Akashi College	Year	2022	Course Title	Advanced Electromagnetics

Course Information

Course Code	4019	Course Category	Specialized / Elective
Class Format	Lecture	Credits	Academic Credit: 2
Department	Mechanical and Electronic System Engineering	Student Grade	Adv. 1st
Term	Second Semester	Classes per Week	2
Textbook and/or Teaching Materials			
Instructor	KAJIMURA Yoshihiro		

Course Objectives

Evaluation item (1) Can formulate laws and problems of electrostatic field phenomena and solve applied problems.
Evaluation item (2) Understand the nature of dielectrics and can solve problems related to the quantitative evaluation of electric fields during polarization.
Evaluation item (3) Can formulate laws and problems of current and magnetic field phenomena and solve applied problems.
Evaluation item (4) Can derive Maxwell's electromagnetic equations and solve applied problems.

Rubric

	Ideal Level	Standard Level	Unacceptable Level
Achievement 1	Can formulate laws and problems of electrostatic field phenomena and solve applied problems.	Can formulate laws and problems of electrostatic field phenomena and solve problems.	Cannot formulate laws and problems of electrostatic field phenomena and solve problems.
Achievement 2	Understand the nature of dielectrics and can solve applied problems related to the quantitative evaluation of electric fields during polarization.	Understand the nature of dielectrics and can solve problems related to the quantitative evaluation of electric fields during polarization.	Do not understand the nature of dielectric materials and cannot solve problems related to the quantitative evaluation of electric fields during polarization.
Achievement 3	Can formulate laws and problems of current and magnetic field phenomena and solve applied problems.	Can formulate laws and problems of current and magnetic field phenomena and solve problems.	Cannot formulate laws and problems of current and magnetic field phenomena and solve problems.
	Can derive Maxwell's electromagnetic equations and solve applied problems.	Can derive Maxwell's electromagnetic equations and solve problems.	Cannot derive Maxwell's electromagnetic equations and solve problems.

Assigned Department Objectives

Teaching Method

Outline	This course is based on Electromagnetics I and II taught in the Electrical and Computer Engineering Department and aims to further enhance and develop the content. Electromagnetics I and II also largely provide university-level lessons, however some parts were either omitted due to academic constraints (related to peripheral basic academic ability, etc.), or simplified by relaxing their stricter handling. However for the Advance Courses, it is desirable to maintain the academic ability for basic subjects like electromagnetics at a university level both in name and reality. Therefore, the course aims to further raise the level while supplementing the content of Electromagnetics I and II.
Style	The evaluation will be based 100% on periodic exam scores. The pass mark is a score of 60 or more in total for these. Handouts will have content on electromagnetic theory, formulation, and specific computational problems.
Notice	This course's content will amount to 90 hours of study in total. These hours include the learning time guaranteed in classes and the standard self-study time required for pre-study / review, and completing assignment reports. It is recommend that students have studied Electromagnetics I and II (in years 3 and 4) at our school's Electrical and Computer Engineering Department prior to taking this course. Students who miss 1/3 or more of classes will not be eligible for a passing grade.

Characteristics of Class / Division in Learning

☐ Active Learning	☐ Aided by ICT	☑ Applicable to Remote Class	☐ Instructor Professionally Experienced

Course Plan

			Theme	Goals
2nd Semester	3rd Quarter	1st	Electrostatic fields in a vacuum Explain about the virtual concepts of electric fields and electric power lines as fields of electrical phenomena. Define the electric potential as potential of an electric field, and consider the electric field as an electric potential gradient. Use ▽ and grad for calculations in this case.	Understand the virtual concepts of electric fields and electric power lines as fields of electrical phenomena. Can define the electric potential as potential of an electric field, and consider the electric field as an electric potential gradient.
		2nd	Gauss's theorem Explain Gauss's theorem, which is most likely to be used when calculating electric fields, in terms of its meaning in physics and application to calculations, and introduce example problems.	Understand "Gauss's theorem", which is most likely to be used when calculating electric fields, in terms of its meaning in physics and application to calculations, and solve example problems.
		3rd	Laplace's and Poisson's equations Examine the divergence of electric power lines and vectors in both physical and mathematical terms by introducing divergence (div). Also, explain example uses for Laplace's and Poisson's equations, which are the most versatile and well-known equations for describing electrostatic fields.	Can examine the divergence of electric power lines and vectors in both physical and mathematical terms by introducing divergence (div). Also understand how to use Laplace's and Poisson's equations, which are the most versatile and well-known equations for describing electrostatic fields.

