

# MA1101R

# Linear Algebra I

Introductory Lecture (Lecture 00)



# Welcome

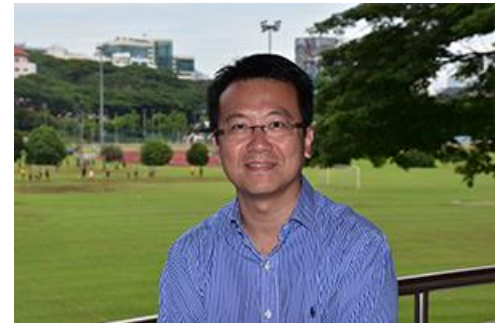
- 💧 All NUS students
- 💧 All non-NUS (exchange) students

# Outline of today's lecture

- ◆ Part I: Module information
- ◆ Part II: About Linear Algebra
- ◆ Part III: Study guide and some features of my lecture group

# Part I – Your lecturers

- ♦ Your (friendly) lecturers:
  - ♦ (Lecture Group 2) Dr Ng Kah Loon (KL) – module coordinator
  - ♦ Office: S17-07-20
  - ♦ Tel: 65162751
  - ♦ Email: [matngkl@nus.edu.sg](mailto:matngkl@nus.edu.sg)
  - ♦ (Lecture Group 1) Dr Zhang Lei
  - ♦ Office: S17-06-05
  - ♦ Tel: 65162747
  - ♦ Email: [matzhlei@nus.edu.sg](mailto:matzhlei@nus.edu.sg)
- ♦ Each lecturer will be covering the same content of the course (difference in delivery and styles).



# Part I – Contact hours

## 💧 Lectures

### 💧 2 lecture groups

- 💧 Group 1 (Monday 4.00-5.30pm, Wednesday 8.00-9.30am)

- 💧 Group 2 (Tuesday 8.00-9.30am, Thursday 2.00-3.30pm)

### 💧 23 lectures (including Lecture 0, approx. 1.5 hours each)

### 💧 2 lectures per week, excluding recess week (22<sup>nd</sup> Sep – 30<sup>th</sup> Sep)

### 💧 Lectures for both groups will be webcasted (<https://luminus.nus.edu.sg>)

← → ↻ 🏠 [National University of Singapore \[SG\] | https://ivle.nus.edu.sg/v1/Module/Student/Default.aspx?CourseID=1B599D99-A3B5-41C6-BBBB-079616A389C7](https://ivle.nus.edu.sg/v1/Module/Student/Default.aspx?CourseID=1B599D99-A3B5-41C6-BBBB-079616A389C7) ☆ 🖨️ 📁 🔔

Ng Kah Loon

 You are in Preview Mode

## Overview

## Class & Groups

## Announcement

## Assessment

## Chat Room

Files (Workbin)

## Forum

Gradebook

## Lesson Plan

Multimedia

## Poll

## Facilitators


## Readings


## Weblinks


## Timetable

## LINEAR ALGEBRA I

2018/2019, Semester 1

 Science (Mathematics)

 Modular Credits: 4

 Class Size: 428

Tags: --


 DR Ng Kah Loon

 Anonymous Feedback

 [Printer Friendly](#)

⤴ Collapse All

▼ Quick Access to Active Tools

 Announcement **2**

▼ Learning Outcomes

This module is a first course in linear algebra. Fundamental concepts of linear algebra will be introduced and investigated in the context of the Euclidean spaces  $\mathbb{R}^n$ . Proofs of results will be presented in the concrete setting. Students are expected to acquire computational facilities and geometric intuition with regard to vectors and matrices. Some applications will be presented. Major topics: Systems of linear equations, matrices, determinants, Euclidean spaces, linear combinations and linear span, subspaces, linear independence, bases and dimension, rank of a matrix, inner products, eigenvalues and eigenvectors, diagonalization, linear transformations between Euclidean spaces, applications. [Top](#)

A screenshot of the Windows taskbar. The taskbar is dark grey and contains several application icons: Windows Start button, Search, File Explorer, Microsoft Store, Mail, Google Chrome, Word, PowerPoint, Excel, OneNote, Edge, a folder icon, a game controller icon, a puzzle piece icon, a gear icon, a speech bubble icon, and a network icon. On the right side of the taskbar, there is a system tray area showing the date and time as '10:31 AM 6/8/2018', the language 'ENG', and a notification icon with the number '21'.

