ENGS 152/PHYS 115 **MAGNETOHYDRODYNAMICS** **Winter, 2009**

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Class time: Tuesdays and Thursdays 2-4 pm, X-hour Wednesday 4:15-5:30 pm **Classroom:** Cummings 200

Evaluation criteria: Weekly Exercises (55%); Midterm Exam (20%); Final Exam (25%)

Textbook: *Principles of Magnetohydrodynamics: Applications to Laboratory and Astrophysical Plasmas* by Hans Goedbloed and Stefan Poedts, Cambridge University Press, 2004

Tentative Lecture Schedule

Week 1	Plasma Physics and Magnetohydrodynamics	
	Motivation: The MHD description Review: Essential plasma physics	1,2, Notes
	MHD model: Postulates and derivation of two-fluid and one-fluid MHD from kinetic theory; scale independence	3

Week 2	MHD Conservation Properties	
	Magnetic flux tubes; flux conservation; conservative form of MHD equations; conservation laws	4.1-4.3
	Dissipative MHD; jump conditions; MHD discontinuities	4.4-4.6

Week 3	MHD Waves and Characteristics	
	MHD waves; phase velocity, group velocity; dispersion diagrams	5.1-5.2
	Friedrichs diagrams; characteristics	5.3-5.4

Week 4	MHD Equlibria	
	MHD equilibria; magnetohydrostatics; Grad-Shafranov equation	Notes
	Cylindrical plasmas	9

Week 5	Spectral Theory	
	Stability concepts; force operator formalism; initial value problem	6.1-6.3
	Quadratic forms; variational principles; energy principle; extension to interface plasmas	6.4-6.6

Week 6	Waves and Instabilities in Inhomogeneous Plasmas	
	Gravitating magnetofluids; interchange and Rayleigh-Taylor instability	7
	Kelvin-Helmholtz instability; rotational instability	Notes

Week 7	Channel Flows and Boundary Layers	
	Channel flows; boundary layers	Notes
	MHD generators and propulsion	Notes

Week 8	Resistive Plasmas	
	Force-free magnetic fields; resistive equilibria	Notes
	Magnetic reconnection; tearing instability	18, Notes

Week 9	Transonic Flows and Shocks	
	Stellar and planetary outflows	Notes
	Transonic equilibria	Notes

Week 10	Resonant Absorption	
	Alfvén continuum, phase mixing and resonant absorption	10,11