University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of Electromagnetic Field

Course Code (BE213)

I. Course Identification and General Information:

1	**Course Title:**	Electromagnetic Field				
2	**Course Code & Number:**	BE213				
b	**Credit hours:**	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	--	--	2	3
4	**Study level/ semester at which this course is offered:**	Third Level / First Semester				
5	**Pre –requisite (if any):**	Engineering Physics (FR002)				
6	**Co –requisite (if any):**	None				
7	**Program (s) in which the course is offered:**	Biomedical Engineering Program				
8	**Language of teaching the course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Assoc. Prof. Dr. Radwan AL Bouthigy				
11	**Reviewed by:**	Dr. ----				
12	**Date of Approval:**					

II. Course Description:

This course provides students with fundamental theories of Electrostatics, Magneto statics, and electromagnetic waves. The Course topics include: mathematical background, electrostatics magneto statics, time-varying electromagnetic fields. The Students will acquire respectable knowledge of electrostatic and magneto static fields which in future help them to recognize the accurate applications of the course subjects in the various of biomedical engineering aspects involving

electromagnetic fields such as: Magnetic separators. Development of electric generators and motors, transformers, electromagnetic pump and so on. Material will be introduced through textbook readings, then expanded upon in active lectures and tutorials. Student are encouraged to use MATLAB simulation package in solving problems and applications encounter throughout the course delivery.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		**Referenced PILOs** (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Define of the theoretical and mathematical aspects of electric field, magnetic fields, and electromagnetic wave analysis.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Recognize the static and time-varying electromagnetic fields as governed by Maxwell's equations	A3 Recognize and explain the need for a high level of management, professional and ethical behavior, responsibility, quality assurance systems, codes of practice, standards, health and safety requirements, and environmental impacts in biomedical systems.
B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Apply engineering principles of electric and magnetic quantities and their role in electrical equipment design	B1 Apply engineering principles; basic of life-science; mathematical theories; and modern tools professionally in modelling, analyzing, designing, and constructing physical digital systems; devices and/or processes relevant to

		Biomedical Engineering fields.
b2	Identify the behavior of the electric and magnetic s fields and their application in different aspects of biomedical engineering	B2 Identify, formulate and solve the complex problems related to the Biomedical Engineering fields in a creative and innovative manner by using a systematic and analytical thinking methods.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Apply the concepts of the electromagnetic field in studying and analyzing biomedical devices performance.	C1 Apply integrally knowledge of mathematics, life science, IT, design, business context and engineering practice to solve problems and to design systems/processes relevant to Biomedical Engineering.
c2	Use Simulink MATLAB tool to solve of the problems involving electromagnetic force, torque, and energy.	C2 Use a wide range of analytical tools, techniques, IT, modern engineering tools, software packages and develop required computer programs to solve, modeling and analyzing Biomedical Engineering problems
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
d1	Interact effectively with peers in the group.	D1 Lead and motivate individuals, show capability to work in stressful environments and within constraints, collaborate effectively within multidisciplinary team.
d2	Communicate effectively to	D5 Demonstrate efficient IT capabilities and

	professionals and non-specialists alike through reports and presentations.	communicate effectively both orally and in writing technical reports.

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Define of the theoretical and mathematical aspects of electric field, magnetic fields, and electromagnetic wave analysis.	• Interactive lectures & examples, • Tutorials, • Interactive class discussions, • Exercises and home works.	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments.
a2. Recognize the depth of static and time-varying electromagnetic fields as governed by Maxwell's equations	• Interactive lectures & examples, • Tutorials, • Exercises and home works, • Problem based learning.	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Apply engineering principles of electric and magnetic quantities and their role in	• Interactive lectures & examples, • Tutorials,	• Written tests (mid and final terms and quizzes),

electrical equipment design	• Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Exercises and home works.	• Coursework activities assessment, • Home works and assignments,
b2. Identify the behavior of the electric and magnetic s fields and their application in different aspects of biomedical engineering	• Interactive lectures & examples, • Tutorials, • Interactive class discussions, • Case studies, • Exercises and home works, • Directed self- study.	• Written tests (mid and final terms and quizzes), • performance assessment, • Coursework activities assessment, • Home works and assignments.

