MONASH University

MONASH
ENGINEERING
ENG1060

EXAM INFORMATION + REVISION

Edited and Presented by Soon Foo Chong (Joseph)

Slides by Tony Vo

Assisted by Tham Lai Kuan & Christopher Ng

GROUP OF EIGHT AUSTRALIA

HOUSEKEEPING

- Weekly Moodle post
  - Week 12 Moodle announcement
- Lab-related items
  - Lab 9 marks and feedback available on Moodle Grade Book
  - Lab 10 solutions available on Gdrive > Labs
- PASS Sessions

  1) Monday (3:30-5:30pm MYT , 6:30-8:30pm AEDT):
  https://monash.zoom.us/j/89128532133?pwd=VVVOenhDbW5xZ3h6ZFRZR1dieVhldz09
  2) Tuesday (12-2pm MYT , 3-6pm AEDT):
  https://monash.zoom.us/j/85226581851?pwd=d0YxeWVHd0tudnplanFRYWU2ZGJRUT09

HOUSEKEEPING

- Assignment marking is conducted in your lab this week
  - Check the assignment marking schedule (News Forum post or Moodle)
    Lab Group 01,03: LINK Here
    Lab Group 02, 04, 05, 06, 07: LINK Here
  - Late submission penalties will be applied after marking
  - Final mark will be withheld until cleared for academic misconduct

- Part B Consolidation Quiz released this week
  - Requires understanding of the numerical method and function file
  - Students who have used the Part B function files blindly may struggle

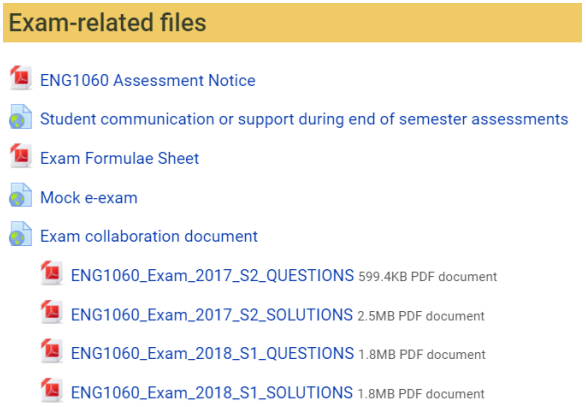
- Ensure that you check Moodle to see if your marks are correct
  - SwotVac week will be your FINAL chance to get it corrected

EXAM COVERSHEET + INSTRUCTIONS

- Final assessment task (50%)
  - Type: Individual exam
  - Mode: e-Assessment platform (non-invigilated)
  - Duration: 3 hours 10 minutes
  - Authorised materials: Open-book, MATLAB, calculator
  - Answers are input into the e-Assessment platform
  - No scanning + uploading is required
  - Weeks 1-12 content examinable

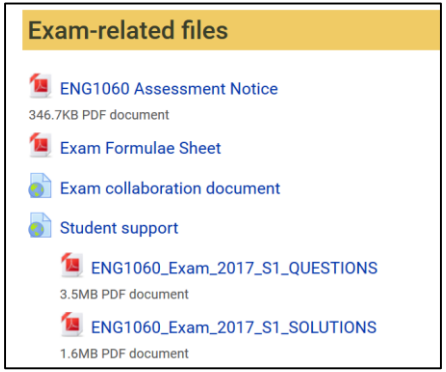
EXAM COVERSHEET + INSTRUCTIONS

- Resources
  - Exam section on Moodle
  - ENG1060 Mock exam (available here)
  - Past exams + solutions (available here)
  - Resources folder on GDrive
  - Exam discussion board
  - MATLAB (use this to check answers)
  - Exam collaboration document
    - Feel free to create and share exam-style questions



EXAM COVERSHEET + INSTRUCTIONS

- Structure and mark distribution
  - Total 100 marks (200 marks inflated)
  - 9 sections (~55 parts)
    - Section 1: 20 multiple choice questions (20%)
    - Section 2: 5 short-response questions (10%)
    - Sections 3-5: Part A focused (24%)
    - Section 6: Root-finding (10%)
    - Section 7: Curve fitting (12%)
    - Section 8: Numerical integration (12%)
    - Section 9: ODEs (12%)
  - Typical breakdown for Sections 3-9
    - 2x numerical response (copy-paste your MATLAB output into the numerical field)
    - 1x coded response (copy-paste your MATLAB code into the text box)



[REVIEW]

W1: MATLAB BASICS + MATRICES

ENG1060

- Importance of computing/programming in engineering
  - Logical thinking and problem solving
- Variable calculations and vector creations
  - Operations
  - […], colon operator , linspace, etc.
- MATLAB built-in functions
  - cosd, log, exp, whos, round, rand, etc.

