

Additional Mathematics Part 1 (first year topics)

Contents

Alpha Guide-in-Chief
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Program Duration
Weekly, 2 Hours, 1 Academic Year

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PROGRAM CODE: AEAM01

Program Contents

ALGEBRA

Equations and Inequalities

- Conditions for a quadratic equation to have:
 - two real roots
 - two equal roots
 - no real rootsand related conditions for a given line to:
 - intersect a given curve
 - be a tangent to a given curve
 - not intersect a given curve
- Conditions for $ax^2 + bx + c$ to be always positive (or always negative)
- Solving simultaneous equations in two variables with at least one linear equation, by substitution
- Relationships between the roots and coefficients of a quadratic equation
- Solving quadratic inequalities, and representing the solution on the number line

Indices and Surds

- Four operations on indices and surds, including rationalising the denominator
- Solving equations involving indices and surds

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Polynomials and Partial Fractions

- Multiplication and division of polynomials
- Use of remainder and factor theorems
- Factorisation of polynomials
- Use of:
 - $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
 - $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
- Solving cubic equations
- Partial fractions with cases where the denominator is no more complicated than:
 - $(ax + b)(cx + d)$
 - $(ax + b)(cx + d)^2$
 - $(ax + b)(x^2 + c^2)$

Binomial Expansions

- Use of the Binomial Theorem for positive integer n
- Use of the notations $n!$ and $\binom{n}{r}$
- Use of the general term $\binom{n}{r} a^{n-r} b^r$, $0 < r \leq n$ (knowledge of the greatest term and properties of the coefficients is not required)

Power, Exponential, Logarithmic, and Modulus Functions

- Power functions $y = ax^n$ where n is a simple rational number, and their graphs
- Exponential and logarithmic functions a^x , e^x , $\log_a x$, $\ln x$ and their graphs, including:
 - laws of logarithms
 - equivalence of $y = a^x$ and $x = \log_a y$
 - change of base of logarithms
- Modulus functions $|x|$ and $|f(x)|$ where $f(x)$ is linear, quadratic or trigonometric, and their graphs
- Solving simple equations involving exponential, logarithmic and modulus functions

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GEOMETRY AND TRIGONOMETRY

Trigonometric Functions, Identities and Equations

Six trigonometric functions for angles of any magnitude (in degrees or radians)

- Principal values of $\sin^{-1}x$, $\cos^{-1}x$, $\tan^{-1}x$
- Exact values of the trigonometric functions for special angles (30° , 45° , 60°) or $(\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3})$
- Amplitude, periodicity and symmetries related to the sine and cosine functions
- Graphs of $y = a \sin(bx) + c$, $y = a \sin\left(\frac{x}{b}\right) + c$, $y = a \cos(bx) + c$, $y = a \cos\left(\frac{x}{b}\right) + c$ and $y = a \tan(bx)$, where a is real, b is a positive integer and c is an integer.
- Use of the following –
 - $\frac{\sin A}{\cos A} = \tan A$, $\frac{\cos A}{\sin A} = \cot A$, $\sin^2 A + \cos^2 A = 1$, $\sec^2 A = 1 + \tan^2 A$,
 $\operatorname{cosec}^2 A = 1 + \cot^2 A$
 - the expansions of $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$
 - the formulae for $\sin 2A$, $\cos 2A$ and $\tan 2A$
 - the expression for $a \cos\theta + b \sin\theta$ in the form $R \cos(\theta \pm \alpha)$ or $R \sin(\theta \pm \alpha)$
- Simplification of trigonometric expressions
- Solution of simple trigonometric equations in a given interval (excluding general solution)
- Proofs of simple trigonometric identities

Coordinate Geometry in Two Dimensions

- Condition for two lines to be parallel or perpendicular
- Midpoint of line segment
- Area of rectilinear figure
- Graphs of parabolas with equations in the form $y^2 = kx$
- Coordinate geometry of circles in the form:
 - $(x - a)^2 + (y - b)^2 = r^2$
 - $x^2 + y^2 + 2gx + 2fy + c = 0$ (excluding problems involving 2 circles)

