## 10.1.1 Visualizing Planes, Lines, and Solutions

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Week 10 due Dec 16, 2023 07:42 IST Completed

# 10.1.1 Visualizing Planes, Lines, and Solutions

## You may want to download the PDF that was used to make the videos (including animations)

This will probably work best if you "right click" on "PDF" and download the file, after which you can use acrobat to view it. Enjoy!

There are multiple (should we say numerous) videos in many of the units of the remainder of the course.

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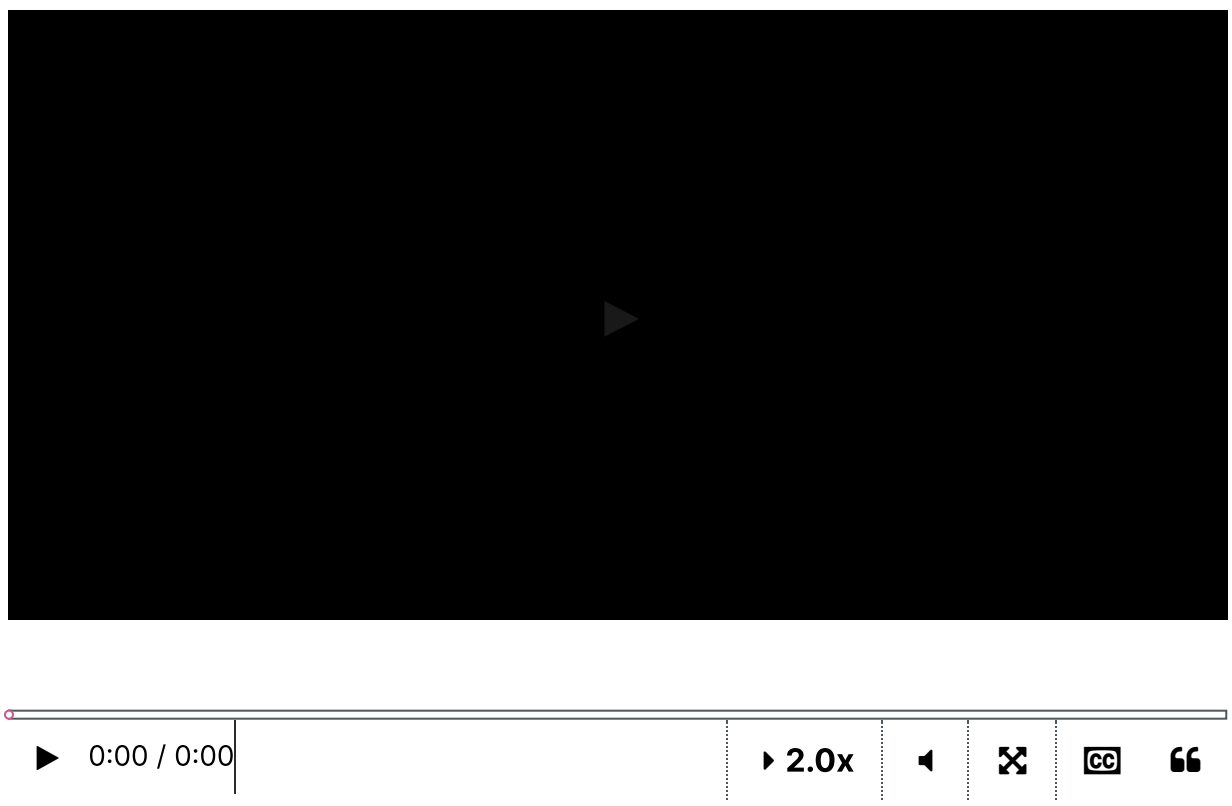
**10.1.1 Part 1**




Start of transcript. Skip to the end.

Dr. Robert van de Geijn: (The) course is progressing nicely.

You have noticed by now that the material

has changed a little bit in nature since we finished the mid-term.

We're now focusing more on the traditional topics that

are covered in a linear algebra course,

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## Reading Assignment

0 points possible (ungraded)

Read Unit 10.1.1 of the notes. [LINK]

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Calculator

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? Why are the null vectors in 10.1.2 <0, 1, 0> and <0, 0, 1>? 3
When solving for the null vectors in 10.1.2, wouldn't we solve the following: x0 + x1 + x2 = 0 Then pick 2 vectors xn0 = Solving for xn0 we get: x0...