OPERATOR PRECEDENCE

1	()	Parentheses
2	.' ' .^ ^	Transpose, Matrix Transpose, Power, Matrix Power
3	~	Logical Negation
4	.* * ./ / .\ \	Multiplication, Matrix Multiplication, Right Division, Matrix Right Division, Left Division, Matrix Left Division
5	+ -	Addition Subtraction
6	:	Colon Operator
7	< <= > >= == ~=	Less Than, Less Than Or Equal To, Greater Than, Greater Than Or Equal To, Equal To, Not Equal To
8	&	Element-wise AND
9	|	Element-wise OR
10	&&	Short-circuit AND
11	||	Short-circuit OR

[REVIEW]

W2: MATRICES + PLOTTING

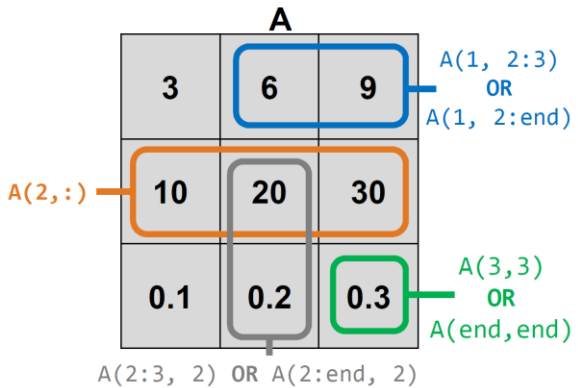
ENG1060 functions summary

MATLAB commands:

```
x = M([rows],[columns])
+   -   .*   ./   .^
plot(…) & loglog(…)
xlabel(…) & ylabel(…)
title(…)
subplot(…)
```

- What are matrices? Why use matrices?
- Matrix creation and addressing
  - Zeros, ones, rand, eye, etc.
- Element-by-element operators
  - Consistent dimensions
- Plotting
  - Labelling axes, title, legend, etc.
  - Line and marker specifications
  - Subplots

```
A = [3:3:9 ; 10 20 30 ; 0.1, 0.2, 0.3];
```



[REVIEW]

W3: FUNCTIONS + PROGRAMMING PRACTICES

ENG1060 functions summary

MATLAB commands:

```
function […] = …(…)
input(…)
disp(…)
```

- What is a function? Why use functions?

- User-defined functions
  - Writing a function with specific inputs and outputs
  - Calling a function from an m-file/command window
  - Why can't you run a function file?

- Comments and documentation
  - Code tells you how and comments tell you why

- More inbuilt functions
  - real, imag, abs, input, disp, etc.

[REVIEW]

W4: INPUT AND OUTPUT

ENG1060 functions summary

MATLAB commands:

```
fprintf('…',…)
char(…)
str2num(…)
num2str(…)
```

- ASCII values
  - Numerical representation of a character

97	a	113	q
98	b	114	r
99	c	115	s

- fprintf vs. sprintf
  - Prints to command window or a file
  - Width and conversion specifiers

Specifier	Description	Examples (output in red)
%f	Fixed-point Notation	`fprintf('%f',pi)` → 3.141593
%e	Exponential Notation	`fprintf('%e',pi)` → 3.141593e+000
%d	Decimal Notation, no decimals if integer variable	`fprintf('%d',2)` → 2
%g	Whichever is shorter, %f or %e	`fprintf('%g',pi)` → 3.14159
%s	String of Characters	`fprintf('%s', 'abc')` → abc

- More inbuilt functions
  - char, str2num, num2str

[REVIEW]

W4: INPUT AND OUTPUT

ENG1060 functions summary

MATLAB commands:

```
fprintf(fid,'…',…)
fopen(…) & fgetl(…) & fclose(…)
importdata(…)
X = … < …
if … elseif … end
switch … case {…}
```

- Importing data
  - fopen, fgetl, fclose, importdata
- Relational and logical operators
  - Statements return either true (1) or false (0)
- If statements
  - Commands run if condition is true
- Switch statements
  - Commands run if case matches switch variable

Relational Operator	Description
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
==	Equal to (double equals)
~=	Not equal to