# Part I – IVLE and LumiNUS

The screenshot displays the LumiNUS web application interface. At the top, a browser window shows the URL <https://luminus.nus.edu.sg/modules/90c044e3-d7d2-466a-92a8-ffb454674e24>. The page header includes the LumiNUS logo, the text "AY2018/2019, Semester 0, Week 0", and a user profile for "Ng Kah Loon". A navigation bar contains links for MY MODULES, MODULE SEARCH, CONTENT BANKS, RESEARCH RECRUITMENT, GUESTS & GROUPS, and STUDENT FEEDBACK.

The main content area is titled "MA1101R Linear Algebra I" and "[1810] 2018/2019 Semester 1". It shows the user as "Co-owner". On the left, a sidebar lists navigation options: GENERAL (Overview, Settings, Module Details, Class & Groups, Attendance, Task Report) and TOOLS (Announcements, Chat). The main content area features a "Module Overview" section with a progress bar (0 to 4) and a "GENERAL" box stating "No credits". Below this is an "ADD MODULE OVERVIEW" button. To the right, there are sections for "LABORATORY" (11 slots total) and "LECTURE" (Every week, LT27, with specific group times). A right sidebar contains an "ADD A TOPIC" button, links to "Switch to All Topics View", "Statistics", "Disable Learning Flow", and "Reset Flow Format". At the bottom right, there is a "LATEST ANNOUNCEMENTS" section with a "CREATE AN ANNOUNCEMENT" button and a message "No announcements."

The bottom of the screen shows a Windows taskbar with various application icons and a system clock indicating 10:33 AM on 6/8/2018.



# Part I – Contact hours

## 💧 Tutorials

- 💧 11 tutorials (1 hour each, final tutorial may be conducted during lectures).
- 💧 1 tutorial per week, attendance will be taken.



# Part I – Contact hours

- ◆ Lab sessions
  - ◆ 5 lab worksheets
  - ◆ Lab weeks are 4, 5, 9, 11, 12
  - ◆ Lab quiz in week 13.
  - ◆ All students – Free and Easy. Attendance will not be taken (more details in a while).

# Part I – Textbook(s)

- ◆ *Linear Algebra – Concepts and Techniques on Euclidean Spaces (Second Edition)*
- ◆ By Ma S.L., V. Tan and Ng K.L.
- ◆ Publisher: McGraw Hill
- ◆ Available at Co-Op (Science@LT27)
- ◆ Chapters used as lecture notes
- ◆ Exercise sets used as tutorial problems (some) and self practice
- ◆ Other reference books (see handouts, uploaded in IVLE)

# Part I – Assessments

Total marks (100%)

```
graph TD; A["Total marks (100%)"] --> B["Final Exam (60%)"]; A --> C["CA (40%)"]; C --> D["Mid Term Test (20%)"]; C --> E["Lab Quiz (10%)"]; C --> F["Homework (10%)"]; D --- G["Week 7"]; E --- H["Week 13"]; F --- I["Weeks 4,6,9,12"];
```

Final Exam (60%)

CA (40%)

Homework  
(10%)

Mid Term Test (20%)

Lab Quiz (10%)

Week 7

Week 13

Weeks 4,6,9,12

# Part I – Final Examination

- ◆ Date: 30<sup>th</sup> November (Friday, PM session)
- ◆ Duration: 2 hours
- ◆ Venue: Not available yet
- ◆ One A4 size helpsheet (double sided, **self prepared\***)
- ◆ Details later
- ◆ No make-up examination

# Part I – Mid Term Test

- ◆ Date: Week 7, date TBC
- ◆ Duration: 1 hour (will start at 7pm, tentative)
- ◆ Venue: Not available yet
- ◆ One A4 size helpsheet (double sided, **self prepared\***)
- ◆ Details later
- ◆ Absent without valid reason  $\rightarrow 0$ ; otherwise, one make up test will be arranged.

# Part I – Tutorial sessions

- ◆ Weekly 1-hour meeting with your tutor
- ◆ First session starts on week 3 (27<sup>th</sup> – 31<sup>st</sup> Aug)
- ◆ Tutorial problem set will be uploaded into IVLE in advance, please attempt all the questions before attending your tutorial.
- ◆ Your tutor will discuss the problems in class. Students may be asked to present their solutions.

