Final Course Outline

Part I – Basics

0. **Coordinate Systems** (Fact Sheet B) ***Lecture 1***

1. **Vectors 1** (Fact Sheet A)
- A. Definition
- B. Components
- C. Simple multiplication and unit vectors
- D. Position vectors
- E. Addition and subtraction

2. **Complex numbers** 1 (Fact Sheet C) ***Lecture 2***
- A. Definition: real and imaginary parts
- B. The complex plane: Cartesian and polar form of complex numbers
- C. Simple operations (addition, multiplication etc.)
- D. Complex conjugation
- E. The division trick
- F. Example: a quadratic equation

3. **Complex numbers 2** (Fact Sheet C) ***Lecture 3***
- A. Euler's equation for the exponential form of complex numbers
- B. Operations with the exponential form
- C. Exploring the unit circle

4. **Vectors 2** (Fact Sheet E) ***Lecture 4***
- A. The dot (or scalar) product
- B. The cross (or vector) products
- C. Applications

5. **Geometry 1** (Fact Sheets D & F) ***Lecture 5***
- A. Direction
- B Equations of a straight line (in 2D)

Lecture 6
- C. The third dimension

6. **Linear equations 1** (Fact Sheets G & L)

A 2 equations in 2 unknowns (2 straight lines)

B. 3 equations in 3 unknowns (3 planes) ***Lecture 7***

7. **Determinants** (Fact Sheet H & B)

A. Cramer's rule and the determinant of the coefficients

B. Evaluation of 3×3 determinants ***Lecture 8***

C. General properties of determinants

D. Exploiting the properties

E. Machinery for bigger systems: double suffix notation ***Lecture 9***

8. **Matrices** (Fact Sheet I)

A. Basic definition: vectors as matrices

B. Matrices in context: matrix multiplication rule ***Lecture 10***

C. Matrix types and properties

D. Minors and cofactors ***Lecture 11***

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Part II – Development

9. **Linear Equations revisited** (Fact Sheet J)

A. Matrix inversion

B. The singular case ***Lecture 12***

B. The homogeneous case

10. **Vectors revisited** (Fact Sheet K)

A. The cross (vector) product with determinants

B The triple scalar product

C. The triple vector product

11. **Geometry revisited** ***Lecture 13***

A. Intersection of planes

B. Shortest distance from a point to a plane

C. Shortest distance from a point to a line

D. Shortest distance between two skew lines

12. Matrices revisited ***Lecture 14***

A. Rotation matrices in 2D
B. Linear transformations: stretch and shrink
C. Rotation matrices in 3D
D. Orthogonal matrices

Lecture 15

E. The eigenvalue problem
F. Diagonalisation
G. A 3×3 example
H. The matrices of quantum mechanics

13. Complex numbers revisited ***Lecture 16***

A. Powers and roots of complex numbers
B. Applications of complex numbers

14. Review