Numerical Methods

ENEL102

Fall 2017

Overall notes and instructions for completing this course

What is ENEL102?

It is presumed that you have successfully completed ENEL101, otherwise you would not have registered in ENEL102 and you wouldn't be spending your time reading through this introductory note. ENEL102 is very similar to ENEL101 with the same format of a set of assignments that are listed in D2L and submitted for marking via D2L. It is an on-line course with no lectures that is based on self-study and completing a set of seven Matlab based numerical computational problem sets. There will be plenty of TA office hours to assist you complete these assignments, similar to what you had in ENEL101.

The primary objective behind ENEL101 and ENEL102 is to get you to develop necessary fundamental skills in numerical analysis and computation that will be of use in your 3rd and 4th year courses. These skills will be acquired by self-study of the textbook and completing the programming assignments. Through completing ENEL101 you hopefully mastered the fundamentals of using Matlab as an extensive calculator, entering equations, writing M files and plotting curves. The objective of ENEL102 it to build on this and learn how to use built-in functions in Matlab for doing various numerical computations such as solving for solutions of multiple equations, integrating functions, solving differential equations and also solving symbolic math problems in Matlab.

It is perfectly ok to collaborate with friends regarding these assignment questions however you will have to submit individual assignments for the TA to mark. Of course you can pay your friends to solve and write up the problem sets for you. We will do some checks on similar solutions and detect assignment plagiarism which is taken seriously by the university. However, it is not rocket science to determine that non-plagiarised assignment solutions can be very similar such that any of our plagiarism detection schemes can be easily fooled by changing comments in your code or small changes to the narrative. So why am I telling you this? Well, I want you to do what it takes to get the assignments finished, discuss with TA, work with your colleagues, and then write up the solutions which will of course look similar to the solutions of

those you collaborated with. That is ok. Don't waste your time cosmetically changing your solutions to make sure they look different and pass the plagiarism test. But do work on the assignment questions to the point where you understand them completely. You will need these programming and numerical computation skills in your engineering courses henceforth and of course when you start your career as an engineer.

So what is the course coordinators obsession with using Matlab? Why not Excel, C++, Mathematica, Maple, Python or a bunch of other possibilities? The real reason for selecting Matlab for ENEL101 and ENEL102 is simply that Matlab is easy to learn, efficient to program and of powerful utility when it comes to numerical computation problems. Hence we don't really have to get bogged down with tedious programming aspects but we can go straight to using the built in numerical functions without much fuss. If that is all that Matlab could do that would be sufficient justification for using it in ENEL102. However, it goes beyond this as Matlab has become a bit of an industry standard as it scales well from the introductory toy problems contained in these assignments to the real thing. That is, the same lines of code you carefully assembled to solve an assignment problem for a differential equation problem is the same code you could use solve a real engineering problem that you will encounter when you finally get out of here and into a job scenario. So my encouragement to you is to take these assignments seriously and understand your submitted solutions completely even though your friend did 'some of it' for you in possible exchange for 'some other stuff' that you did.

As with ENEL101 there is no grade for ENEL102 that becomes part of your overall GPA. The grading is binary. You get a PASS if your average make on the seven assignments exceeds 70 percent and an INCOMPLETE (nicer way of saying fail) if you get less than 70%. If you get an incomplete then you will have to retake ENEL102 the following year with a new set of assignments which is more work for you and your friends will have moved on...

To help you with the assignments there will be extensive TA help. In the previous year we had two hours of drop in TA help in ICT412 every day from Monday to Friday throughout the term excluding except for Thanksgiving and Reading days in November. We aim to do the same this year but I cannot finalize the tutorial location and time yet before the schedulers set it up. Please refer to D2L for this information.

