

A LEVEL PURE MATHS REVISION NOTES

1 ALGEBRA AND FUNCTIONS

a) INDICES

Rules to learn :

$$x^a \times x^b = x^{a+b} \quad x^a \div x^b = x^{a-b} \quad (x^a)^b = x^{ab} \quad x^{-a} = \frac{1}{x^a} \quad x^{\frac{a}{b}} = \sqrt[b]{x^a} = (\sqrt[b]{x})^a$$

$$\begin{aligned} \text{Simplify } 2x(x-y)^{\frac{1}{2}} + 3(x-y)^{\frac{1}{2}} \\ = (x-y)^{\frac{1}{2}}(2x(x-y) + 3) \\ = (x-y)^{\frac{1}{2}}(2x^2 - 2xy + 3) \end{aligned}$$

$$\begin{aligned} \text{Solve } 3^{2x} \times 25^x &= 15 \\ (3 \times 5)^{2x} &= 15^2 \\ 2x &= 1 \\ x &= \frac{1}{2} \end{aligned}$$

b) SURDS

- A root such as $\sqrt{3}$ that cannot be written as a fraction is IRRATIONAL
- An expression that involves irrational roots is in SURD FORM
- RATIONALISING THE DENOMINATOR is removing the surd from the denominator (multiply by the conjugate)

Simplify

$$\begin{aligned} \sqrt{75} - \sqrt{12} \\ = \sqrt{5 \times 5 \times 3} - \sqrt{2 \times 2 \times 3} \\ = 5\sqrt{3} - 2\sqrt{3} \\ = 3\sqrt{3} \end{aligned}$$

Rationalise the denominator $\frac{2}{2-\sqrt{3}}$

$$\begin{aligned} &= \frac{2}{2-\sqrt{3}} \times \frac{2+\sqrt{3}}{2+\sqrt{3}} \\ &= 4 + 2\sqrt{3} \end{aligned}$$

The conjugate of the denominator $2 - \sqrt{3}$ is $2 + \sqrt{3}$ so that $(2 - \sqrt{3})(2 + \sqrt{3}) = 2^2 - \sqrt{3}^2 = 1$

c) QUADRATIC EQUATIONS AND GRAPHS

Factorising – Identifying the roots of the equation $ax^2 + bx + c = 0$

- Look for the difference of 2 squares $x^2 - a^2 = (x+a)(x-a)$ or $(ax)^2 - b^2 = (ax+b)(ax-b)$
- Look for the perfect square $x^2 + 2ax + a^2 = (x+a)^2$
- Look out for equations which can be transformed into quadratic equations

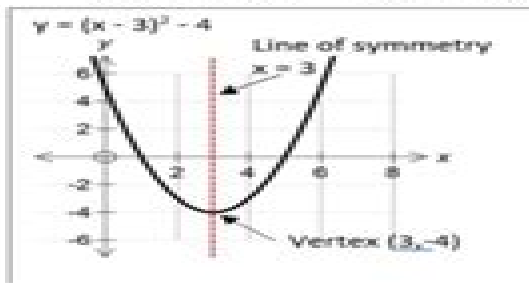
$$\begin{aligned} \text{Solve } x + 1 - \frac{12}{x} &= 0 \\ x^2 + x - 12 &= 0 \\ (x+4)(x-3) &= 0 \\ x &= -4 \quad x = 3 \end{aligned}$$

$$\begin{aligned} \text{Solve } 6x^4 - 7x^2 + 2 &= 0 \\ \text{Let } z = x^2 \quad 6z^2 - 7z + 2 &= 0 \\ (2z-1)(3z-2) &= 0 \end{aligned}$$

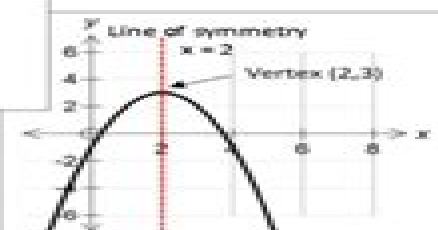
$$z = \frac{1}{2} \quad x = \pm \sqrt{\frac{1}{2}} \quad z = \frac{2}{3} \quad x = \pm \sqrt{\frac{2}{3}}$$

Completing the square – Identifying the vertex and line of symmetry

$$y = (x+a)^2 + b \quad \text{vertex at } (-a, b) \quad \text{line of symmetry as equation } x = -a$$



$$\begin{aligned} \text{Sketch the graph of } y &= 4x - x^2 - 1 \\ y &= -(x^2 - 4x) - 1 \\ y &= -(x^2 - 4x + 4) - 1 \\ y &= -(x-2)^2 + 3 \end{aligned}$$



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 forms and Jacobi forms play a central role in many areas of mathematics Over the last 10 15 years this theory has been
 extended to certain non holomorphic functions the so called harmonic Maass forms The first glimpses of this theory appeared
 in Ramanujan s enigmatic last letter to G H Hardy written from his deathbed Ramanujan discovered functions he called mock
 theta functions which over eighty years later were recognized as pieces of harmonic Maass forms This book contains the

essential features of the theory of harmonic Maass forms and mock modular forms together with a wide variety of applications to algebraic number theory combinatorics elliptic curves mathematical physics quantum modular forms and representation theory

Fractional Differential Equations Praveen Agarwal, Carlo Cattani, Shaher Momani, 2024-04-29

