


HKTKPC M2 Resource 2016

(by CCH)

Chapter 0 *Pre-requisite Knowledge*

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	I. Set Notation	<ul style="list-style-type: none"> Recognise set notation. Define different intervals by sets. 	Teachers may explain to students why they should understand set notations.			<ul style="list-style-type: none"> Basic set operations 	
	1	II. Absolute Value	<ul style="list-style-type: none"> Recognise the definition of absolute value. Recognise the properties of absolute value. 	The absolute value function will be further discussed in Volume 2 Chapter 7.			<ul style="list-style-type: none"> Absolute value 	
	1	III. Summation Notation	<ul style="list-style-type: none"> Understand the summation notation. Understand the properties of the operations of summation notation. 	Students should be aware of the index of summation, the lower and the upper limits of summation.			<ul style="list-style-type: none"> Summation Notation 	
	2	IV. Methods of Proof	<ul style="list-style-type: none"> Understand the concepts of proposition, conditional proposition, biconditional proposition, sufficient condition, necessary condition and necessary and sufficient condition. Learn how to perform direct proof, and indirect proof including proof by contrapositive and proof by contradiction. 	For average or less-able students, teachers may skip this section.			<ul style="list-style-type: none"> Necessary and Sufficient Conditions √2 is irrational square roots of prime numbers are irrational 	

Other Resources:

- [Absolute Value Games and Calculators](#)

Chapter 1 Surds

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	1.1. Basic Knowledge of Surds	<ul style="list-style-type: none"> Learn the definition and the properties of surds. Simplify an expression involving surds by addition, subtraction and multiplication. 	When teaching addition and subtraction of like surds, teachers may remind students of some similar mathematical manipulations, e.g. combining like terms of polynomials.			<ul style="list-style-type: none"> Basic Surds 	
	2	1.2. Rationalization	<ul style="list-style-type: none"> Rationalization of surds in the form $\frac{k}{\sqrt{a}}$. Rationalization of surds in the form $\frac{k}{\sqrt{a} \pm \sqrt{b}}$. 	Teachers can remind students of the identity $a^2 - b^2 \equiv (a + b)(a - b)$ before introducing rationalization of surds.	✓		<ul style="list-style-type: none"> Rationalizing the denominator Rationalization of surds 	✓

Other Resources:

- [Rationalize Denominator Calculator](#)

Chapter 2 Mathematical Induction

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	2.1. Principle of Mathematical Induction	Understand the principle of mathematical induction.	Teachers should introduce the domino effect and compare it with the mechanism of mathematical induction.	✓		<ul style="list-style-type: none"> Proof of finite arithmetic series formula by induction onlinemathlearning.com 	
	5	2.2. Performing Proofs by mathematical Induction	<ul style="list-style-type: none"> Learn to prove propositions involving summation of finite sequences. 	Teachers should emphasize the correct steps of using the principle of mathematical induction.	✓		<ul style="list-style-type: none"> onlinemathlearning.com 	
	OUT C		<ul style="list-style-type: none"> Learn to prove propositions involving divisibility of integers. 		✓			

Other Resources:

НИКТОКРСМАТН

Chapter 3 Binomial Theorem

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	0.5	3.1 The Notations $n!$ and C_r^n	<ul style="list-style-type: none"> Understand the meaning of $n!$. Understand the meaning of C_r^n. 	Teachers may mention why the definition $0! = 1$ is made.	✓		<ul style="list-style-type: none"> Factorial and counting seat arrangements Intro to combinations 	✓
	1	3.2 Pascal's Triangle	<ul style="list-style-type: none"> Explore the pattern in the Pascal's triangle. Understand how to use the Pascal's triangle to find the expansion of $(a + b)^n$, where n is a non-negative integer. 				<ul style="list-style-type: none"> Pascal's triangle and binomial expansion 	
	2	3.3 The Binomial Theorem	<ul style="list-style-type: none"> Prove the binomial theorem. Apply the binomial theorem to find the expansion of $(a + b)^n$, where n is a non-negative integer. Find the coefficients of terms in binomial expansions. 	The following contents are not required: <ul style="list-style-type: none"> expansion of trinomials the greatest coefficient, the greatest term and the properties of binomial coefficients applications to numerical approximation 	✓		<ul style="list-style-type: none"> Intro to the Binomial Theorem interactive-maths.com 	✓