Transformation of given relationships, including $y = ax^n$ and $y = kb^x$, to linear form to determine the unknown constants from a straight line graph

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Alpha Guide-in-Chief

Dr. Jeffrey C. K. Lim, Alpha Guide-in-Chief, has an uncanny knack for taking often complicated concepts and ideas, and breaking them down to bite-sized chunks, and making such chunks understandable to a general audience, using his secret approach that starts from scratch, which is summarized by his famous guiding quotation: “The Secret of the How’s is actually in the Why’s”.

Professionally, Jeff is a certified Financial Risk Manager (FRM¹) and certified Professional Risk Manager (PRM²), is currently the Managing Director of PI ETA Consulting Company, a Treasury & Financial Risk Management Consulting Company.

A Chartered Scientist (C.Sci.³), a Chartered Mathematician (C.Math.⁴) and an elected Fellow of the Institute of Mathematics and Its Applications (IMA), U.K. (FIMA), Jeff earned his Ph.D. in Stochastic Financial Modeling from the University of Cambridge in England. Jeff’s research interest at Cambridge was in the area of Arbitrage Opportunities occurring in the Mispricing of Financial Options, and his original research culminated in the publication of his doctoral dissertation entitled: “Multi-period Mean-Variance Option Portfolio Strategies”.

Jeff was an authorized Securities & Financial Derivatives Representative in London, having been certified by The Securities and Futures Authority (SFA) in England, where he started his career as a Derivatives Analyst with Nomura International in London, England. He subsequently joined NatWest Markets from London, England to become its Head of Currency Structured Products for South and South-East Asia. Jeff then moved to American Express Bank to become its Director of Structured Products, prior to assuming his current position.

Jeff has also contributed to the development and enhancement of talent and infrastructure for Singapore's financial center as a guest Professor at the National University of Singapore’s Center for Financial Engineering, where he was responsible for the curriculum of its Master of Science degree program’s core modules in Financial Derivatives and Treasury Management. In addition, Jeff has also been invited by the Nanyang Technological University and the Singapore Management University to share his expertise in a similar capacity. In recognition of Jeff’s expertise and experience in the field of Treasury and Financial Risk Management, the University of New South Wales

¹ The *Financial Risk Manager* (FRM) designation is awarded by The Global Association of Risk Professionals (GARP), U.S.A.

² The *Professional Risk Manager* (PRM) designation is awarded by The Professional Risk Managers International Association (PRMIA), U.S.A.

³ The *Chartered Scientist* (C.Sci.) designation is awarded by The Science Council, U.K.

⁴ The *Chartered Mathematician* (C.Math.) designation is awarded by The Institute of Mathematics and Its Applications (IMA), U.K.

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Asia appointed Jeff to be its first Adjunct Professor with the university's Division of Business and Humanities.

At PI ETA Consulting Company, Jeff was Principal Inventor in two of the Patents that the company currently holds – one in Treasury & Financial Risk Management Systems, and the other in Knowledge Management Systems.

Professionally, Jeff is a Fellow of both The Global Association of Risk Professionals (GARP), U.S.A. and The Professional Risk Managers International Association (PRMIA), U.S.A. He is also a Fellow of the Cambridge Philosophical Society, U.K. and a Life-time Member of The Cambridge Society, U.K. Jeff is also honoured to be a Fellow of The Cambridge Commonwealth Society, U.K., having been previously awarded the Cambridge Commonwealth Trust and the Shell Group of Companies Doctoral Research Scholarship.

As a special recognition of Jeff's professional achievements, on 9 April 1999, Barons Who's Who conferred Jeff with the Barons Fellowship status, making him a Barons Fellow (B.Fel.). This award by their Charter, is limited to only the top 10% of those selected for publication in Barons Who's Who International.

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