Fractional Differential Equations Theoretical Aspects and Applications presents the latest mathematical and conceptual developments in the field of Fractional Calculus and explores the scope of applications in research science and computational modelling Fractional derivatives arise as a generalization of integer order derivatives and have a long history their origin can be found in the work of G W Leibniz and L Euler Shortly after being introduced the new theory turned out to be very attractive for many famous mathematicians and scientists including P S Laplace B Riemann J Liouville N H Abel and J B J Fourier due to the numerous possibilities it offered for applications Fractional Calculus the field of mathematics dealing with operators of differentiation and integration of arbitrary real or even complex order extends many of the modelling capabilities of conventional calculus and integer order differential equations and finds its application in various scientific areas such as physics mechanics engineering economics finance biology and chemistry among others However many aspects from the theoretical and practical point of view have still to be developed in relation with models based on fractional operators Efficient analytical and numerical methods have been developed but still need particular attention Fractional Differential Equations Theoretical Aspects and Applications delves into these methods and applied computational modelling techniques including analysis of equations involving fractional derivatives fractional derivatives and the wave equation analysis of FDE on groups direct and inverse problems functional inequalities and computational methods for FDEs in physics and engineering Other modelling techniques and applications explored by the authors include general fractional derivatives involving the special functions in analysis fractional derivatives with respect to another function in analysis new fractional operators in real world applications fractional order dynamical systems hidden attractors in complex systems nonlinear dynamics and chaos in engineering applications quantum chaos and self excited attractors Provides the most recent and up to date developments in the theory and scientific applications Fractional Differential Equations Includes transportable computer source codes for readers in MATLAB with code descriptions as it relates to the mathematical modelling and applications Provides readers with a comprehensive foundational reference for this key topic in computational modeling which is a mathematical underpinning for most areas of scientific and engineering research

Random Growth Models Michael Damron, Firas Rassoul-Agha, Timo Seppäläinen, 2018-09-27

The study of random growth models began in probability theory about 50 years ago and today this area occupies a central place in the subject The considerable challenges posed by these models have spurred the development of innovative probability theory and opened up connections with several other parts of mathematics such as partial differential equations integrable systems and combinatorics These models also have applications to fields such as computer science biology and physics This volume is based on lectures delivered at the 2017

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Integral Transformations, Operational Calculus and Their Applications Hari Mohan Srivastava, 2021-01-20 This volume consists of a collection of 14 accepted submissions including several invited feature articles to the Special Issue of MDPI's journal Symmetry on the general subject area of integral transformations operational calculus and their applications from many different parts around the world The main objective of the Special Issue was to gather review expository and original research articles dealing with the state of the art advances in integral transformations and operational calculus as well as their multidisciplinary applications together with some relevance to the aspect of symmetry Various families of fractional order integrals and derivatives have been found to be remarkably important and fruitful mainly due to their demonstrated applications in numerous diverse and widespread areas of mathematical physical chemical engineering and statistical sciences Many of these fractional order operators provide potentially useful tools for solving ordinary and partial differential equations as well as integral differential and integro differential equations fractional calculus analogues and extensions of each of these equations and various other problems involving special functions of mathematical physics and applied mathematics as well as their extensions and generalizations in one or more variables

Mathematics Education in Africa Brantina Chirinda, Kakoma Luneta, Alphonse Uworwabaye, 2022-11-28 This book is about mathematics teaching and learning in Africa during the Fourth Industrial Revolution The Fourth Industrial Revolution 4IR has evolved to utilize new technologies in the teaching and learning of Mathematics It is characterized by the fusion of the biological physical and digital worlds and embodies a new era of innovation in mathematics education leading to the rapid emergence of new technologies for mathematics teaching and learning Because 4IR in mathematics education is happening differently in various parts of Africa the authors of the various chapters in this volume have positioned their work in their respective local contexts The chapters address a wide variety of interests concerns and implications regarding 4IR and Mathematics Education in Africa Additionally a number of chapters address teaching mathematics in the context of the COVID 19 pandemic that has gripped the world Other chapters discuss the implications of inequalities in Africa that affect mathematics education during 4IR Chapters also incorporate arguments observations and suggestions to improve and transform the teaching and learning of mathematics in Africa during the 4IR This book highlights a new era of innovation in mathematics education in the context of the Fourth Industrial Revolution leading to the rapid emergence of new technologies in mathematics teaching and learning It is a valuable resource for graduate students people with research interests in the fourth industrial revolution and mathematics educators at any level including all mathematics teachers mathematics

education curriculum designers and policymakers

Commutative Algebra Irena Peeva, 2022-02-18 This contributed volume is a follow up to the 2013 volume of the same title published in honor of noted Algebraist David Eisenbud's 65th birthday. It brings together the highest quality expository papers written by leaders and talented junior mathematicians in the field of Commutative Algebra. Contributions cover a very wide range of topics including core areas in Commutative Algebra and also relations to Algebraic Geometry, Category Theory, Combinatorics, Computational Algebra, Homological Algebra, Hyperplane Arrangements and Non commutative Algebra. The book aims to showcase the area and aid junior mathematicians and researchers who are new to the field in broadening their background and gaining a deeper understanding of the current research in this area. Exciting developments are surveyed and many open problems are discussed with the aspiration to inspire the readers and foster further research.

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