

Table of Contents

1. **Introduction to Magnetohydrodynamics**
 - Historical background of MHD
 - Electrically conducting fluids
 - Interaction between fluid motion and magnetic fields
 - Kinematic and dynamic aspects of MHD
2. **The MHD Approximation**
 - Fundamental electromagnetic equations
 - Magnetohydrodynamic approximation
 - Ohm's law for a moving conductor
 - Equations of motion of conducting fluids
 - Electrical conductivity
 - Limitations of the MHD approximation
 - Hall effect
3. **The Kinematic Aspect of MHD**
 - Magnetic induction and diffusion
 - Transport of magnetic fields
 - Conservation of magnetic flux
 - Frozen-in magnetic field lines
 - Magnetic Reynolds number
 - Magnetic field convection and diffusion
 - Analogy between magnetic field and vorticity
 - Electromagnetic flowmeters
4. **The Magnetic Force and Its Effects**
 - Lorentz force
 - The $\mathbf{J} \times \mathbf{B}$ force
 - Maxwell stresses
 - Magnetic pressure and tension
 - Magnetohydrostatics
 - Pinch configurations
 - Generation and suppression of vorticity
 - Alfvén waves
 - MHD wakes
5. **External, Boundary and Initial Conditions**
 - MHD boundary conditions
 - Electric currents and circuits
 - Conducting and insulating walls
 - Contact resistance
 - Fluid–wall interfaces
 - Hartmann layers
 - Initial and upstream conditions
6. **Linear Problems of Constant Density**
 - Linear MHD flows
 - Hartmann flow
 - Linear Alfvén waves
 - Oscillating-wall problems
 - Rayleigh problem
 - Two-dimensional flows
 - Electromagnetic flowmeters

- Interaction between Hartmann layers and Alfvén waves

7. Magnetogasdynamics

- Energy and entropy equations
- Compressible conducting fluids
- One-dimensional flow in channels
- Transverse magnetic fields
- Magnetogasdynamics and gas-dynamics analogies
- Magnetoacoustic waves
- MHD shock waves
- Two-dimensional flows
- Infinite-conductivity flows
- Aligned magnetic fields

8. Problems and Applications

- Worked and supplementary problems
- Applications to conducting-fluid flows
- Electromagnetic flow measurement
- Engineering applications of MHD