Logical operator	Description
&	**AND**
|	**OR**
~	**NOT** (Invert)

[REVIEW]

W5: LOOPS AND DEBUGGING

ENG1060 functions summary

MATLAB commands:

```
break
continue
for … end
while … end
```

- Going from pseudocode to MATLAB code
- Debugger tool
  - Breakpoints and stepping
- Repeat a section of code multiple times
  - For loops: when you know exactly how many times to repeat
  - While loops: when you know what condition to meet

[REVIEW]

W6: LOOPS, ADVANCED FNS AND LIMITATIONS

ENG1060 functions summary

MATLAB commands:

```
realmax()
realmin()
f = @(x)…
```

- Limitations of MATLAB (computers)
  - Overflow and underflow
  - Round-off errors
- Variable scope and data types
- Efficient coding
  - Preallocating, unnecessary variables, functions, vectorisation

EXAM SECTIONS 3-5: PART A FOCUSED

- Types of questions
  - Remember each section typically ends with a part requiring a coded response
  - Import a matrix and extract data
    - E.g. Determine the sum values in every X^{th} row, in sub-matrix
    - E.g. Determine the min/max value and the corresponding row/column
    - E.g. Determine the row that has the greatest product of all numbers
  - Create function files
    - Use function file to calculate X, Y, Z
    - Convert function files to anonymous functions
  - Use logicals to extract data
    - Determine how many values are less/greater than X
  - Reproduce the figure shown

[REVIEW]

W7: ROOT-FINDING TECHNIQUES

ENG1060 functions summary

- Solving equations (roots) in the form of f(x) = 0
- Bracketing methods:
  - Initial guesses must bracket the root
  - Bisection and false-position methods
- Open methods
  - Initial guesses does not need to bracket the root
  - Newton Raphson, secant and modified-secant methods

Equations:

$$x_r = \frac{x_l + x_u}{2}$$

$$x_r = \frac{f(x_u)x_l - f(x_l)x_u}{f(x_u) - f(x_l)}$$

$$x_{i+1} = x_i - \frac{f(x_i)}{m_i}$$

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

$$x_{i+1} = x_i - \frac{f(x_i)(x_i - x_{i-1})}{f(x_i) - f(x_{i-1})}$$

$$x_{i+1} = x_i - \frac{f(x_i)\delta}{f(x_i + \delta) - f(x_i)}$$

EXAM SECTIONS 7: ROOT-FINDING

- Types of questions
  - Use method X to determine
    - root of $f(x) = 0$, $f(x) = 999$, $f(x) = g(x)$
    - the maximum/minimum turning point
    - root for different equations
    - root for different brackets
    - multiple roots

[REVIEW]

W8: CURVE FITTING

ENG1060 functions summary

MATLAB commands:

polyfit(…)

polyval(…)

- Linear regression $(y = a_0 + a_1 x)$
  - Fitting a straight line to a set of data
  - Coefficient of determination, r^2
- Non-linear models
  - Exponential
  - Power
  - Saturation growth
- Inbuilt functions
  - Fitting and evaluating polynomials

Equations:

$$a_1 = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{n\sum x_i^2 - (\sum x_i)^2}$$

$$a_0 = \bar{y} - a_1 \bar{x}$$

$$S_r = \sum (y_i - a_0 - a_1 x_i)^2$$

$$S_t = \sum (y_i - \bar{y})^2$$

$$r^2 = \frac{S_t - S_r}{S_t}$$

EXAM SECTIONS 8: CURVE FITTING

- Types of questions
  - Use linear regression on non-linear model X
    - $a_0, a_1, \alpha, \beta, r^2$
  - Use polyfit() to fit a polynomial to a set of data
  - Use polyval() to evaluate a polynomial fit

[REVIEW]

W9: NUMERICAL INTEGRATION

ENG1060 functions summary

MATLAB commands:

trapz(…)

integral(…)

- Approximations
  - Trapezoidal rule
  - Simpson's 1/3 rule
  - Simpson's 3/8 rule
- Inbuilt functions
  - trapz, integral

