Don’t worry - just do your best :-) 

1. The marks you receive during the term will likely be scaled based on the class results on the final exam. Even if it seems difficult, that doesn’t mean the term marks will be low!

2. For questions 2 – 5, generous marks may be given for honest attempts, even if you get stuck - provided you show your work.

Instructions and policies

1. Please print your name, student number, and provide your signature right away, before you attempt any of the problems. Check that this booklet contains ten (10) pages.

2. All your work must be shown for full credit on questions 2 – 5. No work is required in question 1, and a correct answer will receive 3 points; partial credit of 1 point may be given in question 1 if the answer you provide is wrong.

3. Unless a question specifies otherwise, you do not need to simplify your answers.

4. No calculators, electronic devices, or formula sheets are allowed during the test.

5. Ten (10) minutes before the end of the test period you will be given a verbal notice. After that time, you must remain seated until all test papers have been collected.

6. Exposing your test paper to others or looking at the paper of another student, even if unintentional, will be deemed as cheating and subject to disciplinary action.

7. When the test period is over, you will be instructed to put away writing implements. Put away all pens and pencils at this point. Continuing to write past this instruction will be considered cheating. Please remain seated and pass your test paper down the row to the nearest indicated aisle. You may leave your seat only after all the tests have been collected.

8. A certain portion of the tests will be randomly selected and photocopied. This is a warning in case an individual modifies their answers and asks for a re-grading, which would be cheating.
1 Short Answer (15 marks: 3 marks per part)

a Evaluate $\int \frac{(x^2+x+1)dx}{\sqrt{x}}$.

b Find the area above $y = x^2$, and beneath both $y = 5x + 6$ and $y = -x + 2$.

c Plot the polar curve $r = \sin(\frac{\theta}{2})$. 
d Find the average value of \( \sin^2(2x) \cos(3x) \) on \([0, \pi/2]\).

e Express \( \lim_{n \to \infty} \sum_{j=1}^{n} \frac{n}{n^2+j^2} \) as a definite integral.
2 Long Answer (10 marks)

Find the area of the region that lies inside both curves: $r^2 = \sin(2\theta)$ and $r^2 = \cos(2\theta)$. 
3 Long Answer (10 marks)

Find

a (5 marks) \( \int \frac{x^2 + x + 1}{x^2 + 2x + 1} \, dx \)
b (5 marks) \( \int \frac{x \, dx}{\sqrt{6 - 4x^2 - 2x^4}} \)
4 **Long Answer** (10 marks)

A tank is in the form of a right circular cone of base radius 5 m and height 15 m. The cone is situated *pointy-side up*. Find the work done in pumping water *into* the tank *through its base* to a depth of 9 m. Water has a density of 1000 kg m$^{-3}$ and you may approximate the acceleration due to the earth’s gravitational field to be 10 m s$^{-2}$.
5 Conceptual Question (5 marks)

State the Mean Value Theorem for Integrals and *provide an example* to show that the result of the theorem does not necessarily hold for functions that are *not continuous*.
Figure 1: A preview of academic research... This cartoon is complements of S. Harris, with copyright credit from ScienceCartoonsPlus.com.

Bonus a (1 mark)
What is your favourite colour?

Bonus b (1.5 marks)
Find a polar equation of the collection of points the product of whose distances from \((x = -1, y = 0)\) and \((x = 1, y = 0)\) is 1. Find the area enclosed by this curve.
This page is provided for rough work.
Mark breakdown:

<table>
<thead>
<tr>
<th>Question 1 (out of 15)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 2 (out of 10)</td>
<td></td>
</tr>
<tr>
<td>Question 3 (out of 10)</td>
<td></td>
</tr>
<tr>
<td>Question 4 (out of 10)</td>
<td></td>
</tr>
<tr>
<td>Question 5 (out of 5)</td>
<td></td>
</tr>
<tr>
<td>Bonus (out of 2.5)</td>
<td></td>
</tr>
<tr>
<td>TOTAL (out of 50)</td>
<td></td>
</tr>
</tbody>
</table>