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Apply the concepts of the electromagnetic field in studying and analyzing biomedical devices performance.	• Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Computer laboratory-based sessions, • Workshops practices, • Team work (cooperative learning).	• Essay and report writing assessment, • Coursework activities assessment, • Project work assessment, • Project reports (individual and group) assessment.

c2. Use Simulink MATLAB tool to solve of the problems involving electromagnetic force, torque, and energy.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Exercises and home works, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study.	• Coursework activities assessment, • Project work assessment, • Project reports (individual and group) assessment, • Presentations.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1.Interact effectively with peers in the group.	• Presentation/seminar, • Case studies, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Mini/major project.	• Oral exams, • Short reports, • Lab\Project report • Practical lab performance assessment, • Presentations.
d2. Communicate effectively to professionals and non-specialists alike through reports and presentations.	• Videos demonstrations, • Presentation/seminar, • Case studies, • Computer laboratory-based sessions,	• Oral exams, • Coursework activities assessment, • Presentations.

	• Workshops practices, • Directed self- study, • Team work (cooperative learning), • Mini/major project.	

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	**Vector analysis**	**a1,a2**	– Overview of the course – Concept of Scalar and Vector Quantities, – vector notation – Scalar and Vector Fields – Vector components and unit vectors – Vector Algebra, – Dot product, Cross product.	1	2
2	**Orthogonal Coordinate Systems**	**a1,a2,b1,c1**	– Rectangular (Cartesian,) Coordinate System, – Circular Cylindrical Coordinates system, – Spherical Coordinate System	1	2

			– Relationship between Different Coordinate Systems – Transformation of vectors		
3	**Coulomb's Law and Electric Field Intensity (E)**	**b1,b2,c1**	– The Experimental Law of Coulomb – Electric Field Intensity – Charge distributions: point charge, volume charge, Line charge, and Sheet charge Distribution – Field Arising from a Continuous Volume Charge Distribution, – Field of a Line Charge – Field of a Sheet of Charge – Streamlines and Sketches of Fields	1	2
4	**Electric Flux Density, Gauss's Law, and Divergence**	**a2,b1,b2,c1**	– Electric Flux Density, – Gauss Law – Applications of Gauss Law: – Symmetrical Charge Distributions, Differential Volume Element – Divergence and Maxwell's First Equation – The Vector Operator ∇ and the Divergence Theorem	2	4

5	**Potential and Energy**	**b2,c1,c2**	– Energy Expended in Moving a Point Charge in an Electric Field – The Line Integral – Potential and Potential Difference – The Potential Field of a Point Charge – The Potential Field of a System of Charges: – Conservative Property – Potential Gradient – The Electric Dipole – Energy Density in the Electrostatic Field	**1**	**2**
6	**Conductors and Dielectrics**	**a1,a2,b1,b2**	– Current and Current Density – Continuity of Current – Metallic Conductors – Conductor Properties and Boundary Conditions – The Method of Images – Semiconductors – The Nature of Dielectric Materials – Boundary Conditions for Perfect Dielectric Materials	1	2
7	**Midterm Theoretical Exam**	**a1,a2,b1,b2**	– All Topics	**1**	**2**
8	**Capacitance**	**a2,b1,b2**	– Capacitance of: Parallel-Plate Capacitor, coaxial cable, spherical capacitor, and	1	2

			– Capacitance of a Two-Wire Line – Poisson's and Laplace's Equations		
9	**The Steady Magnetic Field**	**a1,a2,b1,b2, c2**	– Biot-Savart Law – Amp`ere's Circuital Law – Curl – Stokes' Theorem – Magnetic Flux and Magnetic Flux Density – The Scalar and Vector Magnetic Potentials	2	4
10	**Magnetic Forces, Materials, and Inductance**	**a2,b1,b2,c1**	– Force on a Moving Charge – Force on a Differential Current Element – Force between Differential Current Elements – Force and Torque on a Closed Circuit – The Nature of Magnetic Materials – Magnetization and Permeability – Magnetic Boundary Conditions – The Magnetic Circuit – Potential Energy and Forces on Magnetic Materials – Inductance and Mutual	**2**	4

			Inductance		
11	**Time-Varying Fields and Maxwell's Equations**	**b1,b2,c1,c2**	– Faraday's Law – Displacement Current – Maxwell's Equations in Point Form – Maxwell's Equations in Integral Form	1	2
12	**Plane Electromagnetic Waves.**	**a2,b1,b2,c1,c2**	– Wave Propagation in Free Space – Wave Propagation in Dielectrics – Poynting's Theorem and Wave Power – Propagation in Good Conductors: – Skin Effect – Wave Polarization	1	2
13	**Final Theoretical Exam**	**a1,a2,b1,b2**	– All Topics	**1**	**2**
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect: (if any)

