THE UNIVERSITY *of* EDINBURGH
School of Mathematics

Using specifications grading in a fully online course

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Plan

About the course

Specifications grading

Outcomes

Fundamentals of Algebra and Calculus

Developed with George Kinnear, see:
Kinnear, G. (2019)
Delivering an online course using STACK
http://doi.org/10.5281/zenodo.2565969

THE UNIVERSITY *of* EDINBURGH
School of Mathematics

Year 1 Curriculum

Semester 1	Semester 2
Introduction to Linear Algebra	Calculus and its Applications
Fundamentals of Algebra and Calculus	Proofs and Problem Solving
Option	Option

Almost entirely online

A typical week

◀ Week 3: Polynomials and rational functions — Week 5: Functions ▶

Week 4: Principles of integration

Your progress

- Getting started
- 1. The area under a curve
- 2. Antiderivatives
- 3. Evaluating definite integrals
- 4. Finding areas
- Week 4 Practice Quiz
- Week 4 Final Test

  Restricted Not available unless: You achieve a required score in **Week 4 Practice Quiz**

Fundamentals of Algebra and Calculus (2018-2019)[SV1-SEM1]

INDEFINITE INTEGRALS

i 1 2 3

STANDARD ANTIDERIVATIVES

i i 4 5 6 7 8

INTEGRATION BY INSPECTION

i 9 10 11 12

MIXED PRACTICE

13 14 15 16 17

Information
Flag question

Antiderivatives and indefinite integrals

Remember that any function we can differentiate tells us about a corresponding antiderivative.

For example, $\frac{d}{dx}(x^2) = 2x$ so we know x^2 is an antiderivative of $2x$.

However, notice that we also have $\frac{d}{dx}(x^2+1) = 2x$. So x^2+1 is also an antiderivative of $2x$.

In fact, if $F(x)$ is an antiderivative of $f(x)$ then so is $F(x)+C$ where C is any constant. We can see this because differentiating both $F(x)$ and $F(x)+C$ gives $f(x)$.

We saw in the last section that antiderivatives are related to definite integrals:

Evaluation Theorem

If $f(x) = G'(x)$ (i.e. G is an antiderivative of f) then

$$\int_a^b f(x)\,dx = G(b) - G(a).$$

Because of this connection, we also talk about indefinite integrals:

The **indefinite integral** $\int f(x)\,dx = F(x) + C$ means $F'(x) = f(x)$.

It represents the most general antiderivative of f, so must always include an arbitrary constant (usually $+C$).

Note that:

- we say that $f(x)$ is the **integrand**.
- The dx is very important because it indicates the variable we are integrating with respect to.
- the function F is often just referred to as the **integral** of f.

The notation is very similar for definite and indefinite integrals -- the only difference is whether we attach limits to the integral sign. However, notice that the result of an indefinite integral is a *function*, whereas the definite integral gives a *number*.

Example

Returning to the example above, we can write the indefinite integral

$$\int 2x\,dx = x^2 + C$$

to represent the fact that $x^2 + C$ is the most general antiderivative of $2x$.

Question 1
Tries remaining: 1
Marked out of 1.00
Flag question

Which of the following are antiderivatives of x^6?

- (a) $\frac{x^7}{7} + 6$
- (b) $\frac{x^7}{7} + 1$
- (c) $\frac{x^7}{7}$
- (d) $\frac{x^6}{7}$
- (e) $6x^5 + x$
- (f) x^7

