Fluids and Waves

Roger Moore

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This material was developed for the second term of the first year calculus-based, introductory physics course at the University of Alberta. It contains a richer, more in-depth mathematical treatment of the material than many standard texts for first year courses and starts with the assumption that the reader is already familiar with calculus of polynomials and trigonometric and exponential functions.

The book has the following chapters each of which has its own end of chapter problems:

Mathematics - Complex numbers, complex exponentials, partial derivatives, experimental uncertainties.

Elasticity - Stress, strain, moduli of elasticity, bulk stress, strain and modulus

Fluid Statics - pressure, Pascal's law, measuring pressures, Archimedes' principle

Fluid Dynamics - continuity equation, Bernoulli's equation, Torricelli's law, viscosity, Poiseuille's law, Stokes' law

Oscillations - simple harmonic motion, simple and compound pendulums, damped harmonic motion, driven oscillators

Waves - types of waves, mathematical description of a wave, waves on a string, acoustic waves, wave power and intensity

Wave Interactions - principle of superposition, reflection at a boundary, interference, beats, standing waves, the relativistic and non-relativistic doppler effect

Light Waves - basic geometric optics, Huyghens' principle, dispersion, polarization, thin film interference, diffraction

Introduction to Quantum Mechanics - atomic spectra, blackbody spectrum, photo-electric effect, Bohr atom, de Broglie wavelength, Schrodinger equation

In addition there are two appendices which cover some of the more mathematically challenging topics in detail:

Wave Equations - derivation and general solution of the partial differential wave equation, derivation of the pressure and displacement wave equation for acoustic waves

Blackbody Spectrum - 2D and 3D standing waves, density of states for a cavity, calculation of Planck's spectrum, derivation of Wien's displacement law

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