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	None			
Number of Weeks /and Units Per Semester				

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	**Vectors Analysis** – **Concept of Scalar and Vector Quantities,**	1	2	a1

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
	– vector notation – Scalar and Vector Fields – Vector components and unit vectors – Vector Algebra, – Dot product, Cross product.			
2	**Orthogonal coordinate systems** – Rectangular (Cartesian,) Coordinate System, – Circular Cylindrical Coordinates system, – Spherical Coordinate System – Relationship between Different Coordinate Systems – Transformation of vectors	1	2	a1
3	**Coulomb's Law and Electric Field Intensity (E)** – The Experimental Law of Coulomb – Electric Field Intensity – Charge distributions: point charge, volume charge, Line charge, and Sheet charge Distribution – Field Arising from a Continuous Volume Charge Distribution, – Field of a Line Charge – Field of a Sheet of Charge – Streamlines and Sketches of Fields	1	2	a1, b2, c2
4	**Electric Flux Density, Gauss's Law, and Divergence** – Electric Flux Density, – Gauss Law – Applications of Gauss Law: – Symmetrical Charge Distributions, Differential Volume Element – Divergence and Maxwell's First Equation – The Vector Operator ∇ and the Divergence Theorem	1	2	a1, a2, b2

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
5	**Potential and Energy** – Energy Expended in Moving a Point Charge in an Electric Field – The Line Integral – Potential and Potential Difference – The Potential Field of a Point Charge – The Potential Field of a System of Charges: – Conservative Property – Potential Gradient – The Electric Dipole – Energy Density in the Electrostatic Field	2	4	a1, b2, c2
6	**Conductors and Dielectrics** – Current and Current Density – Continuity of Current – Metallic Conductors – Conductor Properties and Boundary Conditions – The Method of Images – Semiconductors – The Nature of Dielectric Materials – Boundary Conditions for Perfect Dielectric Materials	2	4	a1, b2, c2
7	**Capacitance** – Capacitance of: Parallel-Plate Capacitor, coaxial cable, spherical capacitor, and Capacitance of a Two-Wire Line – Poisson's and Laplace's Equations	1	2	a1, b1, b2, c2
8	**The Steady Magnetic Field** – Biot-Savart Law – Amp`ere's Circuital Law – Curl – Stokes' Theorem – Magnetic Flux and Magnetic Flux Density – The Scalar and Vector Magnetic Potentials	1	2	a1, b1, b2, c2

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
9	**Magnetic Forces, Materials, and Inductance** – Force on a Moving Charge – Force on a Differential Current Element – Force between Differential Current Elements – Force and Torque on a Closed Circuit – The Nature of Magnetic Materials – Magnetization and Permeability – Magnetic Boundary Conditions – The Magnetic Circuit – Potential Energy and Forces on Magnetic Materials – Inductance and Mutual Inductance	1	2	a1, b1, b2, c2
10	**Time-Varying Fields and Maxwell's Equations** – Faraday's Law – Displacement Current – Maxwell's Equations in Point Form – Maxwell's Equations in Integral Form	2	4	a1, a2, b1
11	**Plane Electromagnetic Waves..** – Wave Propagation in Free Space – Wave Propagation in Dielectrics – Poynting's Theorem and Wave Power – Propagation in Good Conductors: – Skin Effect – Wave Polarization	2	4	a1, a2, b1, b2,c2
Number of Weeks /and Units Per Semester		**15**	**30**	

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Tutorials,
- Interactive class discussions,
- Case study
- Exercises and home works,
- Computer laboratory-based sessions,
- Team work (cooperative learning).
- Directed self- study,
- Individual design projects,
- Individual design project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Home works and assignments,
- Coursework activities assessment,
- Design and problem solving exercises,
- Computer Lab performance assessment,
- Project work assessment,
- Project reports (individual and group) assessment,
- Oral and visual presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignments1: Orthogonal coordinate systems, and coordinate transformations	a1,a2	3	6
2	Assignments2: Electric Flux Density, Gauss's Law, and Divergence	a2,b1,c1,d1	5	6
3	Assignments3: Conductors and Dielectrics	b1,b2,c2	9	6
4	Assignments4: Magnetic Forces, Materials, Magnetic Circuit, and Inductance	a1,a2,b1,b2	12	6
5	Assignments5: Time-Varying Fields and Maxwell's Equations	a1,a2,b1,b2,d2	13	6
Total				30

