MSc. program, Biomedical Engineering Department

Course Unit Title	Advanced Electromagnetics and Its Biomedical Applications
Course Unit Code	BME570
Type of Course Unit	Elective
Level of Course Unit	MSc/PhD. program
National Credits	3
Number of ECTS Credits Allocated	10
Theoretical (hour/week)	4
Practice (hour/week)	-
Laboratory (hour/week)	-
Year of Study	
Semester when the course unit is delivered	
Course Coordinator	Assist.Prof. Dr. Refet Ramiz
Name of Lecturer (s)	Assist.Prof. Dr. Refet Ramiz
Name of Assistant (s)	-
Mode of Delivery	Face to Face,
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	Mathematic skills

Course description:

Coulomb's Law, Electric Field Intensity, Electric Potential, The Field Outside an Electrically Charged Body, Gauss Law, Poisson's Equation, Laplace's Equation, Conductors, Calculation of the Electric Field Produced by A Simple Cahrge Distribution, Electric Dipole, The Linear Electric Quadrupole, Electric Field Outside An Arbitrary Charge Distribution, Ptential Energy of A Charge Distribution, Energy Density in an Electric Field, Forces on Conductors, Dielectric Materials, Electric Polarization, Electric Field at an Exterior Point, The Bound Charge Densities, Elrectric Field at an Interior Point, The Electric Susceptibility, Divergence of E and the Dielectric Displacement D, Relative Permittivity, Calculation of Electric Fields Involving Dielectrics, Frequency Dependence, Anisotropy and Nonhomogeneity, Potential Energy of a Charge Distribution in the Presence of Dielectrics, General Methods for Solving Laplac's and Poisson's Equations, Continuity of V, D,E, at the Interface Between Two Dielectric Media, Normal Component of the Electric Displacement, Tangential Component of the Electric Field Intensity, Bending of Lines of Force, The Uniqueness Theorem, Images, Point Charge Near an Infinite Grounded Conducting Plane, Solution of Laplace's Equation in Rectangular Coordinates, Solution of Laplace's Equation in Spherical Coordinates, Solution of Poisson's Equation for E, Magnetic Forces, The Magnetic Induction B, The Biot Savart Law, The Force on a Point Charge Moving in a Magnetic Field, The Divergence of the Magnetic Induction B, The Vector Potential A, The Line Integral of the A over a Closed Curve, The Curl of B, Ampere's Circuital Law, Magnetic Dipole, Faraday Induction Law, Faraday Induction Law in Differential Form, Induced Electric Field Intensity in Terms of the Vector Potential A, Energy Stored in a Magnetic Field, Magnetic Energy in terms of B, Magnetic Energy in terms of J and A, Magnetic Energy in terms of I and Φ, Magnetic Field Intenisty H, Ampere's Circuit Law, The Equivalent Current Density and J, Boundary Conditions, Maxwell Equations, Maxwell Equations in Integral Form, Nonhomogeneous Wave Equations for E and B, Plane Electromagnetic Waves in Free Space, Poynting Vector, The E, H Vectors in Homogeneous, Isotropic, Linear and Stationary Media, Propagation of Plane Electromagnetic Waves in Nonconductors, Propagation of Plane Electromagnetic Waves in Conducting Media, Propagation of Plane Electromagnetic Waves in Good Conductor Media, Reflection and Refraction, The Laws of Reflection and Snell's Law of Refraction, Fresnel's Equations, Refelction and Refraction at the Interface Between Two Nonmagnetic Nonconductors, Guided Waves, Radiation of the Electromagnetic Waves, The Vector Potential A and H, The Electric Field Intensity E, Radiation From a Half-Wave Antenna

Objectives of the Course:

- To provide a student with the necessary tools for the critical evaluation of existing and future electromagnetic and its application in biomedical phenomena
- To teach the concepts and principles of constructions of electromagnetics
- To enable a student to evaluate and choose an electromagnetic tools to match the problem

Learning Outcomes

	At the end of the course the student should be able to	Assessment
1	Use of evaluation criteria for an assessment of electromagnetic applications	1, 2
2	Demonstrate and reconstruct a specific electromagnetic problems	1, 2
3	Apply electromagnetic principles for verification of the problems	1, 2
4	Analyze variables of electromagnetic problems	1, 2
5	Examine different concepts implemented in electromagnetic problems	1, 2
6	Compare electromagnetic and biomedical problems	1, 2

Assessment Methods: 1. Written Exam, 2. Assignment, 3. Project/Report, 4. Presentation, 5. Lab. Work