Other Resources:

- [Interactive Mathematics: The Binomial Theorem](#)
- [Binomial Expansion Calculator](#)
- [Mathcentre.com \(video download\)](#)

Chapter 4 More about Trigonometric Functions (I)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	2	4.1 Radian Measure	<ul style="list-style-type: none"> Learn the concept of radian measure. Learn the conversion between degrees and radians. Learn to find arc lengths and areas of sectors using radian measure. 	<ul style="list-style-type: none"> Students should understand that the relationship between the degree measure and the radian measure is given by $\pi \text{ rad} = 180^\circ$. Students should know how to apply the formulas $s = r\theta$ and $A = \frac{1}{2}r^2\theta$, where θ is in radian measure. 	✓		<ul style="list-style-type: none"> Introduction to radians 	
	4	4.2 Trigonometric Functions	<ul style="list-style-type: none"> Recognise the definitions of the six trigonometric functions of angles of any magnitude. Understand the trigonometric relations. Learn the concept of a periodic function. Recognise the graphs of the six trigonometric functions and their characteristics. 	<ul style="list-style-type: none"> Students should know how to apply the trigonometric relations when they simplify trigonometric expressions. Teachers should discuss the period, the maximum value, the minimum value and the range from the graph of each of trigonometric functions. 	✓ ✓ ✓		<ul style="list-style-type: none"> The unit circle definition of sine, cosine, and tangent The reciprocal trigonometric ratios Using trigonometric identities 	
	2	4.3 Solving Simple Trigonometric Equations	Learn different techniques to solve trigonometric equations for solutions in the interval from 0 to 2π .	<ul style="list-style-type: none"> Students should know how to apply the trigonometric relations when they solve trigonometric equations. Students should pay attention to the interval of the solutions when they solve equations like $\sin nx = k$, where $n \neq 1$. 				

Other Resources:

Chapter 5 More about Trigonometric Functions (II)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	3	5.1 Compound Angle Formulas	<ul style="list-style-type: none"> • Learn and prove the compound angle formulas of sine, cosine and tangent functions. • Apply the compound angle formulas to solve trigonometric problems. 	<ul style="list-style-type: none"> • Students should understand the proofs of compound angle formulas. 	✓		<ul style="list-style-type: none"> • Introduction to the trigonometric angle addition identities 	✓
	2	5.2 Double Angle Formulas	<ul style="list-style-type: none"> • Learn and prove the double angle formulas of sine, cosine and tangent functions. • Apply the double angle formulas to solve trigonometric problems. 	<ul style="list-style-type: none"> • Students should understand the proofs of double angle formulas. 	✓		<ul style="list-style-type: none"> • Using the cosine double-angle identity 	✓
	3.5	5.3 Product to Sum and Sum to Product Formulas	<ul style="list-style-type: none"> • Learn and prove the sum to product and product to sum formulas of sine and cosine functions. • Apply the product to sum and sum to product formulas of trigonometric functions to solve trigonometric problems. 	<ul style="list-style-type: none"> • Students should understand the proofs of product to sum and sum to product formulas. 	✓			

Other Resources:

Chapter 6 Introduction to Number e and Natural Logarithms

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	3	6.1 Introduction to Number e	<ul style="list-style-type: none"> Recognise the definition of the number e. Learn the characteristics of the graphs of $y = e^x$ and $y = e^{-x}$. Recognise the exponential series $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots$ 	Teachers should illustrate the concept of a limit by some simple examples, e.g. the value of $\frac{1}{n}$, where n tends to positive infinity.	✓	✓	● e as a limit	
	2	6.2 Natural Logarithms	<ul style="list-style-type: none"> Understand the definition of the natural logarithm. Apply the properties of natural logarithm to simplify logarithmic expressions. Learn the characteristics of the graph of $y = \ln x$. Learn how to solve equations involving e and natural logarithms. 	Teachers may remind students of the logarithmic function which is discussed in Compulsory part book 4A chapter 5.	✓		● Evaluating natural logarithm with calculator	

