

Mathematics I (M101)

Study Guide for Success

For students pursuing BEng. Degree in Industrial Systems

How to Use This Guide

This guide is not a set of exam questions. It is a **roadmap** to help you:

- Understand difficult topics
- Avoid frequent errors
- Study effectively for continuous assessment and the final exam

Use it alongside your lectures, exercises, and the recommended textbooks (Bird, Croft & Davison).

Unit 1 – Number Systems, Relations, and Functions

What Students Often Struggle With

- Confusing *irrational* numbers (like $\sqrt{2}$, π) with rational numbers (fractions)
- Thinking every relation is a function (not true – functions have one output per input)
- Finding inverses of non-linear functions

Effective Study Strategies

Concept	Strategy
Number sets	Draw a Venn diagram: Natural \subset Integers \subset Rational \subset Real
Function vs relation	Use the vertical line test on graphs
Inverse function	Swap x and y, then solve for y. Check: $f(f^{-1}(x)) = x$
Composite functions	Work from inside out: $f(g(x))$ – do g first, then f

Common Mistakes to Avoid

- **✗** Saying $\sqrt{4} = \pm 2$ (principal root is +2 unless solving an equation)
- **✗** Forgetting that f^{-1} means inverse, not reciprocal $1/f(x)$

STUDENT SUCCESS TIPS

Practice with real numbers first, then move to abstract functions. Use online graphing tools (Desmos) to visualize functions and inverses.

Unit 2 – Basic Algebra (Indices, Logs, Surds, Binomial Theorem, Polynomials)

What Students Often Struggle With

- Mixing up index laws: $a^m \times a^n = a^{m+n}$ vs $(a^m)^n = a^{mn}$
- Solving logarithmic equations – forgetting domain restrictions ($x > 0$)
- Polynomial long division – the procedure feels new

Effective Study Strategies

Topic	Strategy
Laws of indices	Memorize the 5 laws; practice with negative/fractional powers
Logarithms	Rewrite as exponentials: $\log_b a = c \Leftrightarrow b^c = a$
Surds	Rationalise denominators by multiplying top/bottom by conjugate
Binomial theorem	Use Pascal's triangle for small n ; formula for larger n
Factor theorem	If $P(a) = 0$, then $x - a$ is a factor

Common Mistakes to Avoid

- **✗** $\log(x + y) = \log x + \log y$ (WRONG – multiplication only)
- **✗** Forgetting to check for extraneous solutions in log equations
- **✗** Losing signs in polynomial division

STUDENT SUCCESS TIPS

Check your work backwards. After factoring, multiply out to see if you return to the original polynomial.

Unit 3 – Graphical Methods

What Students Often Struggle With

- Finding the equation of a line from two points
- Recognizing when to use parallel vs perpendicular gradient rules
- Linearising non-linear equations ($y = ae^{bx}$ becomes $\ln y = \ln a + bx$)

Effective Study Strategies

SKILL	STRATEGY
GRADIENT LINE EQUATION	$m = \frac{y_2 - y_1}{x_2 - x_1}$ $y - y_1 = m(x - x_1)$
PARALLEL LINES	Same m
PERPENDICULAR LINES	$m_1 \times m_2 = -1$
LINEARISATION	Take logs of both sides \rightarrow straight line form $Y = mX + c$

Common Mistakes to Avoid

- **X** Swapping x and y in the gradient formula
- **X** Forgetting to plot enough points for curves (need 5–7 points)

STUDENT SUCCESS TIPS

Always label axes, intercepts, and key points (min/max, intersections). Graphs in exams are marked for accuracy, not beauty.

Unit 4 – Trigonometry

What Students Often Struggle With

- Knowing when to use Sine Rule vs Cosine Rule
- Using compound angle identities correctly
- Understanding hyperbolic functions (new concept for many)

Effective Study Strategies

Rule	When to use
Sine Rule	Two angles + one side, or two sides + non-included angle
Cosine Rule	Two sides + included angle, or three sides
Pythagorean identity	$\sin^2 \theta + \cos^2 \theta = 1$ (memorize this)
Small angle approx	$\sin \theta \approx \theta, \cos \theta \approx 1$ (radians only)

Common Mistakes to Avoid

- ✗ Using degrees in derivative/integral contexts (exam specifies)
- ✗ Forgetting the ambiguous case in Sine Rule (two possible triangles)
- ✗ Confusing $\sinh x$ with $\sin x$ – they are different functions

STUDENT SUCCESS TIPS

Write down all given values, sketch the triangle, then choose the rule. For identities, start with one side and work toward the other – don't work on both sides at once.

Unit 5 – Complex Numbers, Matrices, and Vectors

What Students Often Struggle With

- Dividing complex numbers – need to multiply by conjugate
- Matrix multiplication order (M×N times N×P)
- Determinant of 2×2 matrix and condition for inverse
- Cross product vs dot product confusion

Effective Study Strategies

Topic	Strategy
Complex division	Multiply numerator & denominator by conjugate of denominator
Matrix multiplication	Inner dimensions must match: $(a \times b) \times (b \times c) = a \times c$
Determinant (2×2)	$\det = ad - bc$. If zero → no inverse
Cramer's Rule	Solve one variable at a time using determinants
Dot product	Result = scalar (use for angle)
Cross product	Result = vector (perpendicular)

Common Mistakes to Avoid

- **×** $i^2 = 1$ (WRONG – $i^2 = -1$)
- **×** Multiplying matrices left-to-right incorrectly (do row × column)
- **×** Forgetting that matrices do not commute: $AB \neq BA$ generally

STUDENT SUCCESS TIPS

For vectors, always write components clearly: $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$. The dot product formula $\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}| |\mathbf{b}| \cos \theta$ is your key to finding angles.

General Exam & Study Strategies

Before the Exam

- **Review the course schedule:** Topics in Weeks 1–13 are examinable.
- **Continuous assessment (50%):** Do all exercises and attend lectures.
- **Final exam (50%):** Practice past-style problems, not just reading notes.

During the Exam

- Read each question twice.
- Show all working – partial marks matter.
- For graphical questions, a rough accurate sketch is better than a perfect late one.
- For polynomials, test simple roots ($\pm 1, \pm 2, \pm 3$) first.

Recommended Weekly Study Plan

Day	Activity
Monday	Review lecture notes (1 hour)
Wednesday	Practice problems from the week's unit (2 hours)
Friday	Work through one past exam question (1 hour)
Weekend	Group study – explain concepts to others

Final Word based on your Course Outline

“These basic concepts are covered so as to give students a basic foundation which will allow them to pursue further studies in later courses in mathematics and engineering.”


Master Unit 2 (algebra) and Unit 4 (trigonometry) – they appear in every later engineering course. **Matrices and vectors (Unit 5)** are essential for statics, dynamics, and circuits.

Good luck. Study actively, not passively. You've got this.


Additional Support

For assistance with research or accessing resources such as past papers, visit the CMU Library or contact:

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 **WhatsApp:** (876) 564-4274

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