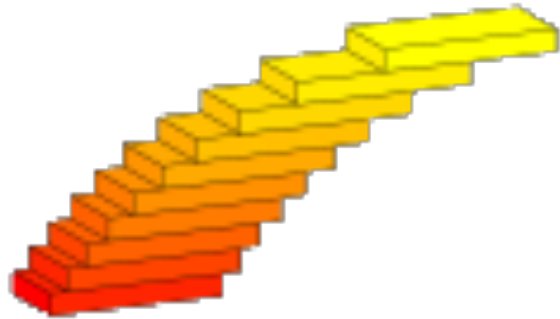


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EAMS - 2018

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Improving the quality of questions in  
online assessment for mathematics.



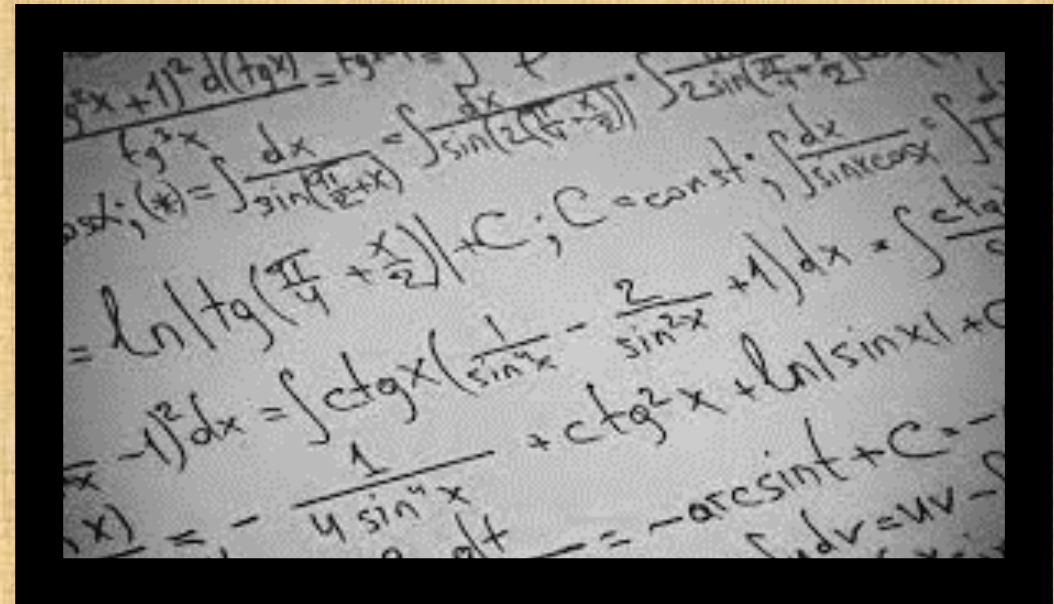
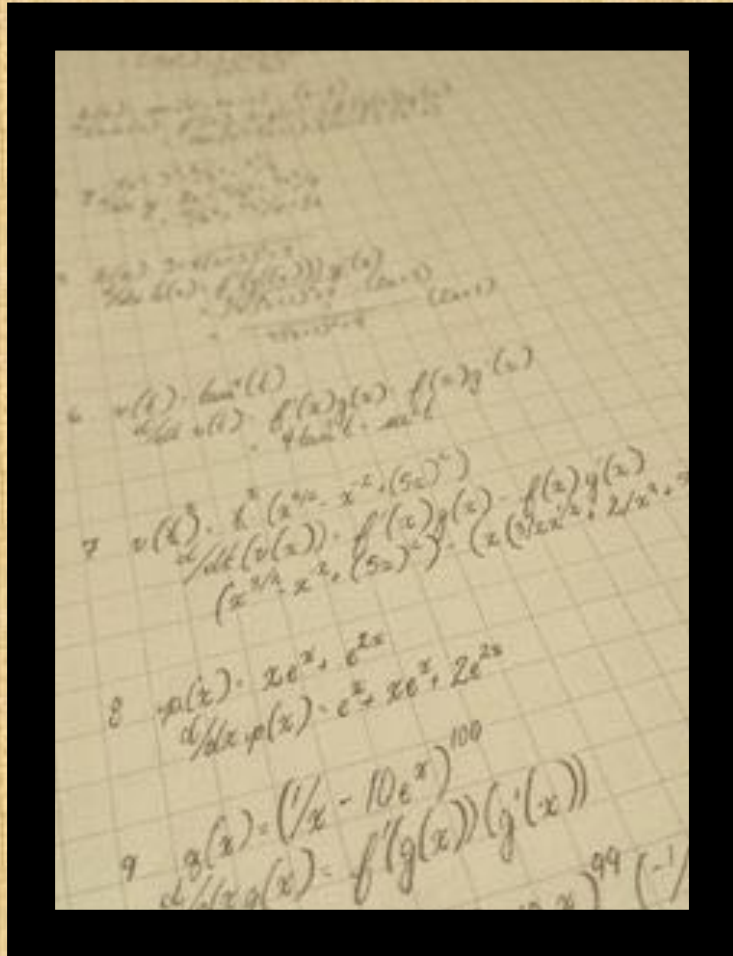
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Dr. Konstantina Zerva  
School of Mathematics  
University of Edinburgh