Other Resources:

Chapter 7 Limits and Derivatives

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	7.1 Functions	<ul style="list-style-type: none"> Understand the concept of functions. Understand the concept of composite functions. 	Concepts of functions, domains, co-domains, dependent variables and independent variables are taught in the Compulsory Part Book 4A Chapter 3.	✓		<ul style="list-style-type: none"> What is a function? Composing functions 	
	3	7.2 Limits of Functions	<ul style="list-style-type: none"> Understand the intuitive concept of the limit of a function. discontinuous functions. Understand the concepts of continuous functions and Learn how to distinguish 'continuous functions' and 'discontinuous functions' from their graphs. Recognise some common continuous functions and discontinuous functions. Learn how to evaluate limits of continuous functions. Understand and apply theorems relating to limits of functions. 	<ul style="list-style-type: none"> The proof of the existence of a limit is beyond the scope of the curriculum. The formal proof of continuity of functions is not needed. 	✓ ✓		<ul style="list-style-type: none"> Intro to limits Continuity using limits 	
	1.5	7.3 Limits at Infinity	<ul style="list-style-type: none"> Understand the concept of limits at infinity. Learn how to evaluate limits of functions at infinity. Recognise infinity as a limit. 	Students should understand the concepts of left-handed limit and right-handed limit. In Chapter 10, students must use such concepts to find asymptotes of a curve.	✓ ✓		<ul style="list-style-type: none"> Limits and infinity 	
	2	7.4 Limits of Trigonometric Functions	<ul style="list-style-type: none"> Learn how to evaluate the limits of basic trigonometric functions. Learn and apply the formula $\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$. 	Help students revise trigonometric identities which are useful to find limits involving trigonometric functions.				
	1	7.5 The Limit $\lim_{x \rightarrow 0} \frac{e^x - 1}{x}$	<ul style="list-style-type: none"> Learn the theorem $\lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1$. 	Make sure that students have already understood the concept of the number e in Chapter 6.				

• Apply $\lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1$ to evaluate limits.

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	3	7.6 Derivatives	<ul style="list-style-type: none"> • Understand the meanings of the tangent to a curve and the slope of a curve. • Find the slope of the tangent to a curve at a given point. • Understand the definition of derivatives of functions. • Understand the geometric meaning of derivatives of functions. • Recognise the notations for the derivative of a function. • Find the derivatives of elementary functions from first principles. 	<p>Finding derivatives of trigonometric functions, exponential functions and logarithmic functions from first principles are discussed in Chapter 9.</p>	<p>✓</p> <p>✓</p>	<ul style="list-style-type: none"> • Taking derivatives 	
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Other Resources:

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Chapter 8 Differentiation (I)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	4	8.1 Basic Rules of Differentiation	<ul style="list-style-type: none"> Learn theorems to differentiate power functions, sum and difference of functions. Understand product rule and quotient rule. 	Teachers may show the proofs of the basic rules using first principles.	✓		<ul style="list-style-type: none"> Product and quotient rules 	
	3	8.2 Differentiation of Composite Functions	<ul style="list-style-type: none"> Recognise the concept of composite function. Understand the chain rule. 	Teachers may show the proof of the chain rule, given in the appendix.	✓		<ul style="list-style-type: none"> Chain rule 	
	4	8.3 Differentiation of Inverse Functions and Implicit Functions	<ul style="list-style-type: none"> Recognise the concept of inverse function. Understand the inverse function rule. Recognise the concept of implicit function. Understand implicit differentiation. 	Teachers may prove the inverse function rule by the chain rule.	<ul style="list-style-type: none"> ✓ ✓ 		<ul style="list-style-type: none"> Derivatives of inverse functions Implicit differentiation 	

Other Resources:

