ENG1060 ASSIGNMENT – S2 2021

Due: 11:55PM, Friday 15th October (Week 11)

Late submissions: A 10% penalty (-1 mark) per day, or part thereof, will be applied. No submissions will be accepted once the penalty has reached 50%.

GUIDELINES

This assignment is to be completed INDIVIDUALLY. Students are advised to review Monash University's policies on academic integrity, plagiarism and collusion. Plagiarism occurs when you fail to acknowledge that the ideas or work of others are being used. Collusion occurs when you work in a manner not authorised by the teaching staff. Do not share your code or code with others. You may discuss ideas with your peers but the approach to coding must be your own. You must have full understanding of it.

All assignments will be checked using the Measure of Software Similarity (MOSS) plagiarism and collusion detection software. Files with high similarity counts will be flagged and reviewed. In the event of suspected misconduct, the case will be reported to the Chief Examiner and the student's unit total will be withheld until the case has been reviewed and a decision has been finalised by the Associate Dean of Education (Engineering).

INSTRUCTIONS

Download the assignment template files from Moodle and modify the code within the template files (e.g. **`Q1.m`**, **`Q2.m`**, etc.). DO NOT rename the template m-files OR modify **`run_all.m`**. Check your solutions by running **`run_all.m`** and ensuring all questions are answered as required. Do not use close all, clear all, clc in any m-files except run_all.m. The variables must remain in the workspace upon each file call, i.e. so all variables are present at the end for your demonstrator to examine.

This assignment assesses your ability to apply concepts taught in ENG1060. Therefore, do not use any toolboxes or functions that are not taught in ENG1060, unless otherwise specified.

SUBMITTING YOUR ASSIGNMENT

Submit your assignment online using Moodle. Read the "**Assignment upload instructions.pdf**" to prepare your **ZIP file** for submission. Your ZIP file (not .rar or any other format) must include the following attachments:

a. Solution m-files for assignment tasks (e.g. **run_all, `Q1.m`**, **`Q2.m`**, etc.)
b. Any additional function files required by your m-files (e.g. **comp_trap.m**, **heun.m, newraph.m**, etc.)
c. All data files needed to run the code **including the input data provided to you** (e.g. **10friends_gold.txt, SpiralPerformance.txt**, etc.)

Your assignment will be marked in your usual computer lab session during Week 12**.** You must attend and be present for the assessment to be marked. You will receive a score of 0 if you are absent. Your zip file will be downloaded from Moodle and only these files will be marked.

Your demonstrator will extract (unzip) your ZIP file and mark you based on the output of **run_all.m**. It is your responsibility to ensure that everything needed to run your solution is included in your ZIP file. The assignment will not be downloaded to your individual laptops for marking.

MARKING SCHEME

This assignment is worth 10% of the unit mark. Your assignment will be graded using the following criteria:

1. `run_all.m` produces results **automatically** (additional user interaction only if asked explicitly)
2. Your code produces correct results (printed values, plots, etc…) and is well written.
3. Poor programming practice will result in a loss of up to 2 marks out of 10.
4. Your ability to answer the demonstrator's questions that test your understanding of the assignment questions and the submitted code.
5. This assignment assesses your ability to apply concepts taught in ENG1060. Therefore, do not use any toolboxes or functions that are not taught in ENG1060, unless otherwise specified.

ASSIGNMENT HELP

1. You may use the function files that you have written in the labs and workshops.
2. There will be a dedicated "Assignment Discussion" forum on moodle to clarify any uncertainties or ambiguities for the entire class. If you ask questions to us via email, we may ask you to submit a question to the discussion board, so that the entire class can see the answer we give.
3. The m-file templates contain pre-written comments and sections only as a guide. You do not need to follow its structure. You may delete the comments.
4. Hints may also be provided during workshops.
5. Bold text has been used to emphasize important aspects of each task. This does not mean that you should ignore all other text.
6. The task have been split into sub-questions. It is important to understand how each sub-question contributes to the whole, but each sub-question is effectively a stand-alone task that does part of the problem. Each can be tackled individually.
7. It is recommended that you break down each sub-question into smaller parts too and figure out what needs to be done step-by-step. Then you can begin to put things together again to complete the whole.
8. Ensure to solve the question or plan your algorithm by hand before attempting to code the solution.
9. You may discuss general ideas and approaches with peers. However, you should not share your code directly with other students as this may consitute collusion.
10. You may also discuss the assignment with your demonstrators, however be aware that they will only answer general questions related to theory (e.g. "How can I determine if my step size is small enough when I'm solving an ODE?") and not specific questions (e.g. "I'm stuck on question 3, how can I approach this?").