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	**Assignments**	3,5, 9,12,13	30	20%	a1,a2,b1,b2,c1,c2,d1,d2
2	**Quizzes 1 & 2**	6, 12	20	13%	a1,a2,b1,b2
3	**Mid-Term Theoretical Exam**	8	30	20%	a1,a2,b1,b2
4	**Final Theoretical Exam**	16	70	47%	a1,a2,b1,b2
Total			150	100%	

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

Example

1- Niku, Saeed B., 2011, **Introduction to Robotics: Analysis, Control, Applications**, 2nd Edition, USA, Wiley.

1- Required Textbook(s) (maximum two).

1. W.H. Hayt and J A Buck, 2019, Engineering Electromagnetics, Tata McGraw Hill Publications, 9th Edition,
2. M. N. O. Sadiku, 2010, Elements of Electromagnetics, 5th Ed., Oxford University Press.

2- Essential References.

1. F. T. Ulaby and U. Ravaioli, 2015, Fundamentals of Applied Electromagnetics, 7th Ed., Pearso.
2. Sunil Bhooshan,2012, 'Fundamentals of Engineering Electromagnetics', Oxford University press.

3- Electronic Materials and Web Sites *etc*.

Websites:

	1- Simulink of MATLAB www.mathworks.com

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating:** For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student.

	If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Template for Course Plan (Syllabus)

Electromagnetic Field- BE213

I. Course Identification and General Information:					
1	**Course Title:**	Electromagnetic Field			
2	**Course Code & Number:**	BE213			
3	**Credit Hours:**	**Credit Hours**	**Theory Hours**		**Lab. Hours**
			Lecture	**Exercise**	
		3	2	2	--
4	**Study Level/ Semester at which this Course is offered:**	Third Level / First Semester			
5	**Pre –Requisite (if any):**	Engineering Physics (FR002)			
6	**Co –Requisite (if any):**	None			
7	**Program (s) in which the Course is Offered:**	Bachelor of Biomedical Engineering			
8	**Language of Teaching the Course:**	English			
9	**Location of Teaching the Course:**	Faculty of Engineering			
10	**Prepared by:**	Assoc. Prof. Dr. Radwan AL Bouthigy			
11	**Reviewed by:**	Dr. ----			
12	**Date of Approval:**				

II. Course Description:

This course provides students with fundamental theories of Electrostatics, Magneto statics, and electromagnetic waves. The Course topics include: mathematical background, electrostatics magneto statics, time-varying electromagnetic fields The Students will acquire respectable knowledge of