Chapter 9 Differentiation (II)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	6	9.1 Differentiation of Trigonometric Functions	Learn theorems to differentiate trigonometric functions.	Teachers may let students prove the theorems from first principles.	✓		<ul style="list-style-type: none"> • Derivatives of common functions 	
	7	9.2 Differentiation of Exponential Functions	Learn theorems to differentiate exponential functions.	Teachers may let students find the derivative of e^x from first principles.	✓		<ul style="list-style-type: none"> • Derivatives of common functions 	
	7	9.3 Differentiation of Logarithmic Functions	<ul style="list-style-type: none"> • Learn theorems to differentiate logarithmic functions. • Find $\frac{dy}{dx}$ by the method of logarithmic differentiation. 	Teachers may let students find the derivative of $\ln x$ from first principles.	✓		<ul style="list-style-type: none"> • Derivatives of common functions 	
	4	9.4 Second Derivatives	<ul style="list-style-type: none"> • Recognise the concept of the second derivative of a function. • Find the second derivatives of explicit functions. 	<ul style="list-style-type: none"> • Third and higher order derivatives are not required. • Students are not required to find the second derivatives of inverse functions. 	✓			

Other Resources:

Chapter 10 Applications of Differentiation

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	3	10.1 Tangents and Normals to Curves	<ul style="list-style-type: none"> • Use differentiation to find the equations of tangents to curves. • Use differentiation to find the equations of normals to curves. 	Students should have the pre-requisite knowledge of point-slope form of a straight line.	✓		<ul style="list-style-type: none"> ● Equations of normal and tangent lines 	
	2	10.2 Local Extrema and First Derivative Test	<ul style="list-style-type: none"> • Understand the concept of increasing function and decreasing function. • Learn the concept of local extremum. • Learn and apply the first derivative test to find local extrema. 	Students should have the pre-requisite knowledge of the direction of a straight line with positive slope or negative slope.	✓ ✓ ✓	✓	<ul style="list-style-type: none"> ● Critical points and graphing with calculus ● Testing critical points for local extrema 	
	3	10.3 Concavity and Second Derivative Test	<ul style="list-style-type: none"> • Understand the concept of concavity of a curve. • Learn and apply the second derivative test to find local extrema. 	Students should understand the cases that the second derivative test is not applicable in finding local extrema.	✓ ✓	✓	<ul style="list-style-type: none"> ● Concavity, concave upwards and concave downwards intervals 	
	6	10.4 Curve Sketching	<ul style="list-style-type: none"> • Learn the concept of points of inflexion. • Learn the concept of asymptotes. • Learn how to sketch the graphs of polynomial functions and rational functions. 	Some software (e.g. GeoGebra) can help students check whether they sketch the graphs of functions properly. Teachers may introduce the software to students.	✓ ✓		<ul style="list-style-type: none"> ● Inflection points ● Graphs of rational functions 	
	4	10.5 Global Extrema and Optimization Problems	<ul style="list-style-type: none"> • Learn the concept of global extrema. • Learn the method of using differentiation to solve optimization problems. 		✓		<ul style="list-style-type: none"> ● Optimization with calculus 	
	3	10.6 Rates of Change	<ul style="list-style-type: none"> • Understand the concepts of instantaneous velocity and acceleration. • Use differentiation to find the instantaneous velocity and acceleration. • Use differentiation to find the 	Students should distinguish the concepts of the average rate of change and the instantaneous rate of change.	✓ ✓		<ul style="list-style-type: none"> ● Related rates 	

rate of change of a quantity.