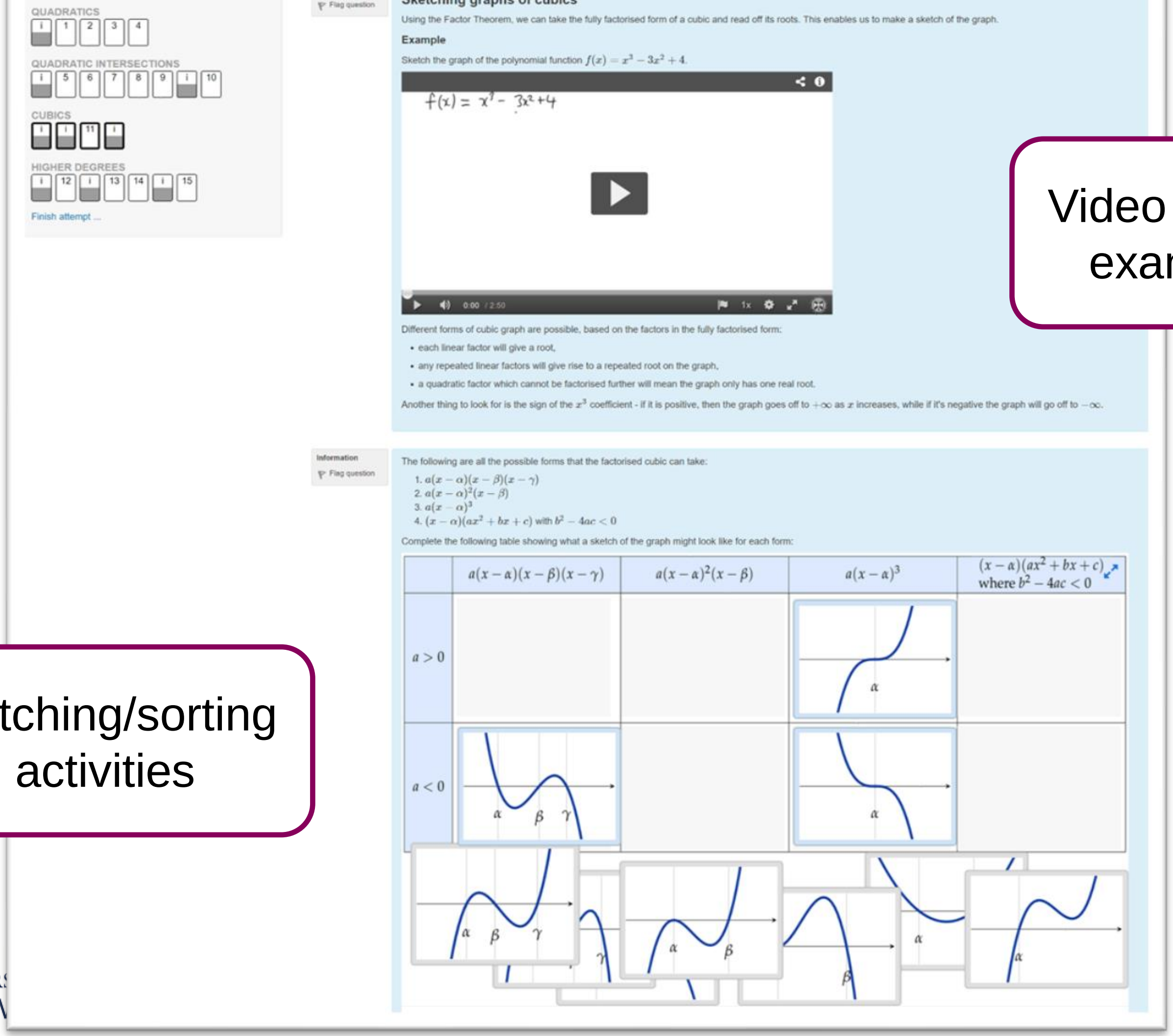
Check

Question 2
Tries remaining: 1
Marked out of 1.00

$\int x^2\,dx =$

Check

Simple questions to check understanding



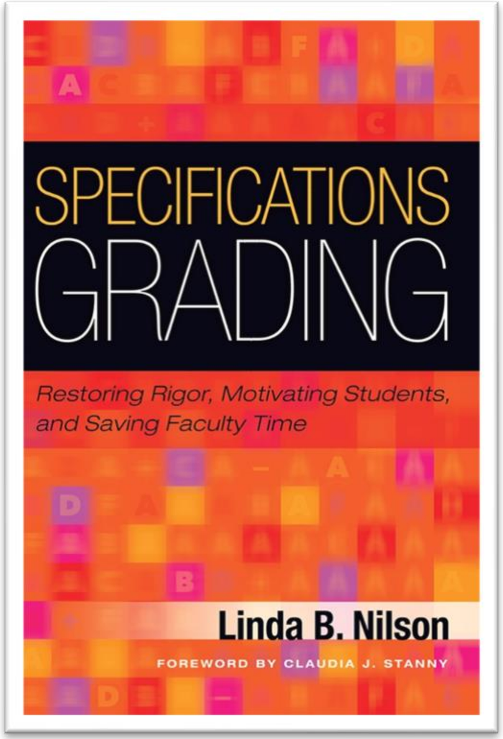
Video worked examples

Matching/sorting activities

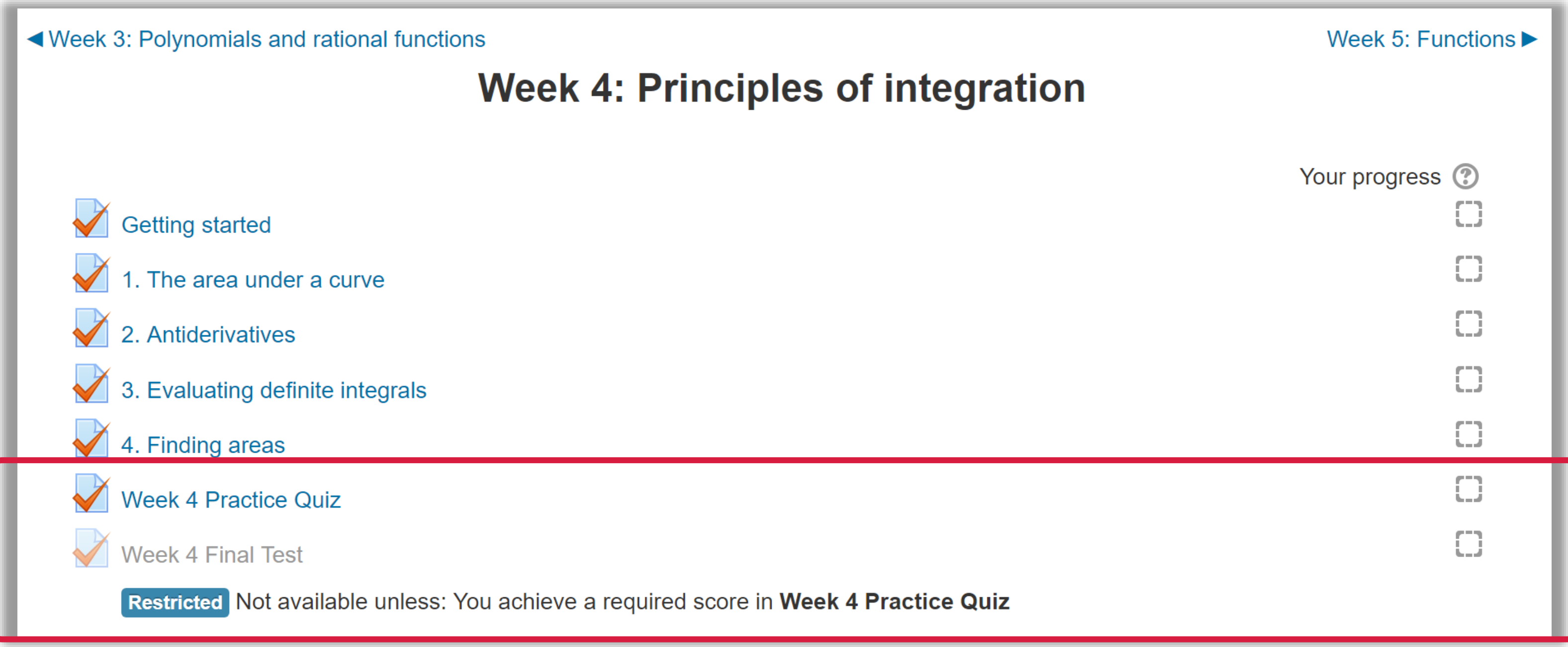
Specifications grading

Theory

- Individual assessments are graded pass/fail
- Some amount of resubmission is allowed
