internet; web pages and basic html scripting.	Putting it all together – GUI-based programs.	8. Creating a web-page.	**Finals**