# Part I – Homework

- ◆ There will be a total of 4 homework sets
  - ◆ Homework sets will be available in IVLE.
  - ◆ Homework must be handed in during Monday's (Group 1) or Tuesday's (Group 2) lecture on weeks 4,6,9,11.
  - ◆ Late submissions will not be accepted without valid reason.



# Part I – Homework

Group 2 – on weeks where homework is due

- ◆ Submission is done during Tuesday lecture 8-10am
- ◆ Envelope to be placed outside lecturer's office (S17-07-20) after Tuesday lecture and be **left there until 3pm on Tuesday (same day)**.
- ◆ Students can place their homework in the envelope if they did not submit it during lecture.
- ◆ No further extension given (other than MC) once 3pm is passed.

# Part I – Homework

Group 1 – on weeks where homework is due

- ◆ Submission is done during Monday lecture 4-6pm
- ◆ Envelope to be placed outside lecturer's office (S17-06-05) after Monday lecture and be **left there until 3pm on Tuesday**.
- ◆ Students can place their homework in the envelope if they did not submit it during lecture.
- ◆ No further extension given (other than MC) once 3pm is passed.

# Part I – Lab Sessions/Quiz

- ◆ 5 Lab Sessions + 1 Lab Quiz
- ◆ Lab Session weeks: 4, 5, 9, 11, 12
- ◆ Lab Quiz week: 13
- ◆ Worksheets
  - ◆ Downloaded from IVLE
  - ◆ Enhance your understanding of concepts
  - ◆ Use MATLAB for lab activities
  - ◆ No computer programming knowledge needed
  - ◆ No need to hand in worksheet
  - ◆ Venue: S17-03-02

# Part I – Lab Sessions/Quiz

- ◆ No formal class structure
- ◆ On lab session weeks, go to S17-03-02 anytime during the following designated time slots to complete your worksheet.
  - ◆ Monday 8am-10am; Tuesday 1pm-3pm
  - ◆ Wednesday 1pm-4pm; Thursday 12pm-2pm and 4pm-5pm
  - ◆ Friday 12pm-1pm
- ◆ Once you have completed your worksheet, you can leave the lab. No attendance will be taken.
- ◆ During the above time slots, there will be a lab assistant to assist you if necessary.
- ◆ If you are unable to go to the lab during the above time slots, you may still complete your worksheet in the lab at any other time convenient to you. However, there will not be any lab assistant present.
- ◆ Availability of computers is on a first-come-first-served basis.
- ◆ You do not need to go to the lab at the same time every week.
- ◆ There will be formal class structure for the lab quiz in week 13. More details later.

# Part I – Tutorial registration

- ◆ CORS balloting: 17<sup>th</sup> – 21<sup>st</sup> August (Iteration 2, Rounds 1A and 1B)
- ◆ Manual registration: 22<sup>nd</sup> – 24<sup>th</sup> August. For students who failed to secure any groups.
- ◆ Non graduating (and Exchange) students: contact me between 17<sup>th</sup> – 19<sup>th</sup> August and state your (ranked) preferences

Time slot	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7
Monday	T08 (S17-04-04)			T07 (S17-06-11)	T10 (S17-04-04)					
Tuesday						T14 (S16-03-04)			T05 (S16-04-31)	
Wednesday										
Thursday				T09 (S16-04-31)	T15 (S16-04-31)			T02 (S17-04-05)	T04 (S17-04-05)	
Friday					T03 (S17-04-05)	T06 (S17-04-05)	T11 (S16-03-09) T13 (S16-04-35)		T01 (S17-04-05) T12 (S16-03-09)	

All labs at S17-03-02

Time slot	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6
Monday	B1	B2								
Tuesday						B3	B4			
Wednesday						B5	B6	B7		
Thursday					B8	B9			B10	
Friday					B11					

# Part I – Module Web Page

- ◆ IVLE – <https://ivle.nus.edu.sg>
  - ◆ Forum
  - ◆ Workbin (tutorials, lab worksheets, homework)
  - ◆ Announcement
  - ◆ Gradebook (to check your homework, test and lab quiz scores)
- ◆ LumiNUS – <https://luminus.nus.edu.sg>
  - ◆ For Webcast lectures (both groups)



# Part I – Is this module for me?

- ◆ If this module is part of your major requirement –  
NO CHOICE!
- ◆ If you are taking this module as an elective
  - ◆ It's Level 1000 math, but...
  - ◆ Many students find it challenging
  - ◆ Very different from A-Level (H2) math

# End of Part I


💧 Take a 10 minutes break!