- Letter grades are based on performance across multiple assessments



A typical week



Implementation in FAC

Practice Quiz → **Final Test** → **Final Test (Resit)**

Practice Quiz	Final Test	Final Test (Resit)
Unlimited attempts	Single attempt	One more attempt
Full feedback	**80% required to pass**	**80% required to pass**
80% score required to unlock Final Test		

Each week gets either a

Mastery (80%+)

or

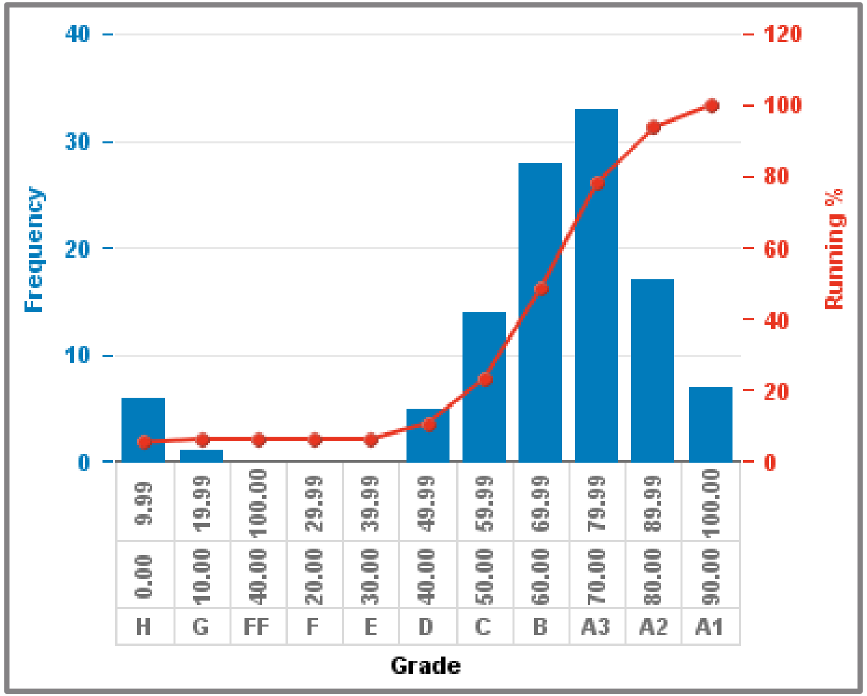
Distinction (95%+)