Other Resources:

Chapter 11 Indefinite Integration (I)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	11.1 Concept of Indefinite Integration	To recognise the concept of indefinite integration.		✓		<ul style="list-style-type: none"> • Indefinite integral as anti-derivative 	
	3	11.2 Basic Integration Formulas for Elementary Functions	<ul style="list-style-type: none"> • To learn how to use the integration formulas of algebraic, exponential functions to find integrals. • To understand the basic properties of indefinite integrals. 	Teachers should help students understand the basic integration formulas and their proofs.			<ul style="list-style-type: none"> • Integration techniques 	
	4	11.3 Integration by Substitution	To learn how to use integration by substitution to find indefinite integrals.	For the integrand in the form $f(g(x))g'(x)$, teachers should explain why $\int f(g(x))g'(x)dx$ can be written as $\int f(g(x))d[g(x)]$ without introducing the substitution $u = g(x)$.	✓		<ul style="list-style-type: none"> • Integration techniques 	
	6	11.4 Solving Problems by Indefinite Integration	<ul style="list-style-type: none"> • To learn how to use indefinite integration to solve geometrical problems.. • To learn how to apply indefinite integration to physics and other real-life or mathematical contexts 	For daily-life applications, teachers may also explain the actual meanings of the integration constants.	✓			

Other Resources:

Chapter 12 Indefinite Integration (II)

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	2	12.1 Integration Formulas for Trigonometric Functions	Learn how to use basic integration formulas to find the indefinite integrals of trigonometric functions.					
	5	12.2 Integration of Trigonometric Functions by Substitution	<ul style="list-style-type: none"> Learn how to find integrals involving trigonometric functions by simple substitution. Learn how to find integrals using product to sum formulas. Learn how to find integrals in the form $\sin^m x \cos^n x$. Learn how to find integrals in the form $\tan^m x \sec^n x$ or $\cot^m x \operatorname{cosec}^n x$. 	<ul style="list-style-type: none"> Ask students to prove new formulas introduced in this section. Help students revise product to sum formulas. 			<ul style="list-style-type: none"> Integration using trigonometric identities Trigonometric substitution 	
	2.5	12.3 More about Integration by Substitution	<ul style="list-style-type: none"> Understand the concept of inverse trigonometric functions and their principal values. Learn how to find integrals involving $\sqrt{a^2 - x^2}$, $\sqrt{a^2 + x^2}$ and $\sqrt{x^2 - a^2}$. 	Students should understand why we substitute $x = a \sin \theta$, $a \tan \theta$ and $a \sec \theta$ for integrals involving $\sqrt{a^2 - x^2}$, $\sqrt{a^2 + x^2}$ and $\sqrt{x^2 - a^2}$ respectively.	✓		<ul style="list-style-type: none"> Division and partial fraction expansion 	
	3	12.4 Integration by Parts	Learn how to find indefinite integrals using integration by parts.	Teachers should consider going through all examples in this section as the examples show different techniques of using integration by parts.	✓		<ul style="list-style-type: none"> Integration by parts 	

Other Resources:

Chapter 13 Definite Integration

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	5	13.1 Definite Integration	<ul style="list-style-type: none"> To recognise the concept of definite integration. To understand the properties of definite integrals. To recognise the Fundamental Theorem of Calculus. 	Teachers may skip the proof of the Fundamental Theorem of Calculus.	✓	✓	<ul style="list-style-type: none"> Riemann sums and integrals 	
	4	13.2 Evaluating Definite Integrals by Substitution	To evaluate definite integrals of algebraic functions, trigonometric functions, exponential functions and logarithmic functions by substitution.	The main concept of finding definite integral by substitution is to transform the integrand to another form that the primitive function can be found with basic integration rules.	✓		<ul style="list-style-type: none"> Properties of the definite integral 	
	4	13.3 Evaluating Definite Integrals Using Integration by Parts	To evaluate definite integrals of algebraic functions, trigonometric functions, exponential functions and logarithmic functions using integration by parts.	Techniques of using integration by parts in this section are similar to those in Chapter 12.	✓			
	3.5	13.4 More about Definite Integrals	<ul style="list-style-type: none"> To understand the properties of the definite integrals of odd, even and periodic functions. To evaluate definite integrals of odd, even and periodic functions using these properties. 	Proofs of the theorems in this section are not difficult. Teachers may explain the proofs given in the appendix on p.E.22.	✓ ✓			

Other Resources:

