



Lecture Notes for

**ENGI 4430**  
**Advanced Calculus**  
**for Engineering**

by

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**Table of Contents**

- 1. Parametric and Polar Curve Sketching**
- 2. Parametric Vector Functions**  
Arc length (Cartesian and polar); tangent, principal normal and binormal; curvature; velocity and acceleration (radial, transverse, tangential and normal components); surface of revolution (equation, area); area within curves (Cartesian and polar); review of lines and planes.
- 3. Multiple Integration**  
Double integrals (Cartesian and polar); re-iteration; change of variables and the Jacobian; second moments; triple integrals
- 4. Lines of Force**
- 5. Numerical Integration**  
trapezoidal and Simpson's rules for numerical integration; Newton's method for roots of  $f(x) = 0$
- 6. Gradient, Divergence and Curl**  
[Cartesian vectors only]
- 7. Non-Cartesian Coordinates**  
Conversion matrices Cartesian  $\leftrightarrow$  polar (cylindrical and spherical); derivatives of non-Cartesian basis vectors; gradient, divergence, curl and Laplacian in any orthonormal coordinate system
- 8. Line Integrals and Green's Theorem**  
Work, centre of mass of a wire; path independence; potential function (in  $\mathbb{R}^2$ )
- 9. Surface Integration**  
Projection method; surface method; centre of mass of a surface
- 10. Theorems of Gauss and Stokes**  
Gauss' divergence theorem; Archimedes' principle; Gauss' law; Stokes' theorem; path independence; potential function (in  $\mathbb{R}^3$ )
- 11. PDEs: d'Alembert solutions**  
Classification of PDEs; waves on infinite strings; d'Alembert solutions
- 12. PDEs: Fourier solutions**  
Waves on finite strings; Fourier solutions (separation of variables)
13. Suggestions for Formula Sheets

[Replace this page by the Course Outline  
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