Traditional lectures with 21st Century students

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Reminiscences of my undergraduate study

- I graduated in 1998 (so not THAT long ago?)
- All material was delivered using traditional lectures
- Nearly all ‘chalk and talk’
- All of us were in the race against the board rubber
- One or two ‘innovative’ lecturers gave hand-outs or used OHP acetates
- All of us took notes?
- Long queues for the library photocopier to get the notes for the odd missed lecture
- Nearly everything assessed by examination

Now I’m the lecturer

- Under lots of pressure to put stuff onto our VLE
- Expected to pre prepare PowerPoints and provide hand-outs
- Have to justify why I assess via examination
- HAVE to use at least some different assessment types
- I cant reach whiteboards!

BUT

- I learnt a lot using the ‘old school’ methods
- Lots of academic journals confirm note taking aids learning (DeZure et al, Nolen, Wadsworth to name but a few)

When I started lecturing (in 2003)

- I produced typed notes and a powerpoint (which took AGES)
- Carried lots of heavy, printed handouts for the students
- The students read it all and thought they understood it!
- No students took their own, handwritten, notes

- After a matter of months I decided there was a better way of doing this
- Work got me a tablet PC to 'play' with

- Calculate the following
- $\frac{1}{6+3i} = \frac{6-3i}{(6+3i)(6-3i)}$

$$= \frac{6-3i}{36-9i^2}$$

$$= \frac{6-3i}{45}$$

$$= \frac{6}{45} - \frac{3}{45}i$$

Using Tablet PCs for 'chalk and talk' – first year engineers (a copy goes on the VLE)

$a = 1, \; b = 0, \; c = 1$

$x^2 + 1 = 0$ when $x = \dfrac{0 \pm \sqrt{0^2 - 4.1.1}}{2.1}$

$x = \dfrac{\pm\sqrt{-4}}{2}$ ← ← w I didn't think we could do this!!

$\sqrt{-1}$ isn't real, it's a pretend number

so lets call it j

…As do typed notes that are more legible

Properties and uses of *j*

Consider the quadratic equation $x^2 - 2x + 2 = 0$. (*)

Using the quadratic formula with $a = 1$, $b = -2$ and $c = 2$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4 \times 1 \times 2}}{2 \times 1} = \frac{2 \pm \sqrt{-4}}{2}.$$

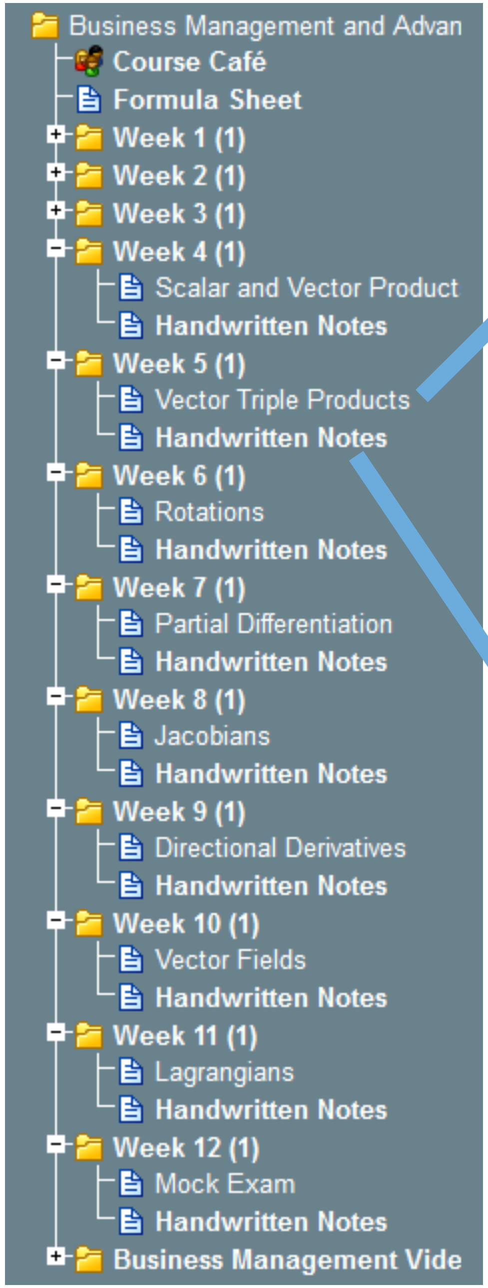
Since the discriminant $(b^2 - 4ac)$ is negative (-4) we cannot obtain roots to this equation that are real numbers. However the roots can be found using our new number *j*.

