

## MTH-2B81 : Mathematics for Physical Scientists III

**1. Introduction:** This Autumn Semester unit is designed for students of physical science who have already passed the first year mathematics pre-requisites **Mathematics for Scientists I** and **II**. This unit is the pre-requisite for **Mathematics for Physical Scientists IV**, studied in the Spring. **Mathematics for Physical Scientists III** is taught by lectures and seminars. The unit goes on to cover the elements of complex variable theory. The calculus of vector fields is also treated.

**2. Timetable Hours, Credits, Assessments:** This is a 10 UCU unit of 16 lectures with 4 seminars. There are 2 modules : vector calculus (10 lectures + 2 seminars) and Matrix Algebra (6 lectures + 2 seminars). Assessment is by 100% coursework (marked homework and a test).

**3. Overview:** The vector calculus module is essential for modelling quantities or processes which vary in two or three dimensions. The vector operators div, grad and curl are defined, and various vector identities are explored. The divergence and Stokes' theorems are introduced. These theorems are particularly useful in the study of fluid dynamics. The Matrix Algebra module introduces the concept of a matrix, its basic algebra, and its usefulness in solving applied mathematical problems. In particular, the power of matrices in solving large sets of linear equations in many unknowns will be demonstrated. Such problems arise in a host of practical problems such as weather prediction.

### 4. Recommended Reading:

E Kreyszig "Advanced Engineering Mathematics" (Wiley)

This is available in the library.

### 5. Lecture Contents:

#### Vector Calculus and Matrix Algebra Modules

Scalar fields, gradient, directional derivative, level surfaces. **(3 lectures)**

Vector fields, divergence, Laplacian, curl, divergence theorem, Stokes's theorem, solenoidal vector fields. **(7 lectures)**

Introduction to matrices. Simple application (predator/prey population model). Systems of linear equations (introduced via two equations in two unknowns case). Solving systems of linear equations using elementary operations. Matrices and systems of linear equations. Gaussian elimination, row echelon form and back-substitution. Reduced row echelon form; use of rank to distinguish cases of no solution, unique solution, infinitely many solutions. **(4 lectures)**

Matrix inversion. Determinants and how to calculate them by expansion. Determinants and solutions to systems of linear equations (including homogeneous systems). **(2 lectures)**