Prospecting for and mining beach gold
(Total marks for this assignment = 60)

1. Beach mining with your friends **(4 parts worth 7 marks in total)**

You and 10 of your friends spend a day at a beach that is known to contain rich amounts of gold in the sands. Your 10 friends come with small shovels and just their gold pans. Their performance for the day is summarised in the data file "10friends_gold.txt". The first column contains the number identifying each of your friends:

1 = Tom, 2 = Jeff, 3 = Bianca, 4 = Olivia, 5 = Mark, 6 = Dave, 7 = Chee, 8 = Kate, 9 = Hiro & 10 = Sanjay.

The second column in the file "10friends_gold.txt" lists the amount of gold that each of your friends got (in grams) and the third column lists the amount of time (in minutes) each of your friends spent trying to get some gold out of the beach.

(i) Import the data from the file "10friends_gold.txt". **(1 mark)**

(ii) Use the "max" function to determine who got the most gold for the day. Use "fprintf" to print the name of that person and how many grams of gold they got to 3 decimal places. **(2 marks)**

(iii) Who of your friends had the highest recovery rate in grams per minute? Use "fprintf" to print the name of the friend and their recovery rate in grams per minute to 3 significant figures. **(2 marks)**

(iv) Gold is currently worth $80 per gram. From your answer to part (iii), use "fprintf" to print how much your most productive friend made in $/hour to the nearest cent. **(2 marks)**

2. Your secret weapon – the spiral separator (4 parts worth 16 marks in total)

You were working the same area of the beach alongside your friends, but you had a secret weapon with you… **THE SPIRAL SEPARATOR!!!** (watch the video in Moodle to see it in action)

Figure 1: The video shows all aspects of operating the gold spiral and mining beach sands for gold. It is worth watching in order to give you every bit of information that you will need to understand the limitations of how it works, why it works and how its use determines what is physically possible as you dig up the beach for gold. **This is your secret weapon so understand it by watching the video.**

You have previously run some tests at different spin speeds to check the performance of the spiral separator. The results from these tests are tabulated in the data file "SpiralPerformance.txt". The first line is a header and the first column gives the time used to spin one spiral-load of dirt in seconds. The second column gives the recovery for the corresponding spinning times as a fraction of 1. I.e. a recovery of 0.78 means that you are recovering 78% of the gold in the load of dirt being spun in the spiral separator.

(i) Import the data from the file "SpiralPerformance.txt". Plot the recovery data versus spinning time as blue diamonds as Figure 1. Don't forget to label your axes and give your plot an appropriate title. **(3 marks)**

(ii) Fit an appropriate function to the data that you have just plotted. Plot the fitted function in the same plot as the raw data (Figure 1). Don't forget to include a legend. **(5 marks)**

(iii) Using "fprintf", report the recovery rate predicted by the fitted function if you were to take an infinitely long time to spin a load of dirt in the spiral? In your "fprintf" statement, explain what is significant about the predicted recovery rate for an infinitely long spinning time. **(3 marks)**

(iv) The gold standard (pardon the pun) of mineral extraction in the mining industry is 95% recovery (5% losses are tolerable economically). What is the shortest amount of time, to the nearest second, that you should spin a load of dirt in the spiral separator to achieve at least 95% recovery. Use "fprintf" to report this amount of time. **(5 marks)**