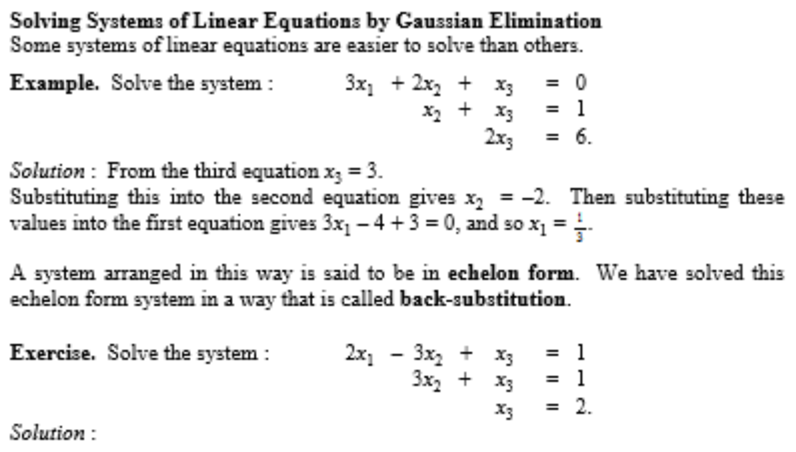
$$x = \frac{2 \pm \sqrt{4 \times -1}}{2} = \frac{2 \pm \sqrt{4} \times \sqrt{-1}}{2} = \frac{2 \pm 2j}{2} = 1 \pm j.$$

The roots of equation (*) are therefore the complex numbers $1 + j$ and $1 - j$.

The VLE

- Everything goes on the VLE
- Typed notes prior to the lecture
- Handwritten notes afterwards
- The students do want the handwritten notes
- Even though they are basically the same





Solving Systems of Linear Equations by Gaussian Elimination
Some systems of linear equations are easier to solve than others.

Example. Solve the system :

$$\begin{aligned} 3x_1 + 2x_2 + x_3 &= 0 \\ x_2 + x_3 &= 1 \\ 2x_3 &= 6. \end{aligned}$$

