MONASH University

MONASH
ENGINEERING
ENG1060

WELCOME TO ENG1060!

INTRODUCTION, VARIABLES AND MATRICES

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Slides by Tony Vo

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GROUP OF EIGHT AUSTRALIA

UNIT STAFF

Lecturer

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Robotics and Mechatronics Engineering Discipline

Monash University Malaysia

Workshop and laboratory demonstrators

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MY GOALS

- Better teaching, better learning
  - Relatability → Approachable (We are human!)
  - Genuine interactivity in class
- Provide you the opportunity to learn
  - Enhance your natural talents and explore your curiosity
  - Provide support at all levels
- Help me, help you – provide feedback
  - Are the workshops engaging and informative?
  - What do you like? What don't you like? Why?
  - Repeating student? Come have a chat

ENG1060 IN A NUTSHELL

- Why computing?
  - Computers are everywhere, highly efficient and required to solve complex systems
  - Structures, artificial intelligence, aerodynamics, climate change, biology, etc.
  - Model environments that experiments can't venture

- Importance?
  - Ability to program = ability to think logically
  - Skills obtained through MATLAB are transferrable to other languages
  - Effective presentation of data

LEARNING OUTCOMES

- This unit will help you develop your logic using MATLAB as a tool

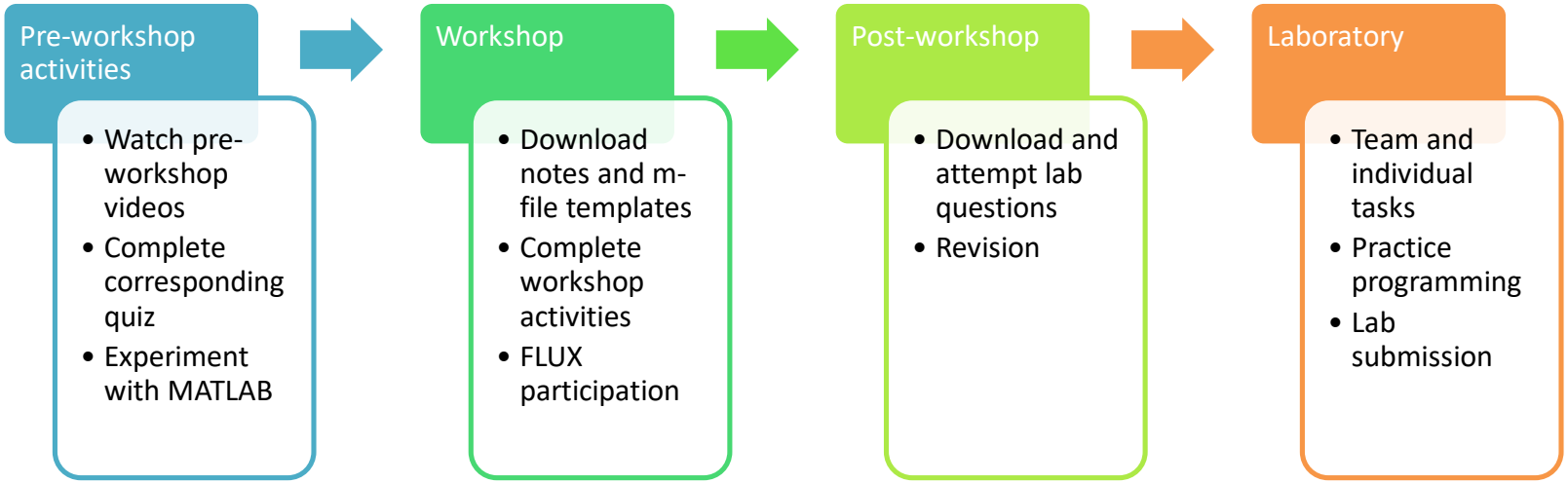
- Part A
  - Identify appropriate MATLAB programming structures to solve simple computational tasks.

- Part B
  - Identify and describe which numerical methods can be used to solve common engineering problems.
  - Construct short computer programs that implement these numerical methods.
  - Apply these numerical methods and programs to basic engineering problems.