? Question 3

## Homework 10.1.1.1

1/1 point (graded)

Consider the equation from Example 10.1 (see text):

$$\chi_0 - 2\chi_1 + 4\chi_2 = -1$$

Which of the following represent(s) a general solution to this equation? (Mark all)

- [x] $\begin{pmatrix} \chi_0 \\ \chi_1 \\ \chi_2 \end{pmatrix} = \begin{pmatrix} -1 \\ 0 \\ 0 \end{pmatrix} + \beta_0 \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}.$
- [x] $\begin{pmatrix} \chi_0 \\ \chi_1 \\ \chi_2 \end{pmatrix} = \begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta_0 \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}.$
- [x] $\begin{pmatrix} \chi_0 \\ \chi_1 \\ \chi_2 \end{pmatrix} = \begin{pmatrix} -5 \\ 0 \\ 1 \end{pmatrix} + \beta_0 \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}.$

✔

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## Homework 10.1.1.2

1/1 point (graded)

Now you find the general solution for the **second** equation in the system of linear equations with which we started this unit. Consider

$$\chi_0 = 2$$

Which of the following is a true statement about this equation:

- [x] $\begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 2 \\ \end{pmatrix}$

Calculator

$\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}$ is a specific solution.

$\begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} + \beta_0 \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.

$\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta_0 \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.

$\begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} + \beta_0 \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} 0 \\ 0 \\ 2 \end{pmatrix}$ is a general solution.

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Answers are displayed within the problem

### 10.1.1 Part 2

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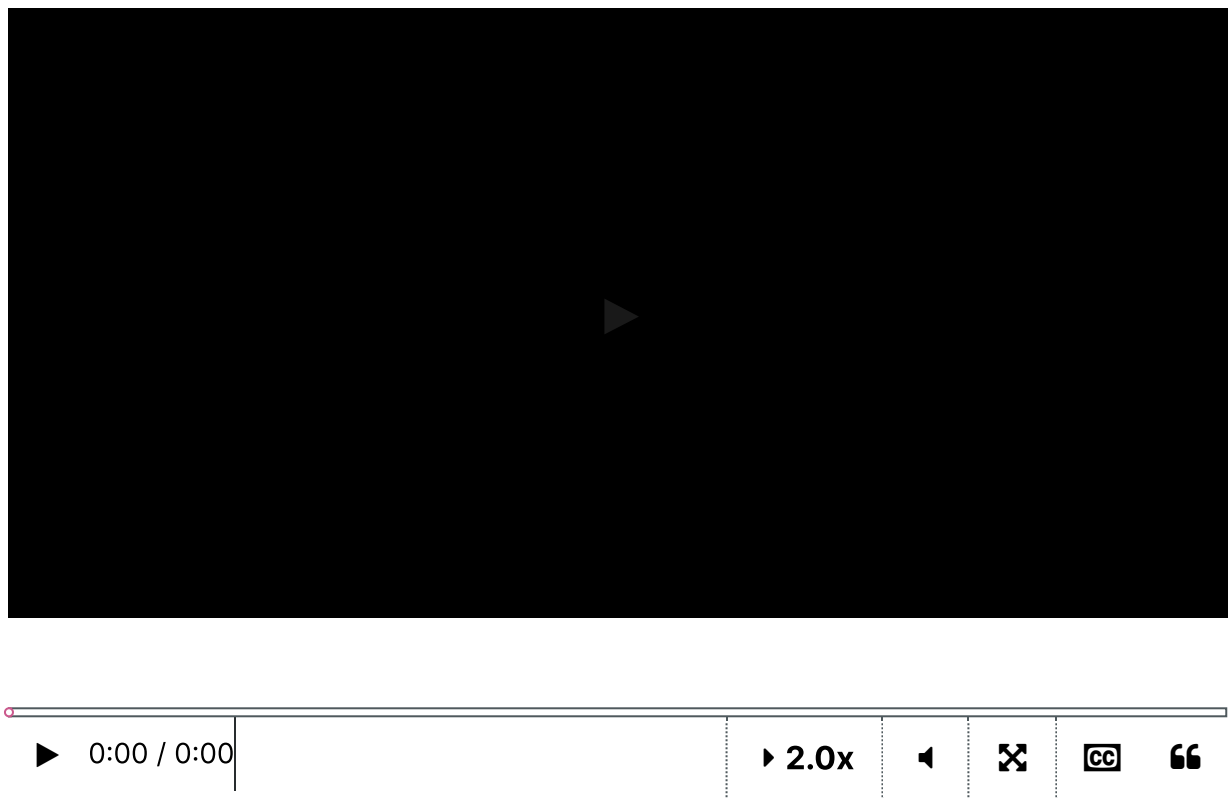