# Part II – About Linear Algebra

## 💧 What is Linear Algebra?

- 💧 Linear = having the properties of lines (线性代数)
- 💧 1 dimensional linear object = line
- 💧 2 dimensional linear object = plane

- 💧 Linear Algebra is the study of **mathematical objects** and properties that are related to lines, planes and their generalization.

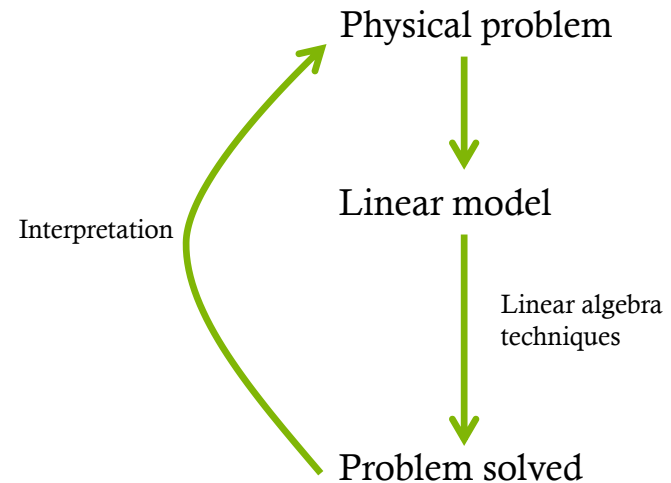


For example:  
Linear systems  
vectors, matrices

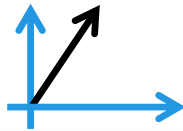
# Part II – What is it for?

- ◆ The techniques and concepts are useful in solving problems in many areas:

- ◆ Mathematics
- ◆ Physics
- ◆ Statistics
- ◆ Chemistry
- ◆ Computer Science
- ◆ Engineering
- ◆ Economics, and many more



# Part II – Vectors and Matrices

2-dimension	$\begin{pmatrix} 2 \\ 4 \end{pmatrix}$	$\begin{pmatrix} 1 & 2 \\ 3 & 6 \end{pmatrix}$	Algebraic expression
		Transformation of a vector to another	Geometrical representation
3-dimension	$\begin{pmatrix} 2 \\ 4 \\ 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 2 & 4 \\ 3 & 6 & 0 \\ -1 & 2 & 3 \end{pmatrix}$	Algebraic
	'arrow' in xyz-space	Transformation of a vector to another	Geometrical
> 3-dimension	$\begin{pmatrix} -1 \\ 0 \\ 4 \\ 1 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 & 2 & 4 \\ -1 & 3 & 6 & 0 \\ -1 & 2 & 3 & 4 \\ 0 & 1 & -1 & 0 \end{pmatrix}$	Algebraic
	None?		Geometrical?

# Part II – Linear systems

Linear system:  
2 equations, 2 variables

$$\begin{cases} x + y = 0 \\ 2x - 3y = 1 \end{cases}$$

Geometrical interpretation: 2 lines

Algebraic generalization

Solution:  $x = \frac{1}{5}, y = -\frac{1}{5}$

Geometrical interpretation: point of intersection of the 2 lines

Linear system:  
4 equations, 5 variables

$$\begin{cases} x_1 - 2x_2 + x_3 - 4x_4 - x_5 = 0 \\ x_1 + x_2 - 3x_3 + x_4 = -1 \\ 2x_1 - 3x_2 - 3x_4 + 2x_5 = 2 \\ 3x_1 - x_3 - 2x_5 = 1 \end{cases}$$

How to find solution?

Any geometrical interpretation?

# Part II – Linear systems (different expressions)

$$\begin{cases} x_1 - 2x_2 + x_3 - 4x_4 - x_5 = 0 \\ x_1 + x_2 - 3x_3 + x_4 = -1 \\ 2x_1 - 3x_2 - 3x_4 + 2x_5 = 2 \\ 3x_1 - x_3 - 2x_5 = 1 \end{cases} \quad \text{Standard form}$$

$$\begin{pmatrix} 1 & -2 & 1 & -4 & -1 \\ 1 & 1 & -3 & 1 & 0 \\ 2 & -3 & 0 & -3 & 2 \\ 3 & 0 & -1 & 0 & -2 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} = \begin{pmatrix} 0 \\ -1 \\ 2 \\ 1 \end{pmatrix} \quad \text{Matrix equation form}$$