ENG1060 WEEKLY WORKFLOW

- 6CP unit = 12 hrs/week of study
  - 2 hour workshops + 3 hour labs + 7 hours self-study

Lab 1 will start in Week 2



Unit Assessments

Assessments	Weighting	Comments
Pre-workshop quizzes	5%	Weeks 2-11. Week 1 not assessed. Closes before the start of the workshop.
Active learning participation (FLUX)	5%	Weeks 2-11. Week 1 not assessed. Awarded 5% for correctly answering 80% of selected poll questions, and pro-rated accordingly below 80%. Live participation: Marks awarded for attempt. Post-workhop: Marks awarded for correct answer.
Consolidation Online Quizzes	5% (2x 2.5%)	Weeks 7 (mid-semester break) and 12
Labs	25% (10x 2.5%)	Weeks 2-11. Must be present for full marks. Week 12 lab is reserved for marking. Must be present.
Assignment	10%	Released Week 8. Due in Week 11. Marked in Week 12 during allocated lab time. Must be present
Final assessment	50%	During the exam period. TBA
Total	**100**	

Hurdle: Students are required to achieve at least 45% in the total continuous assessment component and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.

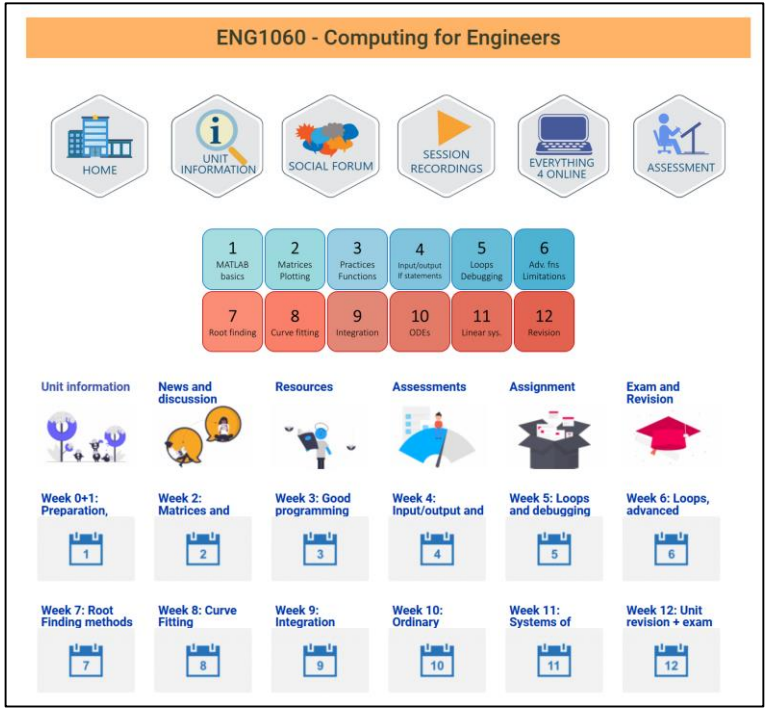
ENG1060 Blue Book + Handbook

- Blue Book (bookmark this)
  - General information and links
  - Unit schedule
  - Assessments
  - Link here

- Handbook
  - Hurdle: Students are required to achieve at least 45% in the total continuous assessment component and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit
  - Link here

MOODLE

- Everything for this unit will be on Moodle
  - Information, communication, pre-workshop videos
  - Link here
- GDrive (bookmark this)
  - Workshop material, lab questions & solutions, assignment files, video links, etc.
  - Link here



FEED CODE: 6GEA45 J9R92L

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1. Visit flux.qa on your internet enabled device
2. Log in using your Authcate/ Monash student email account details
3. Click join an audience in the top-right corner.
   - Monday 1-3pm (MYT), 4-6pm (AEDT) workshop (live participation): 6GEA45
   - Post-workshop (correct answers only): J9R92L
4. Answer questions as they pop up

Answer 80% of questions throughout the semester to earn 5% (pro-rata)

- Participate in these polls live during the workshop, or
- Answer the polls correctly post-workshop

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FLUX EXAMPLE

Where are you now? :)

A. Malaysia

B. Australia

C. None of the above (Tell us please~)

LABS

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- More information on labs will be provided next week
- Allocate+ preferences will close at the end of Week 1
  - Make sure that you are allocated
  - Groups will be created at the start of Week 2
- Zoom lab access
  - You will be emailed a Zoom link for your lab group
  - You will be invited to your lab via a Google calendar invite

FEED CODE: 6GEA45 J9R92L

GETTING HELP

- Unit resources
  - Pre-workshop videos, workshop slides and activities, discussion board, etc.
- Lecturer consultations
  - Email for consultation
- Lab demonstrators

Zoom links

Attend your allocated session.