3. Where to dig the beach (3 parts worth 10 marks in total)

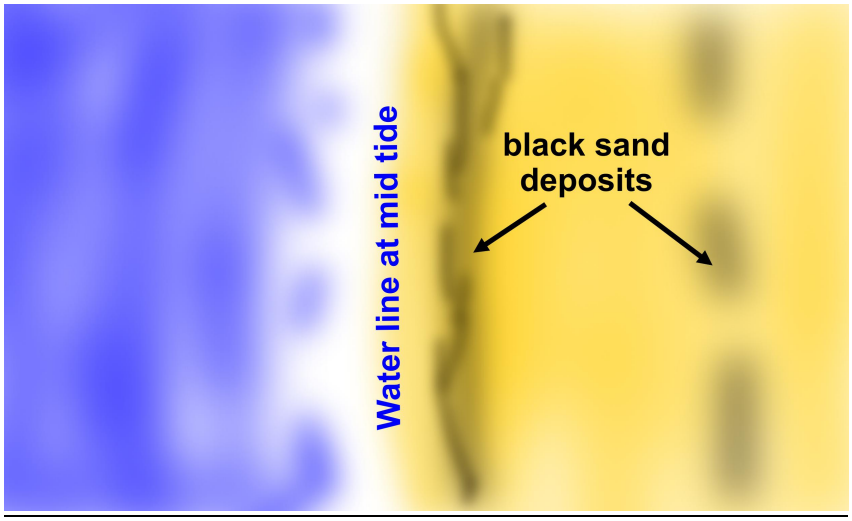

Figure 2: An aerial sketch of the beach. The water is shown in blue, lighter beach sands in yellow and heavier sands in black. The black sand deposits are where gold is most likely to be concentrated. The more concentrated a black sand deposit is, the darker its sketched colour. The surf zone is shown in white.

Figure 1 is an illustration of the beach that you are prospecting / mining with your friends. Black sands are much heavier than yellow sands with black sands dominantly composed of iron oxides with densities of around 5 g.cm^{-3}, while yellow sands are dominantly silica (SiO_2) and have a density of about 2.7 g.cm^{-3}. Black sands are excellent indicators of where a combination of rain, wind, surf and tidal actions have concentrated denser sands and can show you where the gold might be. Gold is of course even denser with a density of 19.2 g.cm^{-3}. Looking for black sand deposits is key to finding gold, not only on the beach but anywhere where gold is known to occur.

The beach you and your friends are at is well known to you and you have done a lot of testing to determine how the concentration of gold in the sand varies as a function of distance from the water line at mid tide. You have developed a description in terms of an ordinary differential equation (ODE) given as follows:

$$\frac{dc}{dx} = 0.5e^{-0.05c} - 0.02x^2c^2 \qquad \text{(Eq. 1)}$$

Note that c is the gold concentration in grams per cubic metre and that c(-10) = 0.5 g.m^{-3}. The variable x is the distance in metres from the water line at mid tide.

(i) Using an appropriate step size, solve the ODE above over the range $-10 \leq x \leq 20$ and plot the solution in Figure 2. **(5 marks)**

(ii) Determine the distance from the water line at mid tide that you should dig in order to be processing the highest concentration of gold through the spiral separator. Use "fprintf" to report this maximum concentration in g.m^{-3} to 3 significant figures as well as the distance in metres from the water line at mid tide at which you should dig, also to 3 significant figures. **(3 marks)**

(iii) Plot the position of the maximum concentration as a black diamond in Figure 2. **(2 marks)**

4. Maximising your returns (5 parts worth 18 marks in total)

Now that you know where to dig and how your spiral separator works and performs, you need to work out your mode of operation to extract as much gold as you can in 5 hours on the beach. Here are some things that you will need to take into account that become clear from watching the video about the spiral separator:

A. Each dirt load processed by the spiral separator is 3 shovel loads worth.
B. Assume that 3 shovel loads of dirt correspond to a 5 L load in the spiral separator.
C. Assume that each shovel load takes 10 seconds to dig and place in the spiral separator.
D. You need to clean out the tailings bin every time you have processed 15 L of dirt.
E. A cleanout of the tailings bin and refilling it with water and reassembling the spiral separator in the bin ready for the next round of processing takes 2 minutes.
F. As the video shows, the spiral bowl itself never needs to be cleaned out and you can just keep processing after the bin has been cleaned out and the setup reassembled.

