ENG1005 S1 2024 Workshop 6
Wifi Access Point II

25 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 (Melbourne time) on Friday 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.

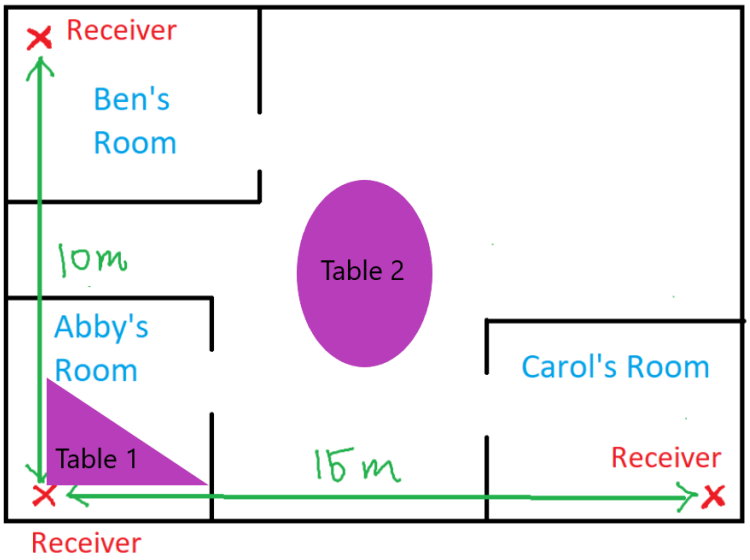
Academic integrity:

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.**

Wifi Access Point

In this week's workshop, we will continue with last week's problem of finding the optimum location for a WiFi access point in a house. Recall that if we set up a coordinate system where Abby's receiver is at the origin $(0,0)$, Ben's receiver is on the y-axis at $(0,10)$, and Carol's receiver is on the x-axis at$(15,0)$, then the power consumption of the access point in watts is given by

$$T(x,y) = \frac{1}{50}(3x^2 + 3y^2 - 30x - 20y + 325)$$



1. Find all the critical points of $T(x,y)$ (you should have already done this in the previous workshop!). **[1 mark]**

2. Use the second derivative test to classify each critical point of $T(x,y)$. **[3 marks]**

Abby wants to put the WiFi access point on a corner table in her room. The corner table is triangular in shape with vertices at $(0,0)$, $(4,0)$ and $(0,2)$.

3. Explain why the access point should be placed along the edge of the table and not in the interior of the table. **[2 marks]**

4. Write down an equation for the diagonal edge between $(4,0)$ and $(0,2)$, make sure you include the range of the variables. **[2 marks]**

5. Using the equation from the previous part, express the power consumption T along the diagonal edge as a function of a single variable y, and hence find the location which minimises T along this edge. **[2 marks]**

6. Repeat the calculation for the remaining two edges, and hence find the location on the table which minimises T. **[3 marks]**

It is decided that the WiFi access point should be placed on a more central table. The second table is oval shaped and can be described by the set of points

$$\{(x,y) : (x-7)^2 + \frac{1}{2}(y-5)^2 \leq 1\}$$

7. To minimise power consumption, should the WiFi access point be place somewhere in the interior of the table or on the boundary of the table? Justify your answer. **[1 marks]**

We will use the method of Lagrange multipliers to minimise the power consumption along the boundary of the table.

8. Write down the *constraint* function $g(x, y)$. **[1 marks]**

9. Write down the three simultaneous equations that x, y, and the Lagrange multiplier λ must satisfy at an extreme value of power consumption along the boundary of the table. **[2 marks]**

10. Use two of the equations to express x and y in terms of λ. **[2 marks]**

11. Using Matlab or CAS, solve the last equation (after substitution) for all possible real solutions of λ, rounded to 2 decimal places. **[2 marks]**

12. Determine the most power efficient position to place the WiFi access point on the oval table, round your answer to 2 decimal places. **[2 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.