1. **Workshop (Mon 1-3pm MYT, 4-6pm AEDT):** monash.zoom.us/j/87311823004
   Password: 1060
2. **Labs:** As provided via email and Google calendar invite after Week 1 (unique link)

- PASS- Peer Assisted Study Sessions (From Week 3 onwards)

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IN THIS WORKSHOP

1. Navigating the MATLAB environment
2. Using m-files
3. Creating variables
4. Scalar operations
5. Matrix operations
6. Array indexing
7. Array concatenation

FLUX

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Which command calculates the natural logarithm of X?

A. log10(X) base 10
B. logN(X)
C. log(X) ✓
D. ln(x) X

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RECAP: VARIABLES AND M-FILES

- What is a variable? What is the syntax to define a variable?
  - Variable naming rules
  - Descriptive variable naming

7a ✗ a b = 1 ✗ a% = 1 ✗

a_b = 1 ✓

Mass ≠ mass

- What are m-files? Why do we use m-files?
  - What commands should be placed at the top of every m-file?
  - Use a separate m-file for each task for your labs
    - Lab1task1.m, Lab1task2.m, etc.

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RECAP: MATLAB BUILT-IN FUNCTIONS

- MATLAB has many built-in functions
  - sqrt, mod, rem, log, log10, exp
  - sin, cos, tan, round, ceil, floor
  - min, max, sign, abs

round(1.6) = 2
ceil(1.6) = 2
floor(1.6) = 1
sign(-1.6) = -1
abs( )-

- Some MATLAB built-in commands
  - who, whos, dir…

- Help vs doc
  - What was "help elfun"?

elem. func.

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RECAP: CREATING 1D MATRICES (VECTORS)

- How to create row and column vectors?

  r=[1,2,3], c=[1;2;3], c=r'

- How to create equally spaced vectors?

  ① linspace(s,e,#) '100' ② s:Δ:e ③ [1,3,5,7] ↗ sq. br.

- How to transpose vectors?

  r' transpose(r)

- How to address a vector?
  - If A(end) provides the last element, then what is the result of A(first)?

  ✗ error A(1) ✓

- What are element-by-element operators?

  .^ .* ./

FLUX

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What would the following command output?

```
X = linspace(5, 1, -5)
```

A. X = 5
B. X = [5, 4, 3, 2, 1]
C. X = [5, 1, 5]
D. X = Empty matrix

[5 MINS]

ACTIVITY: ATTRACTION

ATTRACTION_TEMPLATE.M

Activity involves:

1. Open a new m-file
2. Save the m-file in your personal directory
3. Add variables
4. Create a variable for the gravitational force F_g
5. Inspect:
   - Directory window
   - Command window
   - Workspace
   - Script editor
   - Variable window

[5 MINS]

ACTIVITY: ATTRACTION

ATTRACTION_TEMPLATE.M

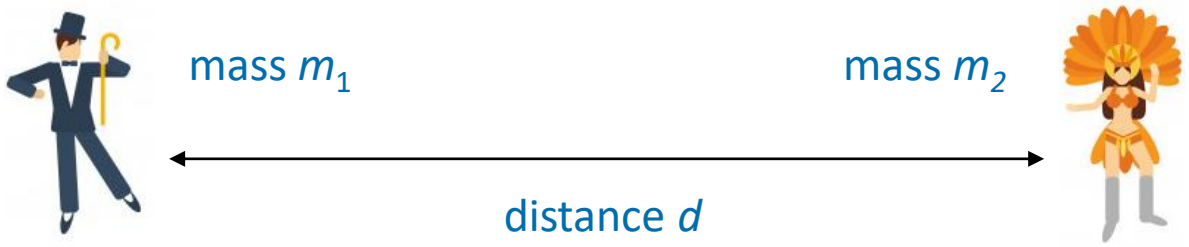
Equations:

$$F_g = G\frac{m_1 m_2}{d^2}$$

$$G = 6.67 \times 10^{-11}\ \text{Nm}^2/\text{kg}^2$$

Tom has a mass of 74.5kg and Sally has a mass of 56.7kg.
Tom and Sally are standing 9.8m apart of a massless dance floor. Sally looks up and she sees Tom. She feels an attraction.

