

# Preparation Guide for Advanced Mathematical Economics

Advanced Mathematical Economics has no prerequisites apart from high school mathematics (Scottish Higher, A-level, or equivalent). Nevertheless, the course is very intensive, so students who prepare early will have a smoother experience. I recommend that students prepare on two fronts: refreshing **high-school mathematics** and learning **logic**. This guide includes links to videos that teach these topics.

## Logic

Modern mathematics only uses logic informally. For example, mathematicians almost never write logic symbols such as  $\forall$ ,  $\exists$ ,  $\implies$  and  $\neg$ . On the other hand, being familiar with the notation and the rules of logic can be very helpful for thinking clearly. None of this material is examinable, but I think many students will find it helpful for mastering the examinable material. I recommend watching videos on both propositional logic and first-order logic. For both topics, I have listed several possible lecture series to watch – only one is necessary for each.

- Propositional Logic Only:
  - [Logic 101](#) by William Spaniel of [gametheory101.com](#)
- Both Propositional Logic and First-Order Logic:
  - [Discrete Math 1](#) from [TrevTutor.com](#) – all videos in the “Set Theory” and “Logic” sections.
  - [Discrete Mathematics](#) by Trefor Bazett – the first 30 videos are the most relevant.

Note that these videos do not include any practice problems for you to try yourself. My [lecture notes](#) include some practice problems with sample solutions in Appendix B.

## High school mathematics

If you are rusty on your high-school mathematics, you can work through the Khan Academy lectures to refresh your memory. Although you can use most of the materials on Khan Academy without setting up an account, creating a free account can help you keep track of your progress. Instructions for creating an account can be found on the [Khan Academy](#) website.

### Functions:

You might want to do the Algebra Challenge on Khan Academy.

- Equations: [Simple Equations](#), [Equations 2](#), [Equations 3](#), [Equations 4](#), [Solving Equations 1](#), [Solving Equations 2](#), [Solving Equations with the Distributive Property](#), [Solving equations with the distributive property 2](#), [Solving Radical Equations 1](#), [Solving Radical Equations 2](#), [Solving Radical Equations 3](#), [Solving Rational Equations 1](#), [Solving Rational Equations 2](#), [Solving Rational Equations 3](#), [Applying Rational Equations 1](#), [Applying Rational Equations 2](#), [Applying Rational Equations 3](#).
- Cartesian Coordinate System: [Plotting \(x,y\) relationships](#), [Quadrants of Coordinate Plane](#), [Graphing using X and Y intercepts](#), [Algebra: graphing lines 1](#).
- Linear Equations and Graphs: [Basic Linear Function](#), [Exploring linear relationships](#), [Recognizing Linear Functions](#).
- Slopes: [Algebra: Slope](#), [Algebra: Slope 2](#), [Algebra: Slope 3](#), [Slope of a line](#), [Slope Example](#).
- Intercepts: [X and Y intercepts](#), [X and Y intercepts 2](#).
- Slope-Intercept Form: [Algebra: Slope and Y-intercept intuition](#), [Graphing a line in slope intercept form](#), [Converting to slope-intercept form](#).
- Determining the Equation of a Straight Line: [Algebra: Equation of a line](#), [Equation of a line](#).
- Concepts and Definitions: [Functional Relationships 1](#), [Testing if a relationship is a function](#), [Domain and Range 1](#), [Domain and Range 2](#), [Exploring](#)

nonlinear relationships.

- Graphing Functions: Graph Parabola , Graph piecewise function , Graph Logarithm , Graph rational function
- The Algebra of Functions: Introduction to functions, Functions Part 2, Functions (Part III), Functions (part 4).
- Solving Quadratic Equations: Solving Quadratic Equations by Factoring, Solving Quadratic Equations by Factoring 2, Solving Quadratic Equations by Factoring 3, Quadratic Functions 1, Quadratic Functions 2, Completing the Square 1, Completing the Square 2, Completing the Square 3, Completing the Square 4, Quadratic Formula 1, Quadratic Formula 2, Quadratic Formula 3.
- Facilitating Non-linear Graphing: See videos on quadratics.

## Solving equations

- Introduction: systems of equations ,system of equations 2.
- Graphical Solutions: Solving systems by graphing, Solving systems by graphing 2, Solving systems by graphing 3, More Solving Systems by Graphing.
- Elimination and Substitution Methods: Solving systems by substitution 1, Solving systems by substitution 2, Solving systems by substitution 3, Solving systems by elimination, Solving systems by elimination 2, Solving systems by elimination 3.

## Calculus

- Limits: Introduction to Limits (HD), Introduction to Limits, Limit Examples (part 1), Limit Examples (part 2), Limit Examples (part3), [Limit Examples w/ brain malfunction on first prob (part] 4), Squeeze Theorem, Proof:  $\lim (\sin x)/x$ , More Limits, Epsilon Delta Limit Definition 1, Epsilon Delta Limit Definition 2.

- The Derivative: Calculus: Derivatives 1 (new HD version), Calculus: Derivatives 2 (new HD version), Calculus: Derivatives 2.5 (new HD version), Calculus: Derivatives 1, Calculus: Derivatives 2, Calculus: Derivatives 3.
- Rules of Differentiation: The Chain Rule, Chain Rule Examples, Even More Chain Rule, Product Rule, Quotient Rule, Proof:  $d/dx(x^n)$ , Proof:  $d/dx(\sqrt{x})$ , Proof:  $d/dx(\ln x) = 1/x$ , Proof:  $d/dx(e^x) = e^x$ , Proofs of Derivatives of  $\ln(x)$  and  $e^x$ .
- Implicit Functions: Implicit Differentiation, Implicit Differentiation (part 2), More implicit differentiation, More chain rule and implicit differentiation.
- Increasing and Decreasing Functions: Behaviour of functions , Behaviour of functions.
- Relative Extrema: Maxima Minima Slope Intuition, Calculus: Maximum and minimum values on an interval, Extreme Value, Min-max points .
- Inflection Points: Inflection Points and Concavity Intuition.
- Curve Sketching: Calculus: Graphing Using Derivatives, Calculus Graphing with Derivatives Example, Graphing with Calculus.
- Optimization of Functions: Optimization with Calculus 1, Optimization with Calculus 2, Optimization with Calculus 3, Optimization Example 4.
- Economic examples: Optimizing profit at a shoe factory, Minimizing sum of squares.