You will ***submit your individual assignments on D2L in soft form .*** Due dates of the assignments are given in the table below:

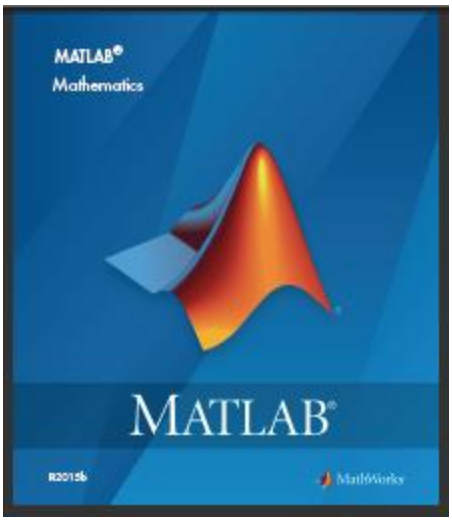
Assignment	**Due date**
1	Sept 18
2	Oct 2
3	Oct 16
4	Oct 30
5	Nov 13
6	Nov 27
7	Dec 11

Assignments have to be submitted by 11:59pm of the posted due date. A late penalty of 10% per regular school day will be imposed. Soft copies of late assignments are emailed directly to TA marking that assignment (this information will be posted on D2L) with a note of why you are late and why the TA should be sympathetic with your plight.

The textbook for the course is the same one that you had for ENEL101. Hope you still have it!

Matlab, an introduction with applications, 4^{th}-6^{th} edition, Amos Gilat, Wiley 2011

There is a new 6^{th} edition you can use but the 4^{th} or 5^{th} edition is fine for this year. The text is a good general introduction to Matlab programming and solving numerical computational problems. It is selected to be the same text as for ENEL101 to help reduce the number of new texts that you need for this year. While the text covers the material that we need for ENEL102 it is a bit too light in places. This is where the Matlab help files and additional documentation is of good help. Suggest that go to the Mathworks web site, mathworks.com and under the support menu tab go to documentation and find the pdf of the 'Matlab Mathematics' book. This is an excellent supplement to the Gilat text and can be downloaded for free. The cover of the 2015b version looks like the following.



Before you can download PDF documents from mathworks.com you will have to register with Mathworks through the webpage. This is a five minute procedure and is worthwhile doing as you will then have access to all of the posted material on the site.

The TAs for ENEL102 are experienced in Matlab programming and are available to help you with your assignments. If for some obscure reason they cannot answer your questions or if you require additional help then you can email me at nielsenj@ucalgary.ca or call at ph. (403)210-9704 to set up a time. Also I will be your instructor for ENEL441 this fall. Hence you can ask a mix of control and Matlab programming questions as needed. Just note that as your class this term is large, I'm anticipating a lot of email traffic so my response may be slow.

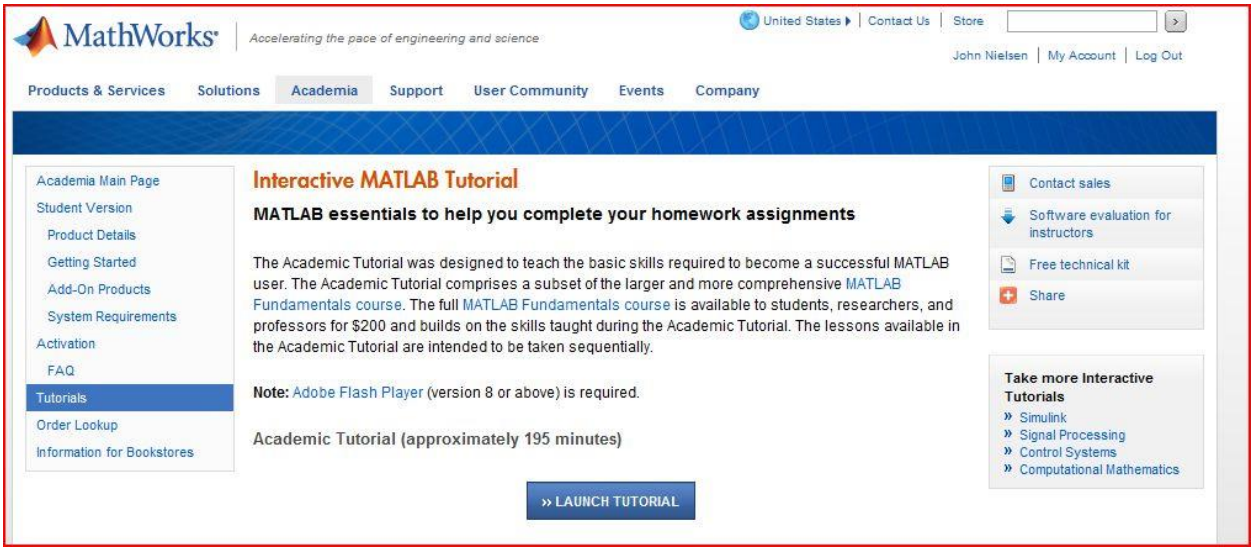
Matlab is available on the common Schulich computers in various locations throughout the Schulich School. Also a student version can be downloaded for free from the Schulich IT website and run on your own computer. Clearly the most expedient way to get through ENEL102 is to set up Matlab on your laptop. This also makes it easier to communicate with the TAs regarding questions about your assignment problems.

