

# Introduction to Numbas

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*x*run



NUMBAS

# This talk

- About Numbas

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- About Numbas
- How we're using Numbas at Newcastle

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- How we're using Numbas at Newcastle
- How to get started using Numbas

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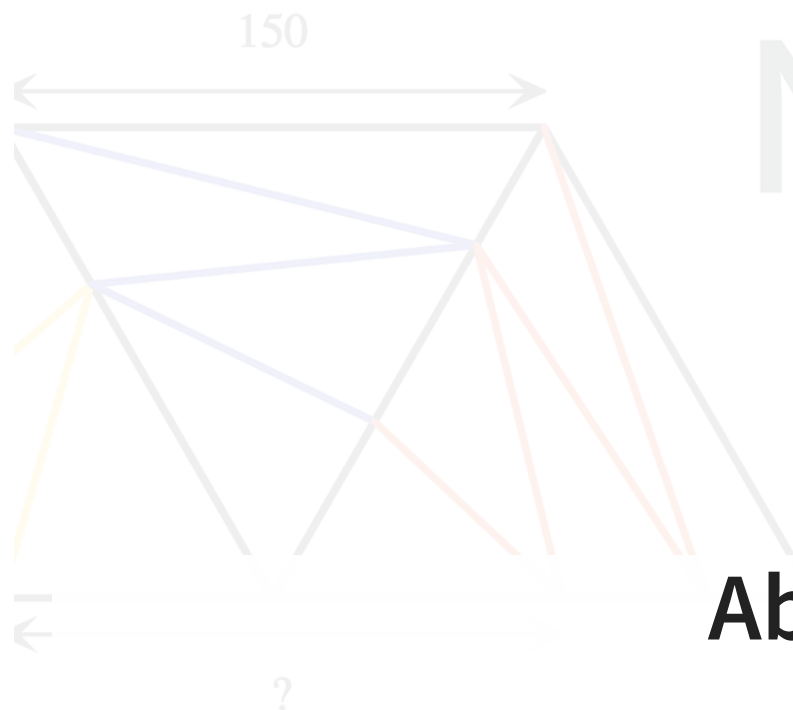
- About Numbas
- How we're using Numbas at Newcastle
- How to get started using Numbas

Hopefully plenty of time for questions / demos.

My colleague Christian Lawson-Perfect will be running the second workshop next week (more hands-on).

## About me (briefly)

- Director of E-Learning / Deputy Director of Education in the School of Maths, Stats & Physics at Newcastle University
- I use Numbas in my own teaching (of programming for maths and physics students) extensively.
- My role leads me to be part of many projects using Numbas around our University and beyond



# NUMBAS

$f(x)$

$$\frac{df}{dx} = 21x^6 + 48x^5 + 9$$

## About Numbas

2 Columns: 2

$\begin{pmatrix} 3 \\ -1 \end{pmatrix}$

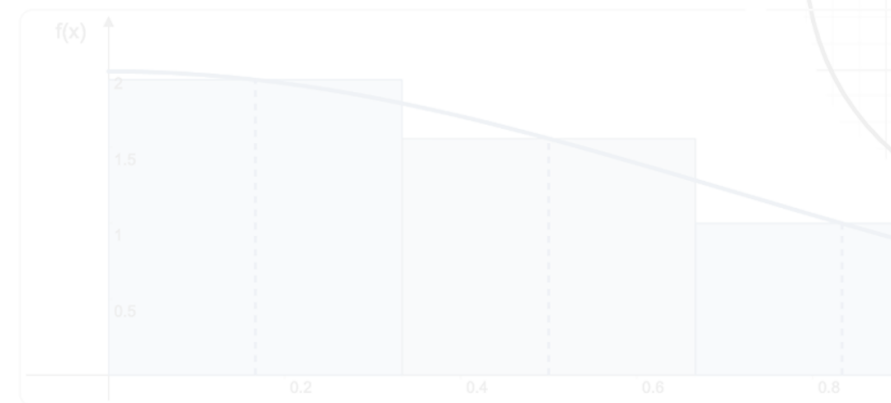


1 seq[-1]

Write Python code

b)

The rectangle rule approximates an integral by dividing an area into rectangles. In the below, the  $x$  range is divided into 3 rectangles of equal width, with the height of each given by the value of  $f(x)$  at the left-hand corner of each rectangle.



Compute the same integral as part a) using this method, with 3 rectangles.

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- Used around the world.

