# ENG1005 S2 2024 Workshop 7
# Pursuit Problems

24 marks total

This problem set is intended for you to apply the mathematical skills you are learning. It is also designed to practice communicating your work clearly.

It is expected that you will use the workshop to develop (rough) solutions. During the workshop, you should discuss the problems with your peers and the academic staff who are there to assist you. In particular, if you are uncertain about what the problems are asking or you are stuck on a particular point, this is the time to get assistance. The time between the end of the workshop and when the solutions are due is only meant to be for writing up your solutions and for this you should not need more than an hour or two at most.

**General submission information:**

1. Electronic submission of your solutions is due on Moodle by **11:55 pm on Sunday of the same week**.
2. **Your solutions should include a description/explanation of what you are doing at each step and relevant working.** Without these you will receive limited marks. The description should be in complete English sentences. All mathematics should be appropriately laid out and with appropriate notation. Your writing should be similar in style to the worked solutions from the Applied Class problem sheets, not the annotations from the videos. For more information and advice, please read the "Guidelines for writing in mathematics" document posted under the "Additional information and resources" section of the ENG1005 Moodle page.
3. Your solutions may be typed or handwritten and scanned (the latter is encouraged). The **final document should be submitted as a single pdf file that is clearly and easily legible**. If the marker is unable to read it (or any part of it) you may lose marks.

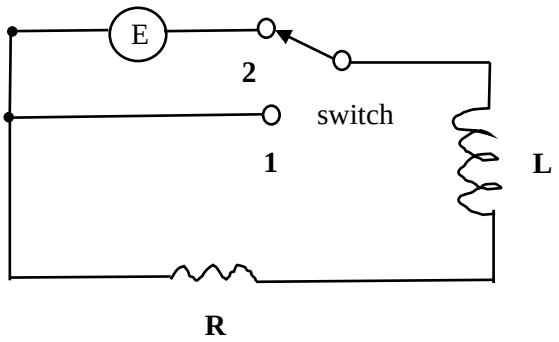
**Academic integrity:**

You can (and should!) discuss your solutions with the other students, but **you must write up your solutions by yourself**. Copying solutions is serious academic misconduct and will be penalised according to Monash University guidelines. Other examples of academic misconduct include asking a personal tutor to do any of your assessments and posting your assessments to a "homework" website. Please refer back to your Academic Integrity module if you are in any doubt about what constitutes academic misconduct. **Your integrity is an important part of who you are. It is much more important than any grade you could receive.**

## Electrical Circuit

A series circuit shown below containing a resistor with a resistance of $R$ ohms, an inductor with an inductance of $L$ henries, and a source $E$ of electromotive force (emf). This system is governed by the first-order equation

$$LI'(t) + RI(t) = E(t).$$




where $I$ is the current which depends on the time $t$, and the prime symbol indicates differentiation with respect to $t$.

1. Identify whether the ODE is linear or nonlinear. Justify your answer. **[1 mark]**

Assume that the switch has been in position 2 for a while, so that a steady current of 5 A is flowing in the circuit. At time $t = 0$, the switch is changed to position 1, so that $I(0) = 5$ and $E = 0$ for $t \geq 0$.

2. Show that the ODE is a separable ODE for $t \geq 0$. **[1 mark]**

3. Suppose that $L = 7$ H and $R = 33\ \Omega$. Find $I(t)$ using separation of variables and evaluate its value at $t = 0.1$. (Give the final answers in 3 significant figures.) **[4 marks]**

4. Suppose that $L$ and $R$ are unknown. After some time, the current decays to 80% of its initial value. It takes another 0.15 seconds for the current to decay to 38% of its initial value. How long does it take for the current to reach 80% of its initial value and what is the ratio of $L/R$? (Give the final answers in 3 significant figures.) **[4 marks]**

Assume that the switch remains in position 2. Suppose that $E(t) = 150e^{-10t}\cos(40t)$, $R = 25$, $L = 5$, and $I(0) = 5$.

5. Identify all techniques that would be appropriate to use to solve the ODE. **[1 mark]**

6. Find $I(t)$ using all the techniques mentioned in the previous question. **[10 marks]**

7. Plot the currents $I(t)$ of Questions 3 and 6 in the same graph. From the graph, find the times for the two currents decay to 50% of their initial values. **[4 marks]**

**There is also 1 additional mark given for the quality of the English and 1 additional mark for correct mathematical notation.** These marks are easy to obtain but the markers will be instructed to be strict in awarding these marks.