0:00 / 0:00 2.0x

Dr. Robert van de Geijn: So you went ahead

and did the exercise of finding a specific solution and general solution

to the second equation.

And just like before, you look at the equation,

you set the free variables to zero, you

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## Homework 10.1.1.3

1/1 point (graded)

Now you find the general solution for the **third** equation in the system of linear equations with which we started. Consider

Calculator

$$\chi_0 + 2\chi_1 + 4\chi_2 = 3$$

Which of the following is a true statement about this equation:

- [x] $\begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix} + \beta_0 \begin{pmatrix} -2 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.
- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta_0 \begin{pmatrix} -2 \\ 1 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.
- [x] $\begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix} + \beta_0 \begin{pmatrix} -4 \\ 2 \\ 0 \end{pmatrix} + \beta_1 \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.

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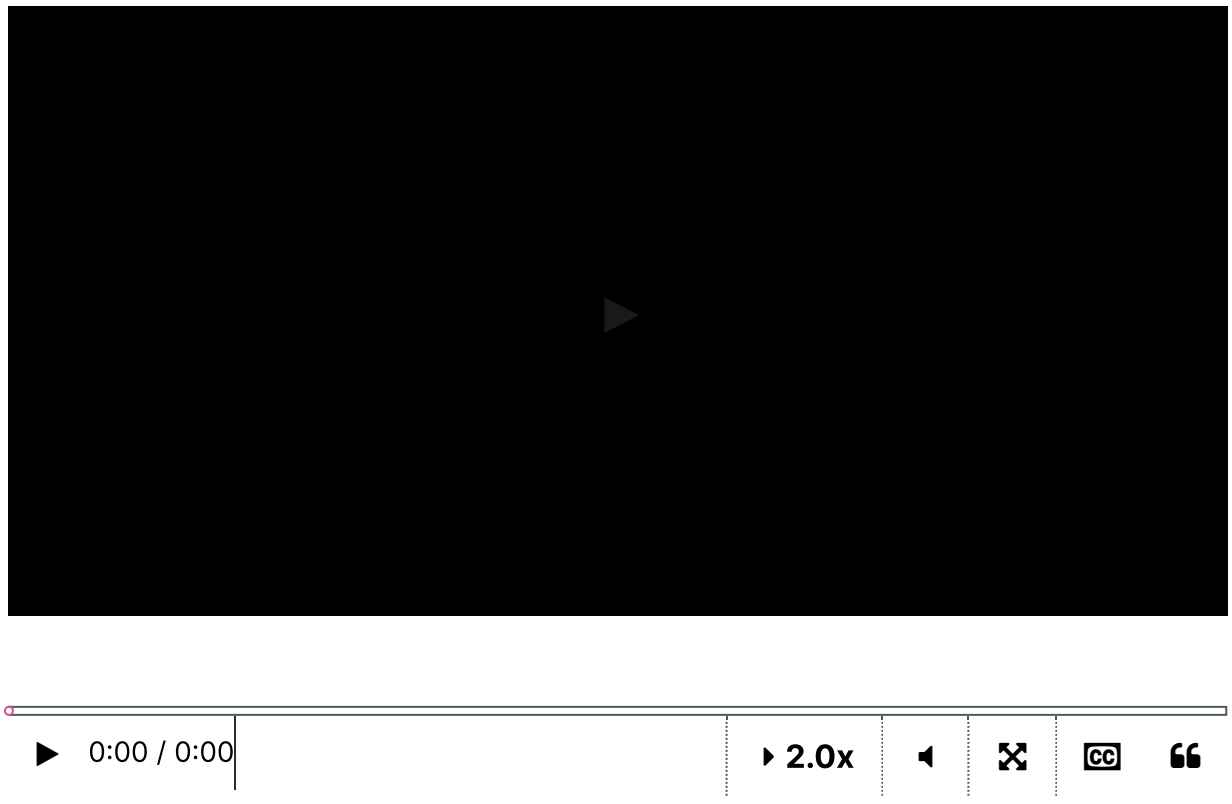
### 10.1.1 Part 3