In addition, there are a few other assumptions that might be helpful:

G. Assume that the width of your shovel is 20 cm.
H. Assume that the gold concentration at the location that you are digging stays constant with the distribution that you determined in Q3.
I. Assume that you can move along the beach and stay at the same gold concentration as long as your distance from the water line at mid tide stays the same.
J. Assume that the tide does not have any influence on your session as it is falling very slowly from the mid tide point and that the change over the five hour session you are undertaking is negligible in the context of what you are doing.

In other words – based on points (H – J), just assume that you are always digging sand with a constant gold concentration.

What is critical **is the spinning time as both the video and Q2 have shown. If you spin each load for a long time, your recovery will be very high but you will not be able to process as much sand; compare this to spinning for a short time but getting a lower recovery as a consequence. You must balance your digging and spinning and cleanout times to maximise your gold take in 5 hours. With this in mind:**

(i) With all of the information presented so far in this assignment, write an equation (which may include one or more unknowns) that describes the total gold in grams that you would extract with the spiral separator and digging the sands with the highest gold concentration on this beach, after working for 5 hours. Use "fprintf" to explain your workings IN FULL in the command window output.

(6 marks)

HINT: Break the problem down into the steps you need to perform and the time each one will take

(ii) Determine the optimal spinning time for each load in your spiral separator to maximise the mass of gold extracted after 5 hours of work. Use "fprintf" to report this spinning time per load (to the nearest second) as well as the recovery (as a fraction < 1 to 3 decimal places) that corresponds to this spinning time. **(8 marks)**

(iii) Using the function that you obtained in Q4 (i), report how much gold you got for the 5 hour session in grams (to 3 decimal places) using "fprintf". **(2 marks)**

(iv) Use "fprintf" again to report how much you earned in $/hour (to the nearest cent) as a result of the mass of gold you extracted in this 5 hour session, assuming gold to be worth $80/gram. Would you say that this is an attractive job considering the returns? **(1 mark)**

(v) How much of an advantage to you was using the spiral separator plus your knowledge of the richest deposits on the beach, compared to your most efficient friend [see Q1 (iii) & (iv)]? To answer this, use "fprintf" to give the ratio of your earnings in $/hour to that of your most efficient friend (to 3 significant figures). **(1 mark)**

5. How do you compare to your YouTube idol? (3 parts worth 9 marks in total)

It is rather unfair to compare yourself to your friends when you not only had the home ground advantage but also a device of your own construction that will massively out-perform a gold pan in sheer processing speed and volume. So a fairer question is how do your techniques and home ground stack up against those of another semi-professional prospector / miner?

One of your favourite prospectors on YouTube uses a homemade river sluice with an enormous throughput. In one of her videos, she came up with an equation that described how many grams of gold per minute she was capturing throughout a 3 hour session on her favourite creek somewhere in the Golden Triangle of Victoria. The equation is reproduced from her video below:

$$m(t) = \frac{0.01}{(1+0.01t)} + \frac{cos^2(0.03\pi t)}{t+50} \qquad \text{(Eq. 2)}$$

Note that t is time in minutes and that m(t) is the mass of gold captured by her sluice in grams per minute.

(i) Plot this function in Figure 3 for $0 \leq t \leq 180$ minutes. **(2 marks)**

(ii) Integrate this function using an appropriate technique over the range $0 \leq t \leq 180$ minutes and report the total mass (in grams) of gold that this prospector got in 3 hours with her river sluice to 3 decimal places using "fprintf". **(5 marks)**

(iii) Work out what her earnings were in $/hour (to the nearest cent), again assuming that gold is worth $80 per gram. Report this value together with the ratio of your earnings per hour relative to her earnings per hour (to 2 decimal places) using "fprintf". Comment on how well spiral separation on the beach compares to river sluicing in the Golden Triangle. **(2 marks)**

END OF ASSIGNMENT