Chapter 14 Applications of Definite Integration

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	4	14.1 Finding Plane Areas by Definite Integration	To use definite integration to find the areas of plane figures.	When students find the area bounded by a certain curve, the graph of the curve sometimes is not given. Teachers should remind students to sketch the curve first so that they know the position of the bounded region.	✓		<ul style="list-style-type: none"> ● Area between curves 	
	5	14.2 Finding Volumes of Solids of Revolution by the Disc Method	<ul style="list-style-type: none"> • To use the disc method to find the volume of a solid revolved about one of the coordinate axes. • To use the disc method to find the volume of a solid revolved about a straight line parallel to one of the coordinate axes. 	Teachers may use the animation provided in the Teaching CD-ROM so that students can visualize the concept of the Disc Method.	✓	✓	<ul style="list-style-type: none"> ● Volume of solids with known cross sections 	
	OUT-C	14.3 Finding Volumes of Solids of Revolution by the Shell Method	<ul style="list-style-type: none"> • To use the shell method to find the volume of a solid revolved about one of the coordinate axes. • To use the shell method to find the volume of a solid revolved about a straight line parallel to one of the coordinate axes. 	Teachers can explain the Shell Method with the website below: http://mathdemos.gesu.edu/mathdemos/shellmethod/gallery/gallery.html So, students can visualize the concept of the Shell Method.	✓			

Other Resources:

Chapter 15 Matrices

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	15.1 Matrices	<ul style="list-style-type: none"> Understand the basic concepts and notation of matrices. Recognise the special kinds of matrices such as zero matrices, square matrices, identity matrices, etc. 	<ul style="list-style-type: none"> Apart from introducing different kinds of matrices, teachers should mention the concept of equality of matrices. 	✓		<ul style="list-style-type: none"> Introduction Zero and identity matrices 	
	5	15.2 Matrix Operations	<ul style="list-style-type: none"> Understand the operations of matrices such as addition, subtraction and scalar multiplication. Understand the properties of transpose of matrices. Understand the properties of multiplication of matrices. 	<ul style="list-style-type: none"> Teachers should emphasize that matrix operations are different from real number operations. Teachers may also compare properties of operations of matrices with that of real numbers. In this section, some questions require students to prove a matrix formula using mathematical induction. Teachers may help students review the related concepts if necessary. 	✓		<ul style="list-style-type: none"> Adding and subtracting matrices Multiplying matrices by scalars Transpose of a matrix Intro to matrix multiplication 	<ul style="list-style-type: none"> ✓ ✓

Other Resources:

- [Interactive Mathematics](#)
- [KHAN Academy](#)

Chapter 16 *Determinants and Inverses of Square Matrices*

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	3	16.1 Determinants	<ul style="list-style-type: none"> Recognise the concept of determinants of order 2 and order 3. Learn to expand determinants of order 3 by Sarrus' rule. Recognise the concept of the minor and the cofactor of an element in a determinant. Learn to expand determinants of order 3 by cofactor expansion. 	<ul style="list-style-type: none"> When evaluating determinants of order 3, students must learn how to choose the most efficient method, Sarrus' rule or cofactor expansion. 	<ul style="list-style-type: none"> ✓ ✓ 		<ul style="list-style-type: none"> Rule of Sarrus Matrix of minors and cofactor matrix 	
	3	16.2 Properties of Determinants	Recognise the properties of determinants.	<ul style="list-style-type: none"> Many students mix up the properties of matrices and determinants. Teachers should emphasize that their properties are completely different. In this section, teachers should not let students use Sarrus' rule. Students should apply theorems 16.4 – 16.10 when expanding a determinant. 	<ul style="list-style-type: none"> ✓ 			
	4	16.3 Inverses of Square Matrices	<ul style="list-style-type: none"> Understand the concept of singular matrices and non-singular matrices. Understand the concept of the inverse of a matrix. Understand the concept of cofactor matrices and adjoint matrices. Understand the computation of the inverse of a matrix. Understand the properties of the inverse of a matrix. 	<ul style="list-style-type: none"> Teachers should make sure that students know how to find the inverse of a square matrix. In Chapter 17, students need to solve systems of linear equations by method of inverse matrix. Many students may carelessly treat properties of the inverse of a square matrix as common properties of all matrices. Teachers should remind students to check whether the given square matrix is non-singular 	<ul style="list-style-type: none"> ✓ 	<ul style="list-style-type: none"> ✓ 	<ul style="list-style-type: none"> Determining invertible matrices (Singular Matrices) Introduction to matrix inverses 	<ul style="list-style-type: none"> ✓

whenever applying Theorem 16.16.