Stepwise Procedure

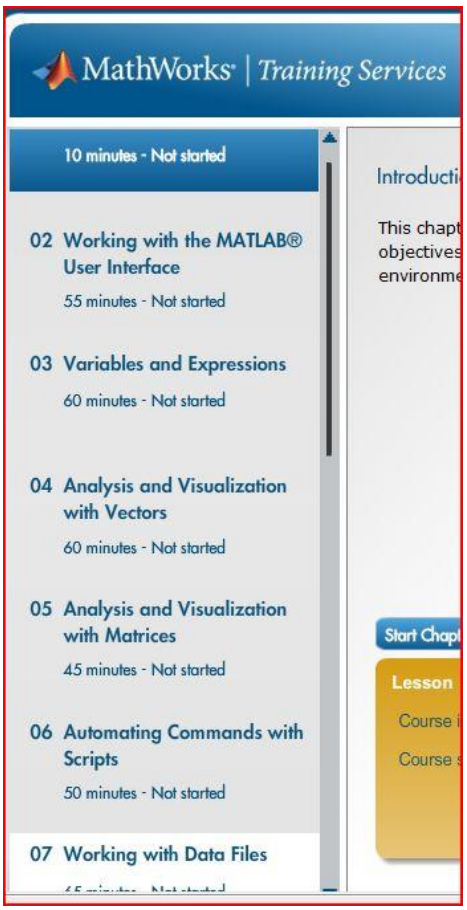
The following is the list of learning modules to go through for this course. It is highly recommended that you execute these sequentially.

If you have forgotten how to program in Matlab over the summer, suggest you go to the Mathworks webpage (mathworks.com) and go through their set of introductory videos. These

are available under the ‘academic’ menu tab at the top of the web page. To access them you will have to register which takes a couple of minutes and is free. You will then set a password such that the set of introductory videos can be accessed at any time. These videos are of course subject to change despite Mathworks confirming the stability of their website. However, it is Mathworks desire that you become addicted to using Matlab for all of your future engineering computational needs. Hence they provide fairly decent support and their introductory material is of high quality. This is a screen shot of the Matlab portal for the video tutorials. You will have access to this page after you have registered.



Launching the tutorial gets you into the menu of introductory tutorials as shown below:



Pick and choose portions that you need.

Assignments for ENEL102

There will be 7 assignments total

assign	description	sections in text	due date, time is 11:59pm of date indicated
1	Review of Matlab calculations	Chapters 1-6	Sept 18
2	Matlab functions	Chapter 7	Oct 2
3	Polynomials and curve fitting	Chapter 8	Oct 16
4	solving nonlinear equations and optimization	Chapter 9	Oct 30
5	numerical integration	Chapter 9	Nov 13
6	Solving Differential equations	Chapter 9	Nov 27
7	Matlab Symbolic math	Chapter 11	Dec 11

Templates for all of the 7 assignments are given in the following sections. Cut and paste each assignment template into a Word document and fill it in. Then submit a Word or PDF version of the assignment on D2L or pint out a hard copy and place it in the drop box.