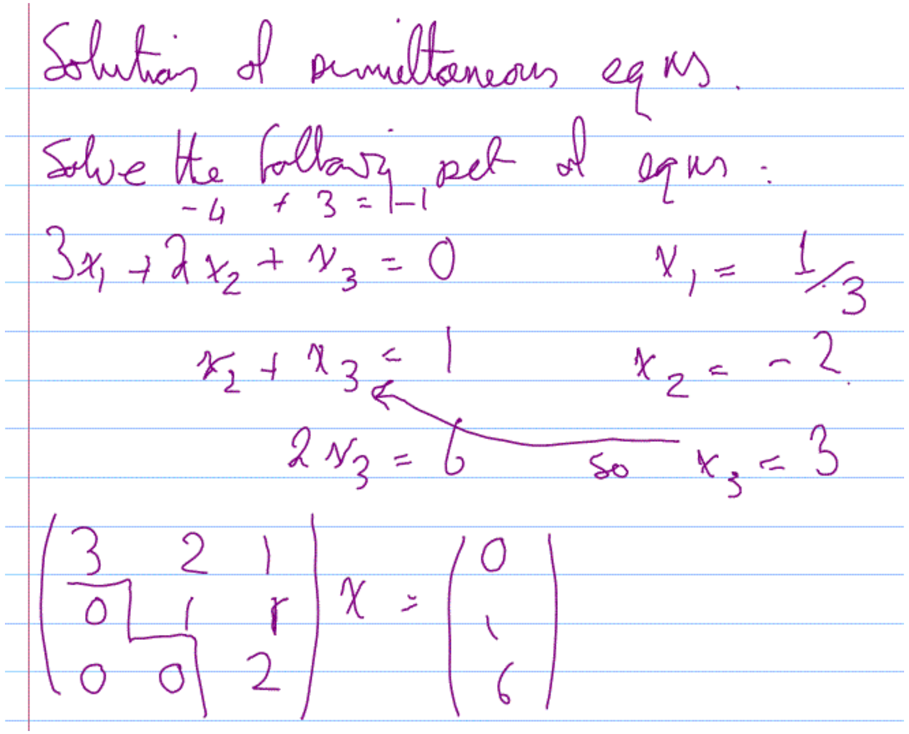
Solution : From the third equation $x_3 = 3$.
Substituting this into the second equation gives $x_2 = -2$. Then substituting these values into the first equation gives $3x_1 - 4 + 3 = 0$, and so $x_1 = \frac{1}{3}$.

A system arranged in this way is said to be in **echelon form**. We have solved this echelon form system in a way that is called **back-substitution**.

Exercise. Solve the system :

$$\begin{aligned} 2x_1 - 3x_2 + x_3 &= 1 \\ 3x_2 + x_3 &= 1 \\ x_3 &= 2. \end{aligned}$$

Solution :



Solution of simultaneous eqns.
Solve the following set of eqns :

$-4 + 3 = -1$

$3x_1 + 2x_2 + x_3 = 0$ $\quad x_1 = 1/3$

$x_2 + x_3 = 1$ $\quad x_2 = -2$

$2x_3 = 6$ so $x_3 = 3$

$$\begin{pmatrix} 3 & 2 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 2 \end{pmatrix} x = \begin{pmatrix} 0 \\ 1 \\ 6 \end{pmatrix}$$

Other ways of using a tablet PC (by my colleagues Pardeep Sud, Nabeil Maflahi and Tamara Nevill)

(i) Express $(1+8\mathrm{i})(2-\mathrm{i})$ in the form $x+\mathrm{i}y$, showing clearly how you obtain your answer.

(ii) Hence express $\dfrac{1+8\mathrm{i}}{2+\mathrm{i}}$ in the form $x+\mathrm{i}y$.

i $\quad (1+8i)(2-i) = 2 - i + 16i - 8i^2 \quad \nearrow \quad i^2 = -1 \Rightarrow -8i^2 = +8$

$\quad = 10 + 15i$

ii $\quad \dfrac{1+8i}{2+i} = \dfrac{(1+8i)(2-i)}{(2+i)(2-i)} = \dfrac{10+15i}{4+1} = 2+3i$

Example: Solve the equation $y'' + y = 0$.
This is a second order linear homogenous ODE with constant coefficients that can be solved rather easily.

To solve by the power series technique, we look for a solution of the form $y = \sum_{n=0}^{\infty} c_n x^n$.
We then have

$$y' = \sum_{n=1}^{\infty} n c_n x^{n-1} \quad \text{and} \quad y'' = \sum_{n=2}^{\infty} n(n-1)c_n x^{n-2}.$$

Substituting into the ODE gives

$$\sum_{n=2}^{\infty} n(n-1)c_n x^{n-2} + \sum_{n=0}^{\infty} c_n x^n = 0$$

Performing an appropriate shift in the index of summation in order that the general term in each sum contains x to the same power gives

$$\sum_{n=0}^{\infty} (n+2)(n+1)c_{n+2} x^n + \sum_{n=0}^{\infty} c_n x^n = 0$$

Collecting like terms gives

$$\sum_{n=0}^{\infty} \left[(n+2)(n+1)c_{n+2} + c_n\right] x^n = 0$$

The identity principle then gives $(n+2)(n+1)c_{n+2} + c_n = 0 \quad \forall n \geq 0$
and thus we obtain the following recurrence relation

$$c_{n+2} = -\frac{c_n}{(n+1)(n+2)}, \forall n \geq 0.$$

Tiling for mathematicians?