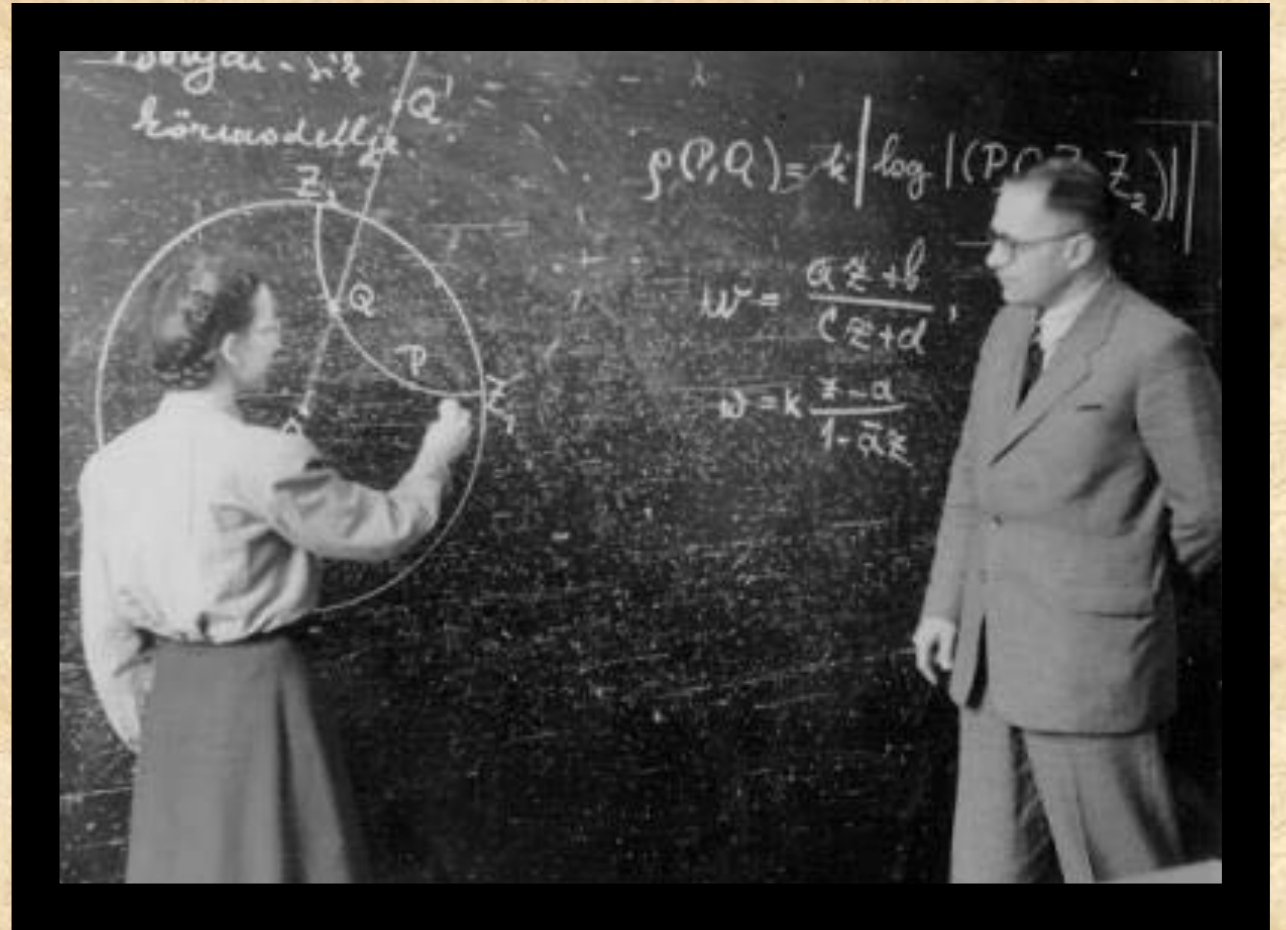


# *Assessment*

# Traditional Assessment methods

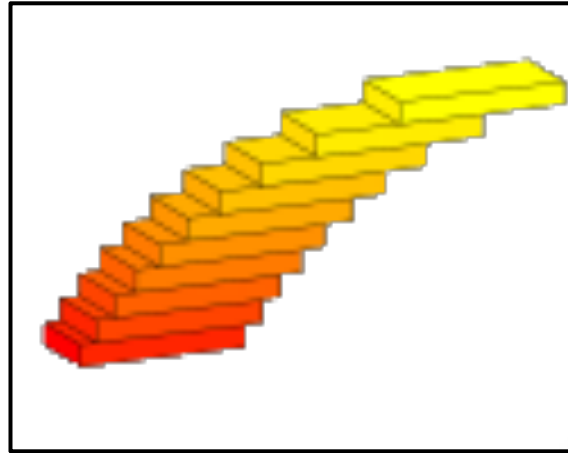


# Traditional Assessment methods





# E – Assessment at the School of Mathematics



System for  
Teaching and  
Assessment using a  
Computer algebra  
Kernel



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# STACK Assessments in 1<sup>st</sup> Year Courses

## **Semester 1:**

- Introduction to Linear Algebra (ILA) ~ 600 students
- Mathematics for Natural Sciences 1a (MNS) ~ 150 students

## **Semester 2:**

- Calculus and its applications (CAP) ~ 500 students
- Engineering Mathematics 1b (EM) ~ 300 students
- Mathematics for Natural Sciences 1b (MNS) ~ 150 students

# STACK Assessments in 1<sup>st</sup> Year Courses

## Introduction to Linear Algebra

- 2 Reading Quizzes: 2 – 3 questions
- 1 Skill Quiz: 4 – 7 questions
- Around 110 questions

## MNS 1b – EM 1b

- 3 Reading Quizzes: 3 – 5 questions
- 1 Assessed Quiz: 7 – 10 questions
- Around 200 questions

## MNS 1a

- 3 Reading Quizzes: 5 questions
- 1 Assessed Quiz: 7 – 10 questions
- Around 240 questions

## Calculus & Applications

- 1 Reading Quiz: 4 questions
- 1 Skill Quiz: 10 questions
- Around 150 questions

---

# STACK Assessments in 1<sup>st</sup> Year Courses

700 used questions  
+  
300 unused questions  
=  
1000 questions



# What is a good quality CAA?


Use all the tools we have...