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Dr. Robert van de Geijn: So then you just did

the homework that walks you through exactly

the same steps for the third equation.

And again, you identify your free variables and your dependent variable.

You plug in your choose your free variables to be equal to zero.

0:00 / 0:00 2.0x

Calculator

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### 10.1.1 Part 4

0:00 / 0:00 2.0x

had some way of putting a line where pairs of planes intersect.

Notice that that means we need to draw three lines where

the three pairs of planes intersect, and that might help us

see where they all intersect in one point.

Now, to do that, you need to do some more calculations.

End of transcript. Skip to the start.

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## Homework 10.1.1.4

1/1 point (graded)

We notice that it would be nice to put lines where planes meet. Now, let's start by focusing on the first two equations: Consider

$$\begin{array}{rcrcrcl} \chi_0 & - & 2\chi_1 & + & 4\chi_2 & = & -1 \\ \chi_0 & & & & & = & 2 \end{array}$$

Compute the general solution of this system with two equations in three unknowns and indicate which of the following is true about this system?

- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 2 \\ 3/2 \\ 0 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 2 \\ 3/2 \\ 0 \end{pmatrix} + \beta \begin{pmatrix} 0 \\ 2 \\ 1 \end{pmatrix}$ is a general solution.

Calculator

- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta \begin{pmatrix} 0 \\ 2 \\ 1 \end{pmatrix}$ is a general solution.

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### 10.1.1 Part 5

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Dr. Robert van de Geijn: The line where the first two planes intersect

is the line of all points that satisfy both of these equations.

So, we need to find all the points that simultaneously

satisfy both of these equations.

And how do you do that?

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## Homework 10.1.1.5

1/1 point (graded)

Similarly, consider

$$\begin{array}{rcl} \chi_0 & = & 2 \\ \chi_0 + 2\chi_1 + 4\chi_2 & = & 3 \end{array}$$

Compute the general solution of this system with two equations in three unknowns and indicate which of the following is true about this system?

- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 2 \\ 1/2 \end{pmatrix}$ is a specific solution.

Calculator

$\begin{pmatrix} 0 \\ 0 \end{pmatrix}$

- [x] $\begin{pmatrix} 2 \\ 1/2 \\ 0 \end{pmatrix} + \beta \begin{pmatrix} 0 \\ -2 \\ 1 \end{pmatrix}$ is a general solution.
- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta \begin{pmatrix} 0 \\ -2 \\ 1 \end{pmatrix}$ is a general solution.