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Get immediate feedback and receive a full solution for each instance of the question.

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## **Randomisation**

Practise similar questions over and over again.

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  - Support for matrices, vectors, quantities with units
  - Work with data files / JSON

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- Lots of maths features
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  - Support for matrices, vectors, quantities with units
  - Work with data files / JSON
- Error-carried forward marking
- Alternative answers

# **What is Numbas used for?**

Pre-entry material, transition, diagnostic tests, in-course practice, in-course assessment, final exams...

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A quick look at a Numbas test:

[Demo test >](#)



# Numbas at Newcastle

## Set up

We're a Canvas institution like you:

- Teachers create questions in the Numbas Editor
- External (LTI) tool in Canvas for formative and summative assessment
- Lockdown browser for high stakes assessments

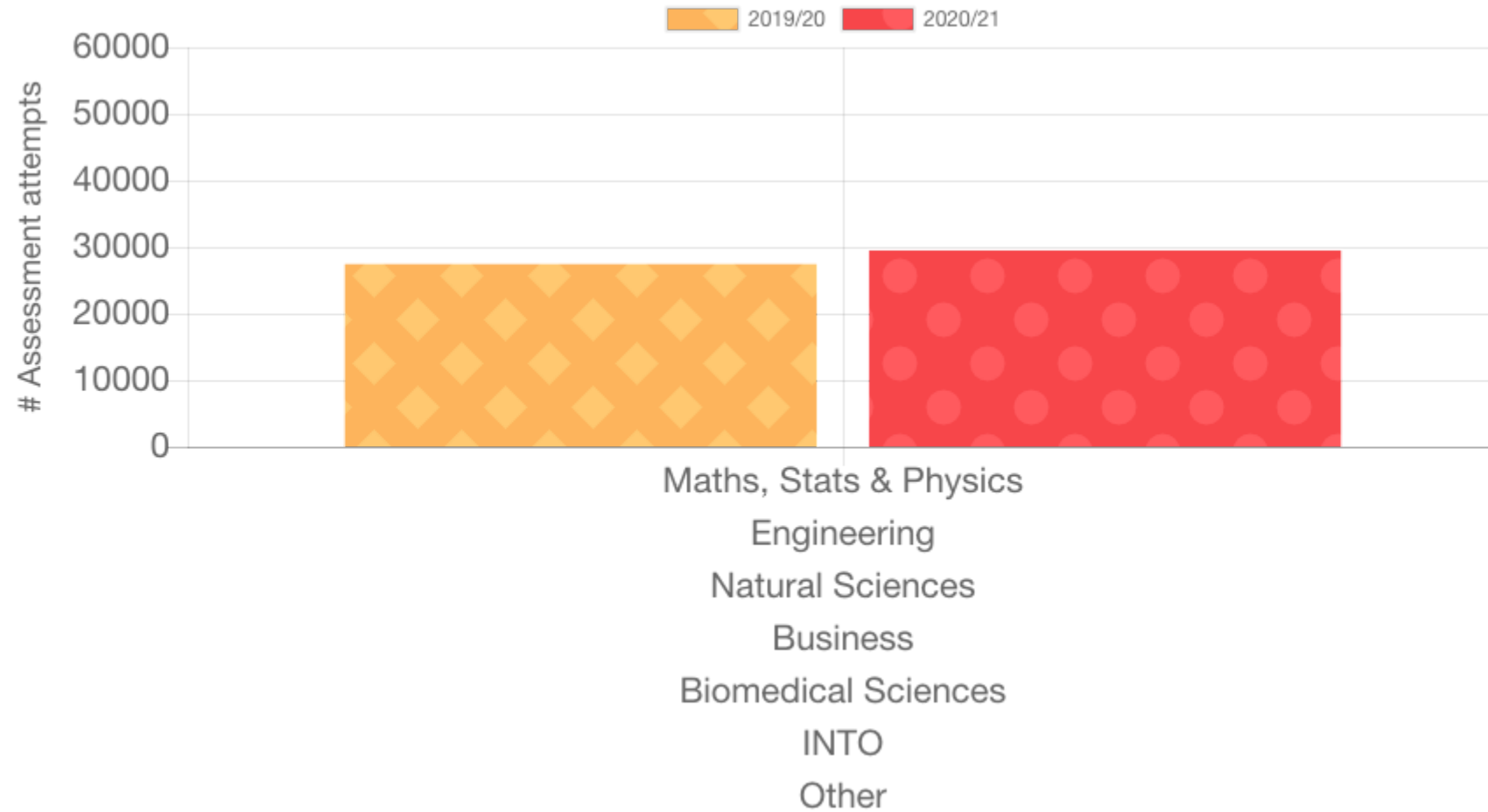


## Numbas trends at Newcastle

A few trends from the past year:

- More diverse and extensive formative assessment
- Dramatic increase in use, particularly in engineering
- Remote 'labs' using Numbas
- Hybrid tests
- Final exams

# Numbas use by department at Newcastle



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Others include Psychology, Geography, Politics, foundation programmes...