1. If the attraction is gravitational, find its magnitude. Assume that both Tom and Sally can be replaced by spherical masses.



[10 MINS]

ACTIVITY: LAMP

LAMP_TEMPLATE.M

MATLAB commands:

```
x = linspace( … )
x = [ … : … : … ]
y = sum( … )
y = length( … )
```

Activity involves:

1. Creating vectors using 2 different methods
2. Operations with scalars
3. Using element-by-element operations
4. Inspect:
    a. Directory window
    b. Command window
    c. Script editor
    d. Workspace
    e. Variable window

[10 MINS]

ACTIVITY: LAMP

LAMP_TEMPLATE.M

MATLAB commands:

```
x = linspace( … )
x = [ … : … : … ]
y = sum( … )
y = length( … )
```

Ms ENG1060 is working as a consultant for a company that installs street lamps. She is asked to install lamps along a street that is 400 metres long.

1. Determine the displacements (x) for each of the following criteria:
   a. Spread out lamps in **20 metre intervals** along the street
   b. Install **23 lamps** that are **equally-spaced** along the street

2. If each street lamp costs $75 to install, determine which option is more economical for the company.

3. For option a, the first street lamp costs $150 to install and each successive one costs $6 less (i.e. lamp 21 costs $30). Determine the total cost.

[10 MINS]

ACTIVITY: PDF + HYPER SPACE

PDF_TEMPLATE.M

Activity involves:

1. Using element-by-element operations
2. Evaluating functions with vectors
3. Determining the min/max value of a vector

MATLAB commands:

```
x = linspace(…)
x = [… : … : …]
y = A.*B
y = min(…)
y = max(…)
y = mean(…)
y = sqrt(…)
Y = exp(…)
```

[10 MINS]

ACTIVITY: PDF

PDF_TEMPLATE.M

Equations:

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-z^2/2}$$

The standard normal probability density function is a bell-shaped curve that can be represented by the $f(z)$ equation. Mr ENG1060 is asked to calculate the function values for *z* ranging from -5 to 5 in increments of 1.

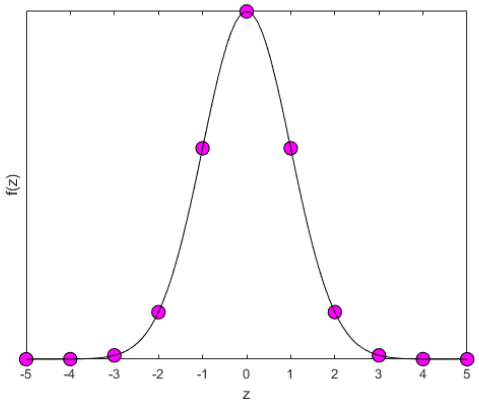
row vector size(z) 1,11 z=[-5 -4 -3 ..]'

z2=5 scalar

z3=[1,2,3 ; 4,5,6] matrix

size(z3) 2,3

1. What is the largest *f* value from this set of *z* values?
2. What is the average *f* value from this set of *z* values?



Typing $f(z)$ as a variable name will result in an error!

[10 MINS]

ACTIVITY: PDF

HYPERSPACE_TEMPLATE.M

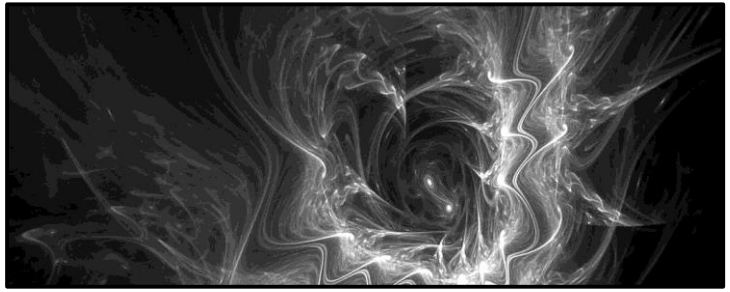
Equations:

$$|v| = \sqrt{v_1^2 + v_2^2 + v_3^2 + \cdots v_n^2}$$

Ms ENG1060 is stuck in hyper-dimensional space again. She is required to calculate the correct magnitude of her input vector to return home. The input vector is an array of values equally spaced starting from 1.6 to 13.7 with 8 points *in between* these end points.

1. What magnitude will take her home?
2. Can you determine the magnitude of *v* using a single line command?

Note: Given a vector $v = [v_1\ v_2\ v_3\ \ldots\ v_n]$, its magnitude can be calculated by the sum of the elements squared



[10 MINS]

ACTIVITY: MAP MATRIX

MAP_MATRIX_TEMPLATE.M

MATLAB commands:

```
x = M(row,column)
x = M([rows],[columns])
x = sum(…)
```

Activity involves:

1. Creating 2D matrices
2. Element-wise indexing
3. Creating a sub-matrix from an existing matrix

[10 MINS]

ACTIVITY: MAP MATRIX

MAP_MATRIX_TEMPLATE.M

MATLAB commands:

```
x = M(row,column)
x = M([rows],[columns])
x = sum(…)
```

Consider the following vectors:

$$A = [13 \quad 27 \quad 41 \quad 55 \quad 69] \qquad B = [20 \quad 40 \quad 80 \quad 60 \quad 10]$$

Create the following by **only** addressing the **A** and **B** vectors.

$$C = \begin{bmatrix} 20 & 40 & 80 & 60 & 10 \\ 13 & 27 & 41 & 55 & 69 \end{bmatrix}$$

$$D = \begin{bmatrix} 13 & 55 & 69 \\ 20 & 80 & 10 \end{bmatrix}$$

Extract the elements circled in red from **C** and **D**.

[10 MINS]

ACTIVITY: MAP MATRIX

MAP_MATRIX_TEMPLATE.M

Ms ENG1060 believes that she has found the map to summon Kosumoth. She has constructed the matrix below in an attempt to decipher the map. She is required to form a 3x3 sub-matrix from the key matrix comprising all elements containing non-zero values.

$$key = \begin{bmatrix} 0 & \mathbf{9} & 0 & \mathbf{8} & \mathbf{1} \\ 0 & \mathbf{6} & 0 & \mathbf{4} & \mathbf{7} \\ 0 & \mathbf{2} & 0 & \mathbf{3} & \mathbf{5} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

- What is the value of the sum of squares of this sub matrix?

[10 MINS]

ACTIVITY: OLYMPICS

OLYMPICS_TEMPLATE.M

MATLAB commands:

```
x = M(row,column)
x = M([rows],[columns])
x = sum(…,2)
```

Activity involves:

1. Column-wise indexing
2. Row-wise indexing
3. Appending an existing matrix

[10 MINS]

ACTIVITY: OLYMPICS

OLYMPICS_TEMPLATE.M

MATLAB commands:

```
x = M(row,column)
x = M([rows],[columns])
x = sum(…,2)
```

Using the Olympic medal tally table below:

a. Extract the 1st and last rows
b. Extract the 1st and last columns
c. Determine the total medals for each country and **append** as the 4th column

Rank	NOC	Gold	Silver	Bronze
1	Norway (NOR)	14	14	11
2	Germany (GER)	14	10	7
3	Canada (CAN)	11	8	10
4	United States (USA)	9	8	6
5	Netherlands (NED)	8	6	6
6	Sweden (SWE)	7	6	1
7	South Korea (KOR)*	5	8	4
8	Switzerland (SUI)	5	6	4
9	France (FRA)	5	4	6
10	Austria (AUT)	5	3	6

+

Total
39
31
29
23
20
14
17
15
15
14

IN THIS WORKSHOP

1. Navigating the MATLAB environment
2. Using m-files
3. Creating variables
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5. Matrix operations
6. Array indexing
7. Array concatenation

PART A: MATLAB PROGRAMMING

1. ~~Introduction, variables and matrices~~
2. Matrix calculations and plotting
3. Functions, commenting, debugging and strings
4. Input, output and IF statements
5. Loops and debugging
6. Loops, advanced functions and MATLAB limitations

You can now complete lab 1!