Vector equation form

$$x_1 \begin{pmatrix} 1 \\ 1 \\ 2 \\ 3 \end{pmatrix} + x_2 \begin{pmatrix} -2 \\ 1 \\ -3 \\ 0 \end{pmatrix} + x_3 \begin{pmatrix} 1 \\ -3 \\ 0 \\ -1 \end{pmatrix} + x_4 \begin{pmatrix} -4 \\ 1 \\ -3 \\ 0 \end{pmatrix} + x_5 \begin{pmatrix} -1 \\ 0 \\ 2 \\ -2 \end{pmatrix} = \begin{pmatrix} 0 \\ -1 \\ 2 \\ 1 \end{pmatrix}$$



# Part II – Topics to be covered

- ◆ Chapter 1: Linear systems and Gaussian Elimination
- ◆ Chapter 2: Matrices and its operations
- ◆ Chapter 3: Vector spaces
- ◆ Chapter 4: Vector spaces associated with matrices
- ◆ Chapter 5: Orthogonality
- ◆ Chapter 6: Diagonalization
- ◆ Chapter 7: Linear Transformations

# Part III – Study Guide

## ◆ Discipline is critical to your success

- ◆ Work consistently and regularly
- ◆ Preview and review
- ◆ Practice on the exercise problems
- ◆ Try your best to solve the advanced problems

## ◆ Do I need to memorize?

- ◆ Memorize key definitions and results (after sometime it should come naturally)
- ◆ Do not memorize examples/solutions/proofs
- ◆ Helpsheets = no need to memorize?
- ◆ Make learning more efficient and effective

# Part III – Study Guide

## ◆ Understand the concepts

- ◆ Visualize the concepts (in lower dimension)
- ◆ Extend the concepts (in higher dimension)
- ◆ Learn from examples
- ◆ Apply the concepts to solve problems
- ◆ See the connection among concepts

## ◆ Ask questions

- ◆ Do not wait till you have too many “confounding” questions
- ◆ Do not stop at “knowing” how to solve a question
- ◆ Discuss questions with friends
- ◆ Feel free to see me for consultation

# Part III – Study Guide

## ◆ Computational questions

- ◆ “Life saver”
- ◆ Practice makes perfect
- ◆ Do not rely on “eye-power”
- ◆ Indirect computational questions

## ◆ Proofs

- ◆ Connect concepts
- ◆ Recall definitions and results
- ◆ Proving techniques
- ◆ Learn from examples
- ◆ Practice

# Preview – Read and understand beforehand

- ◆ You will be informed (one lecture prior) what we will be covering in the next lecture.
- ◆ You are strongly advised to read up and understand (as much as you can) the materials before coming for lecture.
- ◆ I will spend less time on straightforward concepts and more time on abstract ones.
- ◆ Numerical examples in book and my lecture
- ◆ Webcast is not an excuse for missing lectures.

# Assessing my understanding – Classroom Response System

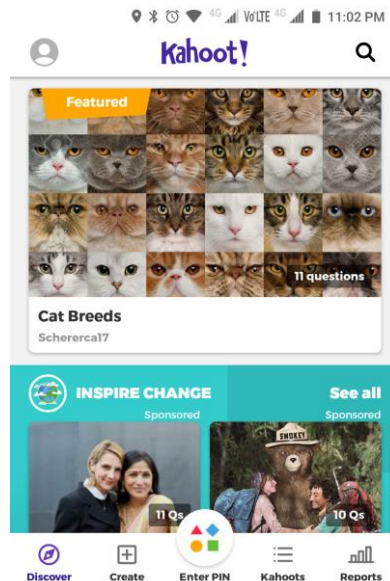
- ◆ What is CRS?
- ◆ Is it graded?
- ◆ What benefits are there?
- ◆ What do I need to do?
  - ◆ Read up the materials beforehand
  - ◆ Come to lecture (with your matric card/remember your matriculation number)
  - ◆ Smart phone (android/iOS), laptop (any browser)