# Units example

## Question 1

A hairdryer expends 6000 J of energy in 10 seconds. What is its power rating?


\_\_\_\_\_ *Include units in your answer.*

---

Created using Numbas (<https://www.numbas.org.uk>), developed by Newcastle University (<http://www.newcastle.ac.uk>).

# Formative assessment

More formative use;  
more appreciation of  
the "weekly quiz".

  
Account  
Dashboard  
Courses  
Calendar  
Inbox  
History  
Help

2020 / 21  
Home  
Announcements  
Syllabus  
Modules  
ReCap  
Assignments  
Grades  
Library Reading List  
NU ePortfolio  
Zoom  
NCL Voice: Let's Talk

MAS2803-MAS2805-PHY2033 (20/21) > Modules > Semester 1 > Week 4 Handout

## Root finding functions

There are functions in Python which can do the hard work for us.

**Using NumPy's `roots` to find the roots of polynomial.**

The function `roots` will find roots of a **polynomial**, given its coefficients.

For example  $f(x) = x^3 + x^2 + x - 3$

```
import numpy as np
p = [1,1,1,-3]
r = np.roots(p)
print(r)
```

You'll see that it returns both real and complex roots.

Note that for missing terms you just insert a zero, e.g.  $x^2 - 2$ :

```
p = [1,0,-2]
r = np.roots(p)
print(r)
```

Though the function really does make this straightforward, you should always check that the output is correct, for example by making a plot.

### Exercise 4.3

[Hide exercise >](#)

Use NumPy's `roots` to find the solution of  $x^2 - x - 1 = 0$

The roots are  and

[Show steps](#) (Your score will not be affected.)

Gap 0

✔ Your answer is correct. You were awarded 1 mark.

Gap 1

✔ Your answer is correct. You were awarded 1 mark.

# Formative assessment

More formative use;  
more appreciation of  
the "weekly quiz".

Increasing use in  
physics, engineering,  
chemistry...

The screenshot displays a university Learning Management System (LMS) interface. On the left is a dark blue sidebar with navigation icons and labels: Account, Dashboard, Courses, Calendar, Inbox, History, and Help. The main content area has a breadcrumb trail: MAS2803-MAS2805-PHY2033 (20/21) > Modules > Semester 1 > Week 4 Handout. Below this is a list of navigation links: Home, Announcements, Syllabus, Modules, ReCap, Assignments, Grades, Library Reading List, NU ePortfolio, Zoom, and NCL Voice: Let's Talk. The central content area is titled "Root finding functions" and explains that Python functions can find roots of polynomials. It provides an example of using NumPy's `roots` function with the polynomial  $f(x) = x^3 + x^2 + x - 3$ . A code block shows the Python code: 

```
import numpy as np
p = [1,1,1,-3]
r = np.roots(p)
print(r)
```

 Below the code, it notes that the function returns both real and complex roots and provides an example for a quadratic polynomial  $x^2 - 2$ . Another code block shows: 

```
p = [1,0,-2]
r = np.roots(p)
print(r)
```

 The text states that the function makes this straightforward but advises checking the output. An "Exercise 4.3" section follows, with a "Hide exercise >" button. The exercise asks the user to use NumPy's `roots` to find the solution of  $x^2 - x - 1 = 0$ . The user has input the roots as -0.618034 and 1.618034. A "Show steps" button is present with the note "(Your score will not be affected.)". On the right side of the exercise area, there are two "Gap" indicators: "Gap 0" and "Gap 1", both marked with green checkmarks and the text "Your answer is correct. You were awarded 1 mark."

2020 / 21

Account

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MAS2803-MAS2805-PHY2033 (20/21) > Modules > Semester 1 > Week 4 Handout

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### Exercise 4.3

Hide exercise >

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The roots are  and

Show steps (Your score will not be affected.)