Other Resources:

- [Interactive Mathematics](#)
- [KHAN Academy](#)

Matrix calculator:

<http://matrix.reshish.com/add&sub.php>

<http://ncalculators.com/matrix/inverse-matrix.htm>

<http://www.emathhelp.net/calculators/linear-algebra/inverse-of-matrix-calculator/>

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Chapter 17 System of Linear Equations

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	17.1 Basic Concepts of Systems of Linear Equations	<ul style="list-style-type: none"> Recognise the concepts of a system of m linear equations in n unknowns. Understand the concepts of a system of homogeneous linear equations and a system of non-homogeneous linear equations. Determine whether a system of linear equations is consistent or inconsistent. 	Teachers may give more examples of consistent or inconsistent systems of linear equations if needed.				
	2	17.2 Method of Inverse Matrix	<ul style="list-style-type: none"> Recognise the concept of a matrix equation $AX = B$ and convert a system of linear equations to its matrix equation. Understand the technique of solving a system of linear equations of order 2 or 3 by the method of inverse matrix. Determine whether a system of linear equations of order 2 or 3 has a unique solution or not. 	Teachers may point out that Theorem 17.2 does not imply ' $AX = B$ has no solution if and only if A is singular'. In fact, if A is singular, $AX = B$ has either no solution or infinitely many solutions.	✓		<ul style="list-style-type: none"> Solving equations with inverse matrices 	
	2	17.3 Cramer's Rule	<ul style="list-style-type: none"> Recognise the concept of Cramer's Rule. Solve a system of linear equations of order 2 and 3 by Cramer's Rule. 	<ul style="list-style-type: none"> Teachers should mention that both Method of Inverse Matrix and Cramer's Rule only help us find a unique solution as the required coefficient matrix must be a non-singular square matrix. To raise students' attention, teachers may point out that there is a method for finding not only unique solution but also infinitely many solutions, and such method will be discussed in next section. 	✓			✓

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5	17.4 Gaussian Elimination	<ul style="list-style-type: none"> • Recognise the concept of converting a system of linear equations to its augmented matrix. • Recognise the concept of the three types of transformations involved in solving a system of linear equations. • Recognise the concept of the corresponding three types of elementary row operations involved in simplifying an augmented matrix. • Recognise the concept of Row Echelon form and understand the method of back substitution. • Learn to solve a system of linear equations by Gaussian elimination. • Learn to use Gaussian elimination to distinguish the following cases: <ul style="list-style-type: none"> (a) The system has a unique solution. (b) The system has infinitely many solutions. (c) The system has no solution. 	<ul style="list-style-type: none"> • Students may easily treat the elementary row operations as certain properties of matrices or determinants. Teachers should clarify that the main role of elementary row operations is to transform systems of equations. • Teachers should guide students to transform the augmented matrix into row echelon form. Meanwhile, teachers should emphasize that the process involved is not unique. 	✓		<ul style="list-style-type: none"> • Row-echelon form and Gaussian elimination 	✓
2	17.5 System of Homogeneous Linear Equations	<ul style="list-style-type: none"> • Recognise the concept of a system of homogeneous linear equations. • Recognise the concept and condition for trivial solution and non-trivial solutions of a system of homogeneous linear equations. • Learn to find the non-trivial solutions of a system of homogeneous linear equations. 	Students may mix up the meanings of unique solution, trivial solution, non-trivial solutions and infinitely many solutions. Teachers should give more examples and help students distinguish those keywords.	✓			

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Chapter 18 Introduction to Vectors