What grade will you get?

Number of units Mastered (80%+)	Number of Distinctions (95%+)	Percentage awarded for the Unit Score	Equivalent Grade
Less than 7	-	0	F
7	-	45%	D
8	2 or 3	55%	C
9	4 or 5	65%	B
10	6 or 7	75%	A3
10	8 or 9	85%	A2
10	10	100%	A1

Outcomes

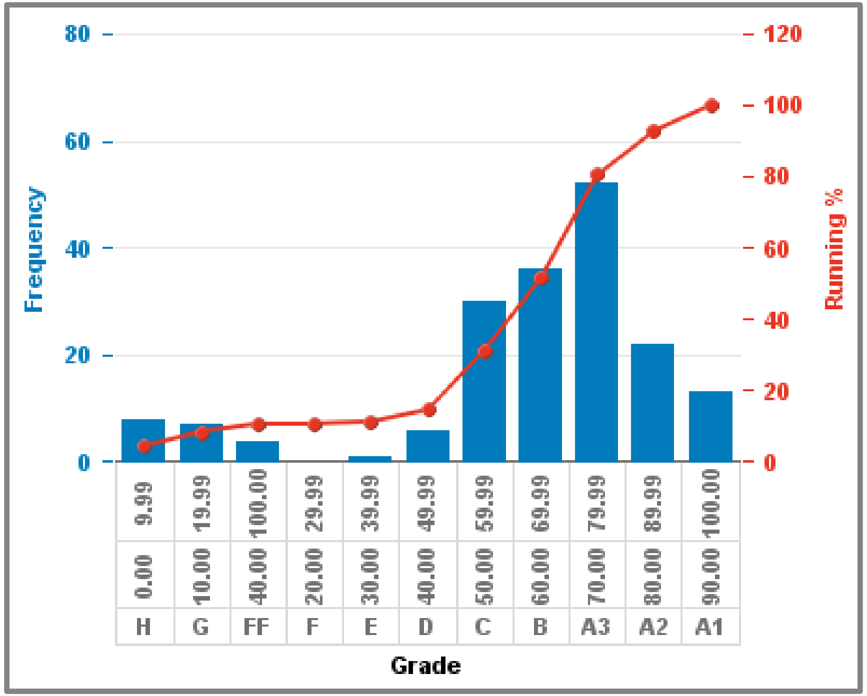
Results (2018/19)



(N=113)

- Mean: 67
- Median: 70
- Pass rate: 94%

Results (2019/20)



(N=181)

- Mean: 65
- Median: 69
- Pass rate: 88%

Early failure

Number of units Mastered (80%+)	Number of Distinctions (95%+)	Percentage awarded for the Unit Score	Equivalent Grade
Less than 7	-	0	F
7	-	45%	D
8	2 or 3	55%	C
9	4 or 5	65%	B
10	6 or 7	75%	A3
10	8 or 9	85%	A2
10	10	100%	A1