Course's Contribution to Program

		CL
1	Apply the rules of scientific research and ethics	5
2	Discuss complex biomedical engineering issues as well as own research results comprehensively and in the context of current international research and present these in writing and orally	4
3	Solve problems by systems analytical thinking both in subject specific and interdisciplinary concepts	4
4	Combine specialized knowledge of various component disciplines	4
5	Carry out in dependent scientific work and organize (capacity of teamwork), Conduct and lead more complex projects	4
6	To assess the social and environment-related effects of their actions	4

CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)

Course Contents

Week	Chapter	Topics	Exam
1		Coulomb's Law, Electric Field Intensity	

		Electric Potential The Field Outside an Electrically Charged Body Gauss Law Poisson’s Equation	
2		Laplace’s Equation Conductors Calculation of the Electric Field Produced by A Simple Charge Distribution Electric Dipole The Linear Electric Quadruple Electric Field Outside An Arbitrary Charge Distribution	
3		Potential Energy of A Charge Distribution Energy Density in an Electric Field Forces on Conductors Dielectric Materials Electric Polarization Electric Field at an Exterior Point	
4		The Bound Charge Densities Electric Field at an Interior Point The Electric Susceptibility Divergence of E and the Dielectric Displacement D Relative Permittivity Calculation of Electric Fields Involving Dielectrics	
5		Frequency Dependence, Anisotropy and Nonhomogeneity Potential Energy of a Charge Distribution in the Presence of Dielectrics General Methods for Solving Laplace’s and Poisson’s Equations Continuity of V, D,E, at the Interface Between Two Dielectric Media Normal Component of the Electric Displacement Tangential Component of the Electric Field Intensity	
6		Bending of Lines of Force The Uniqueness Theorem Images Point Charge Near an Infinite Grounded Conducting Plane Solution of Laplace’s Equation in Rectangular Coordinates Solution of Laplace’s Equation in Spherical Coordinates	
7			Midterm
8		Solution of Poisson’s Equation for E Magnetic Forces The Magnetic Induction B, The Biot Savant Law The Force on a Point Charge Moving in a Magnetic Field The Divergence of the Magnetic Induction B The Vector Potential A	
9		The Line Integral of the A over a Closed Curve The Curl of B Ampere’s Circuital Law Magnetic Dipole	

		Faraday Induction Law Faraday Induction Law in Differential Form	
10		Induced Electric Field Intensity in Terms of the Vector Potential A Energy Stored in a Magnetic Field Magnetic Energy in terms of B Magnetic Energy in terms of J and A Magnetic Energy in terms of I and Φ Magnetic Field Intensity H, Ampere's Circuit Law	
11		The Equivalent Current Density and J Boundary Conditions Maxwell Equations Maxwell Equations in Integral Form Nonhomogeneous Wave Equations for E and B Plane Electromagnetic Waves in Free Space	
12		Pointing Vector The E, H Vectors in Homogeneous, Isotropic, Linear and Stationary Media Propagation of Plane Electromagnetic Waves in Nonconductors Propagation of Plane Electromagnetic Waves in Conducting Media Propagation of Plane Electromagnetic Waves in Good Conductor Media Reflection and Refraction	
13		The Laws of Reflection and Snell's Law of Refraction Fresnel's Equations Reflection and Refraction at the Interface Between Two Nonmagnetic Nonconductors Guided Waves	
14		Radiation of the Electromagnetic Waves The Vector Potential A and H The Electric Field Intensity E Radiation From a Half-Wave Antenna	
15			Final

Recommended Sources
Research papers
Textbook:
Supplementary Course Material

- Edward C. Jordan, Keith G. Balmain, ELECTROMAGNETIC WAVE AND RADIATING SYSTEMS.
- John D. Kraus, Electromagnetics, Fourth Edition.
- Paul Lorrain and Dale Corson, Electromagnetic Fields and Waves, Second Edition.

Assessment

Attendance	10 %	
Assignment	%	

Midterm Exam	40 %	Written Exam
Final Exam	50 %	Written Exam
Total	100 %	

Assessment Criteria

Final grades are determined according to the Near East University Academic Regulations for Undergraduate Studies

Course Policies

1. Attendance to the course is mandatory.
2. Late assignments will not be accepted unless an agreement is reached with the lecturer.
3. Students may use calculators during the exam.
4. Cheating and plagiarism will not be tolerated. Cheating will be penalized according to the Near East University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload(hour)
Course duration in class (including Exam weeks)	15	4	60
Labs and Tutorials	10	10	100
Assignment	-	-	-
Project/Presentation/Report	3	10	30
E-learning activities	-	-	-
Quizzes	-	-	-
Midterm Examination	1	6	6
Final Examination	1	12	12
Self Study	15	7	105
Total Workload			313
Total Workload/30(h)			10.4
ECTS Credit of the Course			10