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	1	18.1 Basic Concepts of Vectors	<ul style="list-style-type: none"> Understand the concepts of scalars and vectors. Recognise the notation of vectors. Understand the equality of vectors. Understand the concepts of negative vector, zero vector and unit vector. 	<p>Apart from introducing scalars and vectors, teachers should stress the concept of equality of vectors.</p>	✓		<ul style="list-style-type: none"> Intro to vectors & scalars Equivalent vectors 	
	3	18.2 Operations and Properties of Vectors	<ul style="list-style-type: none"> Understand basic operations of vectors, including addition, subtraction and scalar multiplication. Understand the properties of the addition and scalar multiplication of vectors. 	<ul style="list-style-type: none"> Teachers should emphasize that vector operations are different from real number operations. Students must consider both magnitudes and directions of vectors when performing vector operations. Teachers may also compare properties of operations of vectors with that of real numbers. Teachers should make sure that students understand the characteristics of parallel vectors and collinear points. 	✓	✓	<ul style="list-style-type: none"> Scalar multiplication of vectors Vector addition and subtraction Combined vector operations 	<ul style="list-style-type: none"> ✓ ✓ ✓
	2	18.3 Vectors in 2-dimensional Space	<ul style="list-style-type: none"> Understand the concept of position vectors. Understand the representation of a vector on a rectangular coordinate plane. 	<p>Teachers should clearly explain the concept of position vectors with respect to different reference points so that students should not constantly treat the point named O as the only reference point.</p>	✓			
	2	18.4 Vectors in 3-dimensional Space	<ul style="list-style-type: none"> Understand the 3-dimensional rectangular coordinate system. 	<p>Students may fail to recognise vectors in 3-dimensional space. Teachers should give more examples and explain them in details.</p>	✓			

		<ul style="list-style-type: none">• Understand the representation of a vector on a 3-dimensional rectangular coordinate system.					
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	3	18.5 Division of a Line Segment	Understand how to find the point of division using vectors.	Teachers should help students understand Theorem 18.7 for vectors in both 2D and 3D spaces.	✓			
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Chapter 19 **Scalar Products and Vector Products with Applications**

Week	Time Ratio	Section	Teaching Objective	Teaching Guide	5-Minute Lecture	Animation	KHAN	Interactive
	5	19.1 Scalar Product of Two Vectors	<ul style="list-style-type: none"> Understand the definition of scalar product of two vectors. Understand the properties of scalar product. Understand the scalar product of vectors in rectangular coordinate system. Understand the application of vectors to plane geometry. 	<ul style="list-style-type: none"> Teachers may let students prove some properties of scalar products in Theorem 19.1 by definition. Teachers should explain the geometric meaning of scalar product in details. Teachers should discuss scalar products of vectors in both 2D and 3D spaces. In this section, teachers should guide students to analyse geometric problems by using vectors only. 	✓	✓	<ul style="list-style-type: none"> Vector dot product and vector length 	✓
	5	19.2 Vector Product of Two Vectors	<ul style="list-style-type: none"> Understand the definition of vector product of two vectors. Understand the properties of vector product of two vectors. Understand the vector product of vectors in 3-dimensional coordinate system. Understand the scalar triple product in 3-dimensional coordinate system. 	<ul style="list-style-type: none"> Teachers should explain the geometric meaning of vector product in details. Teachers may help students review properties of determinants if needed. Teachers may let students prove Theorems 19.5 – 19.7 by using determinants. 	✓	✓	<ul style="list-style-type: none"> Cross product introduction 	✓
	4	19.3 More about Scalar Products and Vector Products	<ul style="list-style-type: none"> Understand the definition of projection of a vector onto another vector. Learn to find areas of plane figures using vectors. Learn to find volumes of solids using vectors. 	<ul style="list-style-type: none"> Teachers should discuss projection of vectors in both 2D and 3D spaces. Teachers should explain the geometric meaning of scalar triple product in details. 	✓		<ul style="list-style-type: none"> Vector triple product expansion 	<ul style="list-style-type: none"> ✓ ✓ ✓

Vector calculator:

<http://www.mathportal.org/calculators/matrices-calculators/vector-calculator.php>

<http://onlinemath.com/math/assistance/vector/>

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