# Kahoot!



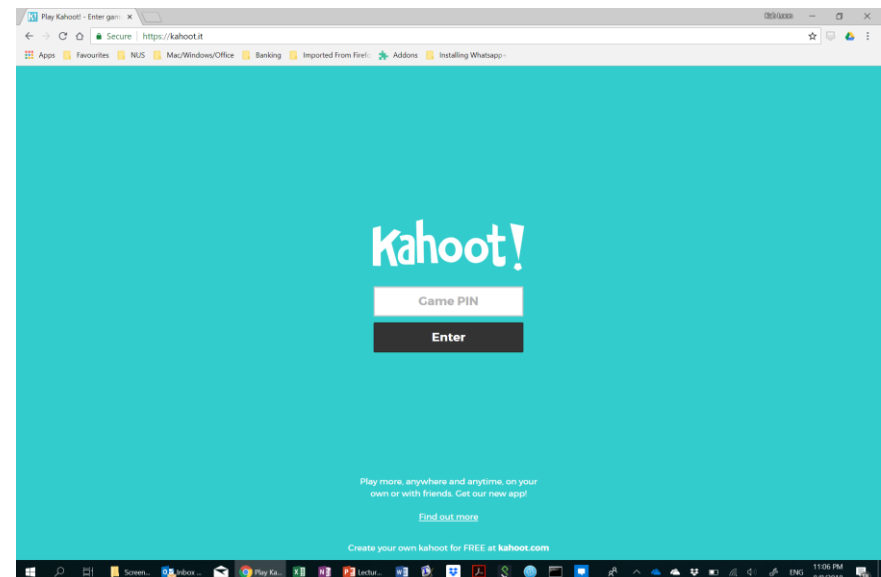
## Smartphone/tablet user

- Download the Kahoot! App
- Launch app
- All set!



## Laptop user

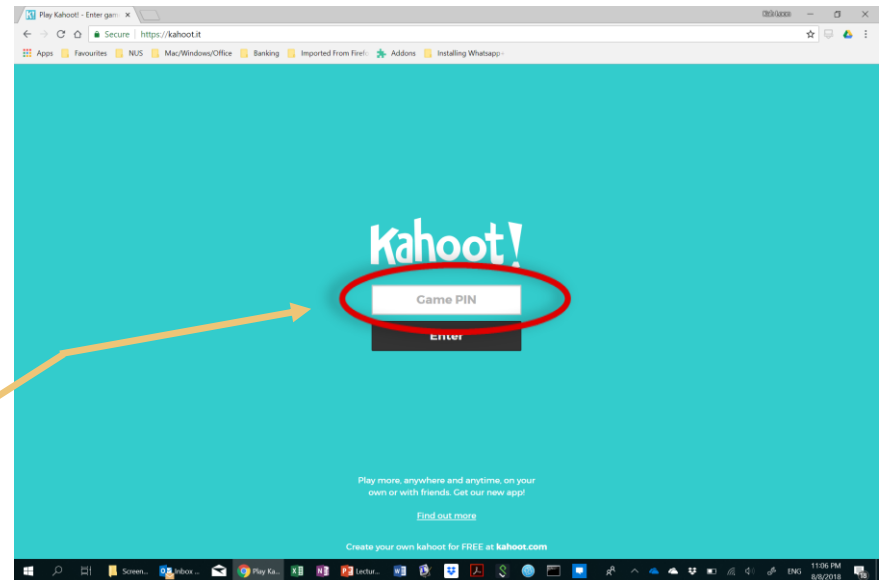
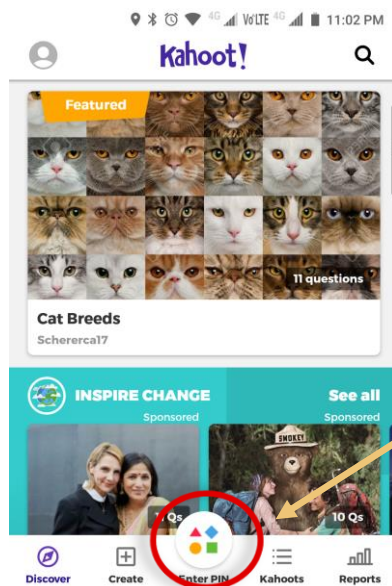
- Use any web browser
- Navigate to <https://kahoot.it>
- All set!