- My husband thinks he can tile at a rate of 2sqm an hour. I want the Spanish look and my house is 6m x 8m
- He can tile for 4 hours a day
- How many days before I get my new floor?

6 days

- If 6 tiles are 1sqm how long does it take him to lay 1 tile?

1 hr for 12 tiles (60 mins)

- Do you think his estimate is realistic?

for 1 tile $\frac{60}{12} = 5$ minutes

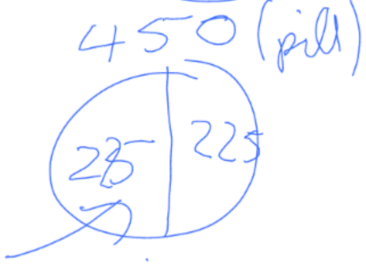
Pills

- A prescription is for 1g of drug X a day
- Pills are in 250mg doses
- How many pills a day?

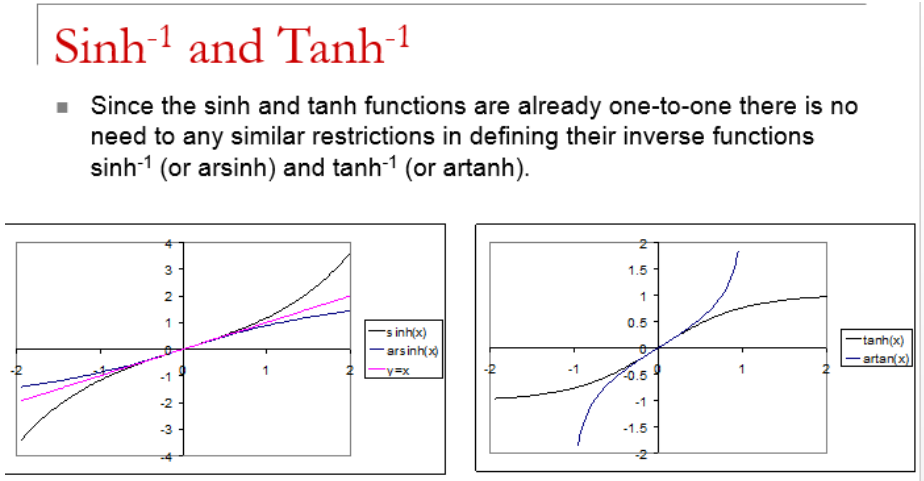
4

- A prescription is for 225mcg of drug Y
- Pills are in 450mcg doses
- How many pills a day?

$\frac{1}{2}$



Reflections



• Plus points:

- ALL my students take their own notes
- It slows me down
- All I need is my notes and my laptop (plus some cables)
- No death by powerpoint
- The students get good grades in assessments in the main

• Minus Points:

- I end up using the printed notes for graphs etc
- It's a disaster if my laptop breaks / I forget the charger …
- A lot of the students complain I don't give hand outs
    - My colleagues often give 'partial' handouts
- I get asked 'what does that word say … third line down, second one across?'

Other observations

- The students get legible, typed notes on the VLE in advance to prepare for lectures (sometimes complete, sometimes partial depending on the lecturer)
- Putting the ‘scribbles’ on the VLE after the lecture has eliminated the queue to the photocopier

- Our students have to write the odd essay and do a few presentations
  - … which are mostly in our compulsory History of Mathematics module
  - The students don’t like using the tablet PC for their presentations