Try question | Question text & display area

(a) Find the exact value of  $\int_{-1}^3 (x-2)^2 dx$ .

(b) Find the Riemann sum, using left endpoints and 4 rectangles to approximate the previous integral.

(c) The applet below shows the Riemann sum, using left endpoints and 4 rectangles. The areas of the rectangles is given by  $a_i$  in the applet. You may slide the position of  $A$ ,  $B$  and  $n$  is the number of rectangles.



Estimate the number of rectangles needed to calculate the true area to within 0.01.

$n > \text{  } \rightarrow \left| a - \int_{-1}^3 (x-2)^2 dx \right| < 0.01$

## General feedback

The x-coordinates of the intersection point

$$8x^3 + 25x^2 - 56x - 4x^3 - 16x^2 + 56x$$

$$4x(x^2 + 3x - 28) = 0$$

$$x = -7 \text{ or } x = 8 \text{ or } x = 4.$$

Because  $f(x) - g(x) = 4x^3 + 12x^2 - 112x \geq 0$  when  $-7 \leq x \leq 0$ , and  $f(x) - g(x) \leq 0$  when  $0 < x \leq 4$ , it follows

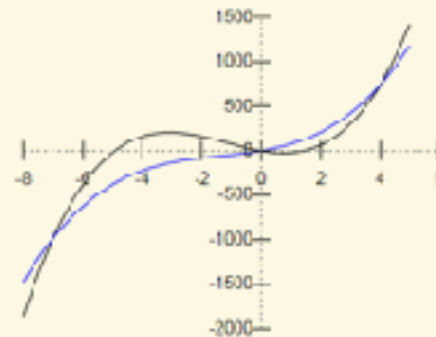
$$\int_{-7}^4 |4x^3 + 12x^2 - 112x| dx = \int_{-7}^0 (4x^3 + 12x^2 - 112x) dx + \int_0^4 (-4x^3 - 12x^2 + 112x) dx$$

$$= \int_{-7}^0 (x^4 + 4x^3 - 28x^2) dx + \int_0^4 (-x^4 - 4x^3 + 28x^2) dx$$

$$= -(-7)^4 + 4 \cdot 7^3 + 56(-7)^2 - 4^4 - 4 \cdot 4^3 + 56 \cdot 4^2$$

$$= 2000.$$

Figure:



Give an example of a function  $f(x)$  with a stationary point at  $x = 2$  and which is continuous but not differentiable at  $x = 0$ .

$f(x) =$

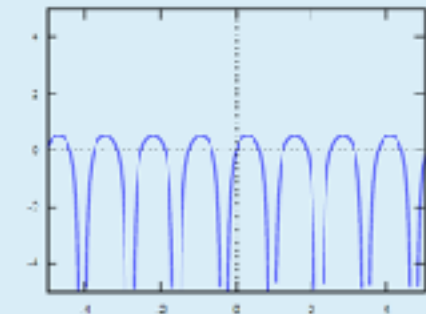
Find  $f \circ g$

$$f(x) = \frac{x}{x+1}, \quad g(x) = \sin(5\pi x)$$

State the domain of the function

$x \neq$   where  $n$  is any integer

(E.g. for  $\tan(x) \neq \pi/2 + n\pi$  where  $n$  is any integer)



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# Review our Assessments

- Quiz level review
- Question level review

Advantage of e-Assessment: we have all the data stored.

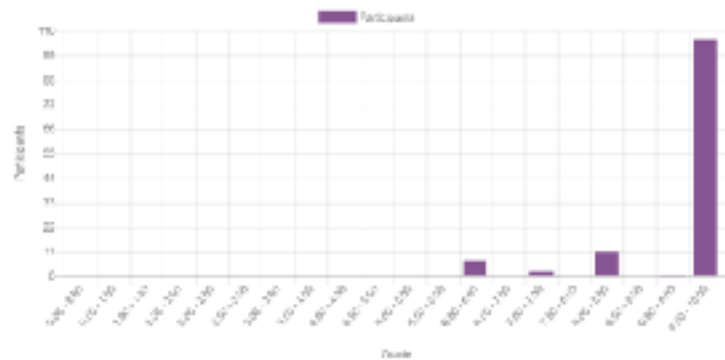
✓ Marks

✓ Time

✓ Attempts

# Review our Assessments – Quiz level

## Marks Distribution



# Review our Assessments – Question level

Are all random versions equal?

