

Mathematics II

STUDY GUIDE

Course Overview

Mathematics II builds on Mathematics I, introducing sequences, series, differential calculus, and integral calculus with applications in engineering and systems operations.

Core Topics & Study Strategies

Unit 1: Sequences and Series

Key Concepts:

- Difference between sequence (ordered list) and series (sum of terms)
- Arithmetic Progression (AP) and Geometric Progression (GP)
- n th term formulas and problem-solving

Challenging Areas:

- Recognizing when to use AP vs GP
- Summation of infinite GP

STUDYING STRATEGIES

- Create flashcards with formulas:
 - AP: $a_n = a_1 + (n - 1)d$, $S_n = \frac{n}{2}(2a_1 + (n - 1)d)$
 - GP: $a_n = a_1 r^{n-1}$, $S_n = a_1 \frac{1-r^n}{1-r}$ (for $r \neq 1$)
- Practice real-world problems (e.g., loan payments, population growth)

SUCCESS TIPS

Always write down the first 3 terms of the progression to identify d or r before solving.

Unit 2: Differential Calculus and Applications

Key Concepts:

- Limits, derivatives from first principles
- Differentiation: algebraic, trigonometric, hyperbolic, exponential, log functions
- Implicit & parametric differentiation
- Leibniz's theorem for higher derivatives
- Partial derivatives, small changes, maxima/minima/saddle points
- McLaurin's & Taylor's series

Challenging Areas:

- First principles for trigonometric functions
- Hyperbolic functions (\sinh , \cosh) and their derivatives
- Partial differentiation and saddle points
- Leibniz's theorem
- Taylor/McLaurin series expansion

STUDYING STRATEGIES

- **First principles:** Memorize the formula

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

Practice with x^2 , $\sin x$, e^x .

- **Derivative rules table:** Create a reference sheet with derivatives of all standard functions.
- **Hyperbolic functions:** Note similarities to trig:
 $\frac{d}{dx} \sinh x = \cosh x$, $\frac{d}{dx} \cosh x = \sinh x$
- **Partial derivatives:** Treat one variable as constant at a time. Practice with $f(x, y) = x^2y + \sin(xy)$.
- **Maxima/minima (2 vars):** Use $D = f_{xx}f_{yy} - (f_{xy})^2$.
 - $D > 0$ and $f_{xx} > 0 \rightarrow \min$
 - $D > 0$ and $f_{xx} < 0 \rightarrow \max$
 - $D < 0 \rightarrow \text{saddle point}$
- **Taylor/McLaurin series:** Start with $e^x = \sum \frac{x^n}{n!}$, then derive $\sin x$, $\cos x$, $\ln(1+x)$.

SUCCESS TIPS

For implicit differentiation, differentiate both sides with respect to x , then solve for $\frac{dy}{dx}$. **Remember:** derivative of y is $\frac{dy}{dx}$.

Unit 3: Integral Calculus and Applications

Key Concepts:

- Indefinite and definite integrals
- Integration by substitution and by parts
- Areas under curves, volumes of revolution, centroids
- Numerical integration: trapezoidal rule, Simpson's rule, mid-ordinate rule

Challenging Areas:

- Choosing correct substitution
- Integration by parts $\int u dv = uv - \int v du$
- Volume of revolution around x-axis or y-axis
- Numerical integration accuracy



STUDYING STRATEGIES

- **Substitution:** Look for a function and its derivative inside the integral (e.g., $\int 2x \cos(x^2) dx$, let $u = x^2$).
- **By parts:** Use LIATE rule (Log, Inverse trig, Algebraic, Trig, Exponential) to choose u .
- **Volumes:**
 - Around x-axis: $V = \pi \int_a^b [f(x)]^2 dx$
 - Around y-axis: $V = \pi \int_c^d [g(y)]^2 dy$
- **Numerical integration:**
 - Trapezoidal rule: good for smooth curves
 - Simpson's rule: more accurate (needs even number of strips)
 - Mid-ordinate: simple but less accurate



SUCCESS TIPS

When stuck on a definite integral, sketch the curve — the area interpretation often gives insight.



General Learning Strategies

1. Daily Practice (30–45 min)

- Solve at least 5 problems per topic per week.
- Focus on AP/GP, derivatives, and basic integrals first.

2. Formula Notebook

- Keep a dedicated notebook for formulas with examples.
- Update weekly: derivative rules, integral methods, series expansions.

3. Error Log

- Record mistakes (e.g., forgetting chain rule, wrong substitution).
- Review before quizzes.

4. Use Multiple Resources

- From the course outline:
 - Bird (2005) – Basic Engineering Mathematics
 - Croft & Davison (2004) – Mathematics for Engineers

5. Group Study

- Teach peers: explaining differentiation from first principles reinforces understanding.
- Quiz each other on McLaurin series expansions.

6. Master the Basics First

- Without limits and first principles, later topics (Taylor series, partial derivatives) become very hard.

FOCUS ON HIGH-DIFFICULTY AREAS

Topic	Why Difficult	Success Tip
First principles (trig functions)	Algebraic manipulation of limits	Memorize the first principles formula: $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$. Practice with x^2 , then $\sin x$, then $\cos x$. For trig functions, also memorize: $\lim_{h \rightarrow 0} \frac{\sin h}{h} = 1$ and $\lim_{h \rightarrow 0} \frac{\cos h - 1}{h} = 0$.
Hyperbolic functions	Unfamiliar notation	Compare graphs of \sinh and \sin ; note $\cosh^2 - \sinh^2 = 1$
Leibniz's theorem	Recursive formulas	Practice with $y = x^2 e^x$, find 3rd derivative using pattern
Partial derivatives & saddle points	3D visualization	Use online graphing (e.g., GeoGebra) to see maxima/minima/saddle
Taylor/McLaurin series	Remembering expansions	Derive from e^x rather than memorizing separately
Volume of revolution	Setting up correct integral	Always draw the region and axis of rotation first
Numerical integration	Choosing rule	Simpson's rule for accuracy, trapezoidal for quick estimate

Course Schedule – Study Plan Alignment

Week	Topic	Study Focus
1–2	Sequences & Series	Master AP/GP formulas; solve 10 mixed problems
3–7	Differential Calculus	Focus: first principles, product/quotient, implicit, partial derivatives
8	Mid Term Test	Review all derivatives & AP/GP; do past paper
9–13	Integral Calculus	Master substitution & by parts; practice volumes & centroids
14	Exam Review	Numerical integration & Taylor series drills
15	Final Exam	Full syllabus mock test



Assessment Preparation

- **Continuous Assessment (50%)** – likely quizzes, assignments, mid-term.
 - Attend all lectures and submit exercises.
 - Practice past continuous assessments if available.
- **Final Exam (50%)** – comprehensive.
 - Expect: AP/GP problems, differentiation (including implicit/parametric), partial derivatives, maxima/minima, Taylor series, definite integrals, volume, numerical integration.
 - Time management: 2–3 minutes per mark roughly.



Final Success Tips

1. **Don't skip limits** – they are the foundation of calculus.
2. **Rewrite complex problems step-by-step** – avoid jumping steps.
3. **Use symmetry** in integrals and series to save time.
4. **Check units** in applied problems (e.g., volume in cm^3 , area in m^2).
5. **Stay consistent** – 30 minutes daily > 3 hours once a week.

Good luck with Mathematics II! With steady practice and active problem-solving, you can master every unit. 🚀

Additional Support

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

✉ **Email:** library@cmu.edu.jm/cmulibrary123@gmail.com

📞 **WhatsApp:** (876) 564-4274

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