TOPICS

A.) Basics of Ideal MHD

i.) MHD equations and their meaning and origin
ii.) Freezing-in law: Formulation, Proof, Application
iii.) Energy and Momentum Conservation Relations
iv.) Linear Waves in MHD: General Calculation, Specific Cases, Fredrick's Diagram

B.) 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.) Basic concepts of Fluid and MHD Turbulent Cascades
iv.) Magnetic Helicity and Taylor Relaxation
v.) Basic Ideas of Mean Field Electrodynamics
vi.) Basics of MHD Shocks
vii.) Nonlinear Alfven Waves and Collisionless Shocks

C.) Ideal and MHD Stability Theory

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

D.) Resistive MHD Stability, Magnetic Resonances, Stochastic Fields

i.) Basic Ideas of Resonances, Resistive Modes, etc.
ii.) Resistive Interchange: Fast, Slow
iii.) Twisted Slicing Modes, Wave Packets and basic ideas of ballooning stability
iv.) Tearing and Magnetic Island Evolution
v.) Review of Quasilinear Theory
vi.) Stochastic Magnetic Fields and Transport
vii.) Implications for Relaxation

E.) Introduction to Drift Wave Turbulence

i.) Non-Ideal Ohm's Law
ii.) Review of Drifts
iii.) Formulating Resistive-Drift Fluid Models
iv.) Hasegawa-Wakatani, Hasegawa-Mima Systems
v.) Drift Waves, Instabilities, Energetics
vi.) Mean Field Evolution: Transport and Zonal Modes
vii.) Dynamics of Zonal Flow Formation