First Semester Area C

CSE 389C/ME 397, Introduction to Mathematical Modeling in Science and Engineering I

1. Non-Linear Continuum Mechanics

1.1. Kinematics of Continua
1.2. Mass and Momentum
1.3. Force and Stress in Deformable Bodies
1.4. The Principles of Balance of Linear and Angular Momentum
1.5. Transport Phenomena
1.6. The Principle of Conservation of Energy
1.7. Thermodynamics of Continua and the Second Law
1.8. Constitutive Equations
1.9. Examples and Applications

2. Electromagnetic Field Theory

Part 1: Electrostatics
2.1. Coulomb's Law, Electric Field and Electric Flux, Gauss' Law for Electricity.
2.2. Electrostatic Potential
2.3. Free and Bound Charge, Conservation of Free Charge, Ohm's Law
2.4. Electric Dipole, Polarization and Dielectrics, Gauss' Law for Dielectrics
Part 2: Magnetostatics
2.5. Ampere's Force Law, Current Element and Biot-Savart Law
2.6. Ampere's Law for Magnetostatics
2.7. Magnetic Dipole, Magnetic Polarization and Magnetic Field
Part 3: Electromagnetic Wave Propagation
2.8. Maxwell Equations
2.9. Interface and Boundary Conditions, Interpretation in the Sense of Distributions.
2.10. Examples of EM Waves
2.11. Examples of Initial Boundary-Value Problems

3. Introduction to Quantum Mechanics

3.1. Wave and Particle Mechanics
3.2. Heisenberg's Uncertainty Principle
3.3. Schrödinger's Equations
3.4. Dynamical Variables and Observables
3.5. The Harmonic Oscillator and the Hydrogen Atom
3.6. Spin and Pauli's Principle
3.7. Atomic and Molecular Structure
3.8. Ab-Initio Methods: Approximate Methods and Density Functional Theory