QID	Question name	Attempts	Facility Index	Standard Deviation	Minimum guess score	Intended weight	Effective weight	Discrimination Index	Discriminative efficiency
1	Q. L1.1 Q3: Fractional powers	14	95.54%	39.30%	1.00%	90.00%	91.20%	42.87%	61.07%
1.1	Q. Variant 1 of L1.1 Q3: Fractional powers	18	75.00%	48.66%	1.00%	90.00%	69.36%	61.27%	
1.2	Q. Variant 2 of L1.1 Q3: Fractional powers	10	70.00%	48.96%	1.00%	90.00%	0.95%	1.25%	
1.3	Q. Variant 3 of L1.1 Q3: Fractional powers	1	00.00%	48.66%	1.00%	90.00%	18.50%	29.48%	
1.4	Q. Variant 4 of L1.1 Q3: Fractional powers	4	50.00%	39.33%	1.00%	90.00%	38.33%	130.70%	
1.5	Q. Variant 5 of L1.1 Q3: Fractional powers	15	84.67%	37.95%	1.00%	90.00%	51.38%	68.96%	
1.6	Q. Variant 6 of L1.1 Q3: Fractional powers	12	91.67%	38.67%	1.00%	90.00%	-12.39%	-32.47%	
1.7	Q. Variant 7 of L1.1 Q3: Fractional powers	8	88.89%	39.33%	1.00%	90.00%	62.86%	130.30%	
1.8	Q. Variant 8 of L1.1 Q3: Fractional powers	17	94.12%	34.26%	1.00%	90.00%	58.14%	67.22%	
1.9	Q. Variant 9 of L1.1 Q3: Fractional powers	1	00.00%	39.33%	1.00%	90.00%	19.22%	56.61%	

4	Q. L1.1 Q3: Fraction simplification	142	100.00%	0.00%	0.00%	20.00%	0.00%		
4.1	Q. Variant 1 of L1.1 Q3: Fraction simplification	28	100.00%	0.00%	0.00%	20.00%			
4.2	Q. Variant 2 of L1.1 Q3: Fraction simplification	17	100.00%	0.00%	0.00%	20.00%			
4.3	Q. Variant 3 of L1.1 Q3: Fraction simplification	13	100.00%	0.00%	0.00%	20.00%			
4.4	Q. Variant 4 of L1.1 Q3: Fraction simplification	16	100.00%	0.00%	0.00%	20.00%			
4.5	Q. Variant 5 of L1.1 Q3: Fraction simplification	6	100.00%	0.00%	0.00%	20.00%			
4.6	Q. Variant 6 of L1.1 Q3: Fraction simplification	15	100.00%	0.00%	0.00%	20.00%			
4.7	Q. Variant 7 of L1.1 Q3: Fraction simplification	13	100.00%	0.00%	0.00%	20.00%			
4.8	Q. Variant 8 of L1.1 Q3: Fraction simplification	19	100.00%	0.00%	0.00%	20.00%			
4.9	Q. Variant 9 of L1.1 Q3: Fraction simplification	23	100.00%	0.00%	0.00%	20.00%			

Simplify the algebraic expression:  $x^3 \times x^{-9}$ .

Simplify the algebraic expression:  $x^{17} \times x^{-10}$ .

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# Thank you for attending!

You may want to prove that:

$$\sqrt[3]{\sqrt{108} + 10} - \sqrt[3]{\sqrt{108} - 10} = 2$$

