TOPICS

A.)   Structure of MHD

i.)   MHD equations and meaning
ii.)   Foundations of MHD
iii.)   Energy and Momentum Conservation Relations, Virial Theorems
iv.)   Reduced MHD: origin, construction

B.)   Waves and Turbulence in MHD

i.)   The Alfven Wave
ii.)   Waves: General Calculation, specifics, Fredricks Diagram
iii.)   Basics of MHD Shocks
iv.)   Nonlinear Alfven Waves, collisionless shocks
v.)   Basic Physics of Wave Interactions
      1.)   3 Wave interactions, Manly-Rowe Relations
      2.)   Wave Kinetics, Resonance Conditions
      3.)   Non-Local Interactions
      4.)   Langmuir Turbulence
      5.)   Decay Instability of Alfven Wave
vi.)   Basics of MHD Turbulence
      1.)   Navier-Stokes Turbulence
      2.)   MHD Turbulence – basic ideas
      3.)   Kraichnan-Iroshnikov, Goldreich-Sridhar Scalings
      4.)   Alignment

C.)   Stability Theory I

i.)   Formulation and Structure of MHD Energy Principle
ii.)   Basic Examples
      a.)   Rayleigh-Benard
      b.)   Rayleigh-Taylor (review)
      c.)   Interchange Instability, Line-Tying
iii.)   Magnetic Instabilities
      a.)   Sausage Mode and hydro analogue
      b.)   Kink Mode, Kruskal-Shafranov Criterion
      c.)   Magnetorotational Instability
iv.)   Kinetic Energy Principle for Self-Gravitating Matter

D.)   Introduction to Non-Ideal MHD

i.)   Local Non-Ideal Behavior: Sweet-Parker Reconnection: Basic Scalings
ii.)   Global Non-Ideal Behavior (2D): Prandtl-Batchelor Theorem, PV
      Homogenization, Flux Expulsion
iii.)   Magnetic Helicity, Selective Decay, Taylor Relaxation
iv.)   Basics of Mean Field Electrodynamics, Kinematic Dynamo Theory

E.)   Stability II (Resistive Modes), Stochastic Fields

i.)   Basic Ideas of Resonances, Resistive Modes
ii.)   Resistive Interchange: Fast, Slow
iii.)   Tearing and Magnetic Island Evolution
iv.)   Stochastic Fields and Transport
v.)   Implications for Relaxation