Gap 0  
✔ Your answer is correct. You were awarded 1 mark.

Gap 1  
✔ Your answer is correct. You were awarded 1 mark.

# Formative assessment

More formative use;  
more appreciation of  
the "weekly quiz".

Increasing use in  
physics, engineering,  
chemistry...

More diverse  
applications to ask  
questions involving  
e.g. R, SPSS, Minitab.

Handout example >

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```
import numpy as np
p = [1,1,1,-3]
r = np.roots(p)
print(r)
```

 The text continues: 'You'll see that it returns both real and complex roots. Note that for missing terms you just insert a zero, e.g.  $x^2 - 2$ :' followed by another code block: 

```
p = [1,0,-2]
r = np.roots(p)
print(r)
```

 The text concludes: 'Though the function really does make this straightforward, you should always check that the output is correct, for example by making a plot.' Below this is a section titled 'Exercise 4.3' with a 'Hide exercise >' button. The exercise text says: 'Use NumPy's `roots` to find the solution of  $x^2 - x - 1 = 0$ . The roots are  and '. There is a 'Show steps' button with the note '(Your score will not be affected.)'. On the right side of the exercise box, there are two 'Gap' indicators: 'Gap 0' and 'Gap 1', both with green checkmarks and the text 'Your answer is correct. You were awarded 1 mark.'

# Remote Labs

## NUMBAS

### Gears Lab

Question 1	Score: 0/2 Unanswered
Question 2	Score: 0/7 Unanswered
Question 3	Score: 0/29 Unanswered
Total	0/38

Pause

End Exam

Now wrap the string around the pulley on the 100 tooth gear and hang a weight carrier onto it.

Add masses to the value of 0.30kg (remember to include the mass of the carrier).

### Single Reduction Part 2

Calculate the Applied Force (A, to three decimal places). Applied force =  $mg = \text{ \_\_\_ N}$  ( $g=9.81\text{m/s}^2$ ).

Calculate the Torque  $T_o$  applied to the gear (B, to four decimal places).

Calculate the theoretical torque  $T_i$  at the 20 tooth gear required to lift this weight, neglecting any effects of friction (C, to four decimal places).

Enter your answers into the table below before continuing (but do not submit answers yet!).

In the same way, suspend a second weight carrier from the pulley on the 20 tooth gear. Add masses until this second carrier just falls smoothly, taking about 3s to fall the full height of about 100mm. Insert this mass to the table below under D, and use it to calculate the applied force (to three decimal places) under E.

Calculate the torque  $T_i$  applied to this gear (F, to four decimal places).

Calculate the actual torque ratio -  $T_o/T_i$  - (G, to two decimal places).

Finally, calculate the efficiency as a percentage (H, to one decimal place).

Pulley diameter: 40mm.

