University of Tehran
School of Electrical and Computer Engineering

Course:	**8101450 – Theory of Electromagnetics**
Course type:	EE*: Com ☐ Required ☒ / Elective ☐; E ☐ / ☐; P ☐ / ☐; B ☐ / ☐; Con ☐ / ☐; D ☐ / ☐ CE*: SW ☐ / ☐; HW ☐ / ☐; IT ☐ / ☐ Credit: 3
Level:	Undergraduate ☐ Graduate ■
Co-requisite(s):	None
Prerequisite(s):	Fields and Waves (8101389)
Prerequisite by topic:	Microwave theory and engineering, antenna theory and engineering, partial differential equations
Textbook(s):	R. F. Harrington, *Time-Harmonic Electromagnetic Fields*. New York: McGraw-Hill, 1961, ch. 3 to 6.
Coordinator:	Mahmoud Shahabadi, Professor, School of ECE
Goals:	This course intends to deal with deterministic non-quantum Maxwell's equations in macroscopic world. The course is addressed to graduate students of electrical engineering who are usually familiar with Maxwell's equations through undergraduate courses such as Engineering Electromagnetics, Fields and Waves, Antenna, and Microwave Engineering. It is the goal of the present course to introduce some of the fundamental theorems of electromagnetics such as uniqueness, reciprocity, and equivalence principle in their most general forms. This is followed by a thorough study of canonical scattering and waveguide problems in three coordinate systems, namely in the rectangular, cylindrical, and spherical coordinate systems. To make the course more fruitful for engineers, we apply the methods developed in this course to a number of engineering problems such as near-field antenna measurements, optical waveguides, special antennas, etc.
Outcome:	Upon successful completion of the course, students will be able

	1. to choose appropriate mathematical formulations for a wide range of scattering or waveguide problems in electrodynamics, 2. to understand theoretical basis of various numerical methods in electromagnetics, 3. to benefit from the skills developed during this course for solving real-world engineering problems related to applied electromagnetics.
Topics:	**1. Introduction** **2. Fundamental Theorems of Electromagnetics** (point and integral form of Maxwell's equations, constitutive relations, uniqueness theorem, principle of equivalence, induction theorem, principle of reciprocity, effective currents, scalar potentials) (10 lectures) **3. Plane-Wave Functions** (harmonic functions in the rectangular coordinate system, basic solutions, waveguide problems, radiation and scattering problems, spectral domain technique) (10 lectures) **4. Cylindrical-Wave Functions** (cylindrical Bessel functions, basis functions for waveguide problems, radial waveguides, radiation in the cylindrical coordinate system, scattering by cylinders, diffraction by wedge) (6 lectures) **5. Spherical-Wave Functions** (spherical Bessel functions, potential functions for TE to *r* and TM to *r* modes, radiation as eigen-modes of a spherical waveguide in free space, spherical resonators, scattering by conducting sphere) (6 lectures)
Computer usage:	MATLAB
Assignments:	12 homework assignments
Projects:	
Grading:	Assignments: 25 % Midterm exams 1 and 2: 50 % Final exam: 25 %
Further readings:	[1] R. E. Collin, *Field Theory of Guided Waves*. New York: IEEE Press, 1991. [2] C. A. Balanis, *Advanced Engineering Electromagnetics*. New York: John Wiley, 1989, ch. 7 to 10. [3] J. A. Stratton, *Electromagnetic Theory*. New York: McGraw-Hill, 1941.
Prepared by:	Mahmoud Shahabadi
Date:	December, 2017

*EE: Electrical Engineering		CE: Computer Engineering	
Com	Communications	SW	Software
E	Electronics	HW	Hardware
P	Power	IT	Information Technology
B	Bioelectronics		
Con	Control		
D	Digital System		