		4th	Capacitance Outline the potential and capacity factors, and the energy of conductive systems, in regards to a charged conducting system. Learn more about the two most popular conducting systems, namely capacitance, including examples of actual calculations.	Understand the potential and capacity factors, and the energy of conductive systems, in regards to a charged conducting system. Understand the two most popular conducting systems, namely capacitance, including examples of actual calculations.
		5th	Dielectric materials (polarization) In many cases, capacitors have insulators (dielectrics) rather than vacuums (air). Learn about various materials' dielectric properties by introducing the concept of flux density in order to understand the physical phenomena of dielectric materials in electric fields.	In many cases, capacitors have insulators (dielectrics) rather than vacuums (air). Can explain various materials' dielectric properties by introducing the concept of flux density in order to understand the physical phenomena of dielectric materials in electric fields.
		6th	Electric fields in dielectric materials Solve example problems and explain the handling of electric fields in dielectric materials, in particular, the interface conditions for dielectric devices, electric power line refraction, the energy density of electric fields, and the forces acting on dielectric materials (the virtual displacement method).	Can solve example problems and explain the handling of electric fields in dielectric materials, in particular, the interface conditions for dielectric devices, electric power line refraction, the energy density of electric fields, and the forces acting on dielectric materials (the virtual displacement method).
		7th	Electric field imaging When finding electric fields in vacuums and dielectrics, while it is generally necessary to solve Laplace's and Poisson's equations, in some special boundary conditions, one can use a sophisticated and simple "imaging" method that has been known for many years. Explain this "imaging" method.	When finding electric fields in vacuums and dielectrics, while it is generally necessary to solve Laplace's and Poisson's equations, in some special boundary conditions, one can use a sophisticated and simple "imaging" method that has been known for many years. Can explain this "imaging" method.
		8th	Current fields and electrostatic fields When a current is distributed through a continuous conductor there are times when problems may be easily solved by using similarities with the electrostatic field. Also, electromagnetically express Kirchhoff’s Law, which often appears in circuits.	When a current is distributed through a continuous conductor there are times when problems may be easily solved by using similarities with the electrostatic field. Also, electromagnetically express Kirchhoff’s Law, which often appears in circuits.
	4th Quarter	9th	Magnetic field Explain in detail the process that starts with the Biot–Savart law and derives Ampère's circuital integral law, from the fundamental point of view that currents are the sources of magnetic fields.	Can explain the process that starts with the Biot–Savart law and derives Ampère's circuital integral law, from the fundamental point of view that currents are the sources of magnetic fields.
		10th	Calculation of magnetic field distribution In describing a magnetic field that has a different starting point from that of an electric field, it becomes necessary to have a mathematical expression that differs from that of an electric field. In magnetic fields, the vector rotation (rot) is important. Explain vector potential, forces acting on electric currents, etc.	In describing a magnetic field that has a different starting point from that of an electric field, it becomes necessary to have a mathematical expression that differs from that of an electric field. Can explain vector rotation (rot) in magnetic fields, vector potential, forces acting on electric currents, etc.
		11th	Magnetic substances Most actual electric equipment that utilize magnetic fields use magnetic substances (ferromagnetic substances). Explain magnetic substances that are difficult to handle theoretically, including the correspondence between magnetic and electrostatic fields (BD- and HE-compatible), magnetic circuits, and the energy density of magnetic fields.	Most actual electric equipment that utilize magnetic fields use magnetic substances (ferromagnetic substances). Can explain magnetic substances that are difficult to handle theoretically, including the correspondence between magnetic and electrostatic fields (BD- and HE-compatible), magnetic circuits, and the energy density of magnetic fields.
		12th	Electromagnetic induction phenomenon Electromagnetic induction phenomenon is the principle for many kinds of equipment such as generators. However, electromotive force is generated by both the temporal variation of the magnetic flux itself and the relative motion of the conductor to it. Treat this phenomenon mathematically and derive Maxwell's electromagnetic equations.	Electromagnetic induction phenomenon is the principle of many kinds of equipment such as generators. However, electromotive force is generated by both the temporal variation of the magnetic flux itself and the relative motion of the conductor to it. Can treat this phenomenon mathematically and derive Maxwell's electromagnetic equations.
		13th	Inductance Inductance often appears as a representative element in electrical circuits. Learn about self-inductance and mutual inductance from the perspective of magnetic field energy, and explain the wave propagation speed of the reciprocating line as a calculation example.	Inductance often appears as a representative element in electrical circuits. Learn about self-inductance and mutual inductance from the perspective of magnetic field energy, and can calculate the wave propagation speed of the reciprocating line using calculation examples.
		14th	Maxwell's electromagnetic equations Explain Maxwell's electromagnetic equations in detail, which have critical meaning for those who learn electrical and electronic engineering as well as physics. In addition to deriving equations, do reverse derivations for the basic laws of electric field magnetic fields that have been studied.	Can explain Maxwell's electromagnetic equations in detail, which have critical meaning for those who learn electrical and electronic engineering as well as physics. In addition to deriving equations, can do reverse derivations for the basic laws of electric field magnetic fields that have been studied.
		15th	Solutions for Maxwell's electromagnetic equations and electromagnetic waves Solve Maxwell's electromagnetic equations as simultaneous differential equations and calculate electromagnetic waves' presence and velocity as a result of doing this. Also explain the basic characteristics of electromagnetic waves.	Can solve Maxwell's electromagnetic equations as simultaneous differential equations and calculate electromagnetic waves' presence and velocity as a result of doing this. Can also explain the basic characteristics of electromagnetic waves.

		16th	Final exam	

Evaluation Method and Weight (%)

	Examination	Presentation	Mutual Evaluations between students	Behavior	Portfolio	Other	Total
Subtotal	100	0	0	0	0	0	100
Basic Proficiency	0	0	0	0	0	0	0
Specialized Proficiency	100	0	0	0	0	0	100
Cross Area Proficiency	0	0	0	0	0	0	0