electrostatic and magneto static fields which in future help them to recognize the accurate applications of the course subjects in the various of biomedical engineering aspects involving electromagnetic fields such as: Magnetic separators. Development of electric generators and motors, transformers, electromagnetic pump and so on. Material will be introduced through textbook readings, then expanded upon in active lectures and tutorials. Student are encouraged to use MATLAB simulation package in solving problems and applications encounter throughout the course delivery.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Define of the theoretical and mathematical aspects of electric field, magnetic fields, and electromagnetic wave analysis.
a2	Recognize the depth of static and time-varying electromagnetic fields as governed by Maxwell's equations
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Apply engineering principles of electric and magnetic quantities and their role in electrical equipment design
b2	Identify the behavior of the electric and magnetic s fields and their application in different aspects of biomedical engineering
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Apply the concepts of the electromagnetic field in studying and analyzing biomedical devices performance.
c2	Use Simulink MATLAB tool to solve of the problems involving electromagnetic force, torque, and energy.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
d1	Interact effectively with peers in the group.
d2	Communicate effectively to professionals and non-specialists alike through reports and presentations.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Vector analysis**	– Overview of the course – Concept of Scalar and Vector Quantities, – vector notation – Scalar and Vector Fields – Vector components and unit vectors – Vector Algebra, – Dot product, Cross product.	1	2
2	**Orthogonal Coordinate Systems**	– Rectangular (Cartesian,) Coordinate System, – Circular Cylindrical Coordinates system, – Spherical Coordinate System – Relationship between Different Coordinate Systems – Transformation of vectors	1	2
3	**Coulomb's Law and Electric Field Intensity (E)**	– The Experimental Law of Coulomb – Electric Field Intensity – Charge distributions: point charge, volume charge, Line charge, and Sheet charge	1	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		Distribution – Field Arising from a Continuous Volume Charge Distribution, – Field of a Line Charge – Field of a Sheet of Charge – Streamlines and Sketches of Fields		
4	**Electric Flux Density, Gauss's Law, and Divergence**	– Electric Flux Density, – Gauss Law – Applications of Gauss Law: – Symmetrical Charge Distributions, Differential Volume Element – Divergence and Maxwell's First Equation – The Vector Operator ∇ and the Divergence Theorem	2	4
5	**Potential and Energy**	– Energy Expended in Moving a Point Charge in an Electric Field – The Line Integral – Potential and Potential Difference – The Potential Field of a Point Charge – The Potential Field of a System of Charges: – Conservative Property – Potential Gradient – The Electric Dipole – Energy Density in the	**1**	**2**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		Electrostatic Field		
6	**Conductors and Dielectrics**	– Current and Current Density – Continuity of Current – Metallic Conductors – Conductor Properties and Boundary Conditions – The Method of Images – Semiconductors – The Nature of Dielectric Materials – Boundary Conditions for Perfect Dielectric Materials	1	2
7	**Midterm Theoretical Exam**	– All Topics	**1**	**2**
8	**Capacitance**	– Capacitance of: Parallel-Plate Capacitor, coaxial cable, spherical capacitor, and Capacitance of a Two-Wire Line – Poisson's and Laplace's Equations	1	2
9	**The Steady Magnetic Field**	– Biot-Savart Law – Amp`ere's Circuital Law – Curl – Stokes' Theorem – Magnetic Flux and Magnetic Flux Density – The Scalar and Vector Magnetic Potentials	2	4
10	**Magnetic Forces, Materials, and Inductance**	– Force on a Moving Charge – Force on a Differential Current Element	**2**	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		– Force between Differential Current Elements – Force and Torque on a Closed Circuit – The Nature of Magnetic Materials – Magnetization and Permeability – Magnetic Boundary Conditions – The Magnetic Circuit – Potential Energy and Forces on Magnetic Materials – Inductance and Mutual Inductance		
11	**Time-Varying Fields and Maxwell's Equations**	– Faraday's Law – Displacement Current – Maxwell's Equations in Point Form – Maxwell's Equations in Integral Form	1	2
12	**Plane Electromagnetic Waves.**	– Wave Propagation in Free Space – Wave Propagation in Dielectrics – Poynting's Theorem and Wave Power – Propagation in Good Conductors: – Skin Effect – Wave Polarization	1	2
13	**Final Theoretical Exam**	– All Topics	**1**	**2**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
Number of Weeks /and Units Per Semester			16	32

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	None		
Number of Weeks /and Units Per Semester			

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours
1	**Vectors Analysis** – Concept of Scalar and Vector Quantities, – vector notation – Scalar and Vector Fields – Vector components and unit vectors – Vector Algebra, – Dot product, Cross product.	1	2
2	**Orthogonal coordinate systems** – Rectangular (Cartesian,) Coordinate System, – Circular Cylindrical Coordinates system, – Spherical Coordinate System – Relationship between Different Coordinate Systems – Transformation of vectors	1	2
3	**Coulomb's Law and Electric Field Intensity (E)** – The Experimental Law of Coulomb – Electric Field Intensity	1	2

C. Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
	– **Charge distributions: point charge, volume charge, Line charge, and Sheet charge Distribution** – **Field Arising from a Continuous Volume Charge Distribution,** – **Field of a Line Charge** – **Field of a Sheet of Charge** – **Streamlines and Sketches of Fields**		
4	**Electric Flux Density, Gauss's Law, and Divergence** – **Electric Flux Density,** – **Gauss Law** – **Applications of Gauss Law:** – **Symmetrical Charge Distributions, Differential Volume Element** – **Divergence and Maxwell's First Equation** – **The Vector Operator ∇ and the Divergence Theorem**	1	2
5	**Potential and Energy** – **Energy Expended in Moving a Point Charge in an Electric Field** – **The Line Integral** – **Potential and Potential Difference** – **The Potential Field of a Point Charge** – **The Potential Field of a System of Charges:** – **Conservative Property** – **Potential Gradient** – **The Electric Dipole** – **Energy Density in the Electrostatic Field**	2	4
6	**Conductors and Dielectrics** – **Current and Current Density** – **Continuity of Current** – **Metallic Conductors** – **Conductor Properties and Boundary Conditions**	2	4

C. Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
	– **The Method of Images** – **Semiconductors** – **The Nature of Dielectric Materials** – **Boundary Conditions for Perfect Dielectric Materials**		
7	**Capacitance** – **Capacitance of: Parallel-Plate Capacitor, coaxial cable, spherical capacitor, and Capacitance of a Two-Wire Line** – **Poisson's and Laplace's Equations**	1	2
8	**The Steady Magnetic Field** – **Biot-Savart Law** – **Amp`ere's Circuital Law** – **Curl** – **Stokes' Theorem** – **Magnetic Flux and Magnetic Flux Density** – **The Scalar and Vector Magnetic Potentials**	1	2
9	**Magnetic Forces, Materials, and Inductance** – **Force on a Moving Charge** – **Force on a Differential Current Element** – **Force between Differential Current Elements** – **Force and Torque on a Closed Circuit** – **The Nature of Magnetic Materials** – **Magnetization and Permeability** – **Magnetic Boundary Conditions** – **The Magnetic Circuit** – **Potential Energy and Forces on Magnetic Materials** – **Inductance and Mutual Inductance**	1	2
10	**Time-Varying Fields and Maxwell's Equations** – **Faraday's Law** – **Displacement Current** – **Maxwell's Equations in Point Form**	2	4

C. Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
	– **Maxwell's Equations in Integral Form**		
11	**Plane Electromagnetic Waves..** – **Wave Propagation in Free Space** – **Wave Propagation in Dielectrics** – **Poynting's Theorem and Wave Power** – **Propagation in Good Conductors:** – **Skin Effect** – **Wave Polarization**	2	4
Number of Weeks /and Units Per Semester		**15**	**30**

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Tutorials,
- Interactive class discussions,
- Case study
- Exercises and home works,
- Computer laboratory-based sessions,
- Team work (cooperative learning).
- Directed self- study,
- Individual design projects,
- Individual design project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Home works and assignments,
- Coursework activities assessment,

VI. Assessment Methods of the Course:

- Design and problem solving exercises,
- Computer Lab performance assessment,
- Project work assessment,
- Project reports (individual and group) assessment,
- Oral and visual presentations.

VII. Assignments:

No.	Assignments	Week Due	Mark
1	Assignments1: Orthogonal coordinate systems, and coordinate transformations	3	6
2	Assignments2: Electric Flux Density, Gauss's Law, and Divergence	5	6
3	Assignments3: Conductors and Dielectrics	9	6
4	Assignments4: Magnetic Forces, Materials, Magnetic Circuit, and Inductance	12	6
5	Assignments5: Time-Varying Fields and Maxwell's Equations	13	6
Total			**30**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Assignments**	3,5, 9,12,13	30	20%

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
2	**Quizzes 1 & 2**	6, 12	20	13%
3	**Mid-Term Theoretical Exam**	8	30	20%
4	**Final Theoretical Exam**	16	70	47%
Total			**150**	**100%**

IX. Learning Resources:

- *Written in the following order:*

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher)*

Example

1- Niku, Saeed B., 2011, **Introduction to Robotics: Analysis, Control, Applications**, 2nd Edition, USA, Wiley.

1- Required Textbook(s) (maximum two):

1- W.H. Hayt and J A Buck, 2019, Engineering Electromagnetics, Tata McGraw Hill Publications, 9th Edition,

2- M. N. O. Sadiku, 2010, Elements of Electromagnetics, 5th Ed., Oxford University Press.

2- Essential References:

1- F. T. Ulaby and U. Ravaioli, 2015, Fundamentals of Applied Electromagnetics, 7th Ed., Pearso.

2- Sunil Bhooshan,2012, 'Fundamentals of Engineering Electromagnetics', Oxford University press.

3- Electronic Materials and Web Sites etc.:

Websites:

IX. Learning Resources:

1- Simulink of MATLAB

www.mathworks.com

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating:** For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism:**

	Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.