ECE 604 Electromagnetic Field Theory

Instructor: Professor W.C. Chew, x4-5402, Wang 3053, (wcchew), (m) 217-390-9653
Office Hours: Tue: 7:00-8:00 pm, Wed: 7:00-8:00 pm, Thu: 7:00-8:00 pm (Zoom to accommodate online students) (tentative)
TA: Ivan Okhmatovskii (iokhmato), (Unofficial) TA: Boyuan Zhang (zhang3241)
Assist. Instructor: Dr. Dongyeop Na (na32)
Secretary: Lori Carte, Wang 2080 (lcarte)
Recommended Textbook: Fields and Waves in Communication Electronics, S. Ramo, J.R. Whinnery, and T. Van Duzer, 3rd Ed. (The course will be taught from lecture notes at https://engineering.purdue.edu/wcchew/)
Supplementary Texts: Electromagnetic Wave Theory, J.A. Kong. ECE 350X notes. Theory of Optical and Microwave Guides notes. Waves and Fields in Inhomogeneous Media, Chap. 1. Classical Electrodynamics, J.D. Jackson. Electromagnetic Noise and Quantum Optical Measurements, H.A. Haus.
Spring 2022, Mon Wed Fri online
Course Outline (Revised Jan 10, 2022)

ECE604-I, EMFT-I **Fundamentals, Complex Media, Theorems and Principles**

	Mon	**Wed**	**Fri**
Week 1 Jan 10- Jan14	1. Introduction, Maxwell's equations.	2. Maxwell's equations, differential operator form.	3. Constitutive relations, wave equation, electrostatics, and static Green's function.
Week 2 Jan 17- Jan21	4. Magnetostatics, boundary conditions, and jump conditions.	5. Biot-Savart law, conductive media interface, instantaneous Poynting's theorem.	6. Time-harmonic fields, complex power. (delivered by Dr. NA)
Week 3 Jan 24- Jan28	7. More on constitutive relations, uniform plane wave.	8. Lossy media, Lorentz force law, Drude-Lorentz-Sommerfeld model.	9. Waves in gyrotropic media, polarization.
Week 4 Jan 31- Feb 4	10. Spin angular momentum, complex Poynting's theorem, lossless condition, energy density.	11. Uniqueness theorem.	12. Reciprocity theorem.
Week 5 Feb 7- Feb 11	13. Equivalence theorem, Huygens' principle.	Review	EXAM

ECE604-II, EMFT-II **Transmission Lines, Waves in Layered Media, Waveguides, and Cavity Resonators**

	Mon	**Wed**	**Fri**
Week 1 Feb 14- Feb 18	14. Circuit theory revisited.	15. Transmission lines.	16. More on transmission lines.
Week 2 Feb 21- Feb 25	17. Multi-junction transmission lines, duality principle.	18. Reflection, transmission, and interesting physical phenomena.	19. More on interesting physical phenomena, homomorphism with transmission lines
Week 3 Feb 28- Mar 4	20. Waves in layered media.	21. Dielectric slab waveguides.	22. Hollow waveguides.
Week 4 Mar 7- Mar 11	23. More on hollow waveguides.	24. More on waveguides and transmission lines.	25. Cavity resonators.
Week 5 Mar 14- Mar 18	26. Quality factor of cavities, mode orthogonality.	Review	EXAM

ECE604-III, EMFT-III **Radiation, High-Frequency Approximation, Computational Electromagnetics, Quantum Theory of Light**

	Mon	**Wed**	**Fri**
Week 1 Mar 21- Mar 25	27. Scalar and vector potentials.	28. Radiation by a Hertzian dipole.	29. Radiation fields.
Week 2 Mar 28- Apr 1	30. Array antennas, Fresnel zone, Rayleigh distance.	31. Different types of antennas-heuristics.	32. Shielding, image theory.
Week 3 Apr 4 - Apr 8	33. High frequency solutions, gaussian beams.	34. Scattering of electromagnetic field.	35. Spectral expansions of source fields-Sommerfeld integrals.
Week 4 Apr 11 - Apr 15	36. Computational electromagnetics, numerical methods.	37. Finite difference method, Yee algorithm.	38. Quantum theory of light.
Week 5 Apr 18 - Apr 22	39. Quantum coherent state of light.	Review	EXAM

HW=300 pts, EXAMS 1, 2, 3=400 pts, Class/OH/RQ Participation=70, TOTAL=770 pts