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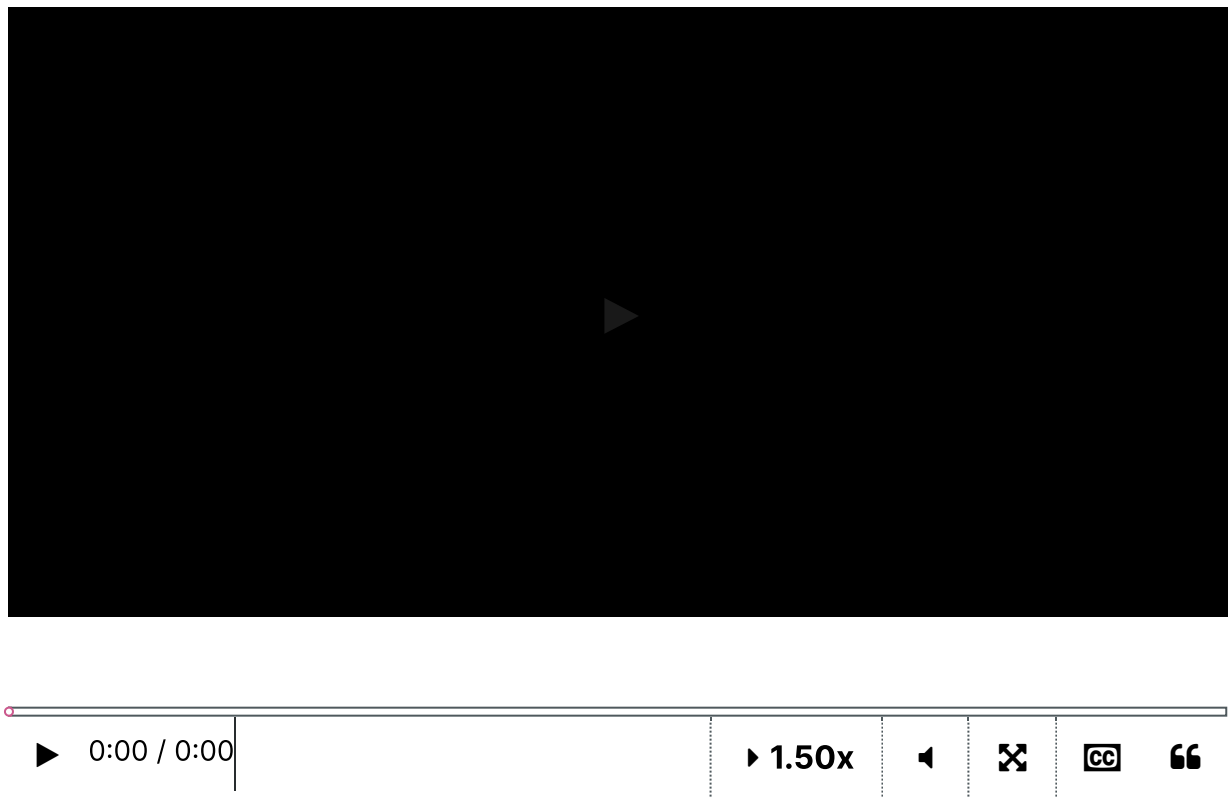
### 10.1.1 Part 6



0:00 / 0:00 1.50x

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Dr. Robert van de Geijn: You can do exactly the same exercise

with the second equation and the third equation.

You can set it up as an appended system, you

can transform it into row echelon form.

You can then identify the free variable and the two dependent variables.

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## Homework 10.1.1.6

1/1 point (graded)

Finally consider

$$\begin{array}{rcrcrcr} \chi_0 & - & 2\chi_1 & + & 4\chi_2 & = & -1 \\ \chi_0 & + & 2\chi_1 & + & 4\chi_2 & = & 3 \end{array}$$

Compute the general solution of this system with two equations in three unknowns and indicate which of the following is true about this system?

- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix}$ is a specific solution.

Calculator

- [x] $\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$ is a specific solution.
- [x] $\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix} + \beta \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.
- [x] $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix} + \beta \begin{pmatrix} -4 \\ 0 \\ 1 \end{pmatrix}$ is a general solution.

✔

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### 10.1.1 Part 7

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0:00 / 0:00 2.0x

Dr. Robert van de Geijn: So then we take the first equation

and the last equation, set it up as an appended system,

reduce it to row echelon form, identifiy a free variable

and the dependent variables, and then we again

recognized that we know a specific

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In the below video, the equation that is added as the fourth equation is not consistent with the other three. (The video discusses it as if it is... Sorry.) So, what should have happened? The new plane does not intersect the others at the same point, and hence the four equations in three unknowns do not have a solution. If this equation is replaced by

$$\chi_0 + 4\chi_1 + 16\chi_2 = 2$$

Calculator

then the equation is consistent since $\begin{pmatrix} 2 \\ 1 \\ -0.25 \end{pmatrix}$ is a solution of that equation. In that case, the new plane intersects the others at that solution.

### 10.1.1 Part 8

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