Mass on Output Pulley (kg)	A: Applied Force (N)	B: Applied Torque $T_o$ (Nm)	C: Theoretical Torque $T_i$ (Nm)	D: Mass on Input Pulley (kg)	E: Applied Force (N)	F: Actual Torque $T_i$ (Nm)	G: Actual Torque Ratio	H: Efficiency (%)
0.30	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Submit answer

Score: 0/7

Try another question like this one

Reveal answers

Stripped-down example



# Hybrid assessments

Used for in-course assessment and final exams

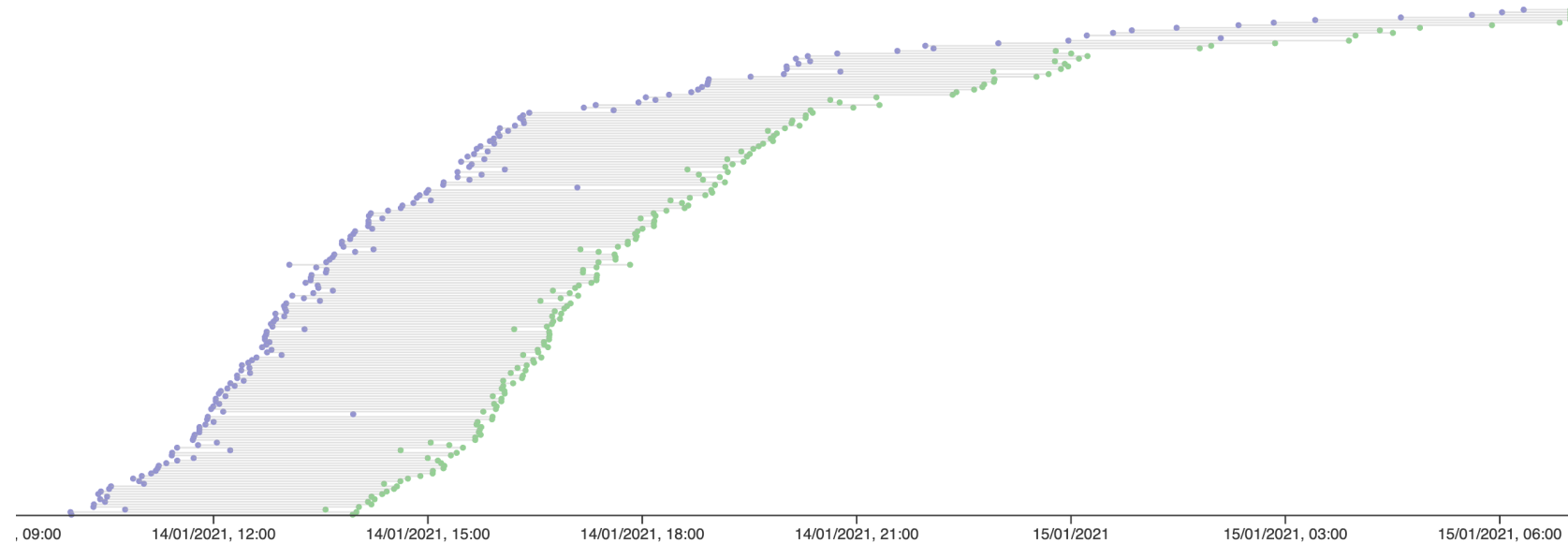
Typically 60-80% auto-marked. Focus manual marking where it is needed.

Question 1	10 marks Unanswered	<p>Implement the method in Python to fill <code>dfdx</code> with values for the gradient in the remaining elements</p> <pre>1 - for i in range(1, len(x)-1): 2     dfdx[i] = (f[i+1]-f[i-1])/(x[i+1]-x[i-1]) 3</pre>
Question 2	6 marks Unanswered	
Question 3	16 marks Unanswered	
Question 4	20 marks Partially answered	
Question 5	23 marks Unanswered	
Question 6	10 marks Unanswered	
Question 7	15 marks Unanswered	
Time remaining:	3:57:04	<p>Submit part</p> <p>7 marks Answered</p> <p>e)</p> <p>Make a plot of <math>\frac{df}{dx}</math> versus <math>x</math> in the range specified in a)</p> <p><input checked="" type="checkbox"/> I have written an answer to submit through Canvas</p>

# Final exams

"4 in 24" hybrid off-campus format used across all of our stage 1 modules in maths and physics.

Some off-campus tests retained for 2021/22, plus around 10 on-campus digital tests.



# Welcome to the Numbas editor.

Numbas is a web-based e-assessment system developed at Newcastle University. It consists of SCORM-compliant exam packages, with an emphasis on maths.

You can find a user guide, including tutorials, at [numbas-editor.readthedocs.io](https://numbas-editor.readthedocs.io).

If you have any comments or questions about Numbas, please send an e-mail to [numbas@ncl.ac.uk](mailto:numbas@ncl.ac.uk).

## Getting started with Numbas

Get started by creating an account.

Sign up

Log in

Or just take a look around.

 Learn about Numbas

 Browse the public

# Using Numbas

Mathcentre public Numbas Editor at [numbas.mathcentre.ac.uk](https://numbas.mathcentre.ac.uk)

Open source LTI tool at [numbas-lti-provider.readthedocs.io](https://numbas-lti-provider.readthedocs.io)

# Public Numbas Editor

**Open to everyone.**

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## Next steps

- Create an account on the Numbas Editor
- Navigate to the Numbas documentation ([numbas-editor.readthedocs.io](https://numbas-editor.readthedocs.io))
- Try out the [first question tutorial](#)



# Thanks for listening

## Contacts:

- [christopher.graham@newcastle.ac.uk](mailto:christopher.graham@newcastle.ac.uk)
- [numbas@newcastle.ac.uk](mailto:numbas@newcastle.ac.uk)

## Useful links:

- Numbas Website [numbas.org.uk](https://numbas.org.uk)
- Numbas Editor [numbas.mathcentre.ac.uk](https://numbas.mathcentre.ac.uk)