# Kahoot!

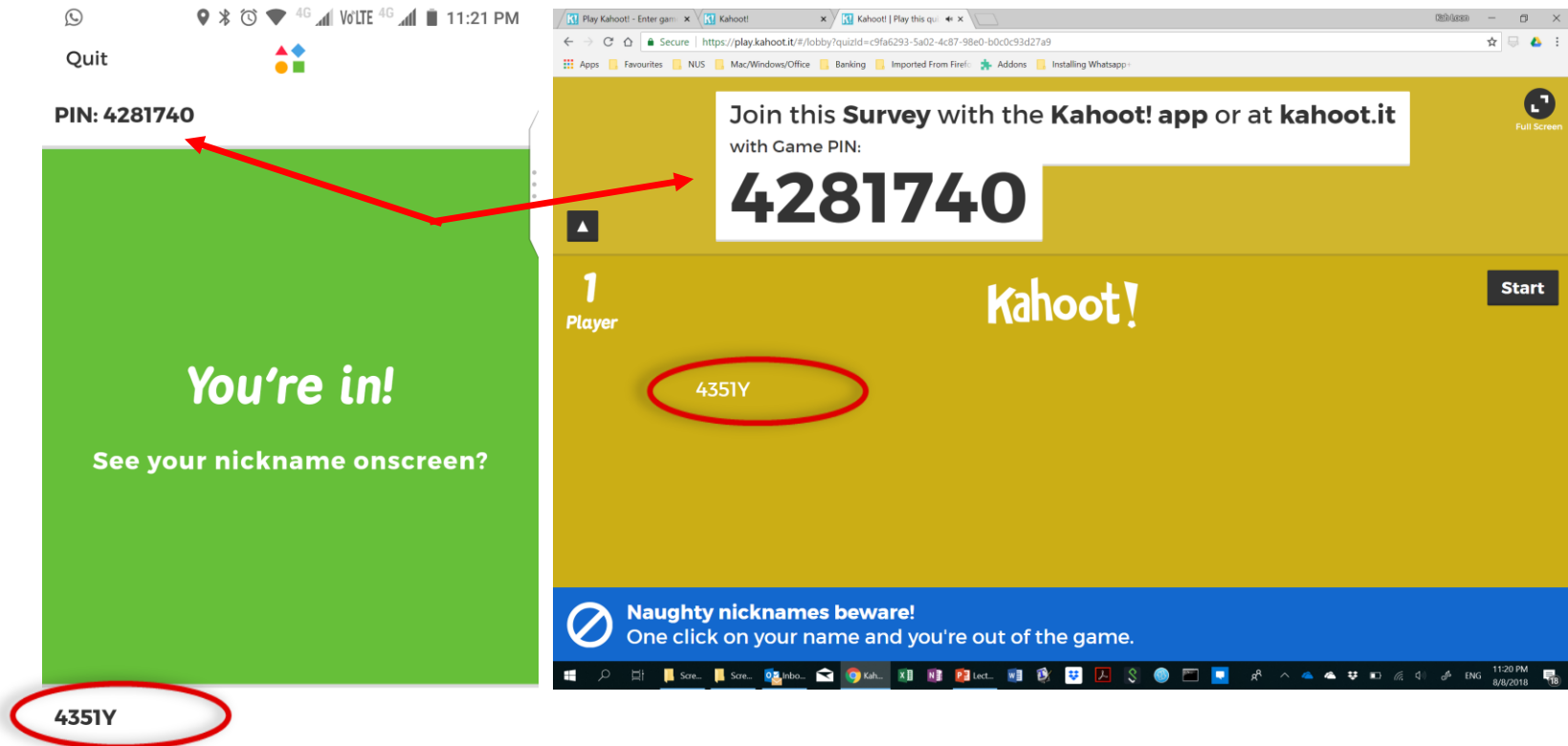
- 💧 To participate in any session, enter the pin given to you.



- 💧 You will then be asked to enter a nickname
- 💧 Enter the last 4 digits of your matric number together with the letter at the end. Click on “Ok, go!”

# Kahoot!

- On the LT projector screen, you should see your own nickname.



- On you device, you will see “You’re in!”

# Kahoot!

- ◆ All questions will be MCQ-type with 4 options for you to choose from.
- ◆ You will see the question and the options on the LT screen.
- ◆ You will make your choice on your smartphone or laptop.
- ◆ All questions will come with a countdown clock. Once the time is up, you won't be able to send in your answers.

# Game rules

- ◆ Answer all the questions yourself. Do not ask your friends, do not copy their answers.
- ◆ Remember, your ability (inability) to answer the questions is an indication of your (continuous) learning. It is meant to help you.
- ◆ Let's try it!



A large, dark blue curved shape that sweeps across the top of the slide, resembling a stylized horizon or a large arc.

The End

See you on Thursday!