Final note before you get started. I'm not perfect and neither are my assignments. Doesn't matter how many times I review them before posting, they always have a typo or two. Hence if a question is really confusing it may be a typo of sorts that needs to be corrected. In that case please send me an email of what you think is wrong with the question and I'll fix it ASAP and post some clarifying notes on D2L. Also if you are just generally confused regarding a question don't waste your time wallowing in that state of confusion. The TA is there to help and they have a lot of experience Matlab. You are also welcome to drop by my office ICT311 for additional help, but please go to the TA first.

The steps for completing ENEL102 are as follows:

Step	**Description**
1	Ensure that you can access Matlab. Go to one of the PC's in the computer rooms, log in and run the Matlab application. With the recent migration to Schulich laptops, you can sign these out and use them as they are all loaded with Matlab. Ensure that the Matlab workspace shows up on the terminal. Or if you have installed the downloadable version of Matlab, make sure it launches the workspace environment. For problems see the IT help on the second floor offices in ICT.
2	Get yourself registered as a student with Mathworks. This will give you access to all of the web based Matlab tutorial material and the PDF documentation. Download the pdf of the 'Matlab Mathematics' handbook. As stated the tutorial videos are well done and worth going through.
3	If you need to review Matlab basics and programming, go to mathworks.com and go to the academia tab and then the video tutorials. Also review the chapters 1-6 of the Gilat textbook that you covered in ENEL101.
4	Complete assignment 1 *'review of Matlab calculations'*, as listed in this document. This is a review assignment based on material already covered in ENEL101. This is due **Sept 18**.
5	Read through Chapter 7 of Gilat
6	Complete Assignment 2, 'Writing Matlab functions' . This is due **Oct 2**.
7	Read through Chapter 8 of Gilat
8	Complete Assignment 3, 'Polynomials and curve fitting' . This is due **Oct 16**.
9	Read through section 9.1 and Matlab help documentation on **fsolve**(), **fzero**() and **optimset**()
10	Complete Assignment 4, 'Solving nonlinear equations' . This is due **Oct 30**.
11	Read through section 9.3 of Gilat and Matlab help documentation on **quad**(), **integral2**() and **integral3**()
12	Complete Assignment 5, 'Numerical integration' . This is due **Nov 13**.
13	Read through section 9.4 of Gilat on ordinary differential equations and Matlab help documentation on **ode45().**
14	Complete and submit assignment 6 'Solving Differential Equations' Due date is **Nov 27**
15	Read through chapter 11 of Gilat on Symbolic math.
16	Complete and submit assignment 7 'Matlab symbolic math' Due date is **Dec 11**
22	Congratulations! You are done!

Getting started on the first assignment

The assignments are all listed in the contents area in the assignments folder. There are separate folders for each of the seven assignments. Opening the assignment 1 folder you will see a Word document which contains all of the questions. This is a template that you can use to fill in all of your matlab code, explanations and Matlab output. Submit the completed Word version of your assignment on D2L using the assignment drop box.

A couple of question examples are given below:

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Example 1 Give the Matlab expression to calculate $x = 3\sin(.2)^4$ and the resulting value of x

(Matlab input)

x = 3*sin(0.2)^4

(Matlab Response)

x =0.0047

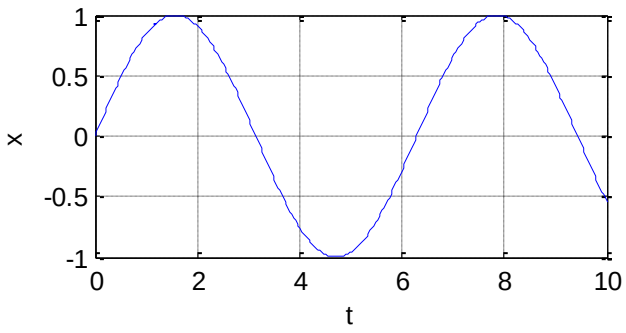
……

Example 2 Generate a plot of y = sin(t) for 0<t<10 and annotate your graph

(Matlab input)

```
t = linspace(0,10,300);
y = sin(t);
plot(t,y);
grid on;xlabel('t');ylabel('x');
```

(Matlab Response)



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