City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A 2022/2023

Part I Course Overview

Course Title:	Applied Electromagnetics in Electronic Design
Course Code:	EE5604
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	EE2104 Introduction to Electromagnetics or EE3109 Applied Electromagnetics or equivalent
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

The course aims to provide students with an understanding of the principles of *Electromagnetic Field theory with* Computational Electromagnetics with emphasis on some basic problem-solving techniques via discovery learning. This leads to the solutions of more advanced and practical electromagnetic problems in circuit or product design, commonly faced by electronic engineers in the industry.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Apply the Maxwell's equations in solving quasi-static electromagnetic problems.		✓	✓	
2.	Understand the Maxwell's equations, and the on-the-market EM field computational software.		✓	✓	
3.	Apply EM field theories in solving some practical and classical problems with Computational Electromagnetics techniques.		✓	✓	✓
4.	Apply practical techniques for solving some industrial EM problems.		✓	✓	✓
		100%			

A1: *Attitude*
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: *Ability*
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lecture	The teaching method of this course is Problem-based Learning in which students learn about the approach to some EM solutions in the context of complex, multifaceted, and realistic problems.	✓	✓	✓	✓			3 hrs/wk (*Some of the lecturers will be conducted in the laboratory)*
Laboratory /Case study	Assignment/case study/experiment designed to gain practical hands-on experience and to reflect what they have learned on Computational Electromagnetics.	✓	✓	✓	✓			

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4				
Continuous Assessment: 50%								
Assignment 1	✓	✓					10%	
Assignment 2		✓	✓				10%	
Case study		✓	✓				30%	
Examination: 50% (duration: 2 Hours, if applicable)								
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1,2,3,4	The application of EM field to engineering problems is central to the aim of this course. Students are encouraged to develop the ability to integrate their learning into a real-world design in Applied Electromagnetics.
2,3,4,5	Students are required to complete an assignment/case study designed to gain practical hands-on experience and to reflect what they have learned in computational electromagnetics with practical problems, including analytical approach using Maxwell's equations and wave equations, to the use of more advance commercial available EM simulation tools such as IE3D, Fidelity, or HFSS.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Fundamental of Electromagnetic Field (5 weeks)
Revision and applications of Coulomb's law. Gauss's law. Ampere's law. Biot-Savart law. Maxwell's Equations. Wave propagation, Boundary conditions and equations.

Field evaluation of Static Electric field, Static Magnetic Field, and Quasi-Static Electromagnetic Field, Time varying Electromagnetic Field.

Common EM problems in electronic design industry. (2 weeks)
Mutual coupling in traces of PCBs, Radiation problem in PCB.

Numerical methods and tools for solving Electromagnetic Field problems (3 weeks)
Method of Moment, Finite-difference method, Finite-Difference-Time Domain Method, Finite-element method, Introduction to software IE3D, Fidelity, and HFSS.

EM techniques in solving industry EM problems (3 weeks)
Grounding, filtering, shielding, impendence matching, and coupling in traces of PCB.

Examples of Case Studies:
Students are assigned with case studies for creating their owned EM models, using either analytical approaches or advance commercial available EM simulation tools in solving some practical problems in:

1. L,R,C of traces of PCB –circuit modeling, using simple circuit equations for PCB design purpose.
2. Mutual capacitance and mutual inductance of traces of PCB –circuit modeling, using simple circuit equations for cross talk, and cross coupling of digital PCB design purpose.
3. Comparison of analytical outcomes with Empirical equations, e.g. 3W rules, 10H rules of PCB designs.
4. Shielding effectiveness of various materials using wave propagation equations.
5. Calculation of shielding effectiveness, of casing with aperture using simple numerical approach driving from Poisson Equations.
6. Shielding effectiveness of electronic equipment casing with apertures, using commercial numerical software.
7. Shielding effectiveness ferrite magnetic materials in for magnetic field interferences at power frequency.
8. Electric and/or magnetic emission of simple geometry using Maxwell's Equations.

9. Emission characteristics of equipment commercial available numerical software to more complex geometry.
10. Radiation patterns using commercial available numerical software to more complex geometries.
11. Component design in RF circuitry, including inductors and filters in GHz

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Designated manual/handbook/paper in the field of the computational EM field for case study and laboratory purpose.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	http://www.mentor.com/electromagnetic-simulation/
2.	"Fundamentals of Applied Electromagnetics" by Fawwaz Ulaby, Prentice Hall
3.	"Electromagnetics" by John Kraus, McGraw Hill.