Mitigation

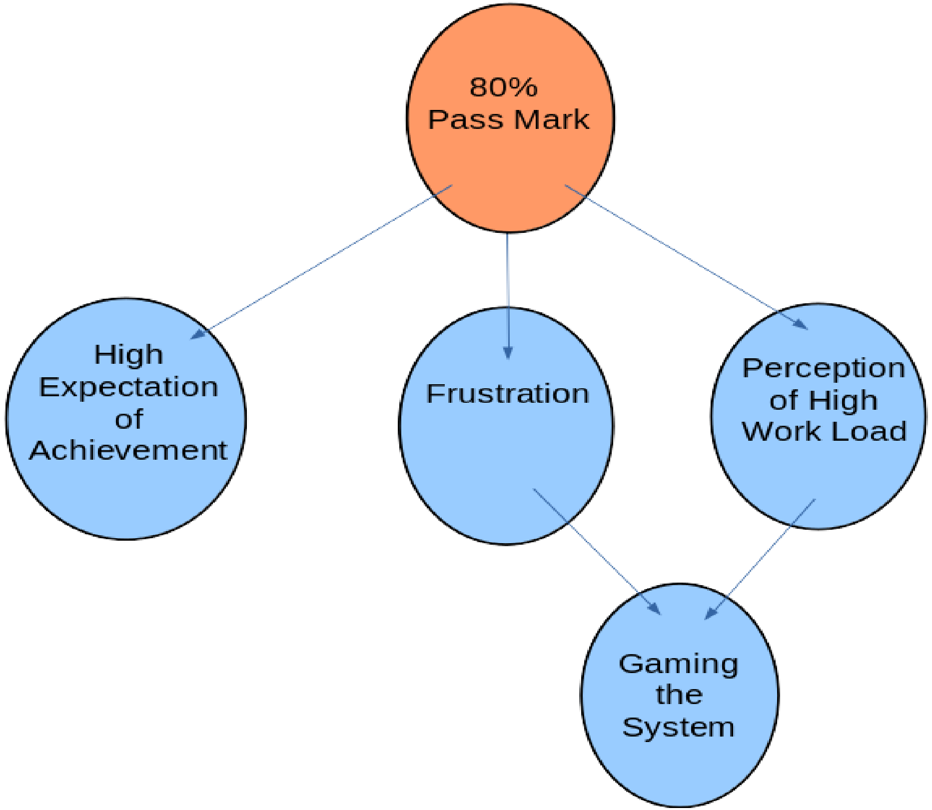
Lots of support

Engagement and progress monitoring

Opportunity for resubmission

Student reaction

Mind-map of themes related to grading system



Gratwick, R., Kinnear, G., Wood, A. K., (2020) An online course promoting wider access to university mathematics. In Marks, R. (Ed), *Proceedings of the British Society for Research into Learning Mathematics*, 40 (1).

Fewer marks per input

Tidy STACK question tool | Question tests & deployed variants

Given that $\int_{-2}^{2} f(x)\,dx = 9$, $\int_{-2}^{3} f(x)\,dx = 10$, $\int_{-2}^{2} g(x)\,dx = 14$, and $\int_{2}^{3} g(x)\,dx = 4$, which of the following can be evaluated?

(Enter the value if you can find it, otherwise enter `none`)

(a) $\int_{-2}^{3} f(x) - g(x) \ \mathrm{d}x =$ ______

(b) $\int_{-2}^{-2} x^2 f(x) \ \mathrm{d}x =$ ______

(c) $\int_{-2}^{2} 3f(x) + 5g(x) \ \mathrm{d}x =$ ______

(d) $\int_{2}^{3} f(x) \ \mathrm{d}x =$ ______

(e) $\int_{-2}^{2} x^2 f(x) \ \mathrm{d}x =$ ______

Check

Partial credit

Fully factorise the polynomial $p(x) = 3\,x^4 + 16\,x^3 + 3\,x^2 - 46\,x + 24$, given that $x = -3$ is a root.

$p(x) =$ (x^2+2*x-3)*(x+4)*(3

Your last answer was interpreted as follows:

$$\left(x^2 + 2\,x - 3\right)\,(x + 4)\,(3\,x - 2)$$

The variables found in your answer were: $[x]$

Check

Your answer is partially correct.
Your answer is not factored. You could still do some more work on the term $x^2 + 2\,x - 3$.
The factor $3\,x - 2$ is correct.

The factor $x + 4$ is correct.

Marks for this submission: 0.50/1.00.

Errors carried forward

Tidy STACK question tool | Question tests & deployed variants

Consider the function $f(t) = 3\,t^2 - 6\,t + 8$.

Let $A(x)$ be the value of the area under the graph of $y = f(t)$, between $t = x$ and $t = x + 1$.

Give expressions for $A(x)$ and $A'(x)$. Your answers should be polynomials in terms of the variable x. Remember from unit 4 how to calculate the area under a graph between two points on the axis!

$A(x) =$ x^2 .

Your last answer was interpreted as follows:

$$x^2$$

The variables found in your answer were: $[x]$

$A'(x) =$ 2*x .

Your last answer was interpreted as follows:

$$2\,x$$

The variables found in your answer were: $[x]$

Your answer is partially correct.
Your expression for the area is incorrect.

Conclusions

Encourages high standards

Can lead to frustration

Careful question-writing required

Promotes mastery of the subject

Thank you!