Course content for MT2220, Vector Analysis and Fluids

Prerequisites:
MT1710 and MT1720

Aims:
- to study the integration and differentiation of vectors and scalars defined at points in space, introducing the concepts of scalar and vector fields;
- to familiarise the student with the use of general orthogonal curvilinear coordinates and the evaluation of differential operators;
- to introduce integral theorems and demonstrate their usefulness;
- to show how simple partial differential equations may be solved by the technique of separation of variables;
- to show how the acquired concepts can be applied in the field of dynamics of inviscid fluids.

Learning outcomes:
On completion of the course students should be able to:
- identify scalar and vector fields;
- calculate the gradient of a scalar field and the divergence and curl of a vector field;
- use general orthogonal curvilinear co-ordinates and, in particular, cylindrical and spherical polar co-ordinates;
- use the divergence theorem and Stokes' theorem;
- recognise when and how variables separate in a partial differential equation;
- apply the equations of continuity and motion for an inviscid fluid and use Bernoulli's equation;
- use velocity potential and apply it to examples of irrotational flow.

Course content:
Vector analysis: scalar and vector fields. Field lines for a vector field. Gradient of a scalar field, divergence and curl of a vector field. The del-operator. Cylindrical and spherical polar coordinates. General orthogonal curvilinear coordinates. Surface and volume integrals. The divergence theorem and Stokes' theorem. Green's theorem.
Partial differential equations: Laplace's equation, the diffusion equation and the wave equation in Cartesian coordinates. Separation of variables, used in plane polar and spherical coordinates.
Dynamics of inviscid fluids: equation of continuity. Velocity and acceleration. Equation of motion. Bernoulli's equation. Irrotational flow and velocity potential. Examples of potential flow of incompressible fluids.