Equations:

$$I = \frac{h}{2}\left[f(x_1) + 2\sum_{i=2}^{n-1} f(x_i) + f(x_n)\right]$$

$$I = \frac{h}{3}\left[\begin{array}{c} f(x_1) + 4\sum_{\substack{i=2,4,6\ldots \\ i,\,even}}^{n-1} f(x_i) + \\ 2\sum_{\substack{j=3,5,7\ldots \\ j,\,odd}}^{n-2} f(x_j) + f(x_n) \end{array}\right]$$

$$I = \frac{3h}{8}\left(f(x_1) + 3f(x_2) + 3f(x_3) + f(x_4)\right)$$

EXAM SECTIONS 9: NUMERICAL INTEGRATION

- Types of questions
  - Use method X to integrate $\int_a^b f(x)\,\mathrm{d}x$
  - Use method X to integrate a set of vectors
  - Determine the minimum number of points needed to achieve Y% error

[REVIEW]

W10: ODEs

ENG1060 functions summary

MATLAB commands:

ode45(…)

- Euler's method
  - Slope at the current point
- Heun's method
  - Slope at the beginning of the step and
  - Slope at the end of the step
- Midpoint method
  - Slope at the midpoint

Equations:

$$y_{i+1} \cong y_i + h\phi$$

$$y_{i+1} = y_i + hf(t_i, y_i)$$

$$y^0_{i+1} = y_i + hf(t_i, y_i)$$

$$y_{i+1} = y_i + \frac{h}{2}\left(f(t_i, y_i) + f(t_{i+1}, y^0_{i+1})\right)$$

$$y_{i+1/2} = y_i + \frac{h}{2} f(t_i, y_i)$$

$$y_{i+1} = y_i + hf(t_{i+1/2}, y_{i+1/2})$$

EXAM SECTIONS 10: ODEs

- Types of questions
  - Use method X to solve $\frac{dy}{dx} = f(x, y)$
  - Solve $\frac{dy}{dx} = f(x, y)$ using different initial conditions
  - Compare solutions of different methods

[REVIEW]

W11: LINEAR SYSTEMS

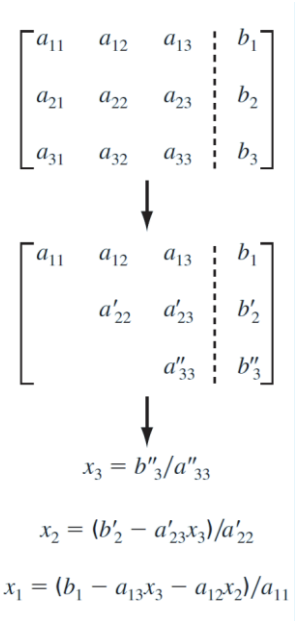
ENG1060 functions summary

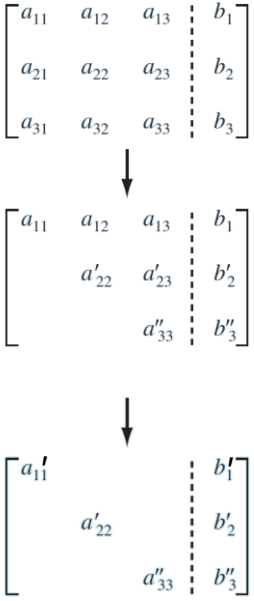
- Solving the matrix equation $[A][x] = [b]$

- Naïve Gaussian elimination
  - Forward elimination and back substitution
  - Potential divide-by-zero issues

- Gaussian elimination
  - Forward elimination and back substitution
  - Partial pivoting is involved

- Gauss-Jordan elimination
  - Forward and backward eliminations
  - Partial pivoting is involved





EXAM SECTIONS 11: ODEs

- Types of questions
  - No dedicated section for linear systems
  - Questions will appear either in MCQs or short-response
    - E.g. Describe the advantages/limitations of method X
    - E.g. Use method X to solve this system of equations

COMMON MISTAKES

- Using non-MATLAB variables or built-in functions
- Misreading a question – don't panic!
- Not reading a question in full
- Not double checking answers (calculator error)

FINAL TIPS

- Look at previous exam papers
  - Look at the types of questions asked
  - Read the question carefully
  - Identify your weak points based on the past exams then revisit the material
  - Familiarise yourself with the lab questions

- Part B > Part A in difficulty
  - *Understand* Part B methods and be familiar with the coding
  - Hand-written based questions from labs are crucial for understanding

ENG1060 – COMPUTING FOR ENGINEERS

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~~
7. ~~Roots and optimisation~~
8. ~~Curve fitting~~
9. ~~Numerical integration~~
10. ~~Ordinary differential equations~~
11. ~~Linear systems~~
